Department of Management Studies,
Indian Institute of Science,
Bangalore

Driving the Economy through Innovation and Entrepreneurship

Emerging Agenda for Technology Management

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Preface

Technological advancement, contributing as the key driving force to the development and prosperity of advanced countries, is a part of history. In the 1980s and 1990s, technology development contributed to the rapid advancement and transformation of newly industrializing economies (NIEs). In the New Millennium, BRICS (Brazil, Russia, India, China, and South Africa) economies have been experiencing relatively high rate of economic growth, thereby influencing and shaping global economic growth, particularly by the means of industrialization through knowledge intensive industries and entrepreneurship. This shift of focus from industrialized to NIEs and further to BRICS economies has been pushing technology development and management to the forefront repeatedly as an agenda for global economic thinking. The way BRICS economies in association with NIEs and industrialized countries contribute to the emergence of new technologies, in addition to the innovation and management of existing technologies, would determine and contribute to the emergence of a new global economy, in the future. It is in this backdrop that the Department of Management Studies, Indian Institute of Science, Bangalore, which is one of the oldest management schools in the country, decided to organize an International Conference on Technology Management between18 and 20 July 2012.

Considering that economic growth in the BRICS and other developing economies in the new century is driven not solely by traditional factor inputs, but more importantly by technology-driven innovation and new generation of entrepreneurship, we have accordingly identified the theme of the International Conference: *Driving the Economy Through Innovation and Entrepreneurship: Emerging Agenda for Technology Management*. We invited theoretical as well as empirical research papers including industry case studies relating to the theme from across the world. We received impressive response in the form of more than 240 paper abstracts from 23 different countries by 31 October 2011. We short-listed 167 paper abstracts and communicated to the authors accordingly, requesting them to submit full papers by 31 January 2012. Overall, we got 128 full papers, and based on a double-blind review process, we short-listed a total of 74 papers (comprising 145 authors across 20 countries) for the final presentation.

This volume comprising three parts is a compendium of 72 papers presented in the International Conference on Technology Management conducted during 18–20 July 2012 at the Indian Institute of Science, Bangalore. The three parts of the volume cover papers under three different streams, namely, (1) Technology Development, Sustainability and Markets; (2) Development of Human Resources for Innovation and Technology Management; and (3) ICT Applications, E-Governance and New Product Development. Under each stream, papers focusing on diverse sectors such as agriculture, industry and services as well as regions ranging from emerging markets like India to Latin America are presented. Further, these papers varied in terms of their methodologies ranging from model building and testing to the development of theoretical propositions and empirical data analysis, apart from case studies. Overall, these papers provide a description and analysis of contemporary technology management issues covering diverse economies in the world.

The organizers of the conference are greatly indebted to all the authors (from academia, R&D institutes and laboratories, government organizations and industry) who have come from different parts of the world, presented their papers and contributed to their intensive and fruitful discussions. We express our sincere gratitude to all the referees who had reviewed the paper in every stage, starting from short-listing of the abstracts, to the final form as it appears in this book. We are thankful to all the session chairs who conducted the proceedings meaningfully and impressively. We are equally grateful to all of our sponsors, particularly the Government of Karnataka, Defense Research and Development Organization (DRDO), Government of India, Bharath Electronics Limited (BEL), Bharath Earth Movers Limited (BEML) and Karnataka Knowledge Commission (KKC), Bangalore, in addition to our institute authorities without whose support this event could not have been organized in this grand manner. Finally, we strongly believe that this volume will contribute significantly to the understanding of emerging issues in technology management, in the era of globalization, and facilitate further research in industry as well as academia.

Editors

About Us

The Indian Institute of Science (IISc), Bangalore, founded by Jamsetji Nusserwanji Tata, came into existence on 27 May 1909. Over the period, IISc has emerged as an institution of higher learning pursuing excellence in research and education in diverse fields of science and engineering. It is probably the oldest and the finest institution of its kind in India; it also has a very high international rating in the academic world. IISc provides facilities for post-graduate research and advanced instruction in traditional as well as in many important emerging areas of science and engineering and collaborates with industry and other research institutions in solving challenging problems in science and technology. Today, IISc faculty members carry out research and consultancy projects in six different divisions comprising 40 departments/centers/cells/laboratories.

The Department of Management Studies at the Indian Institute of Science (IISc), established in 1948, is one of the oldest departments of management in India. It has been running postgraduate programmes and the doctoral programme since the mid-1950s. Based in the premier research institute of higher learning, it positions itself to train students in futuristic areas like technology management, business analytics and policy analysis. The origin of the Department can be traced back to 1947 when the section of economics and social sciences was set up. This pioneering step was largely a result of the long-term vision of J. N. Tata, who had sown the seeds of management education and research in the country. This vision was given substance by the resolution of the Indian Institute of Science to establish a "...Philosophical and Educational Department, including methods of education, ethics and psychology, Indian history and archaeology, statistics and economics, and comparative philology". In the eventful almost six and half decades of its existence, the Department has made pioneering contributions in management education and research in India. Today, the Department comprising 11 faculty and 4 staff members offers the masters of management programme leading to a specialization in business analytics or technology management and research programme leading to the degree of Ph.D.

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Contents

Part 1

Part 1.1
Technology and Emerging Markets

Innovation Objectives, Strategies and Firm Performance: A Study of Emerging Market Firms

Aniruddha

1 Introduction

The ability of a firm to generate continuous innovations is considered to be a source of sustainable competitive advantage (Dess and Picken 2000; Tushman and O'Reilly 1996). Firms which innovate continuously are able to mitigate the negative effects of environmental uncertainty and complexity (Tsai et al. 2009; Li et al. 2008) and generate superior firm performance (Yam et al. 2011; Tsai and Tsai 2010).

The extant research on innovation has so far focussed majorly on the developed markets, and limited research is available on emerging markets (Guan et al. 2009). The environment in which emerging market firms operate is very different from that encountered by firms in developed markets (Tsai et al. 2009; Li et al. 2008). Emerging markets are characterised by higher uncertainty and complexity on account of environmental factors like regulation, institutional voids, varying and diverse consumer demand, rapid rate of technology change, intense competition, etc. (Tsai and Tsai 2010; Li et al. 2008). Various innovation management theories applicable in developed markets may not be applicable as such in the emerging markets (Guan et al. 2009; Li et al. 2008).

The environmental context of a firm decides the primary strategic objectives of the firms (Tidd 2001). These strategic objectives often require creation of value, which can be achieved by pursuing innovation activities in the firm (Chesbrough 2008). The strategic objectives which trigger the innovation process in the organisation are referred to as innovation objectives (Leiponen and Helfat 2010). The innovation objectives of the firm define the innovation strategy to be pursued by the firm in order to achieve the desired innovation performance (Guan et al. 2009; Burgelman et al. 2004).

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Emerging market firms are characterised by increasing competition on account of deregulation leading to surge of multinational corporations along with birth of new firms in industries (Girma et al. 2009). The combined effect of MNCs and new domestic players is the rise in technological intensity, complexity and uncertainty in the market (Barrell and Pain 1997). On one hand, increasing consumer demand has increased the growth potential, and on the other, customers are demanding customised products and services (Woertera and Roper 2010). Firms are continuously pressurised to reduce costs as well as offer differentiated products (Guan et al. 2009). The dynamics of the emerging markets have forced firms to adopt multiple innovation objectives (Guan et al. 2009; Song et al. 2005).

Pursuing specific innovation objectives requires specific innovation strategy which allocates resources and channelises process and system controls (Constantine and Marianne 2009; Burgelman et al. 2004). Each innovation objective requires different sets of resource allocation and control systems to achieve the desired results (Moshe 2010; Voss et al. 2008; Sanchez 1995). Firms which pursue multiple objectives have a difficult and complex task at hand as it requires not only allocating resources but also coordinating resources across these innovation objectives (Constantine and Marianne 2009; Teece 2007; Wang and Ahmed 2007). This can be achieved by adopting suitable strategy which facilitates the firms to achieve the desired set of innovation objectives (Moshe 2010; Burgelman et al. 2004).

Extant research however remains silent on the interrelationship between the various innovation objectives pursued by the firm. The focus of this chapter is to analyse the relationships between the various innovation objectives and the innovation strategies pursued by the firm. Firms need to make certain trade-offs in the portfolio of their innovation objectives based on the choice of innovation strategy. Each innovation strategy can be identified with a basket of favourable and unfavourable innovation objectives. Firms can accordingly make trade-offs amongst the innovation objectives and choose the innovation strategy with the most favourable basket of objectives. We also analyse the impact of each innovation strategy on the innovation performance of the firm so as to enable firms to decide on a suitable basket to achieve desired results.

2 Theory

2.1 Innovation Objectives

Research has identified numerous innovation objectives; however, based on our literature survey, emerging market context and our discussions with practitioners, we have identified a set of 14 innovation objectives. The innovation objectives and their relationship with innovation are described briefly in this section:

1. Develop radically innovative product: Based on the Schumpeterian rents, radical or discontinuous innovations change the market structure and bring

about paradigm shifts in the industry technological cycle (Rehman et al. 2010; Hill and Rothaermel 2003).

2. Introduce niche products or technology: Instead of competing head-on with the market leaders, firms chose to enter the market by focussing on a specific niche segment. The niche segment offers low competition and higher rents (Parrish et al. 2006).
3. Improve production processes for existing products: Firms competing in extremely competitive markets, where dominant design has already been established, are tight pressed to reduce the costs of products. Improvement of production processes results in increased cost efficiencies (Utterback and Abernathy 1975).
4. Replace products being phased out: Firms need to continuously innovate to not only innovate and launch new products but also phase out old products and provide improved substitutes for the earlier products. Cannibalisation or creative destruction of old products is a necessary condition for firms to achieve competitive advantage (Guan et al. 2009; Chesbrough 2008).
5. Maintain or increase market share: Firms continuously strive to increase the market share, for which they perform a combination of product, process and business model innovations. The combination of the three allows firms to capture superior market share by offering differentiated, unique, cost-efficient and accessible products and services (Dess and Picken 2000; Tushman and O'Reilly 1996).
6. Exploit new domestic market: Firms continuously perform market innovations to develop and exploit new domestic markets. The frugal innovations and bottom of the pyramid approach have specifically focussed on developing new domestic markets (Eyring et al. 2011; Wang and Ahmed 2007).
7. Exploit new international market: Domestic market firms which were basically confined to domestic markets have started exploiting other emerging markets for increasing their sales. This requires customising products and services to suit the new international market requirement (Tolstoy and Agndal 2010; O'Cass and Weerawardena 2009).
8. Improve product quality: Increased technologies and production techniques have resulted in higher product quality demands. Organisations in order to stay in competition not only need to bring out new products but also improve the quality of old products and services (Prajogo and Sohal 2003).
9. Improve existing technology to reduce reliance on imported equipment/know-how: Domestic firms have been dependent on external licensed technology from international organisations. Post-deregulation the same technology partners have started competing with the domestic firms. The domestic firms need to develop in-house technology development capabilities so as to reduce their overdependence on external technologies (Jones et al. 2001).
10. Reduce consumption of raw materials: Raw material cost is an important component of the overall product costs. Firms need to continuously innovate and look for processes and materials which can reduce their raw material costs (Tomovic et al. 2010).

11. Reduce energy consumption: Energy consumption is one of the major costs in all organisations. Developing market firms are specifically starved on power supply and many times buy costly power from secondary sources. The energy consumption accordingly becomes an important component of the cost. Firms need to develop processes to reduce the energy consumptions (Johnstone et al. 2010).
12. Improve working conditions: Lately, organisations have started realising the importance of human resource in overall firm growth. Employee retention and motivation is one of the major issues in technology- and knowledge-based firms. Firms must continuously innovate to improve the working conditions of the employees (Antoncic and Antoncic 2011).
13. Reduce production cost: Production cost is another important cost which impacts the overall cost of the product especially in the manufacturing sectors. Firms need to continuously look for available options of reducing the production costs. Firms innovate to design superior production machinery to reduce the production costs (Tomovic et al. 2010; Utterback and Abernathy 1975).
14. Partner with Value Net members for increasing WTP: Firms use their innovation capabilities to partner with superior Value Net partners so as to achieve long-term gains. It is seen that innovation networks usually allow innovating members only to join the network. Membership of a particular innovation network results in long-term technology agreements and knowledge transfers (Esteve and Ramon 2010; Nieto and Santamaría 2010).

Objectives 1 and 2 are in line with the firm goal of extending its existing product range through innovation. Objectives 5, 6 and 7 are measures of increasing sales and market share through innovation. Objectives 10, 11 and 13 majorly focus on cost-cutting exercise. Objective 9 reflects the situation of most Indian firms during the 1990s, whereby they had to spend a lot of money to acquire new equipment or know-how from developed countries.

2.2 Innovation Strategy

Miles and Snow (1978) in their book have identified four broad strategies for innovating firms Defender, Prospector, Analyzer and Reactor. However, based on our qualitative study and review of existing literature on emerging markets, we have identified five broad innovation strategies adopted by firms (Guan et al. 2009). The five innovation strategies are briefly described below:

1. Innovation leader: Maintains technological leadership and is majorly focussed on risk-taking in new products and new markets.
2. Cost-efficient follower: Monitors the actions of leaders with a more cost-efficient product.
3. Imitator: Majorly focussed on imitating technologies, products and processes of innovation leader.

4. Technology importer: The core of its innovation lies at importing technologies from advanced countries and incorporating them in indigenised products.
5. Laggard: Lags in innovation and majorly focussed on protecting its existing products and markets by incremental innovations and cost reductions.

2.3 Innovation Performance

Innovation performance is an integration of exploration (opportunity-seeking activities) and exploitation (advantage-seeking activities) output of the firms (Constantine and Marianne 2009; Lawson and Samson 2001). Innovating firms need to maintain a balance between the exploration and exploitation (Zhou and Wu 2010). Exploitation can be broadly defined as the refinement and extension of existing competences and technologies and generation of immediate predictable returns (Moshe 2010; Zhou and Wu 2010). Exploitation on the other hand deals with experimentation with new alternatives and scanning, identification and seizing of new opportunities (Moshe 2010; Zhou and Wu 2010). The firms not only need to focus on Ricardian rents which are generated from exploitation activities and can be measured by the current and past performance of the organisation but also on the Schumpeterian rents (Chesbrough 2008). Schumpeterian rents are generated from the exploration activities of the firm and involve creating value from radical and discontinuous changes (Chesbrough 2008). We thus need to focus not only on the past and current performance of the firm but also obtain insights on the future performance potential of the firm.

The innovation performance has been measured using the following three measures (Hope 2009; Combs et al. 2005; Lawson and Samson 2001):

(a) The firm's relative performance to the innovation leader in the particular industry of the firm's operations. This is considered as a measure of the exploitation or the advantage-seeking behaviour of the firm, as it reflects the current innovation position of the firm.
(b) Impact of firm's innovative capability and initiatives on the last 3 years' sales and revenue generated by the firm. This is considered as a second measure of the exploitation or the advantage-seeking behaviour of the firm; it explores the exploitation of the innovation capability to generate revenue from the innovation outputs of the firm.
(c) Firm's planned current initiatives in generating innovative capabilities and output for the future performance of the firm. The measure specifically reflects the exploration and opportunity-seeking behaviour of the organisation.

The innovation performance parameters are thus selected so as to measure the balance between the exploration and exploitation capabilities of the firm and the innovation objectives and strategies which specifically lead to exploration and exploitation in a firm.

3 Methodology

The interrelationship between various innovation-influencing factors was measured using a combination of qualitative (Barr 2004) and quantitative techniques (Slater and Atuahene-Gima 2004). We performed our study in two stages (Harrigan 2009). The first stage consisted of a qualitative study where we interviewed five senior managers of an Indian multinational firm operating in a technology-intensive industry (Barr 2004). The insights obtained from the senior managers regarding innovation objectives and innovation strategy trends in the market were linked to the literature review performed by the authors. The combined conceptual model developed based on the inputs from the literature review and qualitative study was used as an input for the second stage of the study.

The second stage of the study included the quantitative analysis using an online questionnaire (Simsek et al. 2005; Slater and Atuahene-Gima 2004). The questionnaire consisted of one question for each of the parameters of our study which has been identified before (Guan et al. 2009). The empirical testing and questionnaire-based methodology were used specifically to test the interrelationship amongst the various factors and the relative importance of each of these factors and their contribution to the final innovation capability and performance of the firm.

The questionnaire consisted of three parts: the innovation objectives, the innovation strategies and the innovation performance. The questionnaire was initially pilot tested in two Indian large-scale enterprises, and the feedback received on understanding and clarity was used to refine the questionnaire before final distribution. The sample consisted of Indian firms which have been incorporated in India before liberalisation, i.e. firms which have seen the pre-liberalisation environment and which have faced the challenges of the transformation. The multinational firms selected for study were those which had operations in India, and at least some percentage of value-adding activity in their final product or service was performed in India.

The questions in the questionnaire were objective type, and all questions were made compulsory. The respondent had to select one option out of the Likert scale ratings (from 1 to 7). Thus, to ensure uniformity of the response and minimum wastage of time by the respondents as the respondents are majorly of middle management rank, the questionnaire was designed using a uniform scale with no subjective questions. The questionnaire was prepared using a popular online questionnaire design tool, and the questionnaire was distributed using online medium only. The author's social network resources were utilised to get the responses filled from the desired organisations. The only criterion for acceptance of the company in the sample set was that at least ten responses from the particular company should have been received for the company to be analysed in the sample set. The questionnaire was responded by managers from 110 companies; however, out of these, only 82 companies fulfilled the criteria of more than ten responses and hence were accordingly selected. All in all, 1,189 responses were evaluated for arriving at the final results.

SPSS software was utilised to perform analysis on the received forms and correlation; OLS regression was used to analyse the relationship between our study parameters, i.e. innovation objectives, innovation strategy, innovation performance and environmental context (Shaver 2007).

4 Results

A definite relationship can be seen between the innovation strategy pursued by the firm and the innovation objectives. Based on the results of the OLS regression, we were able to identify certain objectives which were positively impacted by a particular innovation strategy. At the same time, another set of objectives for the same strategy was identified which were negatively impacted. The results of the relationships obtained from the OLS regression are documented below. The Table 1 describes the relationship between innovation strategy and its favourable and unfavourable objectives. All results were found significant at 0.01 significance level. The overall R^2 for the model was 0.56, which explains the strength of the model in predicting the relationships.

We also performed the relationship analysis between innovation strategy and the exploration and exploitation capability of the firm. From the results presented below, it can be seen that innovation leader is the only strategy which balances exploration and exploitation. It can also be seen that cost-efficient follower is a more efficient strategy for firms specifically focussing on exploitation as it provides better results for exploitation as compared to innovation leader. Imitator is a negatively impacting strategy as can be seen by the negative relationship with the performance. Technology importer strategy coupled with cost-efficient follower can be seen to be the most superior innovation strategy in terms of balancing exploration and exploitation. The firms which focus on cost-efficient follower strategy along with importing complementary technologies are likely to exceed the innovation performance in comparison to the other innovation strategies (Table 2).

5 Conclusion and Future Research

We have been able to establish a relationship between various innovation objectives, innovation strategy and innovation performance of the firms. Trade-off baskets have been identified for the five innovation strategies, which can help managers select the relevant strategy based on the firm objectives. We have also been able to establish that cost-efficient follower combined with technology importer strategy is a superior strategy for emerging market firms as can be seen from the performance impact of firms. Innovation leader adopts a mix of exploration and exploitation. Firms following imitator and laggard strategies are likely not to achieve superior performance in the changing dynamic environment.

Table 1 Innovation strategy and related innovation objective trade-offs

Innovation strategy	Favourable objectives	Unfavourable objectives
Innovation leader	Develop radically innovative product	Maintain or increase market share
	Replace products being phased out	Reduce production cost
	Improve working conditions	Reduce consumption of raw materials
Cost-efficient follower	Maintain or increase market share	Develop radically innovative product
	Improve production processes for existing products	Introduce niche products or technology
	Partner with Value Net members for increasing WTP	
	Improve product quality	
Imitator	Introduce niche products or technology	Develop radically innovative product
	Exploit new domestic market	Improve working conditions
		Improve product quality
Technology importer	Improve existing technology to reduce reliance on imported equipment/know-how	Maintain or increase market share
	Improve production processes for existing products	Replace products being phased out
	Partner with Value Net members for increasing WTP	Exploit new international market
Laggard	Reduce consumption of raw materials	Maintain or increase market share
	Reduce production cost	Develop radically innovative product
	Reduce energy consumption	Exploit new international market

Table 2 Innovation strategy and innovation performance relationship

	Innovation performance					
	Relative to leader		Last 3 years		Future trend	
Innovation strategy	B	Sig	B	Sig	B	Sig
(Constant)	0.27	0.14	−0.19	0.36	−0.23	0.27
Innovation leader	0.19	0.00	0.14	0.00	0.16	0.00
Cost-efficient follower	0.31	0.00	0.22	0.00	0.06	0.08
Imitator	−0.11	0.00	0.08	0.01	−0.03	0.34
Laggard	0.01	0.72	0.08	0.00	0.04	0.06
Technology importer	0.01	0.72	0.04	0.09	0.06	0.00

Our research has certain limitations; the sample was based on convenience sampling. A more refined way of sampling should be adopted to collect the data. The study has adopted a perception-based approach; the study in the future should be conducted using empirical data from supporting secondary sources for validation of results. The antecedents of innovation objective selection need to be identified, and their impact on firm's strategy should be established. The study can also focus on the impact of firm characteristics like ownership, country of origin, technological intensity and product type.

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Technology for Rural Market Development

V.K. Nangia, Vinay Sharma, Anita Sengar, and Ritika Mahajan

1 Introduction

India is a country where more than 70 % of the population lives in rural areas, where rural areas consist of more than 6.38 lakh villages, out of which more than 30% has a population of more than 2,000. Fifty percent of the total GDP of India is contributed by rural areas. The reforms in the post-economic reform period have led to remarkable improvement in the economic growth. This is revealed through analysis of factors like GDP, employment index, human development, balance of payments, etc. The analysis of the impact needs adequate attention, especially in the context of rural markets. An examination undertaken in this respect revealed that though rural India is not shining, there have been massive improvements (Dev 2004). Rural markets are catching the attention of the marketers. Being mostly untapped, the huge potential makes them a strong attention. Mahatma Gandhi always emphasised the importance of rural India. C. K. Prahalad's 'Bottom of the Pyramid' also threw the issue into limelight. The philosophy on which the book is based is the need for developing rural markets. The preface of the book says that the poor must become active, informed and involved consumers (Prahalad 2005). To develop the rural markets, various issues like education, healthcare, efficient markets and governance need to be taken care of. Rural marketing is, in fact, developmental marketing (Dikkatwar 2009). With the use of technology pervading every facet of our lives, endeavours which promote rural market development through technology should be encouraged.

The word technology comes from the Greek word *technologia* (τεχνολογία), meaning skill, art and craft, and *logy* (λογία), meaning the study of (*Merriam Webster dictionary* 2011). It explains the term as 'the practical application of

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knowledge especially in a particular area' (ibid.). According to Prof. G. B. Harrison, technology is the process of using scientific, material and human resources in order to meet human need or purpose. UNDP's Human Development Report (2001) on the issue of transformation being brought about by technology emphasised that 'no individual, organization, business or government can ignore these changes. The new terrain requires shifts in public policy – national and global – to harness today's technological transformations as tools for human development.' The use of technology leads to two potential benefits (Nirvikar Singh 2006). One is that of increased efficiency and the other is of reduced economic inequality. Specifically, in the context of rural markets, the latter holds importance.

2 Defining the Term 'Rural'

'Rural' emerged as an adjective linked to the Latin noun *rus*, meaning an open area. The adjective form stuck and was incorporated into several European languages to refer to something relating to those areas outside cities (Woods 2011). There are numerous other definitions given by several bodies such as RBI, Census of India, NABARD and Planning Commission. It is not possible to justly indicate the place at which rurality ends or where urban conditions begin (Meserole 1938). Sahara group defines it as locations having shops/commercial establishments up to 10,000 are treated as rural, whereas LG defines rural and semi-urban areas as all other cities other than the seven metros (Kashyap 2007). Harish Bijoor (CEO of Brand and Business Strategy Consultants) says, 'Rural is not a geography; it is a mindset. Those who possess it are rural and those who do not are urban.' So, rural sociology and economics play a very vital role in rural markets. Social life of the community is divided into two distinct segments, rural and urban which interact among themselves but each is sufficiently distinct from the other in terms of occupation, density, size of community, mobility, environment, homogeneity and system of interaction (Desai 1969). Rural economy of India is characterised by growing commercialisation, rurbanism (Jha 2003) and huge participation of institutions in socio-economic development of rural areas (Dhingra 1983).

The term 'Rural Marketing' was earliest used by Shah in the reports of sub-committee set up by the National Planning committee in 1937 (Shah 1947). The key for succeeding the rural market lies in comprehending the rural psyche (Dogra and Ghuman 2008). Gopalasawamy (2005) emphasized upon all flows between rural-urban and within rural whereas Iyer (2004) states that Rural marketing refers to developing marketing mix for goods and services leading to exchange between urban and rural markets, which satisfies consumer demand and also achieves organizational objectives.

3 Technology and Rural Market Development

Despite debates on the pros and cons of the uses of technology, there is adequate literature supporting the use of technology for economic and social change (Kaushik and Singh 2004). According to Nandi (2002), economic growth and social empowerment can be achieved through the use of information and communication technology. It can empower the poor by improving their access to use of government services through e-governance as well as to schemes such as those of microfinance (Cecchini and Scott 2003). The availability of opportunities of health, education and access to markets to the poor is also enhanced through the use of technology (Malhotra 2001). Though it may seem paradoxical at a certain level to talk about such initiatives in a country where millions live below poverty line, yet there are many existing examples of such type which need to be emulated. This study is based on one such example which draws its strength from industry-academia collaboration.

4 Integrated Rural Development: A Case Study of Charba Village (Dehradun, Uttarakhand)

4.1 How Was This Idea Conceived?

SIIRD (Students' Initiative for Integrated Rural Development) is the result of the initiative taken up by students of IIT Roorkee for the development of rural areas. In 2006, a few B-Tech students interested in working for rural development approached Prof. V. K. Nangia (Govt. of India Chair Professor in Knowledge Economy, Coordinator Uttarakhand Development Cell and Prof., Dept. of Management Studies, IIT Roorkee) who sensitised them with various problems and possible challenges faced by people in rural India. Prof. Nangia addressed this subject in a very innovative way by supporting this initiative with his National Competitiveness in Knowledge Economy project which was awarded to him by the Department of Information Technology, Government of India, and SIIRD has evolved as its rural development vertical. SIIRD is based on government-academia-industry-society partnerships, and its objective was to develop a sustainable development model in a village called Charba.

4.2 Focus on the Participating Elements of Developmental Efforts Through the People Who Could Best Do It

Uniqueness of the project lies in the voluntary use of student force for the larger good of society by integrating the efforts of industry-academia-government-society. Therefore, selection of students is a key task for SIIRD because travelling for two and a half hours in a rickety state transport bus and then staying in the village during night in the absence of electricity are a very tough task which requires lot of vigour. SIIRD's selection procedure makes sure that right students are selected for the job. The key qualities that it seeks in students are their dedication, willingness, self-motivation to work for the nation and their aptitude to think solutions and as well as strategise them.

When Charba village was identified, SIIRD started the process of recruitment. In the beginning of every new session, SIIRD conducts an orientation talk which is followed by a series of rounds for the selection of interested students (Table 1).

Table 1 No. of students selected against no. of applications

Year	No. of applications	No. of selections
2008	23	8
2009	69	25
2010	149	30

With the passage of time, SIIRD has become one of the most sought-after groups on the IIT Roorkee campus.

4.3 Selection of the Village

After selecting most appropriate participating elements for the project, the next task was identification of a target village which makes SIIRD unique and different from other development agencies. Since centralised planning and lack of coordination among development agencies are few of the major challenges faced by the Indian government, it was very important for SIIRD to identify a village to be worked on having the following characteristics:

1. The village had to be a true representative of Uttarakhand in terms of its topography, social and cultural diversity.
2. The village was to be physically accessible considering the rocky and mountainous topology of Uttarakhand.
3. The village was required to have the support of local government bodies and should be crime-free for students to work.

Through the method of ground surveying, SIIRD decided to search for its targeted village. Seventeen villages in three districts of Uttarakhand were covered in a span of 2 years. The surveys may be broadly classified according to the Table no. 2 mentioned in next page. After all these vast and exhaustive surveys, SIIRD team finally identified Charba village in March 2008 to work in. Charba is located in Sahaspur block of Dehradun District, 40 km from the heart of Dehradun City. Its topography can be classified into three parts: Lower Charba, plain; Middle Charba, semi-hilly; Upper Charba, hilly. SIIRD team observed that Charba, having a population of just over 10,100, represents the whole of Uttarakhand in terms of social and cultural diversity and topography. It is also well connected with NH-72 through an 8-km road.

4.4 Infusion of Developmental Activities

4.4.1 Information and Communication Technology (ICT) Awareness Initiative

The main objective of this initiative is to create awareness about the use and benefits of information and communication technology and develop a healthy relation with the villagers.

Table 2 Surveys for selection of the village

District	Haridwar	Tehri Garhwal	Dehradun
Time period	2006–2006	2006–2008	2008–2008
District topology	Plains	Hilly and rocky	Semi-hilly
Village surveyed	Bhijouli	Tutai Chak Chogani Kilwan Kansyud Daang Jhakogi Brahmanon Ki Jhakogi Kilwano Ki Raiduni Gair Shivalipatal	Rampur Lakshmipur Shekonwala Dhulkot Navgaon Charba
Findings	Village lacked in social diversity	Villages are rich in social diversity but are very difficult to reach	Villages are rich in social and cultural diversity with easy accessibility
Conclusion	It was decided to search Uttarakhand’s culture in its interior; thus, Surkhanda Devi pass in Tehri Garhwal District was selected	Even the first village Tutai Chak was reached after descending for 2 h in Surkhanda Devi valley. Thus, Sahaspur block of Dehradun was selected	Charba village was identified for proceeding with SIIRD work

Methodology: Meetings of villagers were convened, and the uses and benefits of information and communication technology were demonstrated. Door-to-door demonstrations were also done. Practical hands-on exposure of computer and Internet was given to villagers. The villagers were also provided an opportunity to experience the use of computer and Internet. These demonstrations helped SIIRD team to identify ‘champions’ (villagers who were supportive and willing to help carry our initiatives forward).

Achievements: A total of about 350 man days were spent for this initiative (of which about 150 man days spent in the village) from June 2008 to February 2009. The team identified 15–20 champions in the village who help the team during visits. About three-fourth of the village has been covered by door-to-door demonstrations, and the team has spread its presence in the village. Training of Trainers Programme: All the computer centre trainers of Charba have undergone training imparted by IIT Roorkee students in three training programmes. Softwares like Microsoft Office, basic Flash, basic Photoshop, elementary C, Tally, etc., were taught to them.

4.4.2 Entrepreneurship Initiative

The main objective of this initiative is to find the suitable entrepreneurs in Charba village for running the soochna kutir (Janadhar) to ensure awareness and usage of information and communication technology in Charba. Janadhar is the e-Governance initiative of the government of Uttarakhand. It was started in March 2005. The initiative was taken up with funding from the UNDP and technical guidance by the Indian Institute of Technology, Roorkee (IIT).

Methodology: The main objective of the e-Governance initiative is to deliver information of public interest and services related to various government departments at the doorsteps of the citizens of Uttarakhand by setting up citizen-centric information kiosks (soochna kutirs) for e-Governance in the state.

Achievements: A total of about 200 man days were spent for this initiative from September 2008 to March 2009. Suitable entrepreneurs were identified for running the information kiosks (soochna kutir) to ensure the awareness and usage of benefits of information and communication in Charba. Eight soochna kutirs (information kiosks) were studied in Naintal by five students. Three soochna kutirs (information kiosks) were set up and inaugurated in Charba under the UNDP-funded e-Governance project by Prof. H. K. Verma, Deputy Director, IIT Roorkee. Training of the personnel manning the soochna kutirs (information kiosk) was done in UNDP office, IIT Roorkee.

4.4.3 Primary School ICT Education Initiative

Its main objective is to provide basic computer education to the students of primary schools of Charba village and make this education system sustainable.

Methodology: Identification of primary stakeholders (students, parents, teachers, team members) and obtaining their views on computer education, preparing course materials in Hindi for teaching in primary schools in consultation with the teachers in conformity to the private school course structure and integration of Sarva Shiksha Abhiyan (SSA) with SIIRD, thereby ensuring sustained government support to the primary school ICT education initiative.

Achievements: About 150 man days were spent for this initiative from January 2009 to November 2009. Course structure (in Hindi) and details and database of all four primary schools are prepared. ICT education was imparted to students of primary schools by SIIRD team. Met Mrs. Geeta Nautiyal, District Education Officer, Dehradun District, and obtained approval for integration of Sarva Shiksha Abhiyan (SSA) with the primary school ICT education initiative. SSA officials agreed to extend support to SIIRD for its future initiatives. About ten videos were made which will serve as self-learning toolkit illustrating the usage of simple software like Notepad, Calculator, etc.

4.4.4 Girls' Education Initiative

Its main objective is to train the girls of Charba in ICT and make them champions so that they may in turn impart training to other villagers and thus make this education system sustainable.

Methodology: The focus is on training the girls of age group 12–15 years from the village so that they could further train the students in the village. Target is to train about 30 girls in Charba.

Achievements: About 50 man days were spent for this initiative from March 2009 to November 2009. Training was given by IIT R girls: Seven Charba girls were trained in ICT at IIT. Training was given by combined efforts of IIT R girls and Charba: 20 students were trained at the house of Mr. Baljeet Singh (champion) on 15th May 2009. Thirty-six students were trained in primary school no. 3 on 16th May 2009. Five new girls were trained from Charba by IITR girls from 8th to 10th August 2009.

4.4.5 Health Initiative

Its main objective is to improve the health status of the village with the assistance of health institutes in nearby areas, mainly by organising health camps and to connect them with doctors in village by teleconferencing.

Achievements: Contacted Himalayan Institute Health Trust (HIHT) in Dehradun District and discussed about health initiative. SIIRD team is in the process to organise a health camp in the village with HIHT assistance soon. Villagers were made aware about e-Health, and their interest was created in it, and the team got a good feedback from them.

4.4.6 Employability Initiative

Its main objective is to improve the employability of the unemployed or underemployed people of the Charba village by skill development or getting their existing skills tested and certified.

Methodology: Creating a platform for villagers and industry to reduce the gap between them. Designing of training module and training the villagers to impart necessary employment skills. Recruitment of the trained villagers.

Achievements: About 80 man days were spent for this initiative from January 2009 to November 2009. Met CII officials and other local industrialist of Selaqui, Dehradun District, and integrated them with this initiative. In consideration of the industrial demands, motivational training of five villagers was done in Haridwar. Another meeting with CII and other local industrialist of Haridwar to discuss recruitment of trained villagers.

4.4.7 Agriculture Initiative

Its objective is to improve the agriculture status by increasing the rate of production in agriculture using scientific tools and research.

Methodology: Integrate multiple stakeholders (like Krishi Vigyan Kendra, IFFCO, etc.) in this initiative. To focus on a specific group of about 12–15 farmers who would be champions in agricultural initiative. Expertise of professors and students of Biotechnology Department will play a crucial role in this initiative.

Achievements: About 30 man days were spent for this initiative from March 2009 to November 2009. Basic survey of agricultural practices in the Charba village. Identified five potential farmers for the target group of this initiative.

4.5 Associating People and the Institutes for Strengthening These Activities

In order to achieve the defined objectives of SIIRD, there is a need to associate people and various institutes so that these activities could be strengthened. Few of the associations have been mentioned below:

United Nations Development Project's (UNDP) e-Governance initiative:

- Integrated the Uttarakhand government's UNDP-funded e-Governance project by setting up three soochna kutirs (information kiosks) at Charba
- Principal investigator: Prof H. K. Verma, Deputy Director, IIT Roorkee

Sarva Shiksha Abhiyan for primary school ICT education:

- Integrated SSA for the primary school ICT education initiative
- Officials in charge: Mrs. Geeta Nautiyal, District Education Officer, Dehradun District, and Mr. S. P. Semwal, District Head of Computer Aided Learning Program (CALP), Dehradun District

Confederation of Indian industries (CII):

- Integrated CII for the employment initiative and arranged for the training of the unemployed youth of Charba
- Officials in charge: CII, Uttarakhand unit at Dehradun

SIIRD is on the lookout for integrating the private sector in this social cause to create a model synergising the efforts of government, academia and industry (public and private sectors) for rural development.

4.6 Evolution of the Model

A model has been proposed which is an integrated model of several new collaborative approaches that are possible, mainly in the Indian scenario, to strengthen academia-industry interface:

Approach of SIIRD-IITR towards sustainability in Charba through the integrated model:

- Integration with existing projects – SIIRD integrated with e-Governance project of Prof. H. K. Verma, Deputy Director of IIT Roorkee. It installed three information kiosks in Charba where *uttaraportal.in* provides villagers with basic information of weather, competitive examinations, etc., charging only a nominal amount.
- Integration with CSR programmes of corporates – After creating information and communication technology awareness through door-to-door and mass demonstrations, SIIRD integrated with IIT Roorkee and Infosys Foundation which donated 16 and 15 computers respectively to 4 primary schools of Charba.
- Integration with government schemes – In integration with Sarva Shiksha Abhiyan, SIIRD launched Teacher's Computer Training Program. IIT Roorkee students designed a basic computer course material. The course was taught to the primary school teachers so that they can teach the students and make the system sustainable. SSA will issue certificates for the teachers.
- Integration with autonomous education institution and other autonomous bodies – With the aim of solving health problems in the village, SIIRD integrated with LHMC, NRHM, RSBY and CMOs of Dehradun and Sahaspur and organised health camps. Two health camps have already been organised. A total of 673 patients have been treated in an area where normal health camp receives less participation. Such is the goodwill of SIIRD in Charba (See Figure no. 1).
- Integration with industry – To meet the erratic power supply in the primary schools of Charba, SIIRD integrated with JNNSM and Gensol Consultants Pvt. Ltd. to provide 90% subsidy and seed capital respectively for 20-kW solar panel systems which are to be installed in four primary schools of Charba. The letter of intent has been signed, and DPRs have been submitted at UREDA.
- International collaboration – SIIRD has integrated with Acara Institute, USA, after winning Acara Challenge 2010 with 1st and 2nd positions. Acara is funding the "myrain" (winning team) with US $10,000 to install drip irrigation systems in the village. Acara Challenge 2011 is again won by student team of SIIRD
- Towards sustainability – SIIRD recently started Young Champions Program (YCP) with the aim of replicating the student model group in Charba. This model group is being mentored to understand the model of SIIRD. The students of Inter College, Charba, were identified as young champions, and a team of five girls and eight boys was made.

4.7 *Working for the Self-Sustenance of This Constituted System*

SIIRD will promote and propagate the student-driven industry-academia-government-society collaborative model by visiting various institutions in the country. It also aims at replicating its model in all IITs, IIMs and other important institutions of the country. It wants to work in Charba and make it a self-sustainable village and then extend the scope of work in the nearby areas of Charba through the Young Champions team.

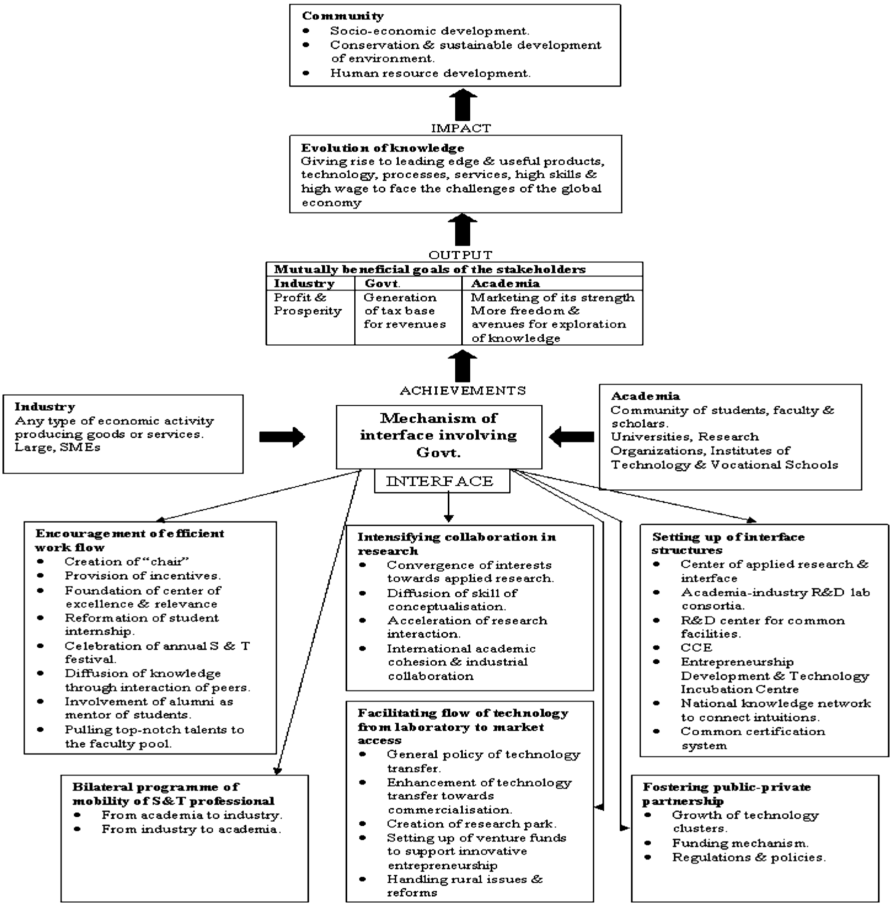

Fig. 1 Integrated model of academia-industry interface (Nangia 2011)

In the coming years, SIIRD wants to double the current workforce from 60 to 120 members. It will continue sensitising the students of IIT Roorkee and other institutions by organising awareness programmes, carrying forward the 170-year-old legacy of IIT Roorkee's contribution to national development.

4.7.1 Strategy for Primary School ICT Education Initiative

This is one of our major initiatives being implemented in Charba. The purpose of this initiative is to provide basic computer education to the students of the primary schools of Charba village and make this education system sustainable. Under this initiative, the student team interacted with teachers of primary schools, students and their parents as regards ICT education in the primary schools of Charba. Course material was prepared (in Hindi) for the students and was used for teaching. Interaction with teachers and students took place, and the database of students was compiled for all the four primary schools of Charba. Ten simple, self-learning video lessons have been prepared for illustrating the usage of Paint, Notepad and other basic software.

4.7.2 Proposed Methodology of SIIRD to Ensure Sustainability

Acquiring Computers for Primary Schools: Obtaining computers from private/ public sector units for installation in the primary schools of Charba. Sarva Shiksha Abhiyan officials, Dehradun District, have agreed to support in the installation of computers in the primary schools of Charba.

Training of Teachers Programme: Once computers are installed in the primary schools, the primary school teachers will be trained under Microsoft Academy or Teach for India in Dehradun under the rural development initiatives of the government of Uttarakhand and by the students of IIT Roorkee. These trained teachers will further impart knowledge to the students thus making the system sustainable.

Developing Simple Software Videos: These would serve as self-learning tools for the teachers as well as students. About ten self-learning videos for MS Paint, Calculator and some basic software have been prepared by SIIRD team using software like Cam Studio.

Refining the Course Content: As this sustainable system gets going, topics in the course structure could be reviewed, and more topics would be included

5 Conclusion

Rise in the rural people's income and enhancement of purchasing power of farmer lead to new opportunity of development in rural market. Initiatives like SIIRD which follows integrated model academia-industry interface truly help in improving the economic condition of rural people. A survey by the National Council for Applied Economic Research (NCAER), India's premier economic research entity, recently confirmed that rise in rural income is keeping pace with urban incomes from 55 to 58% of the average urban in 1994–1995, the average rural income has gone up to 63–64% by 2001–2002 and touched almost 66% in 2004–2005. The rural middle class is growing at 12% against the 13% growth of its urban counterpart. Higher rural incomes have meant larger markets. Already, the rural tilt is beginning to show. Issues of large size, huge potential, low-penetration level, increased accessibility of rural markets, increasing income and purchasing power of rural consumers, saturation and huge competition in urban markets are responsible for rising attractiveness of rural markets (Velayudhan 2007). In order to tap rural markets, there is a need to understand the meaning of 'rural' and rural consumer insight which could only be understood by rural psychology, sociology and economic aspect and thereby help marketers in optimising four Ps (product, price, place and promotion) through rationalising upon the whole of the marketing procedure, logistics, integrated marketing communication, product innovation and amplification at all the steps. As quoted by Levitt (1973):

The patience of the past, which assumed that in due time the right things would somehow finally happen by themselves, no longer works.

Now some are impatiently asking too much, in contrast to those who have asked too little, and society has no choice but to do what is right.

Rural marketers have no choice but to do that is right.

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Bridging Digital Divide and Capacity Building in Rural India

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1 Introduction

ICT encompasses communication services like telephony and Internet that run over telecommunication networks. Recently, telecom sector has registered a phenomenon growth and is considered one of the fast-growing sectors in India. The rapid growth of ICTs has accelerated the economic and social change (Nandi 2002) across all sectors of human activities worldwide, and the blending of ICTs is expected to continue fast. Hence, the pervasive nature of ICTs has made interactive communication possible without any hindrance and a driving force for development and poverty reduction. Now, telecommunication sector has opened new opportunities to make use of telecommunication technologies in their socio-economic and cultural development in a better way. So, penetration of communication technologies is not limited to urban areas only but has shown its presence in rural areas also. Rural telecommunication applications attempt to offer general ideas and solutions to the people who have disadvantages of basic facilities, for example, safe drinking water, education, employment generation and human rights. Therefore, governments of the respective countries have been attempting to exploit the technological advancement by offering improved and affordable services to the rural communities. Accordingly, considerable use of telecommunication technologies such as telephones, mobile technology, Internet, etc., was observed in rural areas. Telecommunication is on

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government's priority with constant emphasis to increase accessibility in rural areas since new economic policies. However, penetration rate of telecommunication services such as telephony is lesser in rural than in urban areas which is attributed to low access of the technology. This resulted to slow diffusion of telecommunication services in rural areas and gave rise to digital divide. But the inter-sectoral applications have boosted demand of telecommunication technologies. Subsequently, a phenomenon expansion in telecommunication network was recorded which has improved quality and labour productivity at different level across the geographical region.

India is a large country comprising nearly 72% rural population that indicates a huge potential of ICTs in rural areas. The Government of India has realised the emerging potential, so various policy measures are formulated to expand the telecommunication network in rural India. The major focus is to make accessible telephone services to reduce gap in teledensity between urban and rural areas. In this context, the Department of Telecommunications (DoT) has taken several positive measures to stimulate demand for telephones in rural areas. It was estimated that every fifth person in villages was connected, from wage earners to shopkeepers and farmers to fishermen, and telecom services are helping to increase their productivity (The Indian Telecom Success Story, India Telecom 2009). Therefore, the objective of this chapter is to provide an assessment of digital divide, in terms of teledensity, and telecommunication potential and capacity building in rural India.

2 Measures of Digital Divide and Relevance of the Problem

'Digital divide' refers to unequal access to ICTs like telephones, Internet, etc., in any social system. The concept of digital divide came into existence during the 1990s which was used to describe a market gap in access to the use of ICT devices like the number of fixed line phones per inhabitants or the number of mobile users or the Internet connections in the population (Singh 2010). The OECD further elaborates digital divide: 'The gap between individuals, households, businesses and geographic areas at the different socio-economic levels with regard to their opportunities to access ICTs and their use of Internet (OECD 2001)'. Thus, the digital divide is analysed in terms of penetration of telecommunication technologies on the following approaches (Buente and Robbin 2008; Hilbert 2011):

- Theoretical explanations for the digital divide or who connects with which attributes: demographic characteristics of connected individuals and their cohorts
- Means of connectivity or how individuals and their cohorts are connecting and to what: infrastructure, location, and network availability
- Purpose of connectivity or why individuals and their cohorts are connecting: reasons individuals are online and uses of the Internet and ICTs
- Lack of connectivity or why individuals and their cohorts are not connecting

Table 1 Telecom network status in India as of December 2010

1.	Number of telephone connections	787.29 million
2.	Number of telephone exchanges	38,461
3.	Switching capacity (public)	135.159 million
4.	VPTs	570,127
5.	Rural phones	259,829,747
6.	Urban phone	527,460,348
7.	Wireless subscribers	752.20 million
8.	PCOs (local + STD + highway)	1,649,826
9.	Broadband subscribers	10.92 million
10.	Internet	17.96 million

Source: Annual report 2010–2011, DoT

The divide appears due to various factors like historical, socio-economic, geographic, educational, etc. On the basis of the variables, Hanimann and Ruedin (2007) classified the digital divide into three categories as (i) a geographical digital divide (between regions and countries), (ii) a social digital divide (between social classes) and (iii) an upgraded digital divide (between technology and humans) (Hanimann and Ruedin 2007). Therefore, the major components of digital divide pertain to diffusion of ICTs which are an integral part of telecommunication technologies. India is one of the emerging telecommunication powers in the world, so it is imperative to analyse the growth pattern of telecom network. Indian telecommunication services network expanded from about 84,000 connections (fixed line) at the time of independence to about 206.83 million working connections as on March 2007 (which consists of 40.77 million fixed telephone lines and 166.05 million mobile phones). At present, India has a robust telephone network comprising 787 million telephone connections (2010), including mobile phones, and is one of the largest in the world and second largest among the emerging economies (after China) with a wide range of services such as basic, cellular, Internet, paging, very small aperture terminal (VSAT), etc. In addition, the National Internet Exchange of India was set up by the Department of Information Technology (DIT) to ensure that Internet traffic, originating and destined for India, is routed within India. The objective of Internet exchange was to cut the cost of Internet usage and to make efficient use of international bandwidth and to save foreign exchange. It also improved quality of services for the customers by avoiding multiple international hops and lowering delays. The status of the present telecom network is shown in Table 1.

The digital divide is due to a variation in the use and degree of accessibility of ICTs. However, the scope of this chapter is limited to analyse the divide in terms of teledensity, which is a major component of telecommunication and ICTs. The analysis is relevant because over the last decade, penetration of telecommunication network has registered an unprecedented penetration in India, and the gap is now narrowing between rural and urban India (Table 2).

The narrowing gap between rural and urban telephony was tested using dependent sample *t*-test (paired *t*-test) to compare the growth of rural versus urban areas.

Table 2 State-wise percentage growth of teledensity (December 2009–March 2011)

Sl. no.	States	Rural	Urban	Total growth
1.	Andhra Pradesh	61.01	45.49	50.41
2.	Assam	49.47	50.45	50.97
3.	Bihar	85.10	57.95	69.28
4.	Delhi	–	–	50.56
5.	Gujarat	62.70	63.79	64.10
6.	Haryana	49.78	68.70	61.31
7.	Himachal Pradesh	57.29	78.73	66.83
8.	Jammu and Kashmir	33.20	7.50	17.80
9.	Karnataka	79.17	49.75	57.33
10.	Kerala	62.74	50.37	54.89
11.	Madhya Pradesh	89.27	51.63	63.59
12.	Maharashtra	68.02	51.34	56.45
13.	North East	56.33	60.17	59.15
14.	Orissa	68.97	78.47	75.50
15.	Punjab	57.63	62.37	61.99
16.	Rajasthan	40.24	42.78	41.79
17.	T. N.	49.28	42.93	46.11
18.	U. P.(W) UP (E)	91.84	53.84	67.36
19.	W. B. and Kolkata	88.16	67.16	74.84
20.	Total	69.37	52.44	58.52

Table 3 Correlations matrix for GDP and ICT growth

		GDP growth	ICT Growth
GDP growth	Pearson correlation	1	0.399[a]
	Sig. (2 tailed)		0.039
	N	27	27
Teledensity growth	Pearson correlation	.399[a]	1
	Sig. (2 tailed)	.039	
	N	27	28

Correlation is significant at the 0.05 level (2 tailed)
[a]Analysis based on state-wise data taken from Planning Commission

The null and alternative hypotheses are H_o: there is no difference in rural and urban growth and H_1: rural growth is more than the urban growth. Average difference (μ) and standard deviation (S_d) were 9.2647 and 18.2871 respectively. The t-value was 2.1494, and p-value was 0.0231 where H_0: $\mu_1 - \mu_2 <= 0$. Here, μ_1 is rural growth, and μ_2 is urban growth. The analysis indicates that at 5% level of significance, the rural growth is more than the urban growth. It can also be concluded that among all states, rural teledensity is growing on an average 9.28% more than the urban teledensity. Similarly, correlation between the GDP growths with the teledensity growth of the states was analysed, and obtained results were represented in Table 3. Here, the null and alternate hypotheses are H_o: there is no relationship between teledensity growth and GDP growth and H_1: there is positive relationship between teledensity growth and GDP growth.

From the above analysis, it can be stated that there is positive correlation at 5% level of significance between teledensity growth and GDP growth.

3 Growth of Telecom Sector

The telecommunication sector has travelled a long journey in India that began with the first experimental electric telegraph line between Kolkata and Diamond Harbour in 1850 which was opened for the use of the British East India Company in 1851 (Communications in India). Since then, there has been a tremendous growth in the telecommunication sector, and now, India has the world's second largest mobile subscriber with over 865 million as of August 2011 (Highlights of Telecom Subscription Data as on 31st August 2011). The increasing potential of telecommunication encouraged foreign investment and private players by means of competition. The studies show that India was the world's most competitive and one of the fastest growing telecom markets in the world (Dharmakumar; Kannan 2010). Competition enhanced quality in services; subsequently, Indian telecommunication services have been recognised the world-over as an important tool for socio-economic development. Accordingly, telecommunication has been witnessing the highest growth rate and is a major contributor in Indian economy. Due to multifaceted applications, telecommunication is considered a basic infrastructure along with power and transportation. The development in telecommunication sector could be possible by expanding required infrastructure mostly after the policy of economic liberalisation. The growth of telecommunication sector in India can be divided into three phases (Indian Telecom Industry).

Phase I represented the pre-liberalisation (1980–1989) period. In this phase, the private sector was allowed in telecommunications for equipment manufacturing in 1984. Subsequently, in 1986, Mahanagar Telephone Nigam Limited (MTNL) and Videsh Sanchar Nigam Limited (VSNL) were set up for expanding infrastructure, and the Telecommunication Commission was set up in 1989. The major achievements were delicensing of the manufacturing of telecom equipments in 1991. The New Economic Policy was announced on 24 July 1991 aiming India's competitiveness in the global market, rapid growth of exports, attracting foreign direct investment and stimulating domestic investments. The second phase represented the post-liberalisation (1990–1999) period which was considered a transformative phase of the telecommunication sector allowing private sectors and value-added service (VAS) such as paging services which was introduced in 1992 followed by the National Telecom Policy (NTP) in 1994. The focus of the NTP-1994 was to ensure availability of telephone on demand to achieve universal service at affordable and reasonable prices. Finally, the third phase (2000 onwards) was a revolutionary period of Indian telecom sector which accelerated the telecommunication growth in India. In this phase, major technological and policy initiatives were taken to enhance quality and access of telecom activities with an objective for penetrating telecom in the remote and rural areas. Further,

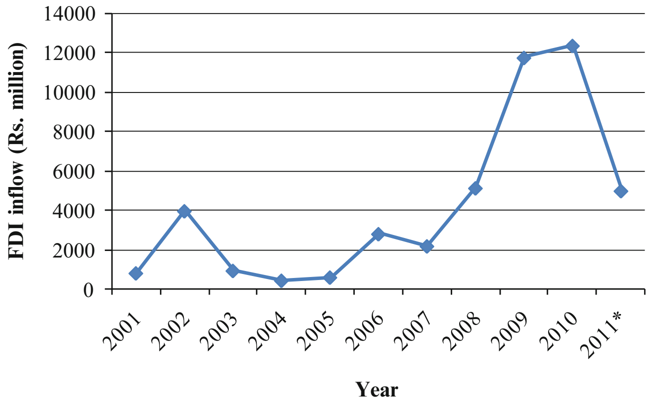

Fig. 1 FDI inflow in telecom sector (in millions) (Source: TRAI and DoT; *FDI inflow from April to November 2011)

Calling Party Pays (CPP) was implemented, and a new NTP came in 2004 with the formulation of broadband policy, and foreign direct investment (FDI) limit was increased from 49 to 74% in 2005. Recently, number portability was implemented in 2011 which was pending since 2006 which gave an option to the subscribers to switch to any mobile operator without changing the number. Driven by various policy initiatives, the Indian telecommunication sector witnessed comprehensive reforms in the last decade which attracted private operators and considerable FDI in the sector. FDI boosted the basic telecommunication infrastructure and network which were required to expand telecommunication services in rural areas. The FDI promoted competition in the market which benefitted consumers by making telecommunication facilities more affordable and improved data quality. The growth of FDI and private network is given in Figs. 1 and 2.

Competition in telecommunication market reduces cost of call charges and mobile sets which increased telephone subscribers base many folds during the last decade. It is significant that the growth of Indian subscriber base happened during that period when the entire world was affected by the global economic meltdown; recessionary trends were observed across the world, but Indian economic growth was affected marginally. The spurt in the subscriber base paved the way for modern communication services in rural areas which contributed the Indian economy due to growth in sales of services and equipments. The number of telephone subscribers reached 621.28 million at the end of the financial year 2009–2010. The share of wireless subscribers reached 584.32 million as compared to 391.76 million in 2008–2009, and the growth was nearly 49.15% during this period. The rural market also reached the 190.88-million mark in 2010 as against 111.63 million in 2009 excluding CDMA which worked out to a growth of about 71% over the last year. According to an estimate, there were 32.67% of total wireless subscribers in rural areas in the year 2009–2010. The total numbers of fixed telephone connections were 36.96 million, while mobile subscribers were 9.93 million in the rural areas. The fast growth of

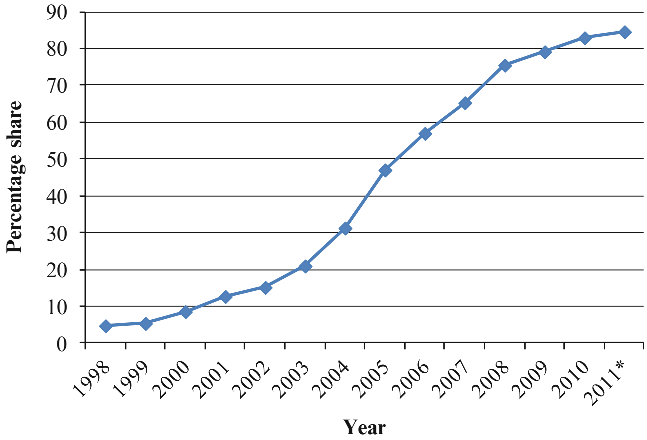

Fig. 2 Growth of private telecom network (1998–2011) (Source: TRAI and DoT various annual reports;*up to March 2010)

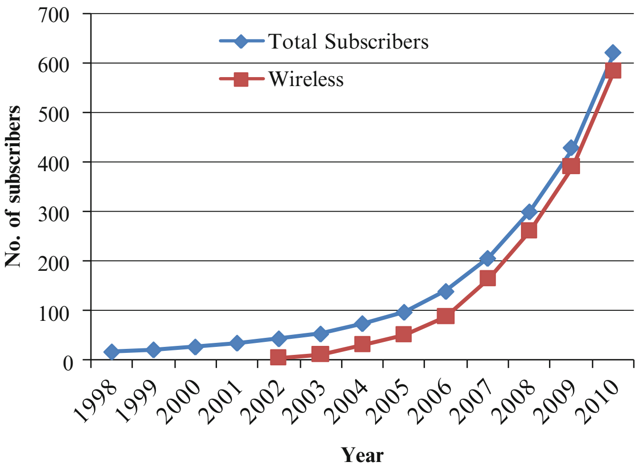

Fig. 3 Growth of subscribers (in millions) (Source: DOT and TRAI)

mobile phones adversely affected fixed telephones in the last few years and replaced the fixed telephone segment. Further, BSNL and MTNL registered a decline while private operators gained a growth of 11.51 % by increasing the connections from 5.04 million to 5.62 million in 2010. The growth of subscribers during the past decade (1998–2010) is given in Fig. 3.

The fast growth of subscribers signifies that the telecommunication infrastructure has grown comparable with the emerging nations of Asia and the world. The Indian telecommunication sector achieved success due to suitable regulatory policies and favourable business environment for the private operators. In 1997, the establishment of the Telecom Regulatory Authority of India (TRAI) encouraged increase in the share of private telecom companies in the telecom market. Later, the new National Telecom Policy with cellular telecom services in 1999 spurred the diffusion of mobile communication in India. Subsequently, several measures were initiated by the Government of India to promote telecom services. Further, Communication Convergence Bill 2001 was established to regulate the transfer of all forms of communication including broadcasting, telecommunications and multimedia. Indian Telegraph (amendment) Rules 2004 was introduced with the objective to set guidelines for development of public telecom services in India.

4 Digital Divide and Teledensity in India

The digital inability and differences in sharing of ICTs are observed between poor and rich communities and between geographical areas. The most prevalent digital divide is found between rural and urban areas in developing countries which are also reflected in India. Since digital divide is generally visible in the accessibility of telephony (fixed line and mobile), the present study is, therefore, limited to penetration of telephony in India. According to the International Telecommunication Union (ITU), the penetration of telephony is one of the core indicators for global identification of teledensity (2007) among the indicators (Core ICT Indicators). In the early days of independence, the telecommunication services were accessible in the urban areas, and teledensity was scanty in India. The reason was insufficient infrastructure and scarcity of resources. The teledensity was 0.37, 0.80 and 2.89 in the year 1980, 1990 and 2000, respectively; however, density was negligible in rural areas. This indicates that the teledensity was very low before the economic liberalisation which increased with economic reforms. The policy of economic liberalisation broke down the government monopoly and several private operators invested in the telecommunication sector particularly in the mobile communication. The entry of private investment and FDI spurred the expansion of telecom infrastructure which yielded a rapid penetration of telephony in India. According to TRAI (2009–2010), the total number of wireless subscriber base (GSM, CDMA and WLL (F)) was at 584.32 million, and the number of wireline subscribers was 36.96 million on 31 March 2010. Further, on an average, more than 15 million telephone subscribers were added every month during the financial year 2010. Moreover, there were 4.59 million public call offices (PCOs), BSNL 1.67 million, MTNL 0.195 million, private operators 2.73 million and 0.58 million village public telephones (VPTs) in 2009–2010. The overall teledensity was 53.46 where rural and urban teledensity was 24.56 and 122.00, respectively, in the financial year 2010. The comparative growth of teledensity is given in Fig. 4.

Also, there were 16.18 million Internet subscribers in the financial year 2010 as compared to 13.54 million 2009. Besides, there were 117.87 million wireless data subscribers who are accessing the Internet through wireless (GSM and CDMA)

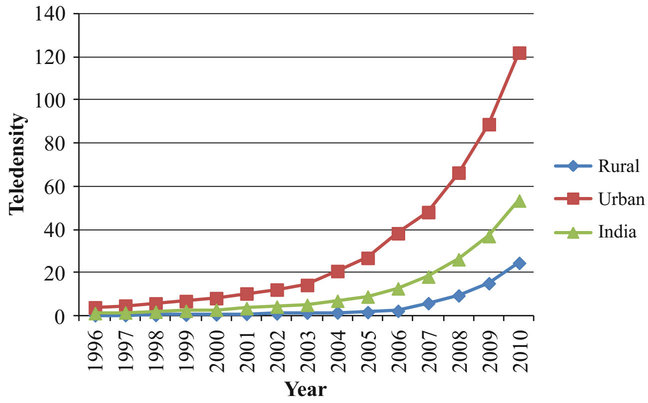

Fig. 4 Comparative growth of teledensity* in India (Source: TRAI and DoT; *teledensity means telephones per hundred persons)

networks. The number of broadband connections was 8.77 million in the year 2010 as compared to 6.22 million in 2009. The growth and diffusion attributed to policy reforms in the telecommunication sector which raised teledensity. The suitable policy reforms in the telecommunication sector provided competitive environment to private telecom operators and inflow of FDI in the country. The competition in telecom market encouraged tariff war which reduced call charges drastically. The decline of tariff charges significantly influenced penetration rate of mobile communication that gave rise to rural subscribers. The disparities in the distribution of telecommunication access also existed within the country despite fast growth of telecommunication connections. Hence, the rural teledensity in some backward states like Chhattisgarh (2.77%); Jharkhand (2.35%); Arunachal Pradesh, Manipur and Nagaland (7.78%); and Uttarakhand (9.46%) is very low.

5 Challenges for Capacity Building in Rural Areas

The digital divide is not simply an issue of access of telecommunication services but also of obstacles in the application and affordability of the services. Though India has achieved a great success in the telecommunication sector, a large number of the population are still deprived of the use of technologies. The statistics are not favourable to rural India where teledensity is nearly 25%. This needs attention as nearly 70% of the population reside in villages. Further, growing population, lack of sufficient funds, affordability and delays in implementation of government policies have led to unequal development which widens digital divide. The issues have been studied in comparison to the existence of relevant differences between geographical areas focusing on the different speeds of diffusion of telecommunication technologies (Kenny 2001). Telecommunication is supposed to play an important role in facilitating connectivity across the country; the policies, therefore, must examine all factors that account for the poor accessibility and quality of services. In order to ensure connectivity in rural community, remedial measures should be taken, and priority should be given to those areas which frequently suffer from seasonal loss of road connectivity. This will enable the affected people to access the information of their interest rather than be isolated.

For providing telecommunication access in rural areas, infrastructure must be built up for both fixed and wireless technologies. In order to properly use ICTs by the rural population, the issues relating to nature of demand, potential investment and revenue and organisational mechanisms should be addressed to ensure reliable service (Bhatnagar 2000). A sizeable population migrates to urban areas for better opportunity of earnings, so for the remaining family members, connectivity telecommunication may be a feasible way. It was argued that the revenue potential from rural areas is small (ICICI 1998), so incentives should be given to private operations and made mandatory for service providers to extend their network to rural areas. However, many small initiatives are already in place that need to be more robustly utilised like the Bangladesh's model of Grameen Telephone (BGT) (Grameenphone). Further, there is a need to look for value addition in telecommunication services like creating Internet kiosks from where multiple operational services can be offered. The services include access to public and market information, delivery of news and education, etc. Further, ensuring just physical availability of phones does not mean that they are working and are being used, as large number of VPTs in villagers reported either out of order or disconnected due to non-payment of bills (Das 1998). Therefore, there is a need to encourage Grameen Telecom initiatives in collaboration with PCOs as microenterprises which can significantly increase access to rural telecommunication systems (Bhatnagar 2000). Growing rural areas have already seen a shift from agriculture-based livelihood to different occupations, so it is important that technology reaches to the large population to exploit the benefits of technology.

Telephone is a useful technology for information flows; therefore, it can play an important role to get various information regarding agriculture-related issues like rate of various crops and more importantly to get information about weather, variety of crops, appropriate season of seed sowing, use of pesticide, etc. For providing such information, the Ministry of Agriculture established Kisan Call Centre (KCC) in January 2004. Farmers can use the facility for management of agriculture-related information through KCC which can be helpful to overcome information asymmetry between farmer and farmer, village and village and region and region. Thus, with the increase in choices of farm inputs, pesticides, herbicides and high-yielding varieties of seeds, a farmer requires guidance from an agriculture expert. The KCC enables farmers to have direct discussions with the subject experts who are able to analyse the problem effectively and provide the solution directly (Anand). The KCC model has helped expedite farmer query faster. Therefore, there is a need to expand the scope of the KCC to the interior rural areas and farmers. However, to increase teledensity only is not a solution for rural welfare. Thus, the capacity building through communication technologies could be achieved by linking technology with livelihood and improving the quality of life of the rural people.

6 Discussion and Conclusions

Telecommunication sector has made a significant impact on the entire economic spectrum in India and captured a significant growth over the last decade. Telecommunication is a part of information technology, and there is a belief in the economic circles that a 1% increase in telephone density leads to a 3% increase in the GDP. Recently, telecommunication technologies have converged due to the mobile communication and increased inter-sectoral and multiple applications of the telephony. According to the Moore's law, in every 18 months, the number-crunching capacity of the computers doubles, and the price comes by half. The analogy may be applicable to the telecommunication as the telecom industry has also experienced fast growth. The pervasiveness of telecommunication helped in the increasing use of computers, but the penetration of telephony in rural India is not as fast as in the urban areas. This is attributed to the insufficient infrastructure and affordability of the technology as nearly 25% of population is still below the poverty line, and statistics is more alarming in rural areas. However, the empirical statistics indicates that growth rate of teledensity was substantial during the last decade. The overall teledensity crossed 53 and rural teledensity was 24.56 and urban teledensity was 122 respectively in the financial year 2010. The growth figures are reasonable; however, slow diffusion of telecommunication services persists in the rural area. Despite existing constraints, there is considerable scope for growth of teledensity attributed to the large niche of unexplored market. This is relevant as there are 640,867 villages (census of India 2011) in India where 68.84 per cent of the population resides. The challenge is to attract potential users such as microclusters of artisan and rural need-based allied services to adopt telephony. Further, availability of electricity in rural areas is also one of the most challenging bottlenecks to bridge digital divide between rural and urban India (Rao 2005).

The operational level of the rural telecommunication is perhaps the most challenging issue to increase penetration of teledensity in rural areas. The government must permit and give preference to Internet connectivity which will be much cheaper than the normal telephony. To address the issue of unreliable power supply which is a major concern for private operators in rural areas, the resources should be channelised towards renewable energy sources. Data indicates that more than two lakh villages still do not have telephones out of six lakh villages, and previous 'go it alone' policies for public and private sector have not helped due to diverse interest; therefore, public-private partnership should be encouraged. One cannot deny that private sector companies too understand their social corporate responsibility as company like Reliance has come up with massive programmes for providing bandwidth in states like Gujarat, Andhra Pradesh and Tamil Nadu. However, with the combination of the efforts of both the private and the government sector, the teledensity in rural India will increase certainly in the coming years with the objective of inclusive growth of rural India. Moreover, the pace for the implementation of rural telecommunication policy must accelerate to minimise digital divide. Therefore, it is important to implement telecom policies comprehensively at a quicker pace to encourage telecom services in rural India. The analysis draws attention that the current policy scenario there is a move and a sure indication that the gap in the digital divide is now narrowing. The study is more relevant if it can assert that the narrowing of the digital divide does contribute to the growth negating the requirement for urban areas to grow at the cost of depleting rural areas making the economy to lean towards a more industrialised segment and negating its agricultural and natural resource development. Analysis further indicates a positive correlation between states' GDP growth and teledensity growth. The greatest challenge of diffusion of teledensity in rural areas, however, remains unsolvable unless the ICT is not linked with the livelihood of the common people.

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Considerations About How to Eliminate the Technological Backwardness of Latin America

Paulo R. Feldmann

1 Introduction

At the beginning of the sixteenth century, some of the inhabitants of Latin America, mainly the Aztecs, Mayas, and Incas, had scientific and technological knowledge many times superior to that of Europe or China. In some fields, such as astronomy, botany, pharmacology, and metallurgy, the Spanish assimilated the knowledge acquired in the region and spread this throughout Europe.

Today, however, Latin America has stopped being an important provider of scientific and technological knowledge, despite that it represents approximately 9% of the world's population, the region as a whole, corresponds to merely 1.2% of the total investment in science and technology. According to the World Bank, in the year 2007, the world invested approximately \$1029 billion in this area of which only \$12.5 of this total came from Latin America. This represents approximately 0.56% of the accumulated GDP of the continent which, when compared to the 1980s, has not increased. During that time, the average expenditure, from Latin American countries, relative to GDP was 0.45% versus 2.0% in European average and 2.9% in the United States.

Different statistical studies indicate that Latin America, its countries, and local companies invest very little in science and technology or research and development. This is, indeed, an important fact as it could compromise the entire future economic development of the region. Hobsbawm (1999, p. 505), upon analyzing the end of the twentieth century, comments that "*... two areas that visibly generate few scientists in absolute and relative terms: Latin America and Africa*."

The theme of this study is to analyze some characteristics of the predominant business environment in Latin America with the intention of verifying which aspects further the emergence of innovations but more importantly the important

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Table 1 Expenditures in science and technology relative to GDP in 2007

Country	Expenditures with Science and Technology relative to GDP in %
Israel	4.76
Japan	3.44
Germany	2.54
USA	2.72
UK	1.82
China	1.44
India	0.80
Latin America	0.56
Brazil	1.10
Argentina	0.51
México	0.37

Data from OCDE – www.oecd.org

obstacles that hinder it and what can be done to minimize them. We intend to highlight the role of a large company in generating technology and to indicate how its absence is a fact that makes it difficult to produce more technology in Latin America.

Below, Table 1 – *Expenditures of some countries in science and technology relative to GDP in 2007* – indicates how much some countries invested in 2007 according to the World Bank. Looking at this table, you can see that even the country that spends the most in Latin America with Science and Technology, which is Brazil, it is much less than what the developed countries spend. This is a chronic problem in the region which has only become accentuated with time. The importance of Latin America in the area of Science and Technology in the world is increasingly less.

2 Historical Background and Main Causes of Technological Backwardness

Freeman and Soete (1997) give a historic retrospective of what happened in the region, commenting that until the beginning of the 1950s the industrial development throughout Latin America was characterized by the reduced degree of technological sophistication and by the simple importation of technology, mainly from the United States and Germany, that was incorporated to capital goods. From the second half of the 1950s, various countries introduced measures of protection to their respective national markets trying to eliminate or substitute the importations.

It was during this time that countries of the region began to manufacture middle and high end items having greater technological complexity. The strategy employed, mostly by Brazil, Argentina, and Mexico, was to seek investments from foreign companies, mainly in the automobile segment. The respective governments also invested, but in the segments with a longer maturation period, such as raw material and infrastructure, but not in the sectors of media and high-density technology. What happened is that explicit technological importation increased without the necessary internal effort to absorb these technologies.

Larrain (in Robert Gwynne 1999), when explaining why Latin America has not advanced as much as Asia in the last 20 years, has attributed much of this backwardness to the closed market and to the protectionism that predominated in the region during the 1970s and 1980s. According to him, the lockup did not expose the region to international competition and ended up delaying the building of the necessary infrastructure for local researchers to develop their projects.

Erber (2002), analyzing the main reasons for the technological delay of Latin America, points to seven principal aspects:

1. The small number of large global-sized companies and being that these same companies are not in mid- or high-technology sectors.
2. The weak relationship between the university and the business world.
3. Low number of graduating engineers.
4. The lack of industrial policy oriented toward greater advances in science and technology.
5. Intellectual property or copyrights are not prioritized, and the legislation pertaining to these themes is weak.
6. Little encouragement for the appearance of a Schumpeterian entrepreneur.
7. Banks do not finance R&D.

We will now touch upon these seven aspects in greater detail.

3 The Relation Between Production of Technological Innovations and the Geographic Characteristics of Latin America

Why is not Latin America a region that produces more technology? And, what is the reason, except for a few distinguished exceptions that there are no companies that stand out globally in more advanced areas of technology originating from this continent? This is an age-old discussion, but a very important one, and which, deep down, is the attempt to answer the question: "What makes some places in the world more propitious to innovation than others?"

The abundance of natural resources in Latin America has been pointed out as an important explanation for having little concern with the innovation that predominates in the region. Fairbanks and Lindsay (2000) state that the local businessmen tend to presuppose that the advantages in natural resources, abundant raw material, and cheap labor will proportion positions of leadership in the export markets and, because of this, do not create the conditions for such innovation. Asian or African countries are constantly surpassing Latin American countries, especially when these countries try to be strong in areas related to natural resources or cheap labor. The reason is that African or Asian countries can and make their costs with labor even cheaper or enter the international market selling a natural resource for less. Furthermore, Fairbanks and Lindsay (2000) point out another important reason for the lack of innovations: It is the deficient cooperation among the companies. According to them, there is no culture of cooperation among the companies of the region. Contrary to countries such as Italy, where they have "clusters," also referred to as industrial groups, promoting cooperation and encouraging the companies to unite, for example, and jointly seek external markets, launch a new brand or even invest jointly in R&D – research and development – whereas in Latin America, almost invariably, the businessmen see the competitor as an enemy that should be knocked down.

This contributes to creating a climate of mistrust, suspicion, in every sector that always destroys any possibility of cooperation. An honorable exception is the automobile industry and their relations with the suppliers of auto parts in Argentina, as well as in Brazil or in Mexico. But this is the exception to the rule, probably, due to the fact that these are sectors where there is a predominance of foreign money.

This lack of business cooperation also explains the small number of *clusters* in the region and as Fairbanks and Lindsay state (2000): *"…we note a profound absence of clusters in correlated or support sectors, and a corresponding lack of innovation: companies that do not cooperate amongst themselves are not capable of learning from one another."*

Dicken (1998) calls attention to the fact that the old division of labor, when the developed countries produced manufactured goods and the developing countries sold their commodities, minerals, or agricultural products, is not valid any longer. Today, the flow of merchandise throughout the world is extremely complex and has become possible because of the fragmentation of the commodity chain. However, what we see is the existence of some commodity chains which extend throughout numerous countries of Latin America, but they are almost entirely headed by companies with headquarters in countries of the developed world. As examples of these chains, we could cite the automobile, pharmaceutical, data processing and telecommunication equipment, finished consumer electronic goods, and the chemical sectors. Generally speaking, the companies of these sectors have North American, European, or Japanese capital and are in Latin America in search of a profitable market, the size of which is not small and also with the intention of obtaining cheap labor to employ in their production lines, which most times is limited to finished goods. Any phase of the vast process of the value chain of global companies will not be realized in the respective subsidiaries in Latin America if in that phase there is a need for some technological development. In this hypothesis, it will certainly be realized in the headquarters of these companies which can be found exactly in North America, Europe, or Japan.

It should be noted that Porter and Stern (2002) mentioned Latin America and emphasized as great vulnerabilities in the region, referring to increased innovations, the lack of a link between the universities and the companies. According to them, "the system of higher education in Latin America has little to do with the companies and little involvement with the national policies related to science and technology."

This is confirmed by other authors who have dedicated themselves to analyze the question of science and technology of the continent. Sagasti (1981) points out that one of the chronic problems of Latin America is the enormous distance between producing science and the generation of technology which, according to him, is a consequence of the nonexistence of a constructive university-company relationship.

This same aspect is placed by Millan and Concheiro (2000) when they analyze the reasons for Mexico's backwardness in the questions of science and technology. They go beyond, mentioning that an additional reason for the country's delay in this question is the lack of an industrial policy that would define the priority areas for investment, and it is very clear that contrary to the more developed countries where the companies invest in research and development; in Mexico, this expenditure is largely done by the government. Thus, while in Japan, Germany, and the United States the private companies are responsible, respectively, for 67.1, 61.1, and 58.4% of the total expenditures with R&D, in Mexico, this amount is merely 17.6.

In 1999, the British magazine *Nature* produced a special edition called "Science in Latin America." In the article dedicated to Mexico, there is an important analysis about the fact that helps to explain the numbers above and that is repeated throughout the continent: "*Part of the problem is cultural. Mexico inherited the European tradition of the scientist as an academic and not the North American model of scientist-inventor and businessman. For a university researcher to have a link with industry is considered prostitution by his colleagues. On the side of industry, there is not a strong tradition in R&D investment. Until the beginning of the 80's, Mexico had an industrial policy defined by the state and protectionism which resulted in little incentive to invest in innovation. Now the companies want to modernize their technology, but they turn more to foreign companies for help, and are not willing to wait the time necessary for national science and technology to find the answers to their needs*."

4 The Problem of the Absence of Large Companies with Capital Originating in the Latin American Region

More than 30 years ago, Galbraith (1978, p. 47) pointed to the fact that large companies are always increasing their supremacy and strength over the economy because *only* they will have the conditions to sustain the expenses needed for innovation. "*The small company does not have the conditions to sustain the cost that innovation demands*" Galbraith said in "The New Industrial State" (1978). In all of his books, Galbraith (1978, p. 21–22) stressed the advantages of a large organization: "*The large organization can tolerate the uncertainty of the market, which cannot be done with a smaller firm. It can escape through contracts, which a smaller firm cannot do (...) All, with the exception of the pathologically romantic, now recognize that this is not the time for the small*."

More recently, Stiglitz and Walsh (2003, p. 338–9) explained the reasons why technological innovation is increasingly a subject restricted to the large corporation. Stiglitz points out four reasons that make it difficult for small companies to generate technology. "*First, to compensate for the expenses with research and development, and in this way stimulate innovation, the inventions are protected from the competition through patents. Patents are destined specifically to limit the competition. Second, the industries in which technological change is important normally have elevated fixed costs. This means that the average cost is decreasing to levels of production that are quite high - another characteristic which limits the competition. Third, the industries that are characterized by rapid technological change are also those in which the advantages of an increasingly larger experiment, with new production techniques, could cause rapidly decreasing costs. Finally, why aren't banks, in general, willing to finance research & development, it is difficult to raise funds for new and small companies. All this makes it difficult to enter the market and reduce the competition in the sense defined by the basic competitive model.*" And this fact, according to Stiglitz, explains the importance of subsidies for small companies.

Through analyzing the relations that usually appear annually about the biggest companies in the world, we note that not even the biggest Latin American companies can be considered expressive and active in the areas where the most important technological developments occur. This was clear, for example, in the 2011 report of the North American consulting firm BoozCo (old BoozAllen) where they investigated the information referring to the year 2010, of the 1,000 companies in the world that most invested in R&D and where they state that there are only five Latin American companies – Petrobrás, Vale, CPFL, Totvs, e Embraer – by the way, these are all Brazilian. Undoubtedly, this causes concern: Despite the fact that the GDP of the region corresponds to 7% of the world GDP, only 0.5%, of those 1,000 companies mentioned in the report are from Latin America.

The same gravity could be noted when one examines the Forbes Year 2010 list – www.forbes.com – which present the 2000 largest companies in the world. There, we note that only 76 companies are from Latin American, in other words, 3.8% of the report. The biggest reason or concern is not so much the number, which is very small, but the fact that only Embraer can be considered as high technology. In other words, almost all of the Latin American companies that are among the 2000 biggest are from sectors such as retail, mining, food, and commodities where the technological component is very low.

Brito Cruz (2004, p. 13–15) calls attention to the role of the company, in general, in the production of technology, highlighting that if the place for science and education is the university, the place for development and technology is, par excellence, the company. He cites the case in the Unites States where in 2001 there were one million people working in R&D – research and development, being that 80% of these same worked for companies and only 20% for universities or government research centers. Brito Cruz states that unfortunately this fact is not the reality in Brazil. In Brazil, in 2001, there were 125 thousand people working in R&D, of which only 23% worked in companies. South Korea has a population four times less than Brazil but has a greater number of researchers: 160 thousand people and approximately 59% of them work for private companies.

With these data in hand, Brito Cruz (2004, p. 6–9) referring to Brazil said that "*contrary to what is imagined, technological innovation is created much more in the company than in the university. In Brazil there has lately been a tendency to attribute to the university the responsibility for the innovation that would make the company more competitive. This is a serious mistake and which, if taken seriously, could cause great damage to the Brazilian university system, taking it away from its specific mission, that of educating professionals and generating fundamental knowledge*".

5 Institutional and Policy Dimension

For Malecki (1997), the general panorama of technology in Latin America shows that institutions are weak and political considerations predominate, which end up costing more due to the lack of long-term strategies for science and technology and the lack of involvement of the private sector.

Peter Dicken (1998) emphasizes that an important characteristic in the development of third world countries, Asian or Latin American, is the strong presence of the state. Nonetheless, this author points to the fact that in Latin America the governments were not as successful as the Asians. According to him, the main reason for this lack of success was the absence of concern with increased internal empowerment aiming to increase exportations. While in Asia, the greatest concern was increasing exportations of industrialized products, in Latin America, the emphasis was in substituting importations.

Related to this aspect in 1999, the British magazine *Nature* published a special supplement called "Science in Latin America" with an interesting article by its editor Collin Macilwain (1999) in which he analyzed the conditions of science and technology on the Latin American continent at the end of the twentieth century, but which continues to be totally valid. In the beginning of this twenty-first century, the intellectuals and Latin American scientists lament the extinction on the noncompetitive industrial base that existed behind the commercial barriers of the old Latin American economy (pre-neoliberalism). In that economy the role of science and technology was clear: Science would help technology build a domestic industrial base that would take the region to the developed world. However, says Macilwain, a large part of this industry, due to noncompetitiveness, collapsed when this became evident during its peak, in the 1990s, and the neoliberal doctrine brought international competition. As such, factories and companies were sold to multinational corporations who are modernizing them, with technology imported from abroad. Macilwain concludes science and technology in Latin America need to redefine their role in this new configuration.

Since the mid-1960s, in all of the countries throughout Latin America, we assisted the creation of numerous centers and institutions of research and development, but all were of a public nature. Nonetheless, few deserved special attention and money from their respective governments. In spite of this, some of these were decisive in creating quality research in the economic sectors of their areas, and today, they play a fundamental role. We can mention at least two Brazilian examples, ATC – Aeronautic Technological Center (CTA, Centro Tecnológico da Aeronáutica), which is considered to be the main reason behind the success of Embraer and EMBRAPA (Brazilian company of cattle and grains) which is considered responsible for the greater part of the research which resulted in the enormous increase of the Brazilian agricultural productivity during recent times. Malecki (1997) considers that what has occurred in these two areas in Brazil should be a model of what should have been followed by the other Latin American countries.

Chris Freeman and Luc Soete (1997), upon comparing the economic development of some nations in Asia, specifically South Korea and Taiwan, with the progress in Latin America during the decade of the 1980s, called attention to the importance of the differences that exist in some few aspects. Some of them are institutional like:

1. Deteriorated educational system with few graduating engineers
2. Much transference of technology, especially the United States, with low absorption capacity due to little investment of local companies in research and development
3. Weak infrastructure of science and technology

Conceding subsidies or fiscal incentives for projects of research and development receives low priority on the agendas of most of the governments of Latin American countries. The country most advanced in this theme is Brazil that only recently approved legislation – the "*Lei do Bem*" or "well-being law" – which supports innovation, but which only timidly fumbles the question of incentives.

We cannot conclude this analysis of the why there is little involvement with innovation and technology, especially when we talked about institutional aspects, without speaking of the vulnerability of the patent system existing in many of the Latin American countries: Many local companies see their investments in research paralyzed by the absence of mechanisms that guarantee the propriety of the research results. As all research activity consists of risk for the companies, it would be vital for the existence of such a mechanism. Nonetheless, to obtain a patent in Latin America is something very difficult and slow.

6 Final Considerations

As we have seen, Latin America is very wealthy in natural resources, and, generally, the labor is cheap, and these are the main ingredients that stimulate large companies of the region, with very rare exception. Why a region so blessed with natural resources and gifts of nature has failed in developing and industrializing in the same way that other regions have had success? We have sought to explain, and, as we have seen, there are many different aspects and explanations. We have emphasized in this chapter one of these aspects related to the fact that the region is not successful at generating an expressive number of global companies. Latin America has a few powerful companies but almost always performing in sectors that were important in the nineteenth century and became irrelevant in this twenty-first century. Being a global player in sectors such as drinks, cement, mining, agriculture fish, or steel is not bad, but it is not sufficient. As we have seen, more developed countries have companies in sectors that dominate the world economy, such as communications, software, hardware, medical equipment, or pharmaceuticals. In other words, we can say that the big Latin American companies, generally, are out of the high technology sectors with very rare exception, such as the Brazilian Embraer, manufacturer of planes, or the Mexican Mabe, in electronics. So it is easy to notice that when companies from Latin America achieve size and projection, they are in low technology industries, most of the time producing "commodities." Petrobras and Cemex are excellent examples.

It is clear that no country can survive, with dignity, exporting only their agricultural and mineral "commodities" to pay, for example, for the importation of pharmaceuticals or computers, as is today the rule in almost all of the countries of Latin America. Increasingly, the wealth of natural resources of the region is being consumed as currency, instead of, at least, being administered as a basis for sustainable development. Basing development in raw materials is never the solution. All we need to do is look at the countries of OPEC, who supposed that they could achieve higher stages of development at the cost of petroleum when the exact opposite is what happened.

Furthermore, the recent globalization of Latin American countries together with the growth of the population is radically affecting the environment of the continent. The growth of exportations has been mainly in the sectors of agriculture, fish, and mining. This means more deforestation for the exportation of wood and making more lands available for agriculture and livestock.

But it is important to make this very clear that the solution of the aspects mentioned in this chapter cannot be exclusively up to the Latin American companies: Some measures of governmental support are necessary. For example, the small investment in education, and the little infrastructure destined to research are very important to explain the little presence of Latin America in all that is relevant today in science and technology. Generally, the fragility of the infrastructure is a serious problem for all the countries of the region. It is fundamental that the same be perfected to facilitate a more competitive flow of material, machines, and goods. The way things are, this kind of inefficiency greatly increases the operational costs and makes it very difficult for the companies to become globally competitive. In fact, this is not the only point where the various governments from the countries of the region fall short. The Latin American companies need to operate in a legal system, but sometimes, they are politicized, and, frequently, they are corrupt and with markets of weak capital and very low levels of savings. Credit is very difficult, and mechanisms for long-term financing are rare. Interest rates are very high, and in some countries like Brazil, the tax load has already surpassed one-third of GDP.

Another important measure that should involve government and society is the stimulation to form big conglomerates as has been done in Korea and Japan and to support the formation of *clusters* as is the case in the United States and Italy.

The treatment of this question is extremely difficult for the various governments of the region and because of this fact the society and the legislators will have to be involved. There are no other alternatives: Without big groups, strong and healthy, and without professional administration, there is no way to compete in the difficult scenario of globalization. Without horizontal and vertical groupings of related companies, in other words, "clusters," you cannot achieve even economies of scale, nor technological development. A typical example is what happens with exportations. The companies will only increase, sustainably, their exportations when they are more productive and more competitive, and this depends very much on them. It has taken Brazil a long time to perceive this mistake, but it seems that now it is clear for its businessmen and government. Nonetheless, it still is a chronic mistake throughout the region, with different shades, to think that increasing exportations is merely a question of macroeconomic policy and that it is enough to change the exchange rate or the interest rate or play with inflation goals. Not that the governments have been wrong, a good part of the governments have acted correctly, from a macroeconomic point of view, but the positive results were short lived, as the problem, truthfully, is due to the companies, in the way that they define their strategies and in their management. Solving the macroeconomic problems could be a necessary condition, but it is not enough to increase competitiveness. It is fundamental that attention is also given to the problems of the company, examining them up close, actuating as soon as they appear, and assisting in what makes it difficult to increase international competitiveness. As incredible as it may seem, in spite of being specific and individual problems, the governments have very much to do, especially because they are responsible for increasing the competitiveness of the countries as a whole.

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Part 1.2
Technology Management

Technology Management to Accelerate Competitiveness Journey: Exploratory Case of a Renewable Energy Focal Firm from India

Kirankumar S. Momaya and S. Chachondia

1 Introduction

Discontinuities such as worldwide recession can provide exciting opportunities for emerging countries and their firms capable of accelerating their competitiveness journey. Among many emerging countries, Brazil, Russia, India, China, and South Africa (BRICS) were expected to provide growth impetus to world economy in recession due to their size and associated markets; China has already emerged to be the second largest economy due to accelerated competitiveness. Relatively younger but huge population is a key driving factor to help India make some remarkable jump in competitiveness ranks (from 47 in 2005 to 28 in 2009, Yadav and Momaya 2011). Competitiveness journey to next stages and the discontinuities demand new perspectives and rapid scale-up in business, technological, management, and other capabilities for sustainability.

With growing aspirations, the countries will need massive scale-up in emerging industry of renewable energy. Large countries by population such as India face unparallel challenges in their journey to development. Economic development models that proliferate with globalization are very energy intensive, and the large countries can become major sources of emissions of carbon and other gases, but the countries do not have maturity of technology to manage them. For instance, despite significant reduction, energy intensity per unit of GDP remains quite high for India (Table 1), indicating wastages and low efficiencies. At the same time, the countries are

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Table 1 Trends in energy intensity for select large countries

Country	Kt oil equivalent/Bn $ GDP (year 2000)	Kt oil equivalent/Bn $ GDP (year 2007)
Brazil	293	177
China	911	578
France	191	102
India	**994**	**505**
Japan	111	117
Russia	2,349	519
UK	152	75
USA	234	170

Source: Composed based on data from PC (2011)

increasingly expected to reduce their carbon load and adopt renewable energies (RE), even with several misfits and resulting imbalances, e.g., in terms of technologies, cost, capabilities, and trade. For instance, a review of thermal power plants, the dominant mode of capacity addition, points to serious issues of resources (coal, water), pollution, and social and environmental damage (e.g., Dharmadhikari and Dixit 2011).

After strong interest in 1970s, photovoltaics (PV) are driving rebirth of solar industry in India. While R&D (e.g., at Indian Institutes of Technology/IITs or IISc) did result in pilots and applications, wider diffusion through cost reduction (e.g., by economies of scale) is the game best played by firms. Rapid diffusion of wireless communication in India is a demonstrated case, and wireless energy may do the same (Kumar et al. 2010). Industries and focal firms that have or build capabilities to address the issues related to energy smartly have a huge opportunity to contribute to world. Focal firms are those close to center of an industry's ecosystem due to unique differentiated positions they strive for (at least in a country) and can often be large firms due to diverse capabilities needed including one related to risk of technology development.

Attractive forecasts and government intervention were driving investments in photovoltaics as firms of Indian origin (FIOs) try to scale-up. As latecomers, many seem to be caught in the vicious loop of "technological capability gap." The $60 billion PV market is expected to increase to $300 billion by 2020. Being less harmful than thermal, several focal firms of Indian origin (FFIOs) are keen to contribute to this growth of PV. Innovations and technology management can play a key role if the firms want to really grow for a long time.

Taking the case of renewable energy industry and a capable focal firm, we try to make sense of the phenomenon of "technological gap vicious loop," key dilemma, including one related to competitiveness, technology management, innovation, and critical success factors (CSF).

2 Brief Literature Review

Literature review has been given briefly for this application-focused chapter. Only two key concepts whose application is being explored are discussed briefly here.

2.1 Competitiveness Stages and Journey

Competitiveness is a context-specific concept with high relevance across levels: from country to firm and beyond. We will focus on firm level in this chapter. Firms can ascend the stages (e.g., from locally competitive to globally; Momaya 2001) and can accelerate the journey up stages by effectively leveraging drivers such as strategy, organizational, and technology management capabilities. In simple generic terms, competitiveness of a firm can be defined as its ability to conceive/design/engineer/manufacture/distribute/service battery of product(s)/service(s) better than competitors on a sustained basis. Such generic competitiveness can be evaluated on performance factors such as productivity, financial, international, and technological as well as several "competitiveness assets/process" factors (Momaya 2011). Specific definitions need to be evolved by the firm considering factors such as stage in "competitiveness journey," mission, vision, and values.

2.2 Critical Success Factors (CSF)

An industry's CSFs are those competitive factors that most affect industry member's ability to prosper in the marketplace. Sometimes referred to as key success factors (KSF; e.g., for breakthrough, Shiba and First Learning Community 2006) that can be the particular strategy elements, product attributes, resources, competencies, competitive capabilities, and market achievements that spell the difference between being a strong competitor and a weak competitor—and sometimes between profit and loss (Thompson et al. 2010). They identify common types of industry CSF across areas from manufacturing, marketing, and distribution to skills and capability-related. For instance, they listed following technology-related CSFs:

- Expertise in a particular technology in scientific research (important in pharmaceuticals, mobile communications, and most high-tech industries)
- Proven ability to improve production processes (important in industries where advancing technology opens the way for higher manufacturing efficiency and lower production costs)

From generic skills and capability-related perspective, technology, manufacturing, and other CSFs can have overlaps.

3 Methods

For this practitioner-focused chapter, we explored multiple methods to address key questions. The most important element is exploratory case study. In light of the context, approach of exploratory case study (Yin 2003) is adapted with focal firms as a unit of analysis. We also use secondary data to make sense of situation, actors, and processes as part of SAP-LAP model (Sushil 2009). Several constructs were adapted from the ones developed and tested for similar context of accelerated growth (e.g., Umamaheswari 2010) and simplified. The case focuses on situation (large emerging country context, vicious loop, latecomer eMNE), actors (top management team, partners, complementors) and processes (e.g., entrepreneurial orientation [EO], opportunity identification [OI], strategic leadership [SL], technology management [TM] including technology assessment, transfer, adoption, adaptation, upgradation), and trends in performance (growth, financial, profitability). Elements of SAP-LAP are implicitly embedded in the case due to limitations of space.

Selection of case company was done after examining several alternatives. Key criteria considered were:

- Active player in some arena of renewable energy (or intent and capabilities to enter)
- Track record of high growth amidst challenges achieving revenues more than 2,000 crore in 2010
- Leading market position in India and preferably internationally
- Manufacturing capabilities

Among several companies that met criteria, Moser Baer India Ltd. (MBIL), Tata-BP, Suzlon, Solar-semiconductor, and Indosolar came closer. Ultimately, Moser Baer was selected for the following reasons:

- Has reached heights such as within top three ranks in the world in manufacturing of storage media
- Has manufacturing capabilities involving sophisticated technologies
  The case draws heavily on official facts given by the company.

4 Case of Moser Baer

4.1 Situation-Actors-Processes (SAP)

Since founding, Moser Baer has played game of technology-related businesses with short life cycles. Moser Baer India was founded in New Delhi in 1983 as a time recorder unit in technical collaboration with Maruzen Corporation, Japan, and Moser Baer Sumiswald, Switzerland (Moser Baer 2011a). In 1988, Moser Baer India moved into the data storage industry by commencing manufacturing of 5.25-in. floppy diskettes. By 1993, it graduated to manufacturing 3.5-in. micro floppy diskettes (MFD).

Entry into CD business helped it climb higher stages of international competitiveness. In 1999, Moser Baer India set up a 150-million unit capacity plant to manufacture recordable compact disks (CD-Rs) and recordable digital versatile disks (DVD-Rs). The strategy for the optical media project was identical to what had successfully been implemented in the diskette business—creating a facility that matched global standards in terms of size, technology, quality, product flexibility, and process integration. The company became the only large Indian manufacturer of magnetic and optical media data storage products, exporting approximately 85 % of its production.

Cooperation with OEMs was a key element of internationalization strategy. Since inception, Moser Baer has always endeavored to create its space in the international market. Aiding the company in its efforts has been a carefully planned and sustainable business model—low costs, high margins, high profits, reinvestment, and capacity growth. Along the way, deep relationships have been forged with leading OEMs, with the result that today there are hardly any global technology brands in the optical media segment that Moser Baer is not associated with.

Company has aggressive plans to repeat the past successes in international arena in photovoltaic. Its cooperation with institutes such as IITs and IT BHU helped it rapidly enter new arena by enhancing technology transfer and absorption. It got approval from Ministry of Science and Technology of India for its in-house R&D center, a driver of its efforts in technology and patents. By 2010, the firm has global presence with products sold in more than 82 countries (Moser Baer 2011a). Key milestones in Moser Baer's photovoltaic-related journey are given in Table 2. Let us have a look at key elements of its PV plan.

Key elements of strategy of Moser Baer build on its generic strategy of other businesses. Here is just a glimpse of key elements (adapted from annual reports e.g., Moser Baer 2011a):

- Present across the entire value chain and investments in multiple PV technologies
- A combination of adapted technology and low-cost manufacturing expertise, with fully automated production facilities ensures top quality products
- Production capacity of 50 MW crystalline cells, 50 MW crystalline modules, and 90 MW thin films in 2011 with expansion plans in place
- Also had an initial capacity of a few megawatts in concentration PV
- Products meet international standards including UL, IEC, ETL, and CE
- Claims strong commitment to R&D and innovation

Firm leveraged core competencies in high-volume manufacturing of optical media products to create a world-class photovoltaic manufacturing facility. CD, DVD, Blue Ray, and PV cells all involve coating a substance on a flat surface. Strategy was to straddle multiple technology platforms and to drive scale to be able to drive down the costs of the technology and make it more affordable to consumers globally.

The solar photovoltaic business got major boost with India's national solar mission. In January 2010, Indian government announced $19 billion plan envisaging 20,000 MW off-grid interactive and 2,000 MW off-grid applications in three stages by 2022. With increasing capacities in manufacturing, strong EPC capabilities, Moser Baer has potential to emerge as a key international player from India if it can come out from the vicious loop.

Table 2 Key technology management-related milestones in Moser Baer's photovoltaic journey

2005
Announced Moser Baer Photovoltaic Ltd. (MBPV) as its wholly owned subsidiary
Signed MoU with IIT, Delhi
2006
Signed technology MoU with IT BHU
In-house R&D center approved by Ministry of Science and Technology
2007
Acquired OM&T BV—a Philips' optical technology and R&D subsidiary
Announced start of trial run of solar photovoltaic cell production facility
Set up the *world's largest* thin film solar fab
Launched US$150 million FCCBs
Moser Baer Photo Voltaic announced commercial shipment of solar photovoltaic cells
Moser Baer Photo Voltaic announced US$880 million strategic sourcing tie-up with REC Group
2008
Moser Baer plans 600 MW thin film PV capacity with an estimated investment of over $1.5 billion
Moser Baer Photo Voltaic announces strategic sourcing tie-up with LDK Solar
Moser Baer announces successful trials of first Gen 8.5 thin film plant
Moser Baer secures customer sales orders of $500 million for solar modules
Global investors inject Rs. 411 crore into Moser Baer's solar photovoltaic business
Moser Baer announces successful trials of first Gen 8.5 thin film plant
Moser Baer Photo Voltaic announces strategic sourcing tie-up with LDK Solar
Moser Baer plans 600 MW thin film PV capacity with an estimated investment of over $1.5 billion
2009
Moser Baer's thin film solar modules are now IEC certified
Moser Baer to set up one of India's largest rooftop solar PV installations in Surat
Moser Baer's thin film line ready for production of ultra-large solar modules
2010
Achieves 7.3% efficiency for single junction thin film modules
Thin film product becomes internationally certified
Emerges as the first solar PV company from India to achieve 100 MW of installations globally "under its own brand"
2011
Starts commercial production of junction boxes
Commissions India's largest 5 MW solar farm in Sivaganga, Tamil Nadu, and 5 MW plant in UK
Doubles warranties on products through in-house R&D
2012
Moser Baer Photo Voltaic was admitted to corporate debt restructuring (CDR) in January

Source: Adapted from Moser Baer (2011a, b), web site, annual reports, and media reports

4.2 Key Learning

While the firm has demonstrated capabilities on mass manufacturing and marketing front, technological capabilities seem to have lagged behind relatively. The firm has been quite fast at seizing opportunities, installing capacities and certifications, and exploring local and international markets. The firm will leverage relationships, distribution, cost leadership, and "can do" attitude to become a global market

Table 3 Trends in recent patent applications by Moser Baer

Year of publication date →	2004	2005	2006	2007	2008	2009	2010
Moser Baer India	1	3	2	–	–	2	7
Moser Baer Photo Voltaic	–	–	–	–	8	6	1

Source: Developed based on search at worldwide database of European Patent Office

leader in every business (Moser Baer 2011a; mission). The firm has been trying to accelerate development of products, services, and even technologies. For technologies, it has started R&D center. It is trying to accelerate technological capabilities through collaborations with institutes such as IITs (see Table 2) as well as acquisitions. Still, patterns in R&D spend or patents are fuzzy (glimpse is given in Table 3) to say it has started climbing on stages of technological maturity.

The case gives some clues to approach taken by latecomers to catch up and the role of technology management in that. Ability to reach among top three ranks in storage media is attributed to capabilities the firm developed in quality mass manufacturing. If the focus is on manufacturing part only, the CSF can be often found in:

- Technology assessment, identification, and selection
- Excellence in technology transfer and adoption, adaptation

Strong urge of the promoters to do a business away from technology hints at challenges to technology-related industries from India. Despite being a very successful company to have played hardware business in fast-growing ICT industry and reached remarkable global heights, the firm is fast diversifying into segments of energy sector where technology is not a key driver. Hence, such firms will be more interested in that part of technology management that is urgently needed for cost competitiveness, such as technology transfer and absorption (TTA). They would not like to play either fast games of rapid invention to commercialization or marathon games of differentiation through deeper technovation capabilities. Mismatches in risk and time profiles of enterprises in India and emerging technologies can be considered a key reason for many Indian firms shying away from playing games based on technology management.

5 Emerging Findings and Discussion

Let us first begin with macro level before going in details. Several countries have active interest in renewable energy and focal firms from those countries having contributed massively to help the country take the lead. Let us start from some quick learning from reality of wind energy, a dominant renewable energy where a focal firm from India did make a mark. Germany has often taken the lead and sustained for quite some time (Table 4). Overall, EU has undisputed lead in the industry and has sustained competitiveness, partly due to innovation and technological capabilities. China often enters late as a follower but has capabilities to

Table 4 Trends in installed wind energy capacity of major countries (MW)

	2001	2002	2003	2004	2005	2006	2007	2008	2009
China	**402**	**469**	**567**	**764**	**1,260**	**2,604**	**5,910**	**12,020**	**25,805**
EU total	17,315	23,159	28,598	34,371	40,551	48,029	56,531	64,719	74,767
Germany	8,754	11,994	14,609	16,629	18,415	20,622	22,247	23,903	25,777
India	**1,456**	**1,702**	**2,125**	**3,000**	**4,430**	**6,270**	**7,845**	**9,655**	**10,926**
Japan	302	338	580	809	1,049	1,394	1,538	1,880	2,056
Spain	3,337	4,825	6,203	8,263	10,027	11,623	15,145	16,689	19,149
US	4,275	4,685	6,372	6,725	9,149	11,575	16,824	25,068	35,064
World	**23,900**	**31,100**	**39,931**	**47,620**	**59,091**	**74,050**	**93,835**	**1,20,297**	**1,58,505**
India as % of world	**6.09**	**5.47**	**5.32**	**6.30**	**7.50**	**8.47**	**8.36**	**8.03**	**6.89**
China as % of world	1.68	1.51	1.42	1.60	2.13	3.52	6.30	9.99	16.28

Source: Global Wind 2009 Report, Global Wind Energy Council

enter top league by shifting the critical success factors toward "performance/price ratios" and manufacturing excellence. India was far ahead of China in terms of installed capacity of wind energy at beginning of 2000, but China overtook in 2008 with a massive lead. Limited success of India can be partly attributed to accelerated competitiveness of the highly entrepreneurial focal firms such as Suzlon, but the firm seems to have entered the vicious loop once the competition intensified, e.g., from China (Table 4).

The case of MBIL and learning from firms in related renewable industries (Suzlon) support the phenomenon we may call "low capability vicious loop." The phenomenon has elements such as slow learning, weak capability focus in strategic intent, gaps in leadership, and weak cooperation in micro and macro environments. The elements have linkages at firm, industry, country, and higher levels (e.g., of the loop, please refer to Mittal et al. 2009). From the case and ongoing research on competitiveness over years, we identified the following characteristics of the phenomenon in terms of generic capabilities:

- Significant scale-up in sales due to opportunity-based growth and profits, often driven by growth and entrepreneurial orientation (e.g., Umamaheswari 2010)
- Yet low investment in human resources and capability building, low learning maturity, less able to scale-up except on sales, e.g., neglect of the technological capabilities (e.g., forecasting, assessments) and hence often opting to be latecomer
- Less able to balance opportunity based and capability based
- Unable to scale-up or even sustain when industry or segment is commoditized (e.g., due to economies of scale by players from China); starts focusing on another segment or industry and less able to break out from the vicious loop

In the context of this chapter, we will focus on technological capability. The MBIL case and Suzlon example support many of the above characteristics. Technology management can be a CSF for FFIO, but they seem unable to scale up TM capabilities and get caught in the vicious loop. There seems to be major gaps in technology assessment and forecasting, transfer and absorption, R&D, design and development (RDDE), and other capabilities. The loops were found to be much adverse in *the information and communication technology and electronic* (ICTE) industry (e.g., telecom, Mittal et al. 2009). For instance, it is estimated that due to similar reasons linked to elements in the loop, even with low actual value added, the domestic production in electronics in India can only be raised to US$100 billion against a demand of US$400 billion in 2020 (MCIT 2011). The rest would have to be met by imports resulting in adverse consequences on several fronts such as employment, national security, trade balances, forex, and technology. Focal firms with stronger capabilities and links between technology and business strategy (e.g., Tata Motors) are more likely to climb up in competitiveness journey.

This exploratory research hints at several potential areas for further exploration, key ones are listed here:

- Business system design at industry level is often done by a leading developed country. It seems that once the technology is embedded in products or components, latecomer firms from emerging countries have only limited choices on downstream of industry value system, e.g., operations, marketing, and services. On such parts, technology is merely an enabler; hence, limited scope for technology management as core technology development is involved. In open markets such as India where pace of change is fast, how should the classical dilemma about long technology development cycles (Nobeoka 2006) and much shorter market cycles be resolved. This is particularly a key dilemma for latecomer firms from emerging countries, where it is very difficult to get out from the vicious loop of "low technological capabilities" (e.g., for a case of telecom, see, Mittal et al. 2009). Asian firms such as Samsung and Huawei could break out and provide rich contexts for research.
- Breakout from the vicious loops often demands breakthrough management on part of a capable focal firm(s). Efforts by some clusters in India (e.g., under the guidance of Shiba and First Learning Community (2006)) may help some firms reach higher stages of competitiveness. Breakout and sustained competitiveness of an industry of a country also require supportive thinking and environment on part of other stakeholders of an industry, including governments (Mittal et al. 2009). Focus on capability-based (e.g., Umamaheswari 2010) approach to accelerate competitiveness demands high cooperation on internal and external fronts. Enormous scale-up that institutes such IIT Bombay are trying in photovoltaics (through centers such as NCPRE) can make much bigger impact, if the cooperative strategies among industry, academia, and governments are implemented effectively.
- Higher stages invariably demand international competitiveness. Accelerated competitiveness journey often requires major focus on international fronts to achieve balances on several fronts. This can be a high potential area of research. Phenomenon of breakthrough growth, particularly by EMNEs from India, is an under-researched and under-implemented dimension.
- Winning through innovation and technology is very challenging but possible. Sustaining the lead is even more challenging. At the same time, balances

with profitability, environmental impacts, and new growth industries are also important that even countries with highly sustainable development such as Japan (e.g., METI 2010; Aoshima 2012) find it challenging.

- More than technological capabilities (which can be sometimes developed in narrow contexts), organizational capabilities assume higher importance, if the technologies developed are to be taken to higher levels of diffusion internationally. There is need to develop frameworks and matrices affecting stages of technology management maturity to accelerate competitiveness journey such as internal factors—organizational and technological capabilities—and external factors such as country's technological competitiveness (Momaya 2008) and related and supporting industries.

6 Concluding Remarks

Few remarks that link this chapter with years of our ongoing research on competitiveness and role of technology management may add value as we conclude this exploratory case-based paper. Focal firms with rapid scale-up capabilities can play a key role in breaking the vicious loops and accelerating growth of sustainable industries, including cleaner energy. Technology management can be a key driver depending on context. While in several countries, particularly China, Japan, and Korea, the cooperative strategies have made the focal firms do impactful scale-up leveraging technology management, the situation in India seems less conducive. There are, in simple strategic management terms, two paths to excellence and sustainable competitiveness: opportunity-based and capability-based. Only a few firms in India are able to achieve the balances needed among the two and other fronts to accelerate the competitiveness journey. The growth also requires building sound ecosystems of related and supporting industries, without which fragmented technological excellence of select firms and institutions cannot be translated into sustainable industries. There is very important role for governments if the firms and industries in India are to break the persisting vicious loops. Obviously, there is enormous scope for execution excellence of strategies and research—a challenge for firms and institutes with youth and energy.

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Assessment of Technology in the View of Sustainability and Capability Approach: A Case-study of Home Inverters

Pramod Khadilkar and Monto Mani

1 Introduction

Unbridled exploitation of natural and societal resources to singularly sustain economic prosperity has evidently resulted in ubiquitous pollution, environmental disruption, inequity, ill-health, starvation, and poverty. While technologies (in the form of products) are intended to enhance human well-being, in pursuit of development, many have infringed upon basic human abilities, traditional practices, societal well-being, and sustainability. For example, obesity, stress, intolerance, etc., are clearly attributed to modern lifestyles based on the influx of modern technology/products/gadgets. Introduction of any technology/product in society carries significance far greater than that originally intended. Though the extent of this significance usually remains unperceived, it is crucial as it determines sustainability. With imminent realities of resource scarcity and climate change, society must cautiously pursue development. Every new technology introduced should thus be evaluated for its implications on sustainability. Despite increasing access to information and consequent awareness, evaluation of products in view of sustainability is uncommon. It is important to mention that the terms *technology* and *product* are used interchangeably in this chapter, as in the modern context, a product essentially is a technology embodiment.

Evaluating a technology in view of sustainability solely on materials used in its manufacture (such as in life cycle assessment) is important but not sufficient.

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The products' mere adoption in society, over time, can result in severe debilitating social consequences (e.g., extensive computer-related occupation and recreation leading to social and health problems such as depression, loneliness, violence, and spinal distress which would not have been foreseen at its time of introduction; social disruption in family and personal relationships are also evident due to social networking portals such as Facebook and Twitter). Products for societal adoption are generally purchased by society (viewed as a market). Every new product potentially views the societal landscape differently, i.e., a different environment with individual with varying aspirations, values, constraints, and capabilities. A seemingly harmless technology in one context might bring in irreversible damaging effects that threaten future sustainability in a different context (e.g., adoption of calculators has vitiated the ability of mental math among youth, even to perform simple basic arithmetic operations).

Sustainability evaluation in view of a technology can be a complex and data-intensive exercise. However, designers and strategists (and even discerning customers) should be able to access a methodology that could permit evaluation of a technology for its impact on sustainability. A methodology that is simple, relatively less data/resource intensive, scientific, and still fairly dependable in its sustainability assessment would be extremely valuable today. Sustainability assessment is difficult without sound methodology and without clear consideration of the various environmental, societal, and social factors involved (Bell and Morse 1998). The main reasons for this include (Ritchey 2011):

1. Relevance of multiple factors of strong social, cognitive, and political nature that are not easy to meaningfully quantify.
2. The complexities involved are in principle nonreducible and often difficult to comprehensively delineate.
3. Dependency of everything on everything else attributed to extreme nonlinearity in social systems. A marginal factor, with change in other parameters over time, could grow to be the most significant factor determining subsequent change.

This means the final *verdict* on sustainability assessment would be a shaded collage rather than a clear black-and-white answer. The methodology presented here attempts to integrate qualitative considerations (as data) with quantitative variables to ascertain likely future (sustainability) scenarios in view of technology/product use. The validity of the assessment depends on the extent of information available and consultation with experts linked with qualitative data.

2 Methodology for Sustainability Assessment

Designing technologies/products directly linked with people are termed wicked as they need long-term social, commercial, and organizational planning (Ritchey 2011) for appropriate product strategizing. Evaluating long-term systemic effects is a part of the wicked problem. Further, the complexity involved and lack of design clarity has been acknowledged in design literature (Cross 2000; Ulrich and Eppinger 2004).

For assessing any technology, an in-depth understanding of the product is crucial. Further, with many variants of the technology in the market, it is important to discern the motive/acceptance underlying each variant. Societal and environmental factors will influence the way a product has been derived (configured), accessed, used, and retired. All these dimensions are interlinked and should be studied in an integrated manner to provide a unified perspective for sustainability assessment. The assessment methodology should aim to alleviate the daunting complexity involved in the seemingly simple sequence of steps as illustrated through a working example on home inverters.

2.1 Understanding History of the Technology/Product

The history behind the technology's conception, the primary underlying need and its evolution over time, should be studied. An appreciation is to be developed on the technical and social challenges faced including societal objections in adopting the technology (e.g., use of calculators in schools). Defining the range of product variants or applications is important.

2.1.1 Home Inverter as a Case Study

A home inverter comprises a technology-intensive product aimed to store and provide backup electricity to run critical domestic appliances, such as for lighting and computers, to mitigate problems of power cuts. The technology was discerned based on definitions – technical/vernacular, reasons for its sustained market demand – both technical and practical (frequent power cuts). The technology depends on alternating current (AC) as the primary source of power, with batteries being viably used to store direct current (DC) for conversion to AC when required. Different types of domestic inverters (sine wave, modified sine wave, etc.) have also been considered. The statistics on its sales, service, and prominent market sizes have been gathered to realize the product's market volume. Evident literature on accidents, repairs, burnouts, and social change pertaining to inverters has also been collaged in this stage. Here, the product is considered as a whole without going into its details.

2.2 Initial View of Sustainability

Here, an initial unbiased perception of sustainability in view of the product is generated and recorded for two scenarios, one for the society with (adopting) the product and another without. This exercise forces the evaluator (individual or a team) to critically look at the product for its positive and negative impacts on the three spheres of sustainability, i.e., society, environment, and economy. This initial view aids in perceiving likely future changes which would permit the identification of missing considerations among the huddle of variables generated later. The generated initial view is presented below.

2.2.1 Inverter: Initial View

- Social factors:
  - Inverters are primarily used to run computers, TVs, fans, etc., categorized into needs, necessities, and luxuries. Thus, predominant use of inverters is toward improving quality of life (computers) and not basic needs (lighting).
  - In earlier days, the absence of electricity saw people gather in a common place to gossip and keep in touch; the availability of inverters has diluted this social interaction.
- Economy:
  - The associated industry provides employment and income to many families.
  - Further, illegal (unregistered) manufacturers offer interesting value proposition through recycled batteries and electronic components. This also supports an informal sector in the recovery of dead batteries and discarded inverters.
- Environment:
  - Inverters contribute to e-waste that poses a major environmental hazard threatening human and biodiversity health.
  - The manufacture and recycling of batteries involves the use and disposal of carcinogenic materials that are generally not safely handled nor disposed.

2.3 Morphological Analysis

The term morphology is derived from Greek word "morphe," which means structure or form. It is the study of the shape and arrangement of parts of an object and how these parts "conform" to create a whole (system). The object in question may be physical (e.g., an organism, a gadget/thing) or conceptual (mental) (e.g., word forms, concepts/ideas) (Ritchey 2006). The product (system) working in a particular environment influences each other and is reflected in the way the product functions. The structure of the product is designed to fulfill certain functions. Understanding this structure permits backtracking through its function, need, and the environment to identify the origin behind the product/technology. These insights are unlikely to be available in printed literature and are often more tacit than verbal.

Morphology of Domestic Inverters						
Input power	grid			sun	wind	
source of generation	coal	nuclear	hydro			
Battery						
Battery type	starting			deepcycle	marine	
non-leak tech	gelled electrolyte			absorbed glass mat cell partitions		
electrode material	lead/lead oxide			lead calcium	lead antimony	
electrolyte material	acidic (sulfhuric acid)			alkaline		
electrode thickness						
battery life	3-4 years			5-8 years	10years-above	
specification of battery	AmH			Volts		
Energy density	energy/weight			energy/size		
Maintainace	maintainance free			regular maintainance		
battery	inbuilt			external		
Converter Ckt						
step up transformer	separate			combined		
step down transformer	separate			combined		
inverter Circuit						
Input power Interface	Regional			International		
Output interface	Regional			International		
Wiring (Inside home)	existing			new		
Output wave form	square			modified sine wave	sine wave	
price	to user			to government	to environment	
size	small			medium	big	
shape						
casing	plastic			metal	mix	
color	local esthetic taste			International brand		
disposal						
Major parts	body			circuits	battery	
places of use	urban			suburban	rural	
portability	portable			stand alone		
manufacturing	standard company			assembled		
assembly	single unit			separated		
charging	use<->charge			use- charge		

Fig. 1 Morphology analysis (partial)

Morphology analysis permits the product to be broken into subparts, with each subpart identified with a specific function, life cycle, and consequent environmental, social, and economic linkages. This detailed exercise enhances the evaluators' appreciation of the product in terms of its basic subparts (and functions). www.techmotivator.iitm.ac.in provides online reference for beginners.

2.3.1 Inverter: Morphology

The morphology analysis also permits the identification of various impacts of the product on the immediate living environment. While the printed circuit boards (PCB) from the inverter contribute to e-waste, insight into the battery used provides information on the hazards, including overheating and generation of fumes which influences where these are placed inside homes. Recycled batteries contribute to lead and chromium contamination of ground water that is consumed by the community. Figure 1 illustrates a part of the comprehensive morphological analysis presented as a table.

2.4 Systems Analysis

A system comprises three aspects: elements, interconnections, and a function or purpose (Meadows and Wright 2008). A technology/product can be viewed as a

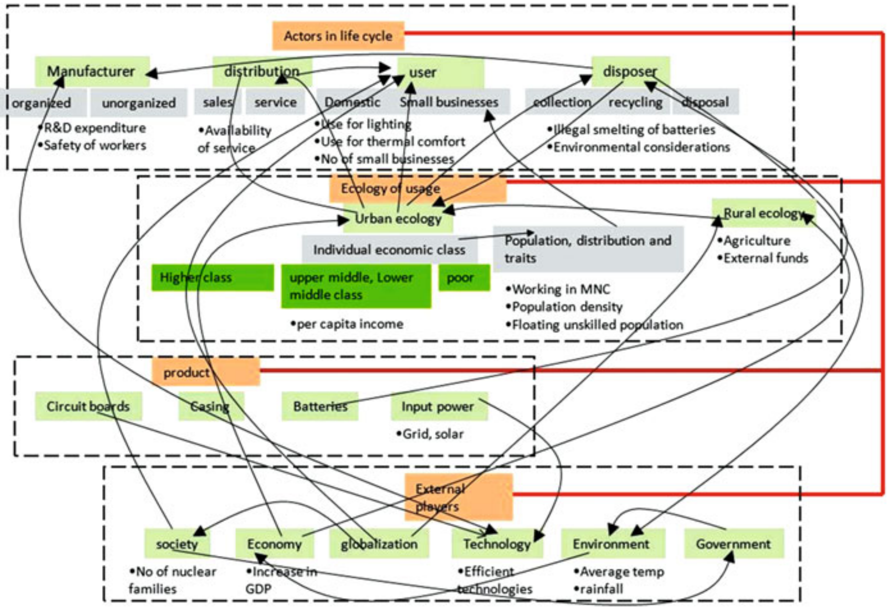

Fig. 2 Entity interaction diagram

system, or the system boundary can comprise the society that adopts it, or the natural environment that supports its manufacture, and so on. Deciding this boundary is a crucial task that is aided through the morphological analysis. The actors (stakeholders) that are involved in the manufacturing, distribution, use, servicing, and retrieval of the product are part of the system. The immediate natural and societal environments connected with these stakeholders are also considered as the part of system.

Following this, the entire system is organized into subsystems and entities that are further characterized into attributes or variables (Mani et al. 2005). Two levels of interactions are evident in systems analysis. The interaction among entities is a generic view and has to be dealt with initially before characterizing detailed interactions at the level of attributes defining entities. Entity interactions provide a bird's-eye view of the entire system, while variable interactions provide an insider's worm's-eye view; the latter, if done first, can limit in comprehending the vastness of the system involved.

2.4.1 Inverter: Systems Analysis

Inverter has been divided into four subsystems (Fig. 2), viz., (1) actors in the product life cycle, (2) ecology encompassing product usage, (3) product (inverter), and

Subsystem	Entity	variables (only 2 representative variables listed as example)
usage ecology	urban Ecology	Availability of electronic and electrical equipments and gadgets Employment opportunities
	Rural Ecology	External funding for rural development profitability of agriculture-related businesses
	Small businesses (Mixed ecology)	number of small businesses Deep cycles of batteries
	Medical facilities (Mixed ecology)	number of C-sections and operations number of vaccination drives
external factors	Social factors	use of social networking websites number of nuclear families
	economy	inflation rates Price of computers, laptops, mobiles
	Globalization	Night shifts Number of old people staying alone
	technology	environmental friendly materials e-waste disposal technologies
	pollution board	Recycling regulations Adherence to regulations
	electricity board	electricity theft Efficiency of distribution of electricity
	government management	Planning for future, emergency(electricity needs) Regulation for take back of e-waste
	environment	Avarage temp (local + global) Rate of Air contamination
actors in product life cycle	manufacturer	number of illegal manufactures (of inverters) safety standards for workers
	distribution	technical know-how of seller and service people availability of service option
	user	use for entertainment use for safety (CCTV etc)
	disposal	amount of illegally recycled inverters environmental consideration while recycling
product`	batteries	efficiency of usage recharging from Grid

Fig. 3 Subsystems, entities, and representative variables

(4) external factors affecting all the three subsystems. The subsystem comprises entities that are mapped based on interactions between them. The positive or negative impact and the extent of impact are also captured graphically. This analysis has been based on extensive primary data. Wherever possible, quantitative data has been gathered and experts have been consulted to verify both the relevance and intensity of interactions.

Interactions can be observed as change in attributes characterizing entities. The variable interaction diagram illustrates every entity characterized as variables involved in the interaction. The entity interaction and variable interaction diagrams have revealed many interesting interactions/influences (e.g., the influence of globalization on inverter use is dominant but not very obvious). Globalization can be viewed in terms of increasing energy-guzzling shopping malls and night shifts, resulting in frequent electricity shortage in residential areas and also an increasing number of aged living alone. The increasing floating unskilled laborers from rural areas rely on small businesses in urban fringes, leaving behind their aged family members. These laborers depend on affordable roadside eateries that in turn represent those largest small businesses in urban areas depending on (recycled) inverters.

Figure 3 lists variables against each entity and subsystem. For example, in subsystem *usage ecology*, the entities include urban ecology, rural ecology, small businesses, and medical facilities (products akin to domestic inverters). Few variables linked with entity *urban ecology* include "availability of electronic and electrical equipment" and "employment opportunities." The availability of electrical and electronic equipment determines the cost and sales of inverters; increased sales (usage) influences electricity consumption. Employment opportunities depend on the rate of urbanization that is influenced by resource usage in the urban ecology. Industry-specific manpower requirements based on data from the Ministry of Commerce have been used as indicators. Density of electronic shop dealers have been used as an indicator for proficiency in inverter availability.

2.5 *Cross Impact Analysis Using Kane's Simulation*

Kane's simulation (KSIM) developed by Julius Kane in 1972 is based on the expected nature of interactions between time-series variables instead of conditional event probabilities (Gordon 1994). KSIM adeptly captures behavior of nonlinear feedback systems without mathematical sophistication (Kane 1972) adopting systems thinking principles. KSIM has been successfully used for sustainability assessment of human settlements (Mani et al. 2005). The interactions among variables identified through a systems approach are captured as a cross impact matrix. The matrix captures causality in terms of direct interactions on a pairwise basis (between two variables); the matrix also permits the identification of variables that are mutually exclusive and collectively exhaustive. Kane (1972) provides a detailed discussion on adopting Kane's simulation. The mathematical formulations can be built as macros in MS Excel to run the simulation for a fixed timeline (between 15 and 25 years).

The steps involved in generating the cross impact matrix include:

1. Listing all the variables in an n row by n column matrix, where n is the number of variables.
2. Interactions are captured as impact (interaction-coefficient) of column variables on the row variables and represented in terms of positive or negative or zero impact on a predefined scale comprising a number of pluses or minuses. The number of pluses and minuses are converted to numeric value by assigning some within a range of $+1 \sim -1$.
3. Each variable is bounded between its own unique minimum and maximum limits. These ranges are assigned for its current status based on statistical data or expert's opinion.

The cross impact analysis evaluates growth or decay trends associated with a variable based on the net result of positive and negative impacts attributed to all other system variables. The results of the cross impact are presented as variable-trend graphs.

2.5.1 Inverter: Cross Impact Analysis

The evaluation of variables in cross impact matrix has also filtered duplication and redundancy among system variables. Gauging and assigning appropriate initial

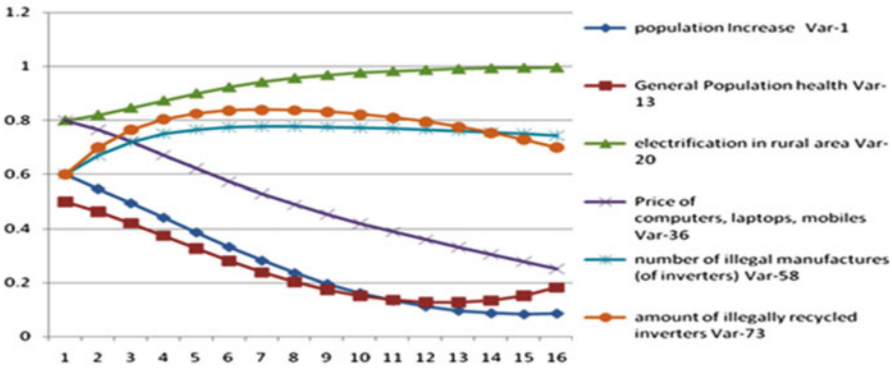

Fig. 4 Trend of salient variables

(base-case) values for each variable and the interaction coefficients require access to extensive statistical data and experts' opinion. This process takes considerable time and effort.

The sustainability assessment into home inverters revealed interesting trends among variables (see Fig. 4). While population increase, computer prices, and population health show negative trends, the number of illegal inverter manufacturers shows a steep increase.

Based on this analysis, strategists could attempt to intervene by altering key variable values to verify/effect controllability on salient (target) variables while also observing the effect on other variables determining social, environmental, and economic sustainability. This would permit dynamic forecasting that would aid appropriate product design and strategy.

2.6 Interlink with Capability Approach

Capability approach (CA) was originally proposed by Nobel Laureate Amartya Sen as a normative framework to broadly evaluate individual well-being and social arrangements. CA can further enhance societal considerations in sustainability assessment, and it would rely on the freedom of individuals operating at two levels, firstly the freedom to decide what the individual wants to be and do, i.e., *capabilities*, and secondly the freedom to achieve and/or realize from the list of capabilities, referred to as *functionings* (Sen 1993). CA emphasizes that technology/product is not exclusively important, but what matters more is how it affects the life of the people. CA comprises salient peculiarities that are linked with sustainability assessment, such as:

1. Distinction between means and ends (Robeyns 2005; Sen 2000) – any given technology is evaluated for the ends it is expected to achieve. Based on the importance to people's freedom in deciding what they want to be and do, every

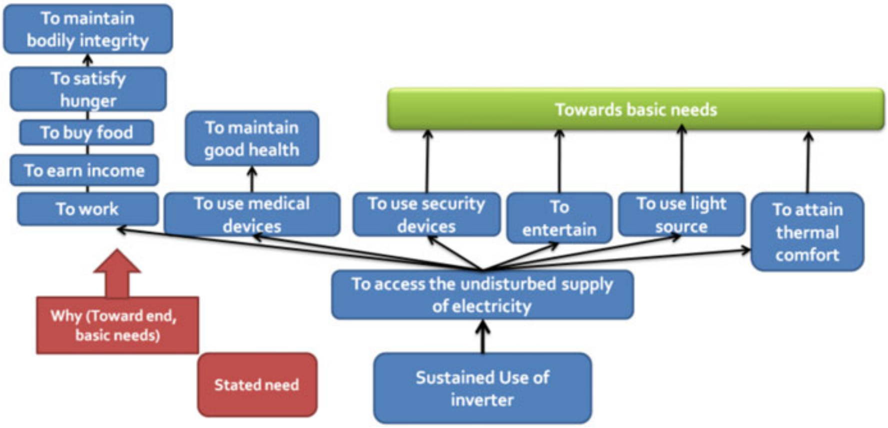

Fig. 5 Connecting means to ends ("why" question)

technology adopted is envisaged to fulfill some basic needs. Adoption of CA in product evaluation will persuade the evaluator to think in terms of "why a product is desired by the user in the first place." In conjunction with the morphological analysis and systems approach, CA would immensely help in identifying suitable product variants/configurations.

2. Distinction between the means and achieved capabilities (Robeyns 2005; Sen 2000): sustained adoption of a product is determined not only based on technical and material means (resources) but also based on other means such as social, infrastructural, and geographical. Appreciating this would aid the evaluator in expanding the system boundary for cross impact analysis. Khadilkar and Monto (2012) introduce such a framework in detail.

Though morphology and systems analysis help evaluators to fathom the complexity involved in sustainability assessment, the initiation into the exercise depends largely on the individual skill of the evaluator. CA, owing to its thought framework (as explained above), guides the evaluator in the initial fuzzy part through a questions-based approach, answers to which would smoothly forge into morphology and systems analysis.

2.6.1 Inverter: Through Lens of Capability Approach

The two questions posed by CA to the evaluator are the following: (1) *Why* would the user want the inverter? (2) *What* means would ensure the inverter's sustainable use/adoption? Thinking through and answering these questions would intuitively lead into morphology analysis and systems thinking. Answering the first question links instrumental need to intrinsic need (basic needs of human being) and, in the process, reveals many different dimensions that are not linked directly with product (see Fig. 5). Answering the second question broadens the system boundary to include nontechnical considerations (see Fig. 6).

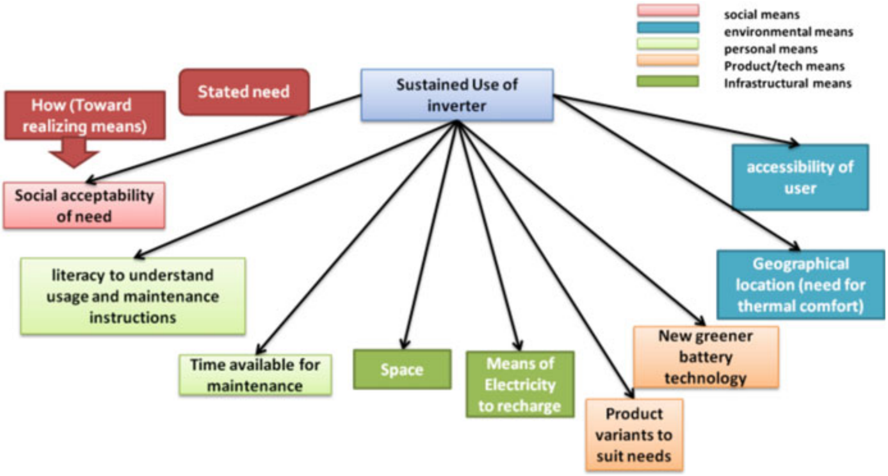

Fig. 6 Differentiating between means and a capability ("how" question)

In discerning the "why" in the question posed in Fig. 5, the evaluator is mentally forced to link the technology with the use intended by the users for the product. Often the inadequate success of a technology/product in terms of its usage can be attributed to disconnect with higher-level needs. For example, if the need for entertainment is not satisfied from a TV program, the user would refrain from using the TV. Thus, if the home inverter is not intended for running TVs, the users would refrain from owning one. They might value the time to be and gossip with friends.

Based on CA-related literature, in discerning the "what" question, the various resources required could be readily identified (Robeyns 2005; Kleine 2010). CA would ensure that evaluator considered the spectrum of available needs which would vary from community to community (or region to region). CA will also aid in interpreting the outcomes of the sustainability assessment. In the case of home inverters, the initial steep rise and subsequent dip in the instances of illegal battery manufacturers can be attributed to stricter recycling regulations, rising public awareness, and international pressure. CA reveals the fact that in the illegal manufacture of batteries, the health and thereby livelihoods of the workers involved are adversely affected. This is likely to continue unless suitable policies and regulations are put in place to ensure appropriate livelihood entitlements such as a healthy work environment. With the same income, the workers have an increased opportunity to live a healthy life.

2.7 Conclusion

Sustainability evaluation in view of a technology can be a complex and data-intensive exercise involving societal, environmental, and economic considerations that are often difficult to quantify. A methodology that is simple, relatively less data/resource intensive, scientific, and still fairly dependable in its sustainability assessment would be extremely valuable to product designers and strategists. The current chapter attempts to present one such methodology to evaluate a technology/product in view of sustainability by adopting a case study of home inverters. Morphological analysis and systems approach form the basis of the proposed methodology leading to a cross impact analysis-based simulation (KSIM). Further, the methodology also integrates capability approach by recognizing the fact that the human dimension is central in the sustainable use/ adoption of any technology.

This chapter also demonstrates, through the case study of home inverters, that the inherent complexity of sustainability assessment can be dealt with using structured thinking. Adoption of CA aids in handling complexity by structuring the thinking behind the assessment and also permits a greater appreciation of the results. The integrated methodology would aid designers and strategists (and even discerning customers) to access a technology for its likely impact on sustainability and identify suitable design strategies.

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Design-Technology and Sustainability

Sudhir Rama Murthy and Monto Mani

1 Introduction

Sustainability requires diversity in both the natural world and in the idea-space. To ensure survival in a competitive environment, one needs to constantly adapt and evolve by being creative. The intellectual capacity to continually innovate has resulted in the advancement of human skill and ingenuity, effectuating the dominance of the human species (McCrone 1991). Design-technology refers to a technology used by designers in the design process. These technologies have evolved over time, and each design-technology has had many common traits with its predecessors. The topic discussed is design-technology in the context of sustainability. Relevant to this topic is an understanding of creativity, design-technology and skills. The introduction section explains these concepts with relevance to the chapter. Based on an understanding of sustainability in the context of design-technology, broad guidelines for the role of technology in the design process are formalized, and then, the capability approach is used as a framework of thought regarding the role of design-technology.

Section 2 details a list of guidelines on the association between technology and design, based on sustainability considerations. Section 3 explores design morphology by employing the capability approach to conceptualize it.

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1.1 Creativity

According to Otto Rank, 'Creativity is an assumptions-breaking process. Creative ideas are often generated when one discards preconceived assumptions and attempts a new approach or method that might seem to others unthinkable'. Creativity requires this freedom from constraints of thought, conformance to standards or adherence to established paths. It is through people thinking differently from everyone around them and before them that novelty is achieved. The accommodation of inept, illogical, and unscientific ideas is also necessary en route to feasible solutions. This perspective on creativity is particularly relevant in the context of a design-technology as it must permit such illogicality to occur.

Societies and cultures are diverse, and so are ways of interpretation, communication, problem-perception, appreciation, thinking and problem-solving. It is also known that cultural beliefs, values and behaviours affect how people interact with technologies. This link between cultural diversity and creativity must be acknowledged by design-technology, particularly if it is to be used across cultures.

A further relevant aspect of creativity is its larger role in sustainable development. Creativity and diversity are essential for society's survival and development. Overspecialization impedes adaptability (Papanek 1984). Sustainable development is one that promotes quality of life (IUCN 1993), while maintaining, among other things, further attributes of humanity such as cultural diversity (IUCN 1986). Human development requires creativity not just for problem-solving but also for nurturing intellectual diversity. Any technology participating in the design process must recognize this importance of maintaining creativity so as to not trample upon intellectual diversity.

1.2 Design-Technology

Design involves a conception in the mind, subsequently externalized through a medium, the outcome being discernable by one or more of the senses. This externalization communicates the (mental) design to oneself, a working group, an audience or client for purposes such as feedback, refinement and appreciation. These externalizations represent the development of designs – they have an interactive role and a crucial effect on the mechanics of the design activity (Bilda and Gero 2005). While the design initiation, conception and preliminary externalizations have predominantly remained a manual 'human' exercise, numerous design tools are available to support subsequent design synthesis, communication and refinement.

Conceptualization happens in the mind of the designer (Ferguson 1992). The design process may involve an individual imagining an idea first, bringing it into form and then communicating it to others with whom the designer may then jointly develop it further – such freedom demands that the tool (or medium) used be flexible. The design-aid must help the person or group communicate readily and flexibly to generate more and richer ideas, while maintaining the diversity of those ideas.

Design-aids have been used through the ages to assist designers in the process of creating new products. Design-technology may assist in all design activities such as conceptualization, implementation (and manufacturability) and product usage (Brooks 2010; Sayers 1941). The capabilities of these design-aids have evolved with progress in technology. The then prevalent sophistication of technology has determined the nature of tools used by society to meet its needs in that period.

Design-aids or tools were originally physical devices such as a template or a specialty artefact that designers and artisans relied on for ensuring dexterity, advancement, extension and mastery over their specialized skill. These tools were relied upon subsequent to a period of manual engagement with that skill, i.e. the tools were rarely used at the beginning, but extensively used after a certain level of skill was manually acquired. In the modern world, however, rapid advancement of technology in computational power has reorganized the entire spectrum of extended design-aid and ability available to the designer. This makes the study of design-technology relevant in recent light. Computer-aided design (CAD) is one such technology prevalent in design practice.

Design-aids serve three principal purposes: (1) visualization (establishing a design space where a fleeting idea is captured and externalized), (2) communication (with a design group, client group or a manufacturer) and (3) documentation (of the design's progress and for archiving purposes). The design-aids adopted in the design process were originally intuitive and indigenous but have gradually become specialized and professional.

Historically, design-aids have illustrated a strong vibe with prevalent technology, viz.:

1. Sketching and colouring: These were the rudimentary ways of conceptualizing in the history of humankind. Early humans used charcoal and plant dyes to design on cave walls. Even this very first form of design-aid satisfies all the three requirements, viz., visualization, communication and documentation.
2. Drawing aids – the invention of geometric tools: With advancements in warfare, architecture and astronomy, new geometric tools were the design-aids. The emphasis shifted away from visualization and moved towards documentation.
3. Engineering drawing: Here, the goal is to accurately and unambiguously capture all the geometric features and communicate them to a manufacturer. This emerged in the time of ship building and mass-production factories. The communication of design to manufacturers became the focus.
4. CAD: The emergence of computer as a design-aid began with the aircraft industry. The advantages of CAD have helped it spread across the product industry.

CAD is today a dominant design-technology. CAD tools primarily aid the capture of only the structure while the description of a design involves its functionality, performance and behaviour as well (Hsu and Woon 1998). Design attempts to bring order to the natural chaos that develops new products (Brooks 2010). A design-technology must nurture the occurrence of this chaos. As an integral design tool, CAD must not interfere with the creative manoeuvers at work by restricting free thinking, which would otherwise lead to stereotypical or inflexible approaches. It is because CAD does not permit vagueness that it is today primarily used in the later stages of the design process, only after all the design parameters are formalized and dimensions are narrowed down with a fair degree of certainty. It is crucial to arrive at a sustainability-based rationale for where design-technology (including CAD) presently stands in the design process and where it should/should not be.

The path of a technology must accommodate diversity, wherein the intention is not merely to augment human abilities but also to recognize, accommodate and foster diversity in culture. Cultural identities are crucial to sustainability as these have evolved in response to local conditions of environment, climate, resources and spiritual values. A design-technology which creates a common platform must not create an environment of uniformity. Any design-technology must appreciate diversity as a trait of the design processes (Leonard-Barton 1995). This requires that the technology be free of single sequential paths for solutions, preconceived techniques, assumptions, distinct methodologies (because there are numerous methodologies and the technology must not vote for or against any model), constraints or standards. The interface between human and machine must be free of distractions and hindrances to communication. A technology used in the design process must be flexible and (a) accommodate effective communication within a group comprising diverse designers, (b) encourage generation of diverse (even inept) ideas that carry potential for new and better ideas, (c) retain contradictory thoughts and unexplored ideas – even those that might appear illogical or unproven and (d) integrate logic and science to aid in the synthesis of design solutions.

1.3 Technology and Skill

Skill represents an ability acquired by training (WordWeb 2005) and may be understood as one's ability to perform a certain task effectively. Humans have used the skills at their disposal to meet their requirements and, with time, enhanced these skills. The very purpose of technology is to expand human capabilities (Oosterlaken 2009), and this plays a central role in the development of skills. Skills are acquired in the adoption of a technology – say, in handling equipment such as a lathe or CAD tool. The very existence of technology implies an underlying existence of skills – the skills to create that technology and the skills to use it (DeGregori 1989). With the incorporation of a technology into a routine, users begin to think through that associated technology (Veblen 1961). It is at this juncture that technology begins to influence the way users think. Designers may be induced to think in terms of the steps and processes by which desired forms emerge. These steps and processes are determined by the technology available. Further, attempts to introduce design-aids at an early design phase have led to the user describing an idea or solution in terms acceptable by the technology/machine

(Willey 1976; Weinzapfel 1973). Design practice and education are also driven in part by the technology available (Bilda and Gero 2005) and so are human capabilities and skills. Technology-intensive skills require time and training for the user to develop proficiency.

Sustainability lays emphasis on a prosperous self-reliant society amidst a stable ecosystem. A self-reliant society fundamentally indicates retention of basic human capabilities and capacity to innovate, be creative and adapt (to ensure survival). Any technology aiding human creative thinking must not substitute the same, thus resulting in a dilution of the original human capacity. 'The best of modern technology and experience is … designed to serve the human person instead of making him the slave of machines' (Schumacher 1973). With changing technologies, some skills will be retained, developed and channelized while few other skills will become extinct. The loss of skills may be understood as the consequence of technology choices and progression (including obsolescence of other technologies). A technology should ideally enhance human skills and abilities and not inhibit human capabilities, creativity or innovation. The loss of certain skills and capabilities on adoption of a certain technology should not adversely affect the survival, stability and sustainability of future generations.

2 Guidelines for Design-Technology

The role of technology in the design process is only as much as humans permit it to be. A technology can be most beneficial by being employed in some activities while kept away in others. Thus, keeping sustainability as the primary criterion, the authors propose the following guidelines to underlie the association between design-technology and the designer:

1. Activities truly cerebral must still be done by the human (Papanek 1984). The human conceives, while the machine computes (Willey 1976), resulting in an intimate co-operative complex (Coons 1963). It is further possible that the machine can take over what is monotonous and repetitive, sparing more time to be devoted towards intellect during the design process. If this help is not provided, the human may, in order to economize on mental effort, resort to a habitual response, leading to similar outcomes (Brooks 2010) by which diversity in design is stunted.
2. The progression and adoption of technology should not inhibit human capabilities of creative expression, innovation, decision-making or self-reliance. The technological path will determine which skills are retained and which skills are lost (e.g. sketching using charcoal, making dyes to paint on cave walls). The lost skills must not threaten the survival and sustainability of future generations.
3. Technology should permit the designer to learn as the design process carries forwards. It should be flexible and be adopted in ways desired by its diverse

users. During the design process, problem-learning with the associated realities and the use of design-aids happens (Hsu and Woon 1998; Willey 1976).

4. Adoption of the same technology (design-aid) should not result in designers thinking alike and arriving at similar designs. Technology must encourage each designer to develop his or her own style and preserve cultural diversity.
5. Designers first think of the entire system in terms of its major subsystems. Then, through finer refinements, more detail gets incrementally added in (Brooks 2010; Cross and Dorst 1999). CAD tools in use today help us work backwards, while a true design-aid should help us design forwards – arrive at a final destination as we move along the design process, with the design-aid aiding us along the path. This is related to technology permitting the designer to learn aspects of the problem/design requirement as the design process progresses.
6. Technology must not become central to the design process to the extent that designers not conversant with that technology are excommunicated from the design world.

It is important to note that despite advancement in design-aid technologies, the most fundamental, or archaic, of techniques for idea/design expression/externalization such as charcoal, sand and clay have prevailed due to their simplicity and intuitive (primal) ease. They offer unparalleled dexterity and versatility of expression only to be matched or amplified by the allied skill and mastery developed by the artist/designer (e.g. calligraphy).

The following section of this chapter shall concentrate on one particular aspect of the guidelines, i.e. the human machine co-operative complex, also relevant to guidelines (1) and (2).

3 Design Morphology and Capability Approach

The quality of the design outcome is determined by the manner in which the technology enhances the capabilities of designers. This relationship can be explored in detail using the framework of capability approach (CA). CA is not a theory that can explain the ‘designer–design-technology’ relationship, but it will help conceptualize and evaluate this relationship better. The key idea of CA is to expand human capabilities – increase the options available to people and their freedom to achieve valuable activities and states – and then let them choose the path they desire towards their goals (Alkire 2005). CA is used here as a framework for the evaluation of how a design-technology enhances the outcome of the design process. This includes people’s ability to represent designs with the technology. CA can evaluate the design-technology based on its impact on the designers’ capabilities to innovate or design.

CAD, or any design-technology, must strive to expand human capabilities to achieve valuable activities or ‘doings’ in CA terminology, such as designing better. A design-technology must create an enabling environment rather than offer multitude of resources or options. The distinction between these is where the strength of the capability approach is evident. An important question to ask is 'which capabilities will the people who will enjoy them *value*?' (Alkire 2005) and 'which capabilities are relevant to the . . . project; which may be affected directly or indirectly'.

Employing the CA terminology (Alkire 2005) and applying the CA framework (Robeyns 2005) to the use of a design-technology, it emerges that the artefacts of the technology (viz., tools, paraphernalia, boards, CAD software, computers) are all resources (goods/services) or *commodities*. Users are concerned with what a technology can do for them – the activities and states (*doings* and *beings* together called *functionings*) that they can achieve with these resources and commodities. These achievable activities and states represent the *capabilities* of the users. These capabilities provide the designers with options to choose from and to finally arrive at the desired design goals. The link between the technological tools (commodity) and the capabilities of the human is the set of *conversion factors*. Based on *conversion factors* (such as individual skills of the designers), these *commodities* (artefacts of design-technology) transform into *capabilities*. Applying Nussbaum's (2000) three categories of capabilities (terminology distinct from Amartya Sen's capability approach) to the design-technology exercise, *basic capabilities* (seeing, limb movement, intelligence) mature into *internal capabilities* (tool-operation skill, professional communication) which then require suitable external conditions (availability of tools, other material and social environments) to finally result in *combined capabilities*. The purpose of this exercise would result in asking the deeper questions of 'how does the designer become capable of designing better' rather than 'what options should a design-technology, say CAD, show him on the work space'. As Sen (2004) argues, functionings (valuable activities and states) relevant to the purpose of the exercise – in this case design-technology usage – will have to be identified anew for each exercise.

A morphological study permits an overall appreciation of the interactions within a structure through an articulation of its constituent components and its association with externalities. Current design literature provides numerous models characterizing design activity (Pahl and Beitz 1996; Brooks 2010). These models assist the designer along the process as the clarity on the design that is evolving improves. However, in this chapter, the focus is not on the entire design process but instead on the interaction between the designer and the technology when the idea is captured, worked on and recorded. This is represented by the following four steps (Fig. 1). To simplify the discussion, we shall focus on the creation of an aesthetically pleasing form by a designer using a design-technology. The attempt here is to understand this human-technology nexus through:

1. Ideation
2. Externalization
3. Communication
4. Documentation

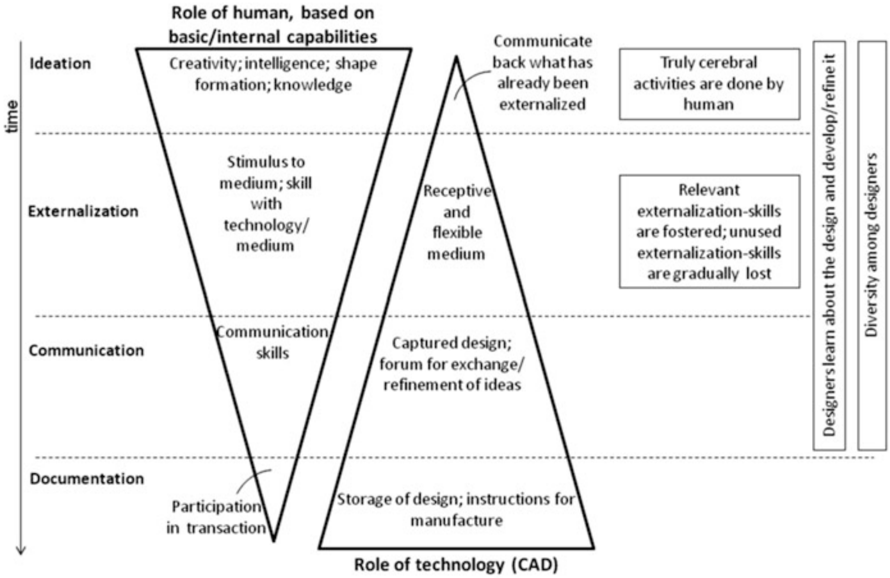

Fig. 1 Role of designer and role of technology

The design-technology influences the way designers think in the following two phases: (1) externalization – dictating the available steps through which a designer must think in order to arrive at the desired outcome (this is itself interference in terms of the thought process of the designer), and (2) communication – the final representation is constrained by what the design-technology permits the designer to represent (a simplified example would be a designer trying to represent a 3D form on paper, a 2D medium).

3.1 Ideation

The design-form or idea is always formed in the mind of the designer. This represents the initiation or seeding of an idea itself and is essentially a mental faculty/capacity and is usually not identified with any medium (Bilda and Gero 2005; Tovey 1989). Sketches and other 2D and 3D representations (models) are attempts to reproduce the designer's mental images (Tovey 1989). An appropriate medium is subsequently important as externalizing an idea can reduce cognitive load (Puttre 1993) and mentally relax the designer to then concentrate on furthering the idea (Tovey 1989). Designers also employ visual thinking to visualize forms and images (McKim 1980; Amheim 1969; Ullman et al. 1989) by devising spatial mental models (Brooks 2010). It is common for designers to first postulate an idea (solution) and then react to it piece by piece (Willey 1976).

The design thus evolves by successive modification as the details begin to emerge – looking at what has already been externalized and then improving those ideas. Externalization is thus an essential requirement for iterative generation and refinement of ideas.

From a CA perspective, the designer's basic capabilities of intelligence, shape perception and logical reasoning must be nurtured into internal capabilities such as having knowledge (of engineering, the purpose of design, usage scenarios, art and existing solutions) and thinking of forms and functions. The role of technology in this phase is to readily communicate to the designer what he/she had already externalized. The design-technology must provide a favourable environment to convert these internal capabilities into combined capabilities. At a deeper level, CA highlights that 'knowledge' and 'thinking of forms' are functionings that must be enabled and fostered.

3.2 Externalization

Ideation represents a spark or momentary occurrence of an idea/approach and utilizes short-term memory, which is fleeting and limited in capacity. Externalization attempts to capture that fleeting idea onto a medium. The dexterity of the medium to quickly capture the idea is crucial (Lipson and Shpitalni 2000; Jenkins and Martin 1993). To be effective, design-aids must accommodate for the nature of short-term memory and mental imagery in designing (Bilda and Gero 2005) by being flexible (Puttre 1993).

The designer having performed the vital task of conceptualization in the ideation stage (Hsu and Woon 1998) needs to now have the idea captured efficiently and effectively. The conduciveness of a design-medium in receiving and representing this information determines the success of the technology (Dorta et al. 2008). For lucid translation, the designer must find it convenient to provide stimulus to the medium (Buxton and Myers 1986; Brooks 2010). Design-aids are still evolving to lucidly receive and translate such stimulus.

The description of a product idea may involve the expression of its structure, function and behaviour. A designer may prefer a combination of these schemes to best capture and communicate thoughts (Hsu and Woon 1998). The design-aid must accommodate interoperability by supporting multiple formats freely and concurrently.

The human wants the idea to be captured in all its aspects before it may be lost. Basic capabilities such as the designer's sense organs and limb control are reflected in her internal capabilities of representing the form as imagined and representing that idea fluently. But these activities require support to develop over time – access to the medium for practice and experience, attuned senses for the task, choosing the design tool from among many and using it appropriately. However, when these activities of representation are of an intuitive nature, they do not require time to develop. In either case (trained or intuitive), the role of the design-technology is to be a receptive medium thereby enabling the functionings mentioned above.

3.3 Communication

This step permits communication and collaboration in the design process, and modern design-technologies have evolved to network designers across the world. This represents the idea in terms of what is captured and the attributes of the concept generated up to the finalization of the concept. It is likely that design acumen and enthusiasm may shift from one member to another in a group – with one designer leading a certain phase; the design-technology must accommodate this (Brooks 2010). Multiple formats need to be accommodated as each (designer-preferred) format has its own advantages. This provides richness to the information captured (Larkin and Simon 1987; Jenkins and Martin 1993; Lipson and Shpitalni 2000). In this design stage, technology can increase its relevance by performing the roles that are repetitive/iterative in nature, if relevant to that task.

The design-technology must serve as a forum for the exchange of information. This involves the designers' basic capabilities of speech and logical reasoning being trained into formal speech, language, access to the forum and professional protocol for communication. The designer wants to communicate the idea already captured on the medium to himself/herself and to fellow designers. The material and social environment to establish and maintain such a forum also become important when viewed from the perspective of CA.

3.4 Documentation

This represents a final outcome of the design. After the design is deemed satisfactory, this will be the final stage before the design is given to a manufacturer. The outcome may be in the form of detailed design drawings for manufacture and subsequent transition for use by a consumer. The delivery usually represents a protocol for the final design and allied deliverables. The communication of information for manufacturability is one of the vital roles of technology.

The designer wants to perform the activities of storing the designs and instructing the manufacturer. CA then identifies that for instructing, the designer must have knowledge of the available manufacturing facilities and establish a communication protocol with the manufacturer. Storage of designs includes choice of storage formats/methods, authorizations and the resources and skill required to access the archives. This is crucial as the same designs may be retrieved frequently for modification and/or reference. The designer must be able to identify what is to be stored and how. The role of the technology is to not only store the final design and unambiguously communicate the design to a manufacturer but to also document the entire design progress such that this record may help the designer at a convenient time. To enable the storage of designs, the design-technology must make available the required options of formats for storage of designs.

4 Conclusion

The chapter explores the purpose and role of a design-technology. Considerations of diversity, creativity and skill are explained in relevance to this topic. A set of guidelines on the association between technology and design is established. The chapter focuses on the role of the designer and the role of design-technology in imagining, capturing, communicating and storing an idea. With the capability approach framework, it is seen that the relationship has more depth than the mere use of a tool for a particular task. With this framework, the chapter attempts to better understand the design process, in terms of the activities and states of the designer. Relevant concerns emerging from the capability approach perspective have been identified in various stages of the design morphology. This entire research theme would help determine the larger direction in which design-technologies must progress, along with numerous related societal processes, thus taking sustainability concerns into consideration.

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Technology Management Issues in the Indian Medical Devices Industry: A Morphological Analysis

Ananthavalli Ramesh and L. Prakash Sai

1 Introduction

Technology management (TM) can be viewed from many different perspectives. The two words *technology* and *management* can be interpreted as technology, management, technology management and management of technology. However, all of them are interrelated and integrated into technology management system as a whole. Technology is defined as applied science and limits the scope on the issues engaged by engineers and scientists. Management involves degree of creativity, leadership, risk, performance and concern about uncertainty. Gaynor (1996) defined management as an applied art that involves using the linkage of data, information, knowledge and the social interaction between people in solving problems.

The management of technology (MOT) has been under the strong influence of engineering-based disciplines (Chanaron and Jolly 1999). The field's structure is inherited from research and development (R&D) management, and the mainstream in the literature initially dealt with topics such as project evaluation and selection, R&D organization, technology forecasting, etc. Strong emphasis was put on the management of technological assets through MOT. However, TM is defined as a whole system of product, knowledge, resources, infrastructure and activities (Dankbaar 1993). TM is applicable to every phase of technology-oriented businesses (application or development) such as R&D, product development and manufacturing and knowledge management and processes. It provides a platform to new business horizon in terms of products, processes and assets (patents).

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Many research articles are published pertaining to technology development (Klepper 1996), diffusion (Rogers 1995), substitution (Dodds 1973) and forecasting (Bass 1969). Authors discuss about the key parameters that affect the stages of technology management. However, mapping of all stages of technology management with adequate parameters does not exist. This chapter attempts to map the parameters in different stages of technology management for Indian medical devices industry.

Major issues pertaining to technology management in the Indian medical devices will be discussed conceptually in this chapter in terms of the following:

1. Regulation issues (from the perspective of the policy planners)
2. Technology choice and justification (from the perspective of manufacturers and users)

Technology leads the medical devices to improve the service quality and also cutting cost in order to cure many diseases. The complicated electrocardiogram 12 lead (ECG/EKG) replaces capillary electrometers and, in turn, is replaced by personal handheld devices. According to Global Harmonization Task Force (GHTF), medical devices referred to all tools ranging from sophisticated computerized medical equipment to simple tongue depressor. However, it does not include aids for disabled, animal treatment devices and accessories.

2 Indian Medical Devices Industry

The medical device industry in India is valued at \$2.7 billion in 2008. Driven by increasing awareness and affordability coupled with an increasing patient pool, the market is forecast to grow by 12% annually for the next 7 years to reach \$6 billion in 2015 (*News Medical* 2009). The fact that the Indian medical device industry, so far, has remained insulated from the global recession can be attributed to several ongoing trends. Medical tourism is estimated around \$45 billion in 2010. Cost of medical tourism in India is cheaper compared to the other countries like Singapore, Thailand and Malaysia (*Businessworld* 2011). Report from Associated Chambers of Commerce and Industry of India (ASSOCHAM) points out that players belonging to private equity segment have started exploring ways for investing in such health-care facilities. The industry is viewed as highly capital intensive, with a long gestation period.

Efficacy, safety and product quality are the key attributes of the medical devices which differentiate from other products (Abrams and Hessel 1987). Efficacy is measured in terms of effectiveness and efficiency. Extensive verification and validation is performed to increase the efficacy. Animal, clinical and market tests are performed to improve the safety and quality parameters. Pre-market approval (PMA) is mandatory to sell the product in the USA especially for class 3 (life-supporting medical devices) products. The product should obey the government regulation which is different from one country to another. TM issues pertaining to policy, technology choice and justification are discussed in this chapter from the perspective of policy planner, manufacturer and user.

Indian medical industry is unique mainly because of the following reasons:

Regulation (for Policy Planners)

Indian regulation calls only for UL marking for all the medical devices. UL marking tests only the product against its stated product performance. FDA and EU categorizes the medical devices into class 1 to class 3 based on risk (class 3 is the highest risk); however, Indian medical device regulation is still on anvil. UL mark facilitates the foreign manufacturers (especially from the USA and Europe) to capture the Indian market (since the CE and FDA norms are more stringent than UL norm). However, Indian manufacturers have to further fulfil the stringent FDA regulation and CE mark if they want to capture the overseas market.

Product Development (for Manufacturer)

Indian medical devices are deployed in hospitals based on return on investment (ROI), the cost of the machine (patient's affordability) and utilization are need for Indian market. Since the development of medical devices depends on the technology platform and innovation, it challenges the Indian manufactures in terms of R&D investment, technology innovation and overseas competition. It took nearly 30 years for GE to capture Indian market. Though GE health care was established in India during the 1960s, it made the breakthrough product (Logic-100 – ultrasonography machine) by 1990 after partnering with Wipro for low-cost product (*Business India* 2008).

Multinational players such as GE and Philips redeveloped the MRI machines to suit Indian market by reducing the price tag to one fifth of the original prices (*Business India* 2008, 2011). However, the original equipment are developed in the USA/EU to suit FDA and CE mark regulation. Apart from the product competition, Indian medical device manufacturer faces competition in terms of financial back up, domain knowledge and development cost.

Medical Insurance (User)

Indian medical insurance is operated by government and private players. Though government insurance is affordable and free for underprivileged population (below poverty line [BPL]), the preferred provider network (PPN)[1] for such scheme is substantially less (*Businessworld* 2010), whereas the private medical insurance has higher premium amount and has higher PPN and covers all the diseases. The difference in PPN is mainly because of hospital tariffs. Most of private hospitals are equipped with latest technology machines, infrastructures, etc., which increase the cost of the medical treatment. If insured in the USA and Europe, Third Party Administrator (TPA) rationalizes the medical treatment tariffs by assessing the prescribed treatment options and medications. In India, 10–15% of the patient population is under medical insurance cover, and the remaining have to pay from their own pocket without TPA assessment (*Business India* 2011). Uninsured

[1] PPN is a list of hospitals that can claim dues directly from the insurer instead of charging the patient.

patients travel across India for the right treatment options. Treatment options are explored in terms of cost, reputation of the doctor and contacts which are ill structured. Considering all these uniqueness, this chapter attempts to bring out the possible technological challenges in Indian medical device industry from the policy planner, producer and user perspectives. This has been done based on the literature review and screening of the variables that are identified as key issues in Indian Medical Devices Industry.

3 Literature Review

In this chapter, literature review is discussed in two categories, namely, technology management and medical devices:

3.1 Technology Management

Technology changes the way many business activities are conducted. The effective TM brings competitive advantage, which is one of the key important factors for many companies. It is necessary to understand, communicate and integrate technology strategy with marketing, financial, operations and human resource strategies.

Technology management maturity model (TMMM) was employed to assess the technology management maturity level by promoting technology management capability (Phaal et al. 2001; Wu et al. 2010). Wu et al. developed empirical model to evaluate the importance of strategic planning of TM for high-tech Chinese organizations. TMMM had five levels, namely, initial level, defined level, managed level, benchmarking level and continuous improvement level. Strategy planning for technology elements were identified (such as resources, organizational culture and quality) were evaluated. Selection of these elements and applicability to multinational organizations were not discussed. Gregory (1995) established TM five-process model through protection, identification, selection, acquisition and exploitation. Skilbeck and Cruickshank (1997) extended Gregory's five-process model, linking the frame work to business activities such as corporate, business and operational level. A technology management assessment procedure (TMAP) was employed to manufacturing organization to assess development and testing processes (Phaal et al. 2001). Through a case study, the authors proved that TMAP improved organizational communication and decision-making process.

Steven Klepper (1996) discussed about product lifecycle (PLC) in terms of entry, exit, growth and innovation. The author further discussed and proved the role of technology selection on PLC such as how technology selection criteria influenced the market penetration. Cooper and Kleinschmidt (1986) conceptually established product development process based on available technology. The authors divided the development process into three different categories with respect to technology, time and risk. Many frameworks were developed to understand the diffusion of new technology (Rogers 1995) and mentioned about different types of followers for adapting new technology such as early adapters, followers, leapfroggers and laggards. Diffusion theory was further deployed to understand the technology forecast (Bass 1969). This chapter addresses this gap through TM processes and conceptually identified the issues faced during this phases.

3.2 Medical Device

Medical Technology constantly strives to innovate to improve the products for the benefit of the patients and healthcare professionals. In addition to this different policy choices, funding, procurement, producer-user relationship are some of key parameters of medical technology management. The technology adaptation process is affected due to government policy especially medical insurance regulation (Nandakumar et al. 2009). The authors further indicated that, medical technology diffusion is also different with respect to economic status of the country. This affects the hospitals to procure and adapt for newer medical devices. 1967 smallpox was eradicated in USA however only by 1970 the eradication program was initiated in India and Nigeria.

Appelt and Hauser (2006) proposed clinical marketing framework to address product introduction, adoption and PLC management of medical devices. The authors commended that the commercial success of medical devices was determined by the strength of clinical evidence. This evidence-based marketing was further supported by Torbica and Cappellaro (2010) through their study on medical equipment diffusion in Europe.

4 Methodology

4.1 Morphological Analysis

Morphological analysis, a term coined by Zwicky (1962), means deconstruction of a specified problem or system into its basic variables, each variable becoming a dimension on a morphological box. Morphological analysis (MA) is employed to list and analyse the various options and dimensions. MA is preferred mainly because of its capability to bring up the qualitative and quantitative methods on surface for the exploration. With this structured methodology, the technology management issues of medical devices can be done very effectively and efficiently. MA is a problem-structuring and problem-solving technique by systematically analysing dimensions and options. It is designed for multidimensional, non-quantifiable problems, where the statistical and mathematical models will not yield results.

Hall (1969) used this technique to develop a three-dimensional morphology of system engineering. Newer, innovative applications of MA have been proposed by some authors. Shurig (1984) introduced the 'Category Grid' method while using the idea of morphology to explore new technologies. Yoon and Park (2005) introduced 'keyword-based' MA to identify technology opportunities. Later, through a hybrid approach, they used MA to forecast new technology (Yoon and Park 2007). MA is applied in this chapter to conceptually address the issues faced by Indian medical devices industry based on the available literatures.

5 Regulation Issues

The regulation of medical devices is a vast and rapid evolving field. It is complicated because it is tied up with legal technicalities in terms of safety, cost and reliability. Regulations for medical devices can be segregated into three different phases, namely, pre-market, on-market and post-market. The following figure (Fig. 1) explains the regulation phases and regulation requirement:

The number of published literatures in the field of medical device regulation is provided in the following graph (Fig. 2). The literature search is performed by searching 'medical devices' and 'regulation' in title, abstract or in keywords. Further, the article is analysed for the relevant contribution. The first article was published by Foote (1978) by analysing the scope for improvement of Food and Drug Administration (FDA). Later, in 1987, Hauptman and Roberts studied about the impact of regulations (pros and cons) for medical device manufacturers. WHO and GHTF published several articles with respect to development of medical device regulations. Seventy percent of the publications are from the USA commenting about FDA. European Union has publication contribution of 10–15%, whereas there is no published literature commending about Indian medical device regulatory system.

Table 1 provides MA for regulation issues which pertain to the Indian medical device policy planner, starting from identification of regulatory requirements for the new medical device. The key dimensions are identified from the published literatures and shortlisted based on the applicability in Indian medical device industry. Few key

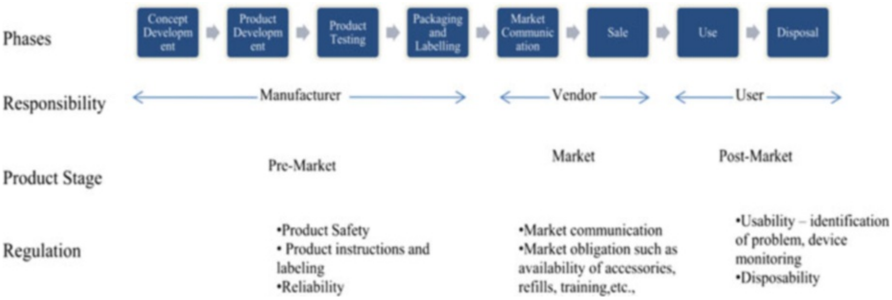

Fig. 1 Medical device regulation

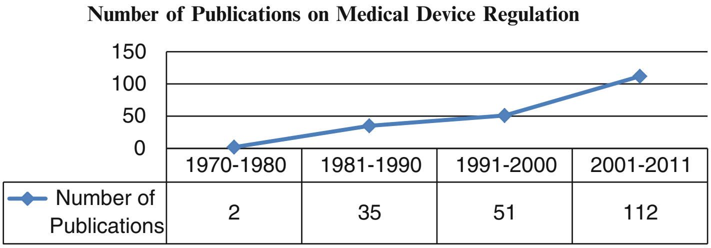

Fig. 2 Published articles in medical device regulation

Table 1 Regulation issues

Dimension (issues)	Options (solutions)			
Regulation certification*	Applicable for medical devices	Not applicable for disable aids		
Certification depends on	References	Technology type	Product class	
Regulation applicability*	Product electronics	Product software	Physical product	
Regulatory type	Pre-market	Post-market	Import	Export
Regulation for*	Manufacturer	Vendor	User	
Applicable standards	India (UL marking)	USA (PMA)*	EU (CE Mark)*	China (SFDA-CE mark)*
Product risk	High risk	Low		
Reference*	Technology	Functional	Software	Electronics
Post-market surveillance	Registration (implants)	Distribution record	Recall procedures	Mandatory reporting

Regulation – legal requirement for medical device to sell in the market; regulations are applicable to product, software and electronic components. Post-market surveillance: after-sale plan, especially for implants, recall activities and reliability
Keeping in mind the constraints on the length of the chapter, only selected dimensions and references are presented and briefly explained. The authors can be contacted for the full morphological analysis explanations and references for the dimensions

differences observed (between India and other countries) through literature review are listed below:

- Medical insurance company is one of the key stakeholders in the USA/EU for medical device approval. They also worked as treatment administrators by controlling the prescribed treatments and costs. Thus, 'Cycle of Care'[2] and 'Flow of Money'[3] is different in India and the developed countries.
- Researchers have contributed by studying US and EU medical device regulation which pertains to its development and effectiveness. However, literatures

[2] Based on how patients interact with medical system in place; it focuses on diagnosis and treatment.

[3] Stakeholders behind the medical treatment to finance the cycle of care.

commending about Indian medical device industry are rare. The listed issues and options facilitate the researchers to contribute in the future to enhance the Indian medical device industry. '*' marked in the MA table indicates the availability of literatures (not from India) in the specified dimension.

6 Technology Choice and Justification Issues

The manufacturers of medical technology constantly innovate new medical devices for the patient's benefits. The technology advancement of every new medical device is beneficiary to healthcare professionals (improved access and process) and to patients (lesser pain and reduced recovery time). Literature search is employed by analysing 'TM' in abstract and keywords further analysing 'medical device' in the complete text. One hundred and forty two articles are identified based on this search, and 53 articles are shortlisted based on the study objective. Product quality in medical device was first initiated by Caceres et al. (1983) by studying the medical technology choice and justification. Literature contribution in TM of medical devices is growing in every decade with different areas of interest (Fig. 3).

Understanding of regulation requirements for the proposed new medical device will pave a way for technology choice (selection, implementation and strategy). Indian medical device industry is different in the following ways for technology choice and justification:

- User justification of medical devices is a complex evolutionary process. The demand as well as on the supply side has a crucial impact on technology justification. Indian medical device industry has yet to establish the relationship between producer and user. In India, associated risk to user/buyer especially in post-market surveillance determines the product justification (*Business India* 2011). Product disposability is key concern in India mainly because of lack of established disposal processes.
- The following MA table (Table 2) provides the research contribution. The '*' marked dimensions have more literature contribution (not from India) than other dimensions.

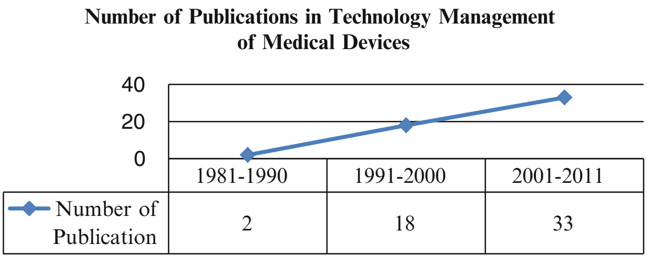

Fig. 3 Published articles in TM of medical device

Table 2 Technology choice and justification issues in Indian medical device industry

Dimension (issues)	Options (solutions)			
Technology choice (for policymakers and manufacturers)				
Technology type*	Existing	Incremental	Breakthrough	
Technology for*	Diagnosis	Prevention	Monitor	Treatment
Value for technology (benefit period of an advanced medical technology)	Very long term (more than 10 years)	Long term (1–10 years)	Short term (less than a year)	
Risk classes (not applicable for India as on date)*	Class I (low risk)	Class II (moderate risk)	Class III (high risk)	Class IV (highest risk)
Sourcing	Imported (finished product/ parts)	Export raw material and import parts	In-house manufacturing	
R&D set-up	In-house	Mergers and acquisitions	Multinational company	
Intellectual property rights*	Patented	Not Patented	Applied for patent	
Proposed technological impact to user*	High	Medium	No impact	
Social impact	Rural	Urban	Public health centres	Donation
User type*	Doctors	Nurses	Lab technician	Individual
Technology testing*	Virtual	Lab testing	Clinical testing	
Technology hazard type*	Hazard	Not hazard		
Usage pattern*	Frequently (once in a day)	Use and throw	Once in a month	Once in a year
Customer expertise	Expert	Skilled	Semi-skilled	Training required
Product launch*	Lead-lag effect (cross-country influence)	Not applicable		
Risk potential on product life cycle stage*	Saddle point	Takeoff period	Technology generations	
Scope of competition*	High (many players)	Medium (few players)	Low (no competition)	

(continued)

Table 2 (continued)

Dimension (issues)	Options (solutions)			
Technology justification issues (for user/buyer)				
Technology impact	Performance	Features	Functionality	Usability
Product operational requirement*	Need refills and accessories	Specific environment		
Calibration/maintenance	Scheduled maintenance	On request		
Product disposal*	Reuse	Recycle	Stringent disposal process	Buy-back
Post-market surveillance*	Registration (implants)	Distribution record	Mandatory reporting channels	Complaints

Saddle is defined as decreased in sales between early and main market (Peres et al. 2010). Takeoff is defined as time at which a dramatic increase in sales occurs that distinguishes the cut-off point between the introduction and growth stage of the product life cycle (Peres et al. 2010)

7 Discussions and Conclusions

Patient population in India continues to demand improved health services. The fact that the corporate hospital groups in India are responding to the demand by building up new health-care infrastructure should ensure that all stakeholders in this industry continue to benefit (*Business India* 2011). Understanding of key dimensions for effective regulation, technology choice and justification will facilitate Indian medical device industry to grow in terms of effective regulation and research contribution. This chapter brings out the key dimensions for TM and research gap (for the benefit of the Indian policy planners, manufacturers, users and researchers) through MA. MA is employed in this chapter mainly because of simplicity and ability to bring out the hidden issues. Buyer/user decision process is different in Indian government and private hospitals which is beyond the scope of this study.

Indian medical device industry should also equip itself by several innovative devices developed by Indian manufacturers to meet the demand.

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Managing Innovation in Perceived Low-Tech Industries: A Review of the Technology Management Practices of the Fish Processing Industry of Newfoundland and Labrador

Christian E. Coronado Mondragon and Adrian E. Coronado Mondragon

1 Introduction

A myriad of studies in innovation management emphasizing the pre-eminence of high-tech industries in the knowledge economy have been the common denominator in the innovation debate. In this regard, Christensen et al. (2011) have acknowledged the fact that the innovation dynamics of industries in the primary sector have received limited attention from scholars, practitioners and policymakers. Nonetheless, primary sector activities are still the source for economic progress for developed and developing nations alike.

This study is aimed to help document the dynamics of innovation and technological chance in the fishing and fish processing industry of the Canadian province of Newfoundland and Labrador. We believe this chapter will be useful to enable the improvement of managerial practices by local producers. In addition, it could assist in the documentation of the policy changes needed to ignite economic sustainable growth for this industry in the province of Newfoundland and Labrador.

1.1 North Atlantic Fisheries and Fish Processing Industry

The fishing and fish processing industry in the North Atlantic has been a source of wealth and labour for centuries. According to Agnarsson (2003), the North Atlantic

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Fig. 1 Automated fish processing facility in Iceland (Courtesy of Mr. Randy Gillespie, reproduced with permission)

countries that are more heavily dependent on the fish processing industry are the Faroe Islands, Iceland, Greenland (Denmark), Newfoundland (Canada) and, to a lesser degree, Norway.

Danielsson (1997), as cited in Agnarsson (2003), emphasized that in terms of labour productivity, the Icelandic fish processing industry is slightly more productive than their Norwegian or Danish counterparts. Olafsson (2001), as cited in Agnarsson (2003), claims that in terms of processing efficiency, Iceland and Norway represent the clear benchmark for the North Atlantic region. In Olafsson's study, the average efficiency of fish processing firms in Iceland and Norway is the same, with a score of 0.83. Newfoundland was not considered in Agnarsson's study due to the lack of detailed and available data. The picture in Fig. 1 shows a highly automated fish processing facility in Iceland *circa* 2009.

1.2 Canada's and Newfoundland and Labrador's Fishing Industry Context

According to Fisheries and Ocean Canada (2011), shellfish (lobster, crab, shrimp, scallop, clam, mussels and oysters) are the most profitable seafood accounting for \$1.26 billion CAD, in landing value (fished shellfish) for the year 2009. In Canada, groundfish (cod, haddock, halibut, Greenland turbot, flatfish, pollock and others) landings accounted for \$237 million CAD in 2009. According to the same report, pelagic fish's (tuna, herring and mackerel) landed value was \$101 million CAD in 2009.

In terms of commercialization formats, the Food and Agriculture Organization (FAO) (2010) report of the subcommittee of Fish Trade reports that due to the increasing changes on consumer patterns, live and fresh fish have become increasingly important sources of monetary value, as stated in the following quotation from the FAOs (2010: p. 7):

> Producers of traditional products, in particular of canned fish, have been losing market share to suppliers of fresh and frozen products as a result of long-term shifts in consumer preferences. Consequently, the price of canned fish products has dropped in most markets.

The Canadian province of Newfoundland and Labrador (NL) is located in the North Atlantic corner of the North American subcontinent. The province has an estimated population of *circa* 511,000 inhabitants (NL Statistics Agency 2011). Historically, the fishing industry in the Canadian province of NL has been the backbone of the provincial economy. It is also a very important component of the social tissue for Newfoundlanders and Labradorians. For more than 200 years of economic provincial history, the fishing industry in NL has been dedicated and focused mostly on the fishing, processing and commercialization of groundfish (i.e. cod fish). Today, the fishing industry has lost relevance to the provincial and national economy.

For instance, in Canada, the fishing industry alone contributes to approximately two billion Canadian dollars into the national GDP (Fisheries and Oceans Canada 2011). In the year 2008, the fishing and fish processing industry provided employment for nearly 80,000 people in the whole country (Idem).

Particularly, for the province of NL, the fishing (hunting and trapping included) and fish product industry contributes 0.7 and 0.8, respectively, to the provincial GDP (Department of Finance 2010). According to Fisheries and Oceans Canada (2011), in the province of Newfoundland and Labrador, the most commonly captured species, for its commercial value, are crustaceans (snow crab, lobster and shrimp) and groundfish (cod and turbot).

Figure 2 below helps to graphically portray the value of captured species in terms of their commercialization format. Basically, for high-value low-yield species (i.e. lobster and snow crab), the fresher it is, the higher value it has.

1.2.1 Current Technology Adoption Practices in the Fishing Industry of Newfoundland and Labrador

Traditionally, the economy of the province of Newfoundland and Labrador has been bound to the exploitation of fish- and fishing-related products for generations (Fisheries Heritage 1998). However, ever since the exploitation of nonrenewable resources started in the late 1990s, the industry has experienced a continuous degradation of its technological and social foundation. This situation has made it harder for Newfoundland's fish producers and manufacturers to remain competitive in the global fish product market. Most of provincial fish producers are small to medium enterprises in size making it harder to devote extensive resources to develop new technologies; most of these manufacturers do not have

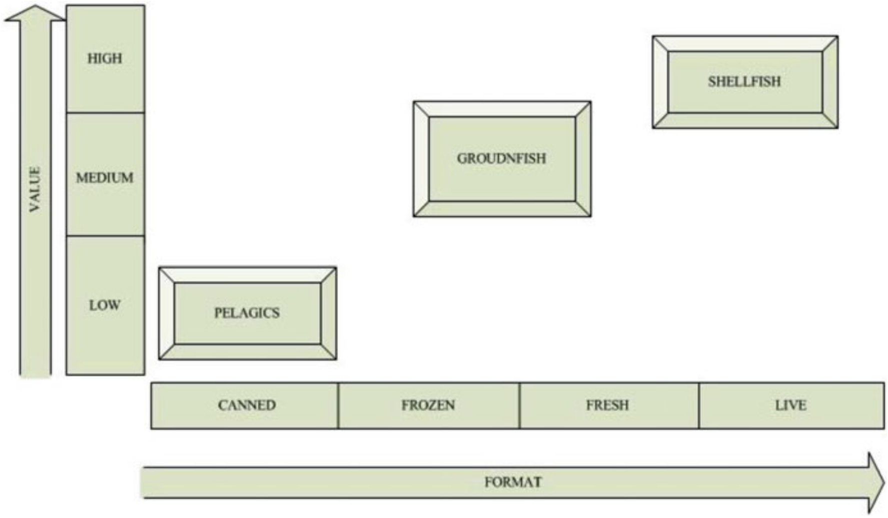

Fig. 2 Format that maximizes economic value of most commonly captured species

R&D departments. According to a prominent executive of the fishing industry in the province, this situation is described as follows:

> Nearly all harvesting and processing enterprise [in the Province] are small and medium sized enterprises (SMEs) and SMEs typically don't spend much on innovation in any industry. Our industry also has the added problems of poor Return-on-Investment (ROI) and a short operating season, so participants are under ongoing pressure to minimize costs.

In addition to the situation described above by the prominent executive, it was highlighted that Newfoundland and Labrador's fishing is defined as being low-tech, labour-intensive and low-yields on ROI. Under these conditions, innovations are mostly incremental and are generated by innovations mostly adopted from outside, not generated from within. As explained by the same prominent executive:

> In the fishing industry, groundbreaking technologies come along occasionally. The steam engine, radar for navigation, sonar for finding fish, and hydraulics for handling fishing gear have all had major impacts on harvesting. Refrigeration technology transformed an industry that preserved its products through salting, smoking, and canning into one that distributes most products fresh or frozen. In groundfish processing, flow-line technology has greatly improved efficiency. Currently, the industry is being transformed, because aquaculture is becoming a big factor in markets for fish products.

Furthermore, the competitive and the low-tech nature of the product and the market dynamics of the industry discourage collaboration between industry participants, as described below in the opinion of the same prominent executive:

> The seafood sector is intensely competitive, with many suppliers, no effective barriers to entry, and many products that are substitutes for each other. This can lead to innovations in products, processing technologies, and marketing. However, it can also lead to unethical practices, where one species is marketed as another that is more valuable or a poorer quality product is represented as being higher in quality.

2 Literature Review

Despite this fact, the so-called low-tech industries account for more that 90% of the GDP for Western European countries (Von Tunzelmann and Acha 2005; Hirsch-Kreinsen et al. 2008; Christensen 2010). Until recently, the study of innovation was heavily concentrated in the study of high-tech industry; fortunately, this pattern is changing as described by Christensen (2010).

Traditionally, primary sector activities have been considered low-tech. According to the OECD (2006), low-tech industries account for the bulk of economic activities in developed and developing nations alike. According to the OECD (1994), the definition of low-tech corresponds to those industries that devote on average less than 0.9% of their expenditures to R&D.

In terms of previous research on these industries, authors such as Von Tunzelmann and Acha (2005) and Hirsch-Kreinsen et al. (2008), among others, have devoted significant efforts to unwrap the dynamics of innovation for low-tech industries. In relation to the fishing industry, early studies in the field of technology management and in the fishing industry described mixed dynamics of innovation (Levine and McCay 1987). According to Levine and McCay (1987), innovation is generated mostly in the way fish stocks are caught. Furthermore, they emphasize the fact that innovation and technological change is driven by the perception of the future. "An optimistic future in the industry will delay change, whereas a pessimistic future will accelerate the adoption of certain catching technologies" (Levine and McCay 1987: p. 252). In a more recent study, Robertson and Smith (2008) clearly demonstrated the increasing technological sophistication in a perceived low-tech industry such as fishing. According to Robertson and Smith (2008: p. 112), current fishing technology "includes the embodiment and adoption of applied technologies in domains such wireless communication, radar, sonar, optical technologies, robotics, fluid dynamics and material science."

3 Methodology

The purpose of this chapter is to present a case study based on qualitative reports of the implications and effects of product innovation, process innovation, systems' integration and the need to rethink the management of technological innovations for the so-called low-tech industries. An ancillary aim of this study is to serve as a cornerstone to develop further research that could help provincial and federal policymakers to devise and enact policies which improves economic development in the province of Newfoundland and Labrador. Case studies were selected as an appropriate research tool since these present and describe a situation for which little or not sufficient empirical studies are available (Yin 2003).

3.1 Case Study No. 1: Industrialization of Fish Processing Plants in Newfoundland

The fish processing industry of Newfoundland and Labrador is characterized for its labour intensity and low levels of automation. Typically, wages in the provincial fish processing industry are high when compared to similar activities conducted in developing nations. This situation ultimately causes Newfoundland's industry to lag behind in competitiveness when compared to developing nations. Nonetheless, the productivity levels of the NL fishing and fish processing industry compared to nations with similar demographics, geography and level of economic development (e.g. Iceland and Norway) are precarious at best. The Icelandic and Norwegian fishing and fish processing industry is well known for their high levels of automation and high productivity and efficiencies (Christensen 2010; Eggert and Tveteras 2011).

On this situation, the premier of the province, Honourable Kathy Dunderdale, expressed her opinion about the grim outlook of the provincial fishing and fish processing industry in the following statement: "We've got many people chasing too few fish, and these plants are going to collapse and fail because they are not on sound economic models" (McLeod 2011).

Development of policies designed to improve the efficiency and productivity in the fish processing industry is lead by the Atlantic Canada Opportunities Agency (ACOA) of the Canadian federal government. ACOA is currently supporting several initiatives aimed to improve the efficiency and productivity of the fish and shellfish processing industry.

3.1.1 The Crustacean Meat Commercialization Project: An opportunity to Maximize Synergies and Improve Efficiency

Currently, the Canadian Centre for Fisheries Innovation (CCFI) is working on the implementation of several projects to automate the extraction of high-value and low-yield species such as lobster and snow crab. The CCFI is committed to the development of automated production lines that minimizes human intervention. Currently, CCFI works on the implementation and integration of complex systems that enable the seamless extraction of shellfish. The integration of these technologies includes systems such as visual controllers, automated conveyors, robots, logic controllers, high-pressure processing equipment, lobster and crab meat extraction apparatus, waste disposal equipment and processed product systems. The drawing below depicts the foreseen automated system to seamlessly extract crustacean meat (Fig. 3).

3.2 Case Study No. 2: Increasing Value Retention in the Logistic Chain of Live Shellfish

Innovations in the transportation of live fish and shellfish have mostly been concentrated on the development of incremental improvement in container technology.

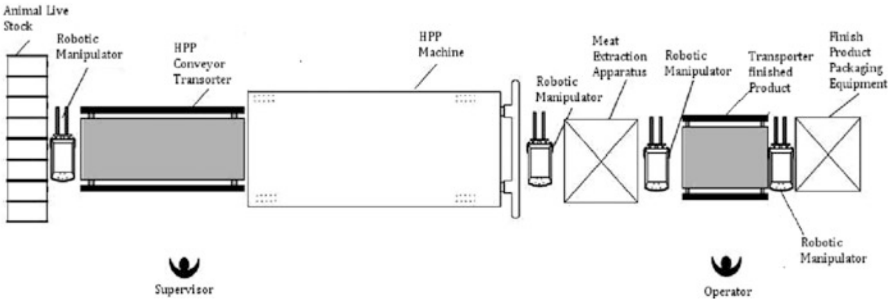

Fig. 3 Conceptual drawing of automated crustacean meat extraction system

Companies such as BioNovations Inc., from the Atlantic province of Nova Scotia in Canada, have pioneered the development of high-tech containers for the transport of live fish and shellfish products. To the best of their knowledge, the authors of this chapter are not aware of any related project to increase the visibility of supply chain for shellfish products.

Lobster and other perishable shellfish products retain higher value alive rather than butchered. For this reason, we believe that a technology that helps increase the survivability rate of shellfish products during transportation (especially for long-haul ground trips) could be very beneficial to harvesters, logistics providers and end users (retail or restaurants).

According to Berka's (1986) report on transportation of live fish, the survival conditions that minimize the mortality rate of transported animals are:

- Quality of transported animals
- Adequate amount of dissolved oxygen
- pH, carbon dioxide and ammonia
- Water temperature
- Activity and quantity of animals transported

The authors are proposing a pilot project that provides harvesters and end users with access to real-time and historical information on the conditions of transported animals such as water temperature, dissolved oxygen, salinity, pH and water temperature information. A better understanding of the dynamic biophysical conditions influencing the survivability of transported animals will be useful for harvesters, logistic operators and end users to better control their value chain and will allow better decisions on improving the transportation of these animals (Fig. 4).

4 Conclusions and Future Research

This chapter has discussed innovation and technology in a perceived low-tech industry, namely, the fish processing industry. Recent studies on innovation in the primary industry sector, such as Christensen et al. (2011), have helped to redefine

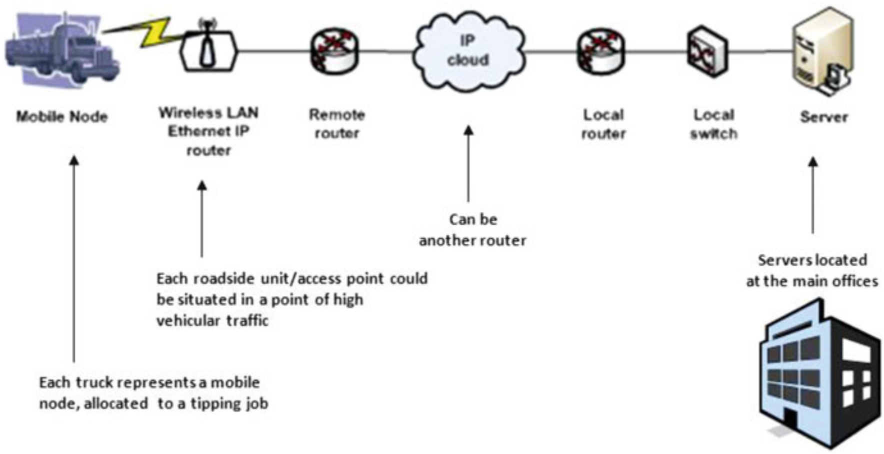

Fig. 4 Topology of proposed network architecture

the perception of low-tech industries. The seafood processing industry in countries like Iceland, Norway or Sweden has become so specialized that seafood processing in these countries denotes all the characteristics described for complex products and systems (CoPS) as defined by Hobday (2000: p. 793). He defines CoPS as "high-cost, technology-intensive, customized, capital goods, systems, networks, control units, software packages, constructs and service." Therefore, on the one hand, this study confirms what was described in the literature review the fact that the dividing boundaries between low-tech and high-tech for certain industries are blurry and cannot be exactly defined. On the other hand, this chapter has documented the grim outlook for the fishing and fish processing industry in the province of Newfoundland and Labrador. Despite the dire state of the province's industry, there is still chance for optimism. As stated by the prominent executive interviewed:

> This crisis in the industry is actually good, since this dire situation imposes an unequivocal need to change the direction of where the industry is heading. This situation forces policy makers, harvesters and labour unions to admit that something has to change . . .

This change is starting to take place. The federal and provincial governments are not only concerned but committed to change the fate of this industry. Initiatives sponsored by ACOA and implemented by CCFI are helping to bring the industry up to par with the industries of nations with similar a degree of development (e.g. Iceland, Norway, Sweden, etc.).

The projects described in this chapter could present good opportunities not only to document the technological transitions from low-tech to high-tech but the social and economic changes that new technologies bring to tightly knitted rural communities.

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Part 1.3
Technology and Development

Role of Technology Management in Development

Niruti Gupta and V. Devadas

1 Introduction

The governments and development agencies around the world have focused on achieving development by targeting on poverty reduction for more than two decades. There have been advances, but still nearly a quarter of the world's population still suffers from extreme *income poverty*, especially in the third world countries. However, increase in income levels and GDP growth rate are inadequate and ephemeral measure for development. Development is multifaceted and goes beyond increases in income levels to incorporate human welfare by enhancing people's choices and their substantive freedoms by providing both social and economic opportunities.

Sustainable development is a theory of socio-economic and physical development, not just a theory of economic growth. It considers human freedom as both the end and the means of development (Sen 1999). Because material resources are important and contribute to the improvement of standards of living, the theory of human development does not deny the need for economic growth, but it holds that growth should increase people's choices, i.e. it should allow people to enjoy the fruits of growth in the form of better nutrition and health, more security, protection against crime and physical violence, better access to knowledge, more time for leisure and rest, greater political and cultural freedom and greater participation in community life (UNDP 2001). To put it briefly, the ultimate objective of development is to provide an environment in which the individual can lead a long, healthy and productive life.

The Declaration on the Right to Development, adopted by the UN General Assembly on 4 December 1986, states in its Article 1 that 'the right to development is an inalienable human right by virtue of which every human person and all peoples

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are entitled to participate in, contribute to, and enjoy economic, social, cultural and political development, in which all human rights and fundamental freedoms can be fully realized'. Thus, right to development becomes central to human development as well as over all holistic sustainable development.

Poverty is widespread in India. The World Bank in 2004 estimated that almost one third of the world's poorest population lives in India (World Bank 2004). The Oxford Poverty and Human Development Initiative study done in 2007 used Multidimensional Poverty Index to conclude that Uttar Pradesh state had the fifth last MPI rank in the Indian states having 69.9% of its total population of 192.6 million living under poverty, contributing the largest share of 21.3% of the total Indian poor. Economic disparities and lack of choices are even more profoundly visible in the rural areas of Uttar Pradesh, where poverty, low quality of life and disguised unemployment are considered to be the way of life.

Poverty reduction, although, can be achieved by increasing economic opportunities, expanding people's choices and freedoms and improving their quality of life and 'livability' are equally important for holistic poverty alleviation; hence, the role of sustainable human development approach becomes prominent (Sen 1993). This requires the provision of both employment opportunities and social and physical infrastructure, that is readily available and usable, as well as an advancement in technology to support productivity, thereby further increasing economic opportunities and improving living standards.

Taking Lucknow District as the case study, this chapter attempts to give an insight to the current development levels in the district and assess the elements responsible towards achieving progressive development and poverty alleviation while understanding the role of technology management for achieving these elements for a holistic development, both in terms of economic development and improvement in quality of life and livability. This chapter concludes with the policy level interventions required for the implementation of the technology-based projects and bringing the stakeholders involved together.

2 Lucknow District Profile

Lucknow District, located in the heart of the state of Uttar Pradesh, housing Lucknow City, capital of the state, has been taken up as the study area for my research 'Planning for Sustainable development in Lucknow District' to understand levels of development in poverty-stricken areas.

2.1 Physical Setting

Lucknow District has an area of 2,528 sq. km. It lies between north latitudes $26^\circ 30'$ and $27^\circ 10'$ and east longitudes $80^\circ 30'$ and $81^\circ 13'$. It is a part of central Ganga Plain with a total population of 3,647,834 as per 2001 census (density, 1,443 persons/sq. km) (Fig. 1).

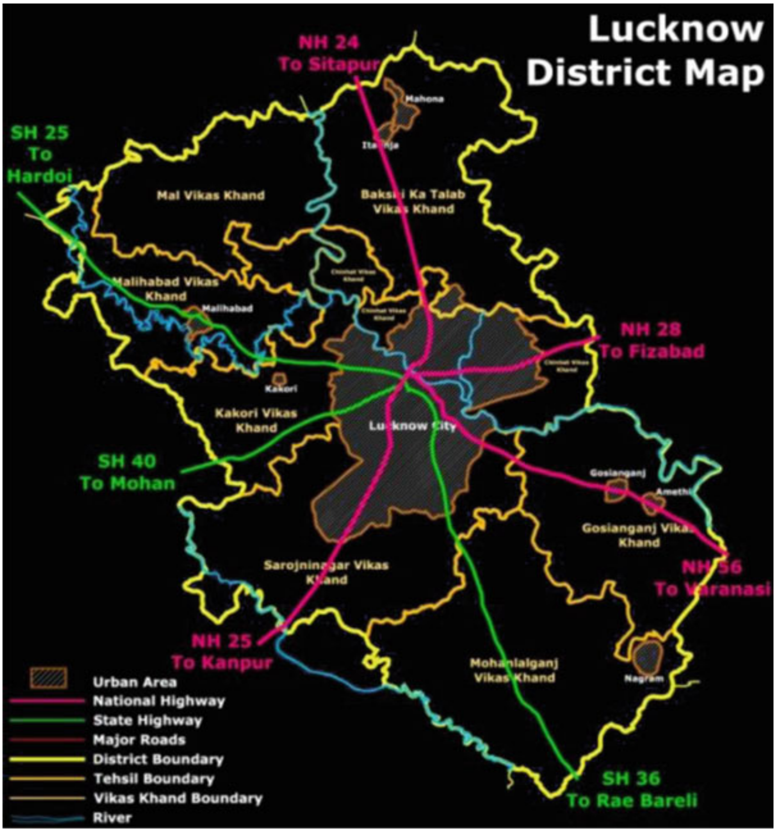

Fig. 1 Census of India. 2001 District Administrative Atlas for Uttar Pradesh. *Lucknow District Map*. [map]. Regenerated by Niruti Gupta: using AutoCAD 2008. 5 October, 2010

The district comprises of four tehsils, namely, Malihabad, Bakshi Ka Talab, Lucknow and Mohanlalganj. Lucknow tehsil forms to be the district headquarter which includes the City of Lucknow, the capital city of Uttar Pradesh and the largest urban centre in the district. The tehsil of Malihabad is further divided into Mal Vikas Khand and Malihabad Vikas Khand, while the tehsil Mohanlalganj is divided into Gosainganj Vikas Khand and Mohanlalganj Vikas Khand.

The district has 835 villages distributed among the tehsils housing a total rural population of 1,326,873. The village and urban centre distribution among the tehsils is shown in the Table 1.

2.2 *Occupational Structure and Economic Profile*

The city is primarily a tertiary and service sector-based city, with a very small percentage of secondary sector. The tertiary sector comprises of about 63% of the total work force of the district, while 32% is involved in agrarian activities (Fig. 2).

Table 1 District profile

Sr. no.	Tehsil	Total no. of villages	Urban centres
1	Malihabad	187	Malihabad, Kakori
2	Bakshi Ka Talab	208	Mahona, Itaunja
3	Lucknow	210	Lucknow
4	Mohanlalganj	230	Nagram, Gosainganj, Amethi
	Total	**835**	

Source: Census (2001)

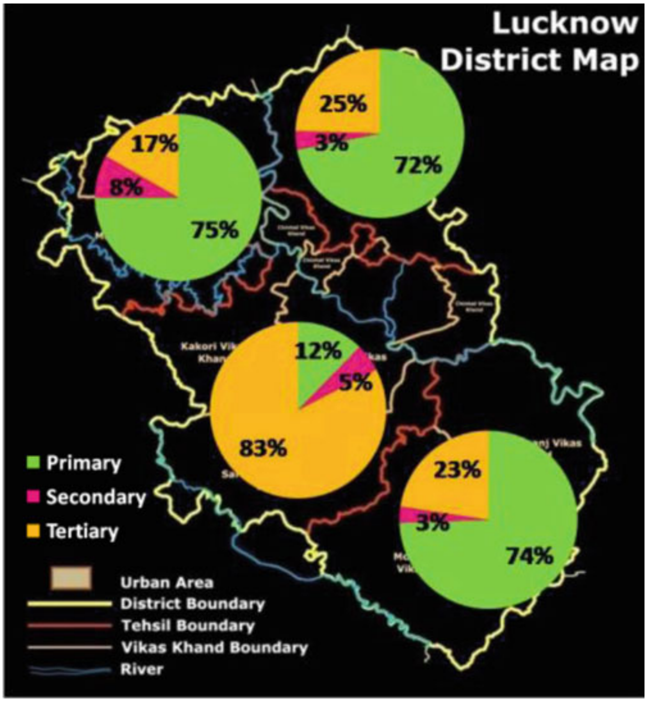

Fig. 2 Census of India. 2001 Primary Census Abstract for Lucknow District. *Tehsilwise Distribution of Occupational Structure in Lucknow District*. [map]. Generated by Niruti Gupta: using AutoCAD 2008, Microsoft Office Excel 2007. 10 October, 2010

2.2.1 Agriculture

Secondary sector being small, primary sector and the rural areas, therefore, become the major income generator for the district. About 92% of the district area is under cultivation. Cultivation mainly includes sugar cane, food grains and tobacco. Malihabad area, famous for its mangoes, contributes hugely to the district's economy through exports.

2.2.2 Industries

In Lucknow, there are 39 large- and medium-scale industries, 12,058 small-scale industries and 21,895 handicraft industries. Some prominent industries located in the city are the units of Tata Engineering and Locomotives, Hindustan Aeronautics Ltd., Scooters India Ltd., Union Carbide Limited and Mohan Meakins Breweries Limited. Among the small-scale industries, the important ones are hosiery and garments, repairing and servicing, rubber and plastics, chemical, and chemical products, paper products and printing (Majumdar 2005).

The rural areas also house the small-scale industry of traditional *chikan* and *zardozi* embroidery and handicraft works, which is the next big contributor to the district's economy.

3 Dissatisfaction from Rural Life in the District

In my research, 18 villages and 14 wards were selected in the district based on their development index (discussed in the next section) for conducting 300 household surveys (180 in rural areas and 120 in urban areas) that focused primarily on poverty levels, quality of life and social and physical infrastructure availability. Based on the results of the primary survey, following inferences were drawn:

3.1 Lack of Employment Opportunities in Rural Areas

Rural areas are less promising in terms of employment opportunities. The worst affected people are the landless farmers who do not find employment as there is a higher percentage of small and medium farmers having small landholdings who do not require agricultural labourers regularly. In addition, the wages offered are also small as compared to the wages offered in the city. Moreover, people with large families find it difficult to support themselves with the income through agriculture. Thus, they are forced to come to the city and work as either ancillary or domestic household workers or construction labourers. These workers eventually settle down in the city in slums and squatter settlements leading to urban blight (Fig. 3).

The primary survey shows that almost 33% of the respondents commute to the city seeking for jobs as ancillary workers or construction labourers. The primary survey also shows that around 21% of the respondents are working as construction workers in the city. This makes them economically vulnerable both in short run and in long run. In the short run, they do not have employment guarantee as they are unskilled as well as the construction process gives only a temporary employment security. Lucknow City is a tertiary and service sector-based city, having a very small secondary sector. It is currently in a developing phase and has high rates of ongoing construction activities. The rate of construction activities would gradually slow down in a few years, making these construction labourers economically vulnerable in the long run.

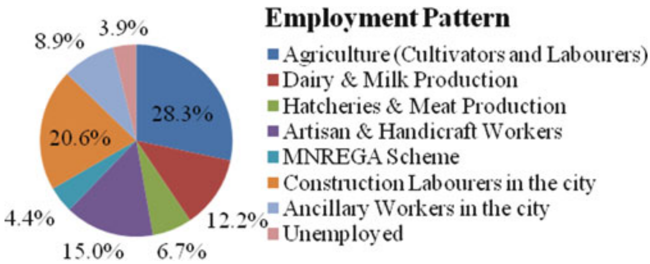

Fig. 3 Gupta, Niruti. *Survey of 180 households in 18 villages of Lucknow district for establishing living standards in rural Lucknow*. Lucknow: Adhaeya, Asti, Ataura, Bajpur Gangaura, Belwa, Bhaisora, Chanda Coder, Jehta, Khargapur, Kharsara, Kuroni, Mall, Paharpur, Parvatpur, Rahata, Samerapitpur, Sardarpur Karora, Udaypur, 8–22 June 2011. Unpublished Survey

3.2 High Instances of Selling of Agricultural Land

The investigation shows that almost 17% of the respondents have sold their agricultural lands in the past 5 years. These people now are either employed in the city as ancillary workers with low salaries or have established some small business of their own. It was observed in all the 31 instances that although the value of their physical assets was high, their expenditures were much higher than their income levels. The current living standards cannot be maintained for a long time with such a huge difference between the income and expenditure levels. Thus, these people also become economically vulnerable in the long run.

3.3 Conversion of Agricultural to Non-agricultural Zones

It was observed that the agricultural lands sold within the past 5 years now have construction of housing schemes being done on them, thereby converting them into non-agricultural zones. Such construction activities result in haphazard development which does not conform to the authorised development plan and therefore also lack in physical infrastructure. The unchecked rezoning limits the land available for agriculture, the primary generator of the economy for the district which would ultimately lead to economic unsustainability in the future.

3.4 Declining Traditional Arts and Local Handicrafts

Lucknow, since long, has been known for its traditional chikan and zardozi works and local handicrafts. The 27 instances in the survey show that these artisans and craftsmen lead a very poor and miserable life. Most of these are women-headed households. It was observed that lack of financial security, income opportunity and raw material and market availability has curbed the traditional art. The artisans now seek for jobs as construction labourers in the city as these jobs are more paying. As a result, the traditional arts are declining.

3.5 Lack of Infrastructure

The major setback in the development of the rural areas is the lack of both social and physical infrastructure. Unavailability of electricity has an adverse impact on the functioning of small-scale and cottage industries. Similarly, unavailability of social infrastructure has an adverse effect on the health and education of the rural people. The infrastructure availability in the urban areas makes the city more of a status symbol for the rural folks, who want to abandon their rural lives and switch to a more 'glamorous' life in the city, thereby increasing the pressure on the city.

4 Measures for Poverty Alleviation

4.1 Poverty, Infrastructure and Development

For understanding the relationship between poverty, infrastructure and development in the district, a development index and a centrality index were developed. The development index has been calculated for every village in the district by finding out the geometric mean of the following sub-indices: growth rate index, population density index, SC/ST population index, sex ratio index, literacy rate index, female literacy rate index, WFPR index and female WFPR index.

Calculation

$$(X)\text{Index} = \frac{x - \min(x)}{\max(x) - \min(x)} \tag{1}$$

Centrality index is a measure of availability of social and physical infrastructure in a village. It is calculated on the basis of provision of following sub-parameters: education facility, medical facility, drinking water supply, power supply, bus service facility, railway service facility, post and telegraph facility, bank service and recreation centre facility. For each of these facilities, a score of 2 is given if the facility is present within the village, 1 is given if it lies within a range of 5 km from the village and 0 if the facility is not at all available.

Figure 4 shows a comparison of development zones and centrality index. The comparison clearly indicates the dependence of development on the provision of infrastructure availability. Provision of infrastructure can thus enhance the levels of development.

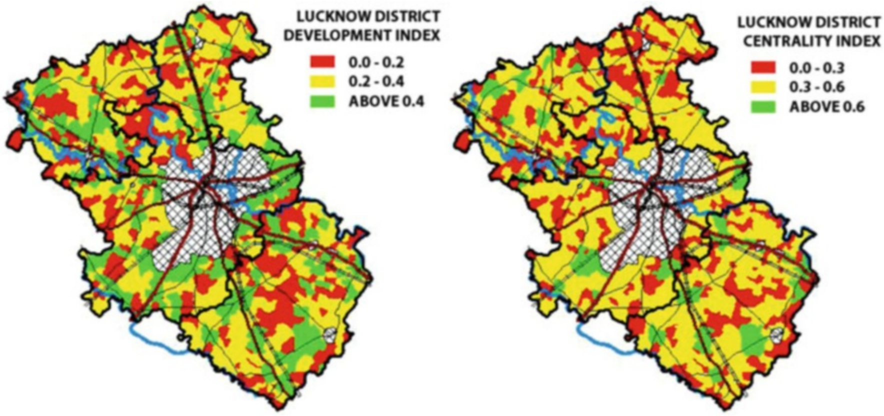

Fig. 4 Comparing development index and centrality index (Source: Maps created on the basis of data from Census 2001)

Table 2 Comparison of development zones, income levels and standards of living

Development zones	Average monthly household income (Rs.)	Average per capita income (Rs.)	Livability	Quality of life
High (above 0.4)	5,943	792	0.65	0.30
Medium (0.2–0.4)	4,923	488	0.63	0.23
Low (0.0–0.2)	2,500	267	0.56	0.14

Source: Primary Survey

On the basis of development zones, 18 villages were selected throughout the district in which primary surveys were conducted for assessing the income levels and standards of living in each zone. Table 2 shows that both monthly household and per capita income levels strongly depend on the development zone in which the household lies. This concludes that for achieving higher income levels and thereby alleviating poverty, higher development is required which can be achieved by provision of adequate social and physical infrastructure. Provision of social infrastructure enhances the capabilities of people, while the physical infrastructure availability provides the enabling economic environments and opportunities.

4.2 *Improving Agricultural Performance for Poverty Alleviation*

A paper produced by DFID (2004) emphasises the historically close correlation between different rates of poverty reduction over the past 40 years and differences in agricultural performance. The authors see a close link between agriculture and poverty reduction. Firstly, there is a direct impact of improved agricultural performance on rural incomes; secondly, better agricultural performance results in cheaper food for both urban and rural poor; and thirdly, agriculture performance has a fundamental role in the economic growth of farm based industrial sector.

4.3 Poverty Reduction by a Shift to Non-farm Activities Within Rural Areas

Another route by which poverty could be reduced even in the absence of economic growth is through migration of farmworkers to off-farm jobs, either in rural or urban areas. Christiaensen and Todo (2009) observe that as countries develop, their economies restructure away from agriculture into manufacturing and services, and people move from rural to urban areas. They also observe that migration from farm to non-farm work in rural areas is poverty reducing but not migration from farm to non-farm jobs in urban areas.

The immigration process to urban areas works best when cities are labour-intensive secondary sector-based cities. Lucknow City and most of the cities in north India are tertiary and service sector-based cities which can only provide low-paying ancillary jobs to the immigrants, which results in lowering of their quality of life. It, therefore, becomes important to create off-farm jobs within the rural areas to bring about the shift to non-farm activities and reduce the disguised unemployment prevalent in the rural areas. Creation of the off-farm jobs in rural areas would not only provide for more economic choices in the rural areas but also account for bigger landholdings which, due to lack of economic alternatives, are subdivided on inheritance and result in low-yield subsistence farming.

5 Technology Management and Enhancing Economic Opportunities

In the light of above mentioned measures for reducing poverty and achieving a holistic development, initiation of technology-based projects, technological innovations and management, knowledge management and dissemination and information management and communication can play a vital role for achieving these measures and advancement of rural areas.

Rural areas in the district as well as in the state form the bottom of the pyramid with immense manpower that is unskilled and hence are economically backward. As observed by Prahalad (2005) both public and private sector need to join hands with the rural folks for refining their skills and improving their performance by imparting focused knowledge and providing them with economic alternatives and choices. Figure 5 shows that the working procedure of the partnership can result in a win-win situation for all stakeholders. The figure shows the development cycle of the plan as each investment cycle results in the improvement of the rural performance.

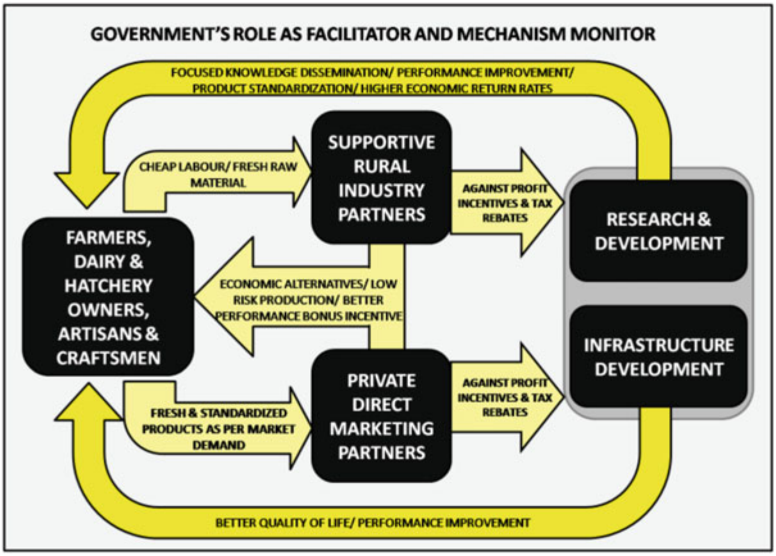

Fig. 5 Performance improvement and development cycle

5.1 Technological Interventions for Improving Agricultural Performance

5.1.1 Research and Development

Research and innovation of technologies is the key to improving agriculture performance. Biotechnological development can be used for hybridisation of better yielding seeds and fighting plant diseases for minimising agricultural risks. Innovation of eco-friendly fertilisers and pest control methods also aids to improve the performance. Research on various herbs, which hold medicinal values, is also important as these herbs may add on greatly to economy generation.

5.1.2 Industrialisation of Agriculture

The involvement of the private sector in agriculture can solve a lot of issues faced by the primary sector in today's context by following a corporate and industrial approach in this sector. The lands being sold off for unauthorised housing development can be instead purchased by the private sector for consolidation into large land chunks with enhance productivity. The farmers can be employed by these private companies on minimum wages as determined by the government. In the cases where farmers do not want to sell their land, private sector can act as funding and marketing partners where they share the profits and the risks with the farmers.

5.1.3 Precision Farming and Geographic Information Systems

The satellite images and soil analysis software can be used to generate the precise amount of fertilisers and chemicals to be used in different parts of the farmland. This enhances productivity along with reducing input costs and thus increases profits.

5.1.4 Product Diversification and Value-Added Product Development

Food processing is an effective way of bringing in diversification of the products along with adding an appreciation value to it for targeted consumers. It also helps in prolonging the shelf life of the product.

5.1.5 Post-harvest Technological Development

As agro-products are perishable, it is important to develop technologies that expand the post-harvest or shelf life of the products. Innovations in food storage, processing, packaging and transportation can result in increasing shelf life in a wide variety of high-quality products being available year round.

5.1.6 Information Technology and Communication for Demand Assessment and Effective Marketing

The twenty-first century has been referred by many as information age. Use of modern communication systems and computers can dramatically enhance the capability of the sector. Firms can assess consumer demands globally, farmers can produce crops for specific markets, and researchers around the world can collaborate to gather and analyse data.

5.2 Technology-Based Project for Providing Off-Farm Jobs

5.2.1 Establishment of Supportive Rural Agro and Dairy Product Industries

The rural area in the district has prevalent unemployment and disguised unemployment. Encouraging private sector to develop supportive rural industries would be beneficial for reducing the employment gaps. The role of the supportive industries is to assess market demand of various products and contract the raw materials to the farmers with an initial investment for timely supply for fresh raw materials.

5.2.2 Involvement of Private Sector and Standardisation of Cottage and Craft Industries

Government with the help of private enterprises, management agencies and NGOs can directly aid the situation through technology management projects, targeted at the grass roots and then upscaled, whose benefits are relevant to enhancing income opportunities through capacity building and focused knowledge dissemination, thereby resulting in standardised, consistent and quality production. The micro-enterprises thus set up can use the homes of the workers as production grounds, reducing the need of their immigration to the city and thereby reducing the urban blight, while the intervention of the private sector for these setups can be utilised for infrastructure provisions against the profit incentives, thereby resulting in a better quality of life and higher income levels of the rural inhabitants.

5.2.3 Capacity-Building Programmes and Certification Courses

Though the government has ongoing capacity-building programmes, but for its rapid implementation, the government should step back and become a facilitator, while the private sector should be the provider. The private sector should run capacity-building programmes as well as focused knowledge dissemination sessions for technical training for the artisans, craftsmen, cottage industry workers as well as farmers and provide them with certification.

5.3 Technological Interventions for Infrastructure Development

5.3.1 Biogas Plants and Rural Energy

Energy is the perquisite for the success of any technological advancement. Private sector in collaboration with dairy owners, as a part of development initiative against profit incentives or tax rebates, can set up biogas plants to generate energy for domestic use.

5.3.2 Water Management and Irrigation

Irrigation technology innovations and water management plans can greatly enhance the agricultural productivity. Effective watershed programmes help in water storage along with revitalising the water table. The rural areas in the district currently depend on tube wells for irrigation purposes other than rainfall. Technological improvements made in water storage and conveyance can reduce energy use and water losses presently being incurred.

6 Conclusion

For a holistic development and poverty alleviation in the rural areas, performance improvement becomes a key point. Government being a facilitator and private sector being the provider is a more efficient way of providing knowledge, technical support and infrastructure in the massive and scattered but potential rural zones. This would also help in reducing the pressure on the urban areas which makes them magnets for urban blight.

The implementation of these projects requires government support in the form of policy interventions. Firstly, a heavy investment in research and development at grass root level is required; secondly, infant industries and private partners should be given protection; and thirdly, emphasis should be given on export quality production for establishing international markets. India, being an agro-based economy, requires saving of agricultural land and increasing agricultural performance with a futuristic view of capturing global food market which can be achieved efficiently by technological advancement and industrialisation of rural areas.

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Role of IT to Encounter Rising Food Inflation

Gururaman Subramanian, Kanishka Maheshwari, and Ashish Kaushik

1 Introduction

There are people in the world so hungry, that God cannot appear to them except in the form of bread. – Mahatma Gandhi

The paradox India is facing today is "Millions of common people are starving for food; tons of food grains are allowed to rot in food depots, while inflation is spiraling high." The cost of food items is increasing rapidly, making them unaffordable to a majority of people. Recently, the onion prices soared (Rs.60–80 per kg^{-1}), and there was a sugar and milk crisis in year 2008.

On the supply side, India is the world's second largest producer of food, behind Brazil, but has the largest number of people suffering with hunger and starvation. India faces a challenge, as high food inflation of 18.32% affects the common man and cripples household incomes—which is alarming, considering that the wholesale price index of food grains had shown only single-digit growth, largely below 5%, throughout the last 13 years. Even the famine of 2002–2003, when food grain production plunged to 174.2 million tons from 212 million the year before, had not hurt the consumer as much. India is also the world's largest producer of many spices; the second largest producer of wheat, rice, sugar, groundnut, and inland fish; and the third largest producer of tobacco and accounts for a tenth of the world fruit production while being the foremost producer of banana and sapodilla (chikoo in India).

The increasing yields over the years, barring sporadic declines, are not rendering food grains affordable. In 2008–2009, food grain production scaled a record

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of 234.47 million tons thanks to a cycle of good monsoons between 2005 and 2008. While drought reduced production to 218.19 million tons in 2009–2010, it was still enough to swell buffer stocks. Prices, however, increased by 19% earlier last year.

So it is mandatory to analyze the causes of inflation, identify the causes within our control, and improve upon them.

2 Causes of Inflation

Globally food prices have been rising since 2005, and many of the factors contributing internationally seem to be contributing equally to the domestic markets. Most of the commonly cited reasons for food inflation are domestic food production, trade and global prices, food grain management, and long-term inflation[1]. Apart from the above, changes in stocks and exports at the cost of domestic consumers lead to inflation.

Domestic food production is dependent on monsoon, and many factors influence global food prices. Long-term inflation is the result of the economic policies and performance year after year, and it is the reflection of what is being done today into the future.

So it is food management which is under our control. Food management is about how we manage the entire food supply chain. Causes that drive inflation that are attributable to food management are as follows:

1. Dependency on the 4-month monsoon season when 80% of rainfall happens. That means that there are no proper round the year irrigation systems.
2. Supply chain constraints are not considered in procurement and are not aligned to demand.
3. Farm production is not linked to market demand.
4. Delayed decision making due to lack of real-time information.
5. Timely release of the stocks held by FCI in small but frequent batches.[2]
6. Reducing percentage of arable land and increase in disposable income.

For example, the first indication of a serious fall under sugarcane acreage was available in the first week of July 2008, but export of sugar continued despite this signal. From Apr to Sep 2008, India exported sugar worth $960 million, and in the next six months (Oct 2008–Mar 2009), it imported sugar worth $127 million. During the Apr–Sep 2009, India imported sugar worth $306[13]. In a short span of time, the price paid for imported sugar turned out to be more than double the price fetched by exports. This implies that with a correct assessment of situation, sugar exported at a low price could have been kept in stock to meet the deficit in production that emerged in a few months.

Going further, we discuss the solutions for points 2 to 5 that can be addressed immediately and within our control—not that other factors are not significant—but they largely depend on government actions, policies, and monsoon.

3 Why India Needs an Efficient Food Supply Chain System

3.1 *Need to Procure at Food-Surplus States and Transport Them to Food-Deficit States*

Wheat and rice are the most commonly consumed food in India. India is a vast country with 28 states and 7 union territories. Out of this, only 7 states have more than 5% share in the total rice production in India with Andhra Pradesh topping the list with 15% contribution. Only 5 states have more than 5% of the total wheat production with Uttar Pradesh topping the list with 35% contribution. But Uttar Pradesh is also the most populous state, and most of the production is consumed within the state. So we are left with only Punjab and Haryana as the food-surplus states. Table 1[4] presents a status of the state-wise food production in India.

As per the authors' discussion with FCI officials in Delhi and the Deputy Director, food and civil supplies department in Karnataka, FCI has storage depots at almost each district head quarters and has to transport the procured grains to each of these locations. FCI maintains that their main constraint is with the railways in transporting the food grains from food-surplus to food-deficit states, particularly to the states where there is no backward traffic (e.g., North East). Karnataka had received food grains from rakes originally headed for North East but were diverted due to some issues.[5]

Table 1 (Percentage of Contribution to total production columns added by the authors)[4]

	Thousand tons		Contribution to total production (%)	
2010–2011	Rice	Wheat	Rice	Wheat
AP	14385	10	**15.09**	0.01
Assam	4752	64	4.99	0.07
Bihar	3320	4670	3.48	5.43
Chhattisgarh	6159	127	**6.46**	0.15
Gujarat	1523	3854	1.60	4.49
Haryana	3472	11041	3.64	**12.85**
Himachal	131	670	0.14	0.78
J&K	508	290	0.53	0.34
Jharkhand	1137	151	1.19	0.18
Karnataka	4047	245	4.25	0.29
Kerala	543	.	0.57	0.00
MP	1772	7627	1.86	**8.88**
Maharashtra	2669	2292	2.80	2.67
Orissa	6558	5	**6.88**	0.01
Punjab	10837	15829	**11.37**	**18.42**
Rajasthan	266	7215	0.28	**8.40**
TN	6139	.	**6.44**	0.00
UP	12014	30001	**12.60**	**34.91**
Uttarakhand	545	887	0.57	1.03
West Bengal	12333	842	**12.94**	0.98
Other states	2215	109	2.32	0.13
All India	**95325**	**85928**	**100**	**100.0**

Bold numbers represent the food surplus states for that commodity in India. State which have more than 5% contribution to the production are marked bold.

So it is an obvious requirement to procure at food-surplus states, store them properly, and transport them to the food-deficit states and again store them till it is lifted by the respective agencies. So this means that a robust supply chain management is required.

3.2 Need to Estimate Demand Accurately

An analysis through the offtake from the respective states vis-à-vis the procurement (Table 2[4]) indicates that procurement is not aligned to the demand. Considering the huge volume handled by the PDS, 1% amounts to 2.25 lakh tons! There is a 17% gap between allotment and offtake which clearly shows that the supply is not aligned to demand.

As per the discussion with the state food department officials in Karnataka (done on a sample basis), the state department calculates the requirement on a monthly basis based on the number of cardholders and their categories and informs FCI/state agencies responsible for storage[5]. So it is possible for FCI to get the estimates for a few years on a rolling basis and allocate the food grains in line with the demand projected by the respective state governments. While this may prove to be a massive task if done manually, FCI has to leverage information technology and use decision support systems.

3.3 Need to Control Mounting Food Subsidy

The quantum of food subsidy depends on the level of procurement of food grains. So it is essential to procure based on demand than procuring based on policies.

The subsidy-released data in Table 3[3] shows that the increase can only be attributed to increased procurement and inefficient supply chain management. A 30% increase in minimum support price (MSP) was implemented in 2007–2008, and there has not been a significant increase in the MSP also since then. Even after accounting for a population growth of an average of 6% and practically no change in the percentage of TPDS population, the increase in food subsidy is not justified.

Table 4[6] is self-explanatory and gives details of consistent increase in stock levels, while the storage capacity is not geared up to meet this stock increase. From the stock levels, we can fairly assume that the procurement is not aligned to demand.

3.4 Need to Maintain Shelf-Life Details and Enable FIFO Process (First In First Out)

To avoid wastage due to various reasons, there is a need to estimate and maintain shelf-life data. For implementing this model, a system is required to track each procurement lot with a shelf-life period attached to it. Another requirement is to issue the lots that arrived first to avoid the wastage due to storage for a long time.

Table 2 Allocation and offtake of wheat, 2009–2010, under TPDS (in thousand tons)[4]

State/union territories	Allotment	Offtake	Offtake (%)
Andhra Pradesh	254.51	30.16	11.9
Arunachal Pradesh	9.43	8.98	95.2
Assam	277.51	223.13	80.4
Bihar	1534.22	1001.24	65.3
Chhattisgarh	238.2	155.8	65.4
Delhi	445.34	436.54	98
Goa	7.48	6.27	83.8
Gujarat	1289.04	712.83	55.3
Haryana	980.47	501.67	51.2
Himachal Pradesh	312.1	289.83	92.9
J&K	224.13	223.14	99.6
Jharkhand	583.93	368.46	63.1
Karnataka	357.44	296.07	82.8
Kerala	249.88	223.96	89.6
Madhya Pradesh	2807.66	2708.11	96.5
Maharashtra	2793.98	2099.03	75.1
Manipur	19.09	14.27	74.8
Meghalaya	17.16	16.72	97.4
Mizoram	7.49	7.46	99.6
Nagaland	34.37	33.58	97.7
Orissa	392.82	371.12	94.5
Punjab	1213.92	987.53	81.4
Rajasthan	1945.46	1919.34	98.7
Sikkim	2.94	2.95	100.3
Tamil Nadu	210.4	211.12	100.3
Tripura	28.04	24.32	86.7
Uttar Pradesh	4318.53	3945.01	91.4
Uttarakhand	260.44	233.81	89.8
West Bengal	1922.27	1908.12	99.3
A&N Islands	8.76	4.45	50.8
Chandigarh	22.1	22.05	99.8
D&N Haveli	0.64	0.34	53.1
Daman and Diu	2.03	0.32	15.8
Lakshadweep	0	0	–
Puducherry	11.94	3.33	27.9
Grand total	**22783.72**	**18991.06**	**83.4**

Table 3 (2009–2010 data up to 10-Feb-2010)[3]

	Subsidy released (Rs. in crore)			
Year	FCI	States	Total	% increase YOY
2004-05	23280	2466	25746	
2005-06	19871	3200	23071	−10.4
2006-07	20786	3042	23828	3.3
2007-08	27760	3500	31260	31.2
2008-09	36744	6924	43668	39.7
2009-10	44879	9660	54539	24.9

Table 4 Annual procurement, offtake and stocks (Quantity in million tons)[6]

	Procurement			Offtake			Stocks		
Year	Rice	Wheat	Total	Rice	Wheat	Total	Rice	Wheat	Total
2005-06	26.69	14.79	**41.48**	25.08	17.17	**42.25**	13.68	2.01	**16.62**
2006-07	26.3	9.23	**35.53**	25.06	11.71	**36.77**	13.17	4.7	**17.93**
2007-08	26.29	11.13	**37.42**	25.22	12.2	**37.43**	13.84	5.8	**19.75**
2008-09	32.84	22.69	**55.53**	24.62	14.88	**39.5**	21.6	13.43	**35.58**
2009-10	32.59	25.38	**57.98**	26.89	21.97	**48.86**	26.71	16.13	**43.36**
2010-11	31.13	25.92	**56.79**	29.8	23.07	**52.87**	28.82	15.36	**44.35**
2011-12	7.79	27.88	**35.67**	2.28	1.68	**3.96**	25.27	35.88	**61.3**

Note: (1) Total stocks include coarse cereals. (2) For 2010–2011, procurement data is up to August 18, 2011, offtake for the period April 30, 2011, and stocks as on August 01, 2011

3.5 Pilferage Due to Theft or Diversion of Food Grains

According to Justice D.P.Wadhwa's committee which was constituted in 2006 to look into the maladies affecting the proper functioning of PDS, some of the deficiencies of PDS are multiple ration cards being issued under a single name, faulty system of issue and record keeping, and pilferage—PDS food grains find way to market, and all the lot do not reach the eligible/needy person, no biometric identification for the users, no central monitoring system to track the carriage trucks, and the delivery mechanism has no RFID (radio frequency identification device)[11].

All the factors explained above justify the need for an efficient food supply chain management and an efficient food supply chain planning system. Efficient operations will result in huge savings on the food subsidy bills, and the same can be used to build better infrastructure. For example, the savings can be used to implement better packing material as the gunny bags used at present get torn in 4 to 5 months, and the food grains are spilled across the warehouse. The warehouse personnel sweep the spilled grains and pack it again, and this activity leads to complaints on the quality food grains distributed through PDS[5].

4 Canadian Wheat Board Case Study

Improved business processes and supporting technologies now provide greater visibility and control of both costs and inventory. The outcome: reliable and consistent product delivery to the customer resulting in better returns for farmers – Dale Martin, Vice President, Logistics and Supply, Canadian Wheat Board[9].

The Canadian Wheat Board (CWB) is a farmer-controlled organization that markets wheat and barley grown by Western Canadian producers, and it is the largest single seller of them in the world, holding more than 20% of the international market. The CWB is the marketing agency for over 75,000 farmers.

The CWB has three main supply chain strategic objectives, namely[7], (1) shipping a safe, consistent, and high-quality product to customers; (2) creating value for farmers by reducing supply chain costs and encouraging competition in the supply chain; and (3) delivering high-quality service to farmers.

The grain from Western Canada travels an average of 1300 km from origin to export position compared to Australia or Argentina where grain travel less than 300 km. The storage capacity of CWB is also less than competitors. Grain exports from Canada's west coast ports average 20 million tons annually, yet the working capacity of the terminals is less than 1 million tons requiring a just-in-time approach to planning and execution of grain shipments[7].

4.1 CWB's Role in Supply Chain

In 2006, the CWB launched a three year initiative—the supply chain transformation (SCT) program—to reengineer its supply chain processes and modernize the backbone of its information systems. This strategic program involved replacing, revamping, and/or improving all aspects of the CWB's supply chain. The goals were to address a number of immediate needs and position the CWB for future growth and change[9]. CWB also has a strong vision, mission, and objectives strengthened by a strong strategy.

The CWB's supply optimization group assesses the quantity and quality of grain available for marketing and combines this information with supply chain capacity and sales information to develop the export sales program. Before a sales is made, the CWB's marketing group coordinates with supply optimization to ensure product and capacity availability. Once a sale is made, the marine logistics assess when to order grain for the sale and communicates its demand to CWB rail logistics. The key objectives of rail logistics are to get the right grain into place at the right time to meet the requirements of the CWB's sales program[7]. The supply chain optimization practices have also been acknowledged in the CWB's Annual report of 2009–2010 under section "CWB Performance Highlights."

4.2 Web Portal for Farmers

Just a note to say – Well Done! Just did my 07 permit. No trip to town, no waiting for anybody, no need to use a line company. Added land and filled out and done in under 5 minutes – Producer, July 2007[9]

The CWB launched an online web portal for farmers—named as the Farmer Procurement and Payment Services (FPPS). FPPS provides the CWB with a single source of information about the producers and provides the producer with a single destination to find out their standing with the CWB[9].

5 Proposed Solution and Suggestions

Food is our common ground, a universal experience. – James Beard

5.1 Proposed Solution and Suggestions

- Design a demand driven supply chain solution.
- Design a web portal to be shared among farmers and procurement bodies. Portal would contain the information of procurement forecast.
- Design an optimal sourcing and distribution strategy and find the optimal location for storage warehouse.
- Embedded intelligence for tracking, monitoring and analyzing various leakage/pilferage factors with all involved organizations under one integrated software though they are separate legal entities. This will ensure proper tracking and accountability and seal pilferage due to theft and "siphoning" to a great extent.
- Once real-time data is available, the agencies involved in food grain procurement, storage, and distribution can work on eliminating the bottleneck constraints since the optimization model identifies such constraints.
- The identification of constraints will also serve a national objective of addressing the growth requirements of backward regions so that railways will not have any constraint to move goods to every corner of India since they will be assured of backward goods traffic.
- With the implementation of nation-wise integrated software to plan and manage operations, FCI and all allied agencies can move to a weekly planning buckets to actively and quickly respond to fluctuations instead of the monthly system being followed at present.
- All the above solutions when implemented will result in an efficient and effective food supply chain in India resulting in controlled inflation and more value to farmers.

5.2 Forecast Demand

Forecasting demand is based on applying statistical models on the history and the underlying causal factors. Purchasing power parity, population, government policies, arable land, sowing area and yield, and monsoon are examples of causal factors that can be modeled.

Considering the massive scale and complexity of operations, we propose a robust software to estimate the demand.

5.3 *Optimize Supply*

India's current wheat consumption is close to 70 million tons, while production is close to 80 million tons—still not a comfortable scenario because of uncertain weather, wastage, and pilferage due to various reasons and export. To have an optimized supply chain, there is a need to forecast agricultural production since it is one of the supply parameters. Whether it is a constraint or not depends on the monsoon which is difficult to forecast. But there are scientific methods to forecast agricultural production based on multiple regressions. These statistical methods certainly give a fairly accurate forecast that is more appropriate for planning[12].

5.4 *Conceptual Optimization Model*

Once demand forecast is available, the supply chain model is optimized using linear programming-based software which recommends least cost supply chain model after going through a huge number of iterations quickly. Our conceptual model has four states and their respective storage facilities. Two states are wheat-surplus states, and two are wheat-deficit indicating that wheat would move from surplus states to meet demand of the deficit states. The transportation system is railway, and it is also modeled as a constraint in the supply chain. Figure 1 is the proposed conceptual flow.

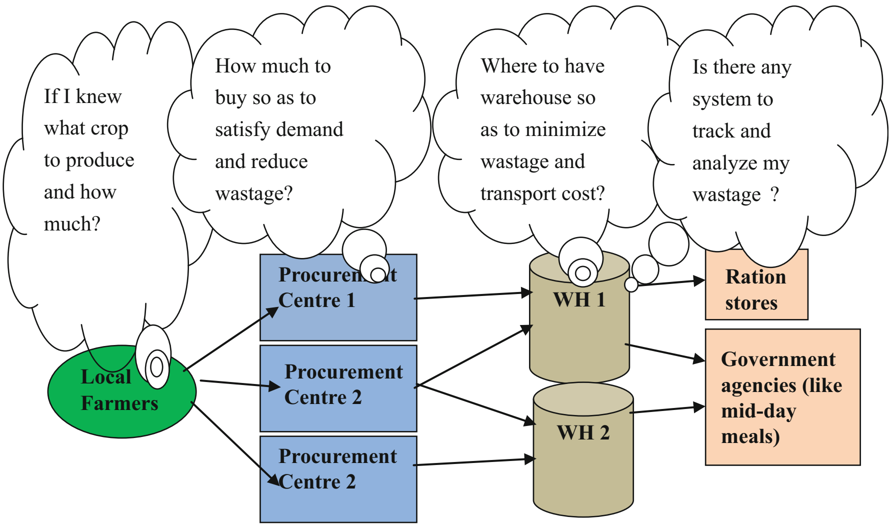
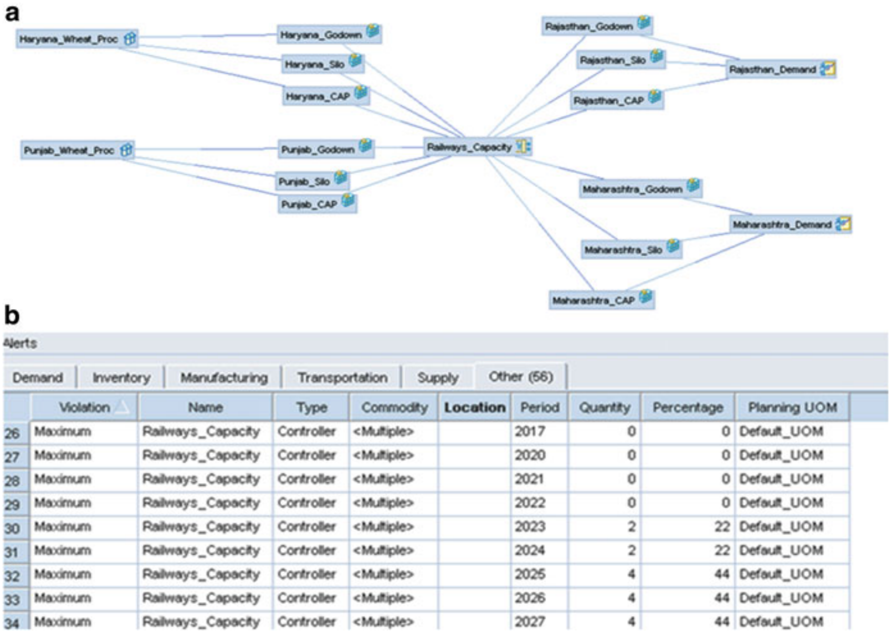


Fig. 1 Pictorial view of issues in Food supply chain



	Violation	Name	Type	Commodity	Location	Period	Quantity	Percentage	Planning UOM
26	Maximum	Railways_Capacity	Controller	<Multiple>		2017	0	0	Default_UOM
27	Maximum	Railways_Capacity	Controller	<Multiple>		2020	0	0	Default_UOM
28	Maximum	Railways_Capacity	Controller	<Multiple>		2021	0	0	Default_UOM
29	Maximum	Railways_Capacity	Controller	<Multiple>		2022	0	0	Default_UOM
30	Maximum	Railways_Capacity	Controller	<Multiple>		2023	2	22	Default_UOM
31	Maximum	Railways_Capacity	Controller	<Multiple>		2024	2	22	Default_UOM
32	Maximum	Railways_Capacity	Controller	<Multiple>		2025	4	44	Default_UOM
33	Maximum	Railways_Capacity	Controller	<Multiple>		2026	4	44	Default_UOM
34	Maximum	Railways_Capacity	Controller	<Multiple>		2027	4	44	Default_UOM

Fig. 2 Conceptual model for Food Supply Chain

The input data we have considered are 15-year demand projection (subjective estimation) from 2 deficit states, available quantity of wheat from surplus states, distribution capacity of railways, and storage capacity of FCI.

The software recommends when and by how much railways should scale up their distribution capacity, when and by how much FCI should scale up their storage capacity, and from where to procure to incur the least cost.

The 15-year model gives enough insight to FCI to collaborate with railways on where and when they should align the distribution capacity. This approach gives all the stakeholders enough visibility and time to plan for infrastructure. Figures 2a, b are screenshots of the conceptual model[10]. Figure 2b is the "alert" screen that lists down the exceptions which need to be resolved by the planners.

6 Conclusion

While food production and yield has consistently increased over the years, it is not reflected in the affordability due to high inflation. This is mainly due to imbalances in regional food grains production and consumption that have not been managed efficiently. Considering the large scale of operations in the food grains management in India, it is practically not possible to manage with manual and disintegrated pockets of computerized software. So there is a compelling need to integrate all the organizations involved in the food grain management under one roof to remove all the operational inefficiencies. The subsidy bill saved in the improved supply chain efficiencies can be invested to minimize the constraints and build better infrastructure, thus triggering a vicious chain of improvements that will become irreversible over a period of time. These operational efficiencies will certainly contain inflation and bring more value to all the stakeholders in the food chain from source to the target consumer. And finally, we do not have to set new trends with high risks, since we already have successful cases as examples to emulate and become efficient.

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Achieving Dynamic Capability Through Collaborative ICT Infrastructure: A Strategic Driver for SMEs in Emerging Economies

Shahriar Sajib and Renu Agarwal

1 Research Background

Small- and medium-sized firms in emerging economies need to strengthen their human capital in order to compete in volatile, dynamic and transitioning environments. We theoretically argue that the managerial and organisational capabilities of these individual firms, as a result of participating within an SVN, consequently foster dynamic capabilities within individual partnering firms. Entrepreneurship alertness of these individual partnering firms is one such capability which plays a vital role in sensing external change and helps managers of such firms to seize opportunities and address the challenges of the changing business environment. No doubt, these SME firms have a less comprehensive knowledge base, are strapped for resources, and possess limited sensing and seizing capability than large-sized firms. However, considering the context of service industries in emerging economies, such as India and China, this chapter theoretically illustrates the interrelationships and interdependencies between various constructs and the instrumental role that formal and informal information/knowledge flow play in facilitating development of this tacit capability.

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2 Literature Review

2.1 Role of ICT in Building Dynamic Capability Through Entrepreneurship Alertness

2.1.1 Importance of Dynamic Capability Building

Dynamic capability view (DCV) emphasises on the capability of integrating, building or reconfiguring organisational resources and internal and external competencies in order to react to changing dynamics of the market (Teece 2007, 2009). Dynamic capability enables firms to sustain their competitive advantage through relentless modification or creation of organisational configuration during turbulence in the external environment through improved capability (Eisenhardt and Martin 2000; Zollo and Winter 2002). As DCV has emerged as a robust theoretical framework, it is, therefore, important to investigate what factors drive SME managers capabilities in real life that help facilitate them coordinate, integrate and reconfigure organisational resources and competencies as changes happen (Eisenhardt and Martin 2000).

Sensing, seizing and reconfiguring capacities are identified as core components of managerial capability in order to achieve dynamic capability (Teece 2007). Pavlou and Sawy (2011) break down the higher-order construct 'reconfigure capability' into two constructs which are 'integrating capability' and 'coordinating capability'. Teece (2007) points that it is challenging for firms to deploy enterprise-level capability of sensing, seizing and reconfiguring capabilities through micro-foundations of dynamic capability, which are organisational structure, decision rules, disciplines, processes or procedures across organisational boundary. Zajac et al. (2000) support this observation by providing empirical evidence that a firm needs to continuously align its core strategies based on its internal resource profile, considering external environmental factors in order to demonstrate excellence in performance.

On the other hand, Sambamurthy et al. (2003) stress that in order to enhance agility, firms are relying more on information technologies, including processes, knowledge and communication tools. They demonstrated that investment in information technology enhances a firm's performance through increased agility, digital options and entrepreneurial adaptation, which ultimately lead firms to achieve a competitive advantage. In order to build and sustain competitive advantage, knowledge sharing is considered as a crucial resource in dynamic environment (Teece 2007). Camisón and Forés (2010) echo the importance of external knowledge to adapt in competitive environment. Empirical studies have grounded this fact that inter- and intra-organisational learning processes create the basis of dynamic capabilities (Agarwal and Selen 2009, 2011). Furthermore, Agarwal and Selen (2009) empirically demonstrate the importance of collaborative agility, collaborative innovative capacity and entrepreneurial alertness in achieving strategic, productivity and performance outcomes in an SVN.

2.1.2 Importance of ICT Capability for SME Firms

Teece (2007) argues that in order to incorporate intuition capability of the organisational sensing process, ICT can play a comprehensive role to aid organisational responsiveness. Reflexive processes need to have the capability to filter mass information from the external environment to identify the relevant information about the competitiveness in the market to facilitate managers, entrepreneurs and business leaders to react rapidly in order to seize the opportunity (Hough and White 2004). Hodgkinson and Healey (2011) argue that technology is participating in search and sense-making activities of organisations in the form of knowledge management systems or decision support systems. Aral and Alstyne (2011) illustrate that ICT mechanisms enable partnering firms to achieve information advantage in a network to intercept novel information from the information flow across the network. Agarwal and Selen (2008) stated that adaptation of technology provides transactional benefits to the firms such as speed, quality, cost, dependability and flexibility. Further, Agarwal and Selen (2008) mentioned that integration of information flow through ICT systems across inter- and intra-organisational boundaries maintaining confidentiality can enrich cognitive and informative dimensions of the business ties in SVN.

2.1.3 Tacit and Explicit Knowledge, Formal and Informal Flow and Its Association with ICT

Johannessen et al. (2001) emphasised that heavy reliance on technology and ICT systems in managing organisational knowledge may undermine the strategic importance of tacit knowledge, which is difficult to transfer through technology. Johannessen further argued that ability to incorporate information technology to transfer the tacit knowledge of employees facilitates organisations to achieve sustainable competitive advantage. As such, Benner and Tushman (2003) emphasised establishing effective interaction between tacit knowledge and ICT infrastructure of the firms. On the other hand, scholars such as Daft and Weick (1984) and Bhardwaj and Monin (2006) emphasised on combining informal and formal information flow in order to capture both tacit and explicit knowledge of an organisation. Conway (1995) showed that during different phases of innovation process such as idea generation, problem solving or testing phase, informal mechanism of information transfer is important for transferring information and ideas.

2.1.4 Importance of Economic Policy Support to Foster SME Advancement

From a micro-level, Ahuja (2000) found that structural hole within an economy has a negative impact on innovation in a firm's network where both direct and indirect ties with other firms have positive effect on the innovation capability of the focal firm. Freeman and Sandwell (2008) demonstrate that networking plays a critical role during the economic development stage of a country; therefore, institutional networks may play a vital role in helping firms in emerging economy's sustain through the transitional period. Due to lack of symmetric distribution, information entrepreneurship opportunities exist (Minniti 2008), which requires better ties and collaboration with SVN in order to contemplate into opportunities. As an example, in order to face innovation challenges, the Indian innovation system needs to focus on creating higher inter-firm cooperation and support cross-fertilisation of knowledge between different industrial sectors in order to diversify internal market (D'Costa and W. B. D. R. Group 2006). In the case of Israel, Breznitz (2006) demonstrated that universities from Israel have a high R&D capability, which helped its IT industry to have a scientific base and innovation orientation. However, as majority of newly industrialised countries lack sophisticated R&D infrastructure, policies should be focused around fostering dynamic capability building within firms.

2.1.5 How Do SMEs Operate in Emerging Economies?

Che et al. (2011) define an emerging economy as one that experiences rapid economic growth through rise in income and purchasing power. Bruton et al. (2008) mention that in emerging economies, SMEs play a vital role in driving and improving economic condition through creating employment opportunities and social development. Globalisation, rapid changes in technology and customer preferences have created significant pressures on SMEs to become competitive at the global standard (Singh et al. 2010), all of which depict the volatile environment under which SME firms operate. Cavusgil et al. (2003) highlighted that direct access to information and knowledge is critical for building competitiveness of SMEs. They further argued that effective collaboration facilitates sharing of tacit knowledge among partners that enable SMEs to access strategic information (Cavusgil et al. 2003). In the context of SMEs in emerging economy Che et al. (2011) emphasises the need to improve network linkages through building capability for internationalisation. We are prefering this line instead. Networking, clustering and collaboration with other firms provide SMEs access to knowledge about opportunities in the international market, which can provide support in accessing necessary resources and capabilities, and also help to reduce entry barriers. Therefore, networking and collaboration are seen as a potential driver of internationalisation of SMEs (Chen 2003).

Having discussed the theoretical background of this chapter, in the remaining part of this chapter, we will now discuss a theoretical model which can facilitate the capability building of partnering firms through increased collaborative entrepreneurship alertness. First, we will present the theoretical model, and then we will briefly present the constructs that are used in deriving the theoretical framework. This is then followed by the hypotheses underpinned by arguments about the causal relationships that exist among various constructs. This chapter will then finally provide implications of the theoretical model at the end.

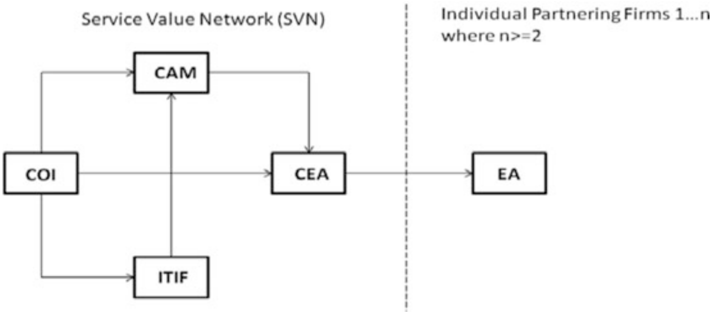

Fig. 1 Theoretical model for achieving dynamic capability in SMEs in emerging economies

3 Hypothetical Theoretical Model

Figure 1 presents the theoretical framework presented in this chapter. It illustrates the interrelationship between various constructs: collaborative architecture management (CAM), collaborative organisational infrastructure (COI), information technology infrastructure flexibility (ITIF) and collaborative entrepreneurship alertness (CEA) which consecutively affect the entrepreneurship alertness (EA) of partnering firms within the SVN network. The CAM construct is underpinned by aspects of collaboration that focus on managerial roles that help facilitate effective collaboration among partners. The COI construct illustrates the adoption of technological infrastructure that facilitates the information and knowledge sharing among partners. The ITIF construct demonstrates characteristics of ICT infrastructure, and finally the CEA construct represents the collaborative entrepreneurship alertness capability of the SVN network, which refers to a collective nature of entrepreneurship practice adopted by a network of firms. The successful interplay between these four constructs affects entrepreneurship alertness (EA) of individual firms belonging to service value network (SVN), and it is the demonstration of this derived capability for a SME partnering firm which is central to this chapter.

4 Defining Constructs of Service Value Network

Agarwal and Selen (2005) described *service value network* (SVN) as a kind of network of value chains which shares a combined core competency of various stakeholders. SVN mobilises resources and competencies for the creation and reinvention of value through reviving roles and responsibilities of different stakeholders (Agarwal and Selen 2005). Basole and Rouse (2008) stated that an SVN creates value through a complex web of relationship between business firms and customers. They further argue that SVN is influenced by social, political, economical and technical factors. Kraemer et al. (2010: p. 8) defined SVN as follows: 'Service Value Networks are Smart Business Networks that provide business value by performing automated on demand composition of complex services from a steady but open pool of complementary as well as substitutive standardized service modules through a universally accessible network orchestration platform'.

SVN offers customers various channels of choice through aligning relationships, technology, knowledge and processes across the network (Agarwal and Selen 2005). Process integration, technology adoption and information sharing across systems are all critical criteria for the success of SVN (Agarwal et al. 2011, 2012). IT can be a potential catalyst for promoting and enhancing capabilities to work collaboratively with flexibility and speed in SVN; therefore, IT process and system integration on an end-to-end basis can enhance organisational benefit (Agarwal et al. 2011; Basole and Rouse 2008).

Each of the constructs in coming up with the framework is defined in Fig. 1, some of the constructs are used as defined by original authors, and some are newly defined in this context.

Agarwal and Selen (2008) defined 'collaborative organisational infrastructure (COI)' as a construct which allows sharing information and knowledge through integration of information and communication technology across the collaborative network with a mutually agreed cost, revenue and risk-sharing performance. The construct COI through the aid of process and system integration across the organisational boundaries enables information and knowledge sharing across SVN which in effect facilitates achieving sustainability in the system for delivering service innovation (Agarwal et al. 2011, 2012).

The elements of *collaborative architecture management* (CAM) are essential managerial skills required to align operational and strategic objectives, mutual goals, capabilities, management style and protection of asset across the collaborative network (Agarwal and Selen 2008). Collaborative alignment, complementarity, conflict management, compatibility and protection of assets are identified as dimensions of SVN in previous empirical studies (Dyer and Singh 1998; Jayaram 2004). CAM is further defined as an organisational driver that delivers the ability of alignment and coordination of resources, routines and activities spanning across inter- and intra-organisational boundaries sharing mutually agreed risk, cost and revenue (Agarwal et al. 2011, 2012).

Duncan (1995) pointed out that compatibility, connectivity and modularity as the major components of *information technology infrastructure flexibility* (ITIF). Compatibility is the ability to share information across the organisation which empowers employees through readily available data, information and knowledge (Duncan 1995; Tapscott and Caston 1993). Connectivity is the capability of IT infrastructure to communicate with internal or external environment (Duncan 1995). Tapscott and Caston (1993) stated connectivity as an ability of seamless information and resource sharing across various platform. Finally, modularity is described as the capability to reconfigure the components of information technology infrastructure for the purpose of sharing and reusing standardised business processes across the organisation (Duncan 1995; Schilling and Steensma 2001).

Duncan (1995) emphasised that through ITIF, firms can achieve strategic innovation across the business processes. In order to succeed in a rapidly changing competitive external environment, ITIF has been considered as a source of core competency (Bhatt and Grover 2005; Chung and Rainer 2003) and elevated service offering (Agarwal et al. 2011, 2012) for organisations.

Entrepreneurship alertness (EA) in firms has been a major concern for academic research. EA is basically identified as a capability of firms which helps them identify unexplored opportunity through maintaining an attentive cognition about the external changes in the markets. Yu (2001) emphasises on maintaining an alertness system to grab and realise the opportunity. Yu illustrates two views; the first one is 'ordinary discovery' where an entrepreneur attempts to exploit opportunities through improving some unnoticed aspects of a particular area of interest. The second view is 'extraordinary discovery' where entrepreneurs contemplate upcoming events through new ideas which have radical implications (Yu 2001).

Organisations need to develop two distinct capabilities namely 'strategic foresight' and 'systemic foresight' in order to explore the current and future opportunities and threats in the marketplace (Sambamurthy et al. 2003: p. 250). Sambamurthy et al. (2003) defined 'strategic foresight' as the ability to anticipate opportunities, threats and discontinuities in the marketplace through increasing alertness about the dynamics of the market. 'Systemic foresight' is defined as the capability to apply knowledge and experience to take competitive actions. Hence, in the context of an SVN, Agarwal and Selen (2009: p. 435) redefine EA of a firm as follows: 'Underpinning the logic of opportunity and innovation, entrepreneurial skills are likely to help front-of-house staff maintain customer satisfaction and provide operations staff with a higher-order ability to explore and exploit options when subjected to varying customer needs, thus arming them with an ability to spontaneously deliver customized solutions to customers'.

We will use this definition to define the EA capability of an SME firm within the context of this firm.

Collaborative entrepreneurial alertness (CEA) is defined by Miles et al. (2005) as a collaborative effort to pursue innovation and commercialisation of innovation through sharing complementing resources, skills and collaborative decision making between firms. Therefore, CEA can be defined as a collaborative process of attaining unexploited opportunities through sharing information among the partners of SVN. Agarwal and Selen (2009) compare entrepreneur skill as a higher-order capability for exploring and exploiting options during the changing nature of customer demands. Agarwal and Selen (2009) further argue that EA creates positive drive to deliver customised solutions to the customers in a spontaneous manner. Ribeiro-Soriano and Urbano (2009) describe 'collaborative entrepreneurship' as facilitated by collaborative relationships and assisted by knowledge creation and continuous innovation. Ribeiro-Soriano and Urbano (2009) further described CE as a business model that can facilitate collaborative activities and decision making through allocating resources appropriately.

Combining the understanding of CE and EA, we are defining and creating a new construct called collaborative entrepreneurship alertness (CEA) which refers to creating a collective cognition of entrepreneurs within SVN through encouraging collective actions among the partners and disseminating strategic information about market dynamics to foster information symmetry across the boundary of SVN in order to build capability of innovation.

5 Research Hypotheses

In this section, we will illustrate the underlying arguments that will enable us to hypothesise relationships between various constructs in support of the research framework postulated herein.

In an SVN setting, efficient information sharing, decisions about technology adoption and integration across end-to-end processes all can have an impact on the performance of partnering firms. COI construct facilitates the process of building a sustainable service system for service innovation through the properties of information and knowledge sharing facilitated by an integrated system (Agarwal et al. 2011). Therefore, the goals of CAM is to synthesise knowledge from COI and successfully coordinates and facilitate the reconfiguration of resources and skills across the organisational boundaries of an SVN using information and knowledge accessible from the service system. Therefore, we postulate that COI will have a positive effect on CAM as postulated by Agarwal et al. (2011). Huber (1991) identified that boundary-spanning personnel of an organisation act as organisational sensors through performing the task of environmental scanning. For example, Stewart (1973) found that public servants of governmental organisations serve as organisational sensors for government. Hough and White (2004) suggested that scanning activities of firms need to increase in accordance with the increase in uncertainty in the environment. Therefore, we can argue that COI will play positive role in delivering CEA through sharing information from various internal and external sources of SVN. Zhang and Ziegelmayer (2009) mentioned that architectural design of collaborative organisation will determine the characteristics of IT infrastructure in a collaborative environment; therefore, COI will effect directly to the dimensions of ITIF.

H1a: COI has a positive effect on CAM, H1b: COI has a positive effect on CEA, and

H1c: COI has a positive effect on ITIF

Flexibility in information technology infrastructure will allow faster information sharing across the organisational boundary which will eventually allow the managers to make rapid decision in collaborative manners (Agarwal and Selen 2008). Moreover, ITIF will bring transparency of information flow across the processes of SVN which will enable the managers to attain the objective of reconfiguring resources and skills across SVN.

ITIF will increase the IT responsiveness of the firm as a result managers will be able to react in a rapid manner in a changing environment (Duncan 1995). IT responsiveness therefore can be reflected as responsiveness to end-users demands, decision making for managers, environmental changes or business process changes. ITIF will make the IT system of SVN more responsive to address the changes; therefore, ITIF will enable managers of partnering companies of SVN to make decisions collaborate and work collectively to achieve mutual goals (Zhang and Ziegelmayer 2009).

H2: ITIF has a positive impact on CAM

Johannessen et al. (2001) pointed out that modern business is facing challenges of globalisation, environmental turbulence, complexity and rapid advancement of information technology. Firms who have demonstrated to successfully achieve dynamic capability in their adaptive business ecosystem have done it through innovation, learning, involvement and collaboration with other enterprises, entities or institutions (Teece 2009). As Ribeiro-Soriano and Urbano (2009) highlighted the importance of collaborative decision-making processes to react sharply in a rapidly changing environment, managerial aspects of collaborative architecture become highly critical to deliver innovation as an outcome of collective effort. Therefore, in order to satisfy the definition of CEA that we stated earlier, it is very critical to deploy effective leadership and managerial skill as formulated by CAM's ability to manage SVN's successfully and to remain competitive in a dynamic environment.

H3: CAM has positive impact on CEA

Huber (1991) identified that boundary-spanning personnel of an organisation act as organisational sensors through performing the task of environmental scanning. For example, Stewart (1973) found that public servants of governmental organisations serve as organisational sensors for government. Kiesler and Sproull (1982) noted that problem sensing is a critical component of managerial behaviour in changing environment which enables organisations to react promptly through cognitive process of formulating effective managerial actions to address the problem. Hough and White (2004) suggested that scanning activities of firms need to increase in accordance with the increase in uncertainty in the environment. Jantunen et al. (2005) emphasised that in order to utilise and renew the knowledge base of firms, SME firms need an ability to internalise externally generated knowledge and combine the information with existing knowledge base. As a result, capabilities of SVN managers to effectively deploy CEA will have positive impact in building EA for the individual companies.

H4: CEA has positive impact on CE

This hypothetical framework provides an interrelationship between constructs that we have defined earlier. The framework needs to be operationalised in order to verify the underlying arguments.

6 Implications for Managers and Policymakers and Future Research

The framework carries significant implications for both managers and policymakers of emerging economies. Ruiz-Mercader et al. (2006) suggest that ICT influences organisational performance when context of learning environment has taken place into practice comes into play. Further, the authors also emphasise that collaborative information technology has positive impact on both individual and organisational level learning outcome. Therefore, the findings of this chapter can motivate SME managers to collaborate with SVN to improve their external information processing capability in order to build dynamic capability through increased situational awareness and entrepreneurship alertness. As cost is a primary concern for the managers of SMEs, connecting flexible collaborative organisational information technology infrastructure will drive operational flexibility and therefore provide competitive advantage to the SMEs (Zhang and Ziegelmayer 2009). Integrating with the SVN through ICT will drive entrepreneurship alertness skills and at the same time reduce institutional cost of receiving strategic information from external environment; therefore, it will be a strategic driver for SMEs to participate in SVN. As a result, SMEs of emerging economies will become more competitive to compete successfully in present globalised world. Therefore, this chapter provides strategic guideline for the policymakers and managers to leverage resources to SMEs more effectively and efficiently in order to build dynamic capability.

7 Conclusion

SMEs need to participate within collaborative network and should focus on institutional aspect of collaboration in order to gain advantage of participating in a network. COI and CAM are very important higher-order construct for building an effective SVN which will able to deliver mutual goal for the partners. On the other hand, through implementing flexible ICT companies with higher resource capacity can leverage SME partners with responsive operational capability to react with the changes in accordance with market dynamics. Sustainable development of SMEs is key factor for the sustainable economic development. Firms in emerging economies need to pay special attention for building dynamic capability which will help drive their economic growth. Identifying strategic drivers to motivate SMEs to participate in SVN therefore carries high significance. This chapter draws upon this issue and provides a theoretical framework for policymakers and SME managers. In order to verify the validity of the theoretical framework developed in this chapter, a robust empirical study is required. This chapter is an initial step towards a bigger step to investigate this important issue.

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Innovation and Economic Performance of Ancillary SMES: An Empirical Analysis

R. Sudhir Kumar

1 Introduction

SMEs account for a considerable majority of industrial units and contribute to the major proportion of employment, output and exports in most developing as well as developed countries. Globalisation, the process of continuing integration of the countries in the world, has increased the movement of goods, services, ideas, capital and technology across national borders. This free movement of goods has enhanced the opportunity for competitive SMEs of developing countries to cater to wider international markets (Bala Subrahmanya 2005).

Innovation is one of the main factors underlying countries' international competitiveness and their productivity, output and employment performance. The production and use of knowledge is at the core of value-added activities, and innovation is at the core of firm's and nation's strategies for growth (Michie 1998). Technological innovation is a strategic weapon to counter global competition and is an important means of acquiring and strengthening competitiveness for a firm. Small firms would be able to achieve technological upgradation through innovations, and climb up the value chain for the production of high-value items, to survive and grow in the competitive environment (Bala Subrahmanya 2006). Because of its flexibility in production and potential for developing managerial skills, individual initiatives and rich personal relations, SMEs are often promoted as a source of technological innovations in industrialised economies (Bala Subrahmanya 2005).

In the globalisation era, there has been an increasing trend of multinational corporations (MNCs) expanding their production bases to developing countries, which offer growing markets on the one hand and better conditions of manufacturing (mainly labour and infrastructural conditions) on the other, to have advantages of

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productivity and distribution (UNCTAD 2002). India is no exception, and many global MNCs in various sectors including automobile industry have started their operations in India. This international expansion of MNCs provides more scope for local ancillary SMEs to receive latest technological inputs for carrying out innovations enabling SMEs to enhance their economic performance.

Whether and how Indian ancillary SMEs would make use of their innovations to enhance their economic performance is the objective of this chapter. This chapter attempts to analyse the innovations carried out by ancillary SMEs in the automobile industry of India and probe the role of innovations in their economic performance using primary data collected from 81 manufacturing SMEs in Bangalore.

2 Literature Review

Schumpeter (1934) defined innovation as related to five types, namely, introduction of new product or a qualitative change in existing product, process innovation new to an industry, opening of a new market, development of new sources of supply for raw materials or other inputs and changes in industrial organisation. Innovation can be defined as the application of new ideas to the products, processes or any other aspect of a firm's activities. A technological product innovation can involve either a new or an improved product whose characteristic differs significantly from previous products. A technological process innovation is the adoption of new or significantly improved production methods, including methods of product delivery (OECD 1997).

Roy and Wield (1985) view technological innovation as the transformation of an idea into a new or improved saleable product or operational process in industry or commerce. Innovation does not occur when new idea is generated, rather when that idea is successfully commercialised. Sen and Egelhoff (2000) argue that the innovation capabilities of a firm may be focused on improving existing products and processes, which are referred to as incremental innovations or developing new products and processes based on entirely different concepts and theories, which can be referred to as radical innovations.

Most of the SMEs, which are basically subcontractors for other large firms, do not perform R&D in any formal sense, and much of their technology is derived from their large enterprise (LE) customers. Engaging in external technical and other linkage activities can increase the technical, market and managerial know-how of the small firm and can form an important part of its overall innovatory activities (Rothwell 1991). Innovative activity is strongest among firms that combine their in-house R&D efforts with technical support from external sources (Macpherson 1997), and customers are considered to be a more important source of innovation than suppliers and scientific developments (de Jong and Marsili 2006). Ancillary SMEs are likely to have fruitful alliance with their LE customers, which generally possess complementary resources, enabling SMEs to carry out more innovations.

Many researchers have pointed out the role of innovation in achieving better firm performance. Edwards and Delbridge (2001) argue that innovation is a key factor for sustaining economic competitiveness and is directly connected to a firm's operational and business performance. Yam et al. (2004) showed that technological innovation capability of a firm is having a positive effect on its competitive performance. Han et al. (1998) argue that organisational innovativeness is a key factor in delivering superior corporate performance. Roper (1997) showed that innovative products introduced by firms made a positive contribution to sales growth. Scherer (as quoted in Coad and Rao 2008) suggested that sales growth is a particularly meaningful indicator of post-innovation performance, and Deshphande et al. (1993) revealed that innovative firms tend to be the better performers.

These studies clearly point out that a crucial factor for enhancing SME performance is the continuous attempt to improve their innovative capacity. In this context, this chapter analyses the innovations carried out by SMEs and probes the role of innovation in the economic performance of SMEs, with reference to ancillary SMEs in the automobile industry of India.

3 Research Methodology

Automobile industry is undergoing rapid transformation with major global players expanding their manufacturing bases to industrialising economies in Southeast Asia, China, India, among others. Local sourcing in the automobile industry has increased, enabling ancillary SMEs of the host countries to have subcontracting relationship with automobile manufacturers and enhance their innovative performance. This context enhances the need as well as scope for SME suppliers to carry out innovations and become competitive to be a part of the supply chain of major automobile manufacturers. The objective of this chapter was studied with reference to ancillary SMEs in the automobile industry of India.

The data were collected from SME suppliers in Bangalore who are manufacturing parts and components for production or assembly line requirements of the automobile industry. The relevant data were collected from 81 ancillary SMEs during the second half of 2006 and first half of 2007 using a structured questionnaire by visiting the firms and having personal interviews with entrepreneurs/senior managers of the firms.

The measurement of innovation is difficult due to the broad nature of innovative activities. One method to assess innovation is to measure the inputs and outputs of innovative activity (Rogers 1998). Most commonly used inputs of innovation activity are R&D expenditure and R&D personnel, whereas outputs of innovation are number of new product/process developments, product/process modifications, patents, etc. (Esposito 1993). Even though none of these measures can be considered stand-alone measure of innovation, these measures can be good indicators of innovation (Rogers 1998). Therefore, details regarding innovations carried out by the sample SMEs in the last 2 years with respect to new product/process developments and modifications, raw material selection and proportion of R&D allocation were collected. Since R&D activity of small firms is distributed over operational areas, R&D expenditures of such firms are either unidentified or underestimated (Roper 1999). Innovative capability of an SME cannot be underestimated just because of the absence of any formal R&D allocation in the firm, and therefore, we collected information regarding the informal resource allocation for R&D or new product developments (NPD) of these SMEs. Innovative performance was measured based on six dimensions of innovation, namely, new product developments, product modifications, process improvements, informal R&D/NPD expenditure, informal R&D/NPD employees and raw material selection.

Economic performance of a firm can be assessed in terms of different indicators depending on the context and objectives for measurement. Tsai and Wang (2008) measure value added as the indicator for firm performance in their study on how external technology acquisition affects a firm's performance because the major purpose for a firm to acquire external technology is to enhance their value added through product or process innovation. In this study, economic performance has to be analysed at the firm level, and therefore, economic performance was assessed in terms of gross value added. In order to probe whether SMEs made use of innovations for their economic performance, multiple regression analysis was performed with innovation score, along with factors of production, capital and labour as explanatory variables and value addition as criterion variable.

To have a more comprehensive picture of the effect of the predictors on the response variable, quantile regression (QR) is performed using the equation. Quantile regression is a statistical technique intended to estimate, and conduct inference about, conditional quantile functions. Just as classical linear regression methods based on minimising sums of squared residuals enable one to estimate models for conditional mean functions, quantile regression methods offer a mechanism for estimating models for the conditional median function and the full range of other conditional quantile functions.

4 Role of Innovation in Economic Performance: Analysis and Inferences

A quantitative assessment of innovations carried out by SMEs was done based on the information gathered for the six dimensions of innovation. Firms were ranked as very low, low, average, high or very high for each of these variables of innovation, and scores ranging from 1 to 5 were given to these rankings (1–very low, 2–low, 3–average, 4–high and 5–very high) for each variable. A consolidated innovation score for each firm was calculated by summing up the scores of all the six variables, and thus, the minimum possible value for innovation score is 6 and maximum possible value is 30. Innovation score thus calculated would clearly indicate the relative performance of these firms in terms of their overall innovation since it is

Table 1 Details of innovation score

						Percentiles		
Dimensions	Mean	Std. deviation	Range	Min.	Max.	25	50	75
New product developments	3.617	1.056	4	1	5	3	4	4
Product modifications	3.432	1.204	4	1	5	3	4	4
Process improvements	3.136	1.232	4	1	5	2	3	4
Informal R&D/NPD expenditure	2.136	0.972	3	1	4	1	2	3
Informal R&D/NPD employees	2.235	1.087	4	1	5	1	2	3
Raw material selection	3.679	1.047	4	1	5	3	4	4
Consolidated innovation score	*18.235*	*3.655*	*18*	*8*	*26*	*17*	*19*	*20*

based on the six different dimensions of innovation. The details of the innovation score along with the scores of the six dimensions calculated for the firms are shown in Table 1.

We considered new products as products which were new to the SME firms and fully developed by these firms as per customer requirements or by own initiative. The mean value for new product developments was above 3.5 implying that the innovative performance in terms of new product developments is above average. Product modifications refer to incremental improvements, which SMEs could achieve for the existing products, and these improvements could have been initiated by the SMEs or their customers. The mean value of 3.432 indicates that these firms were able to carry out significant product modifications, which is an indicator of incremental innovations.

Competitive environment in which the SMEs are operating has put tremendous pressure on SMEs to have continuous improvement for their manufacturing operations, in addition to their product features. Our discussions with entrepreneurs/managers of SMEs revealed that the profit margin for manufacturing SMEs has come down drastically in the decade and these SMEs have to operate with cost reduction in all aspects without compromising on quality and delivery, for their survival. This context calls for the need to continuously improve the manufacturing processes for cost reduction as well as quality improvement, and the mean value above 3 suggests that SMEs were having significant process improvements.

In general, SMEs are constrained to have formal R&D allocation because of their inherent nature of small size and resource inadequacy. At the same time, these SMEs incur a considerable expenditure for innovative activities, mainly, for new product developments which they may not be able to retrieve from the customers. The data related to this informal expenditure were collected as a proportion of annual spending over total sales from the SMEs. The mean value for this innovation dimension score was less than 2.5 which indicates that the extent of informal R&D/NPD expenditure allocation is average only. Given the fact that manufacturing SMEs operate in a highly competitive environment with low profit margins, these SMEs may also be constrained in terms of extra finance for their innovative activities, and this could be one of the reasons for the low mean score of this dimension.

Information regarding the informal allocation of employees for innovative activities by these firms and information based on the proportion of the employees

Table 2 Results of factor analysis on innovation variables

	Factors		
Innovation variables	1	2	3
New product development	0.867		
Product modifications	0.830		
Process improvements	0.494		
Informal R&D/NPD expenditure		0.847	
Informal R&D/NPD employees		0.847	
Raw material selection			0.862
Eigenvalue	*1.934*	*1.453*	*1.142*
Cumulative percentage of variance	*32.23*	*56.45*	*75.49*

used exclusively for new product developments and other innovative jobs over total employees were collected. The mean value was less than 2.5 implying that the innovative performance in terms of informal R&D/NPD employees is also only average. In most of these firms, entrepreneur himself was involved in new product developments and other innovative activities. This could be because of the lesser number of total employees for SMEs as compared to large firms, constraining the SMEs to spare more employees exclusively for innovative activities.

Quality and cost of raw materials play a major role in the operational performance of manufacturing SMEs. SMEs can be innovative in terms of raw material selection by way of searching for better quality raw materials and better source of raw materials which may apparently lead to radical raw material substitution for their products. Innovation score for raw material selection had a mean value above 3.5 indicating the significant SME efforts of searching for better raw materials in terms of quality, price and source.

The mean value of consolidated innovation score between 18 and 19 for SMEs indicates that these small firms were having moderate innovative performances in terms of their overall innovative activities. In order to have more insight into the interrelationship among the variables used to measure innovation and to probe the underlying structure of the data, factor analysis using the data on innovation variables was performed. *R* type of factor analysis based on principal components was performed on these six variables, and the criterion for the number of factors to extract was latent root (eigenvalue) criterion. Hence, the factors having latent roots or eigenvalues greater than 1 were considered significant; all factors with latent roots less than 1 were considered insignificant and were discarded. The results of the factor analysis on innovation variables are summarised in Table 2.

The six variables of innovation are loaded into three factors, and these three factors explained about 75% of the variance of the variables. New product development, product modifications and process improvements which are output indicators of innovation are loaded to the first factor with 32.23% of the variation. Informal R&D/NPD expenditure and informal R&D/NPD employees which are input indicators of innovation are loaded to the second factor with 24.22% of the variation. Raw material selection which cannot be exclusively attributed to input or output of innovations is loaded separately into a third factor with 19.04% of the

Table 3 Results of regression of innovation score (dependent variable: ln Y)

Explanatory variables	Unstandardised coefficients	t-Values	VIF
Constant	9.000***	6.407	
ln K	0.100	1.279	2.690
ln L	0.948***	6.461	2.873
ln Innovation score	0.759*	1.799	1.167
Adj R^2	0.706	Sig.	0.000
F value	60.999	*Durbin-Watson*	2.346

* Indicates significance at 10 % level; *** Indicates significance at 1 % level

variation. This implies that technological innovation of a small firm can be attributed to three factors: output of innovation, input of innovation and raw material selection.

To analyse the role of innovation of these SMEs on their economic performance, innovation score was included in Cobb-Douglas production function as one of the explanatory variables along with capital and labour, and the production function was modified as

$$Y = A\,K^{\alpha}L^{\beta}\ \textit{innovation score}^{\gamma} \tag{1}$$

By taking the logarithm, this equation was written as

$$\ln Y = \ln A + \alpha \ln K + \beta \ln L + \gamma \ln \text{innovation score} \tag{2}$$

The positive role of innovation in the improvement of economic performance would be indicated by a significant positive value for coefficient γ in the equation.

The results of the regression analysis with innovation score as one of the explanatory variables are summarised in Table 3. The coefficient of labour was very high and statistically significant indicating the major contribution of labour for the value addition in these firms. The coefficient of innovation score was also positive and statistically significant implying that innovations of these SMEs also contributed to the value addition along with the labour. The coefficient of 0.759 for the innovation score in the production function implies that an increase of 1% in innovation score would increase value addition by 0.759%, given the other inputs. This implied that though labour was having major contribution for value addition, these SMEs were able to make use of their innovations also for the value addition.

The absence of multicollinearity is ascertained for multiple regression model since the values of variable inflation factors (VIF) for the independent variables were in the acceptable range. The Durbin-Watson coefficient tests for autocorrelation and value 2.346 indicated independence of observations for the regression model.

In order to have a more comprehensive picture of the effect of innovation on economic performance (value addition), we performed quantile regression using the same equation, which will reveal the variation of estimated slope parameters at different quantiles of the response distribution. Quantile regression, which was introduced by Koenker and Bassett (1978), extends the regression model to conditional

Table 4 Results of quantile regression of ln innovation score

Quantiles	Intercept	ln K	ln L	ln innovation score
0.10	11.470004	−0.012779	0.971345	0.149095
	(0.00000)	(0.92559)	(0.00016)	(0.84034)
0.20	7.827181	0.114085	0.914744	**0.937369**
	(0.00001)	(0.25442)	(0.00000)	(**0.08343**)
0.25	7.795429	0.137114	0.838998	**0.958183**
	(0.00000)	(0.14524)	(0.00000)	(**0.05987**)
0.35	8.503905	0.112619	0.988326	**0.736476**
	(0.00000)	(0.21040)	(0.00000)	(**0.12998**)
0.50	8.165824	0.219954	0.700888	**0.718853**
	(0.00000)	(0.01487)	(0.00004)	(**0.14116**)
0.65	6.825956	0.289593	0.646308	**0.988321**
	(0.00003)	(0.00136)	(0.00015)	(**0.04334**)
0.75	6.916520	0.240919	0.742900	**1.152372**
	(0.00002)	(0.00771)	(0.00001)	(**0.01846**)
0.80	6.365077	0.274007	0.675034	**1.279865**
	(0.00004)	(0.00151)	(0.00003)	(**0.00616**)
0.90	7.400799	0.197547	0.853805	**1.231232**
	(0.00000)	(0.02430)	(0.00000)	(**0.00946**)

Coefficients (p-values in parenthesis)

Bold values indicate that the values of coefficient of innovation score for these quantiles are significant at 15 % level

quantiles of the response variable and takes into consideration the heterogeneity of firms. While classical linear regression describes how the mean value of the response variable varies with a set of explanatory variables, quantile regression describes the variation in the quantiles of the response. The values of coefficient γ at different quantiles were used to assess how innovations would influence the value addition of SMEs operating with different economic performance levels.

The results of the quantile regression are summarised in Table 4. The value of coefficient of innovation score was decreasing below median firms and increasing above median firms. The coefficient estimate for the innovation score was having lower values for below average firms evaluated near the median (Q=0.50) and relatively higher values at upper range of quantiles. Figure 1 shows the pattern of change in value addition (ln VA) for change in innovation (ln innovation score) for different quantile values (for constant capital and labour at mean value). The continuous black line represents the OLS regression line. When the quantile regression solution was evaluated below the median firm, slope of the curve was lesser implying that innovations tend to have less influence on the value addition. However, for those SMEs with better economic productivity at the upper quantiles above median firms, slope of the curve was more, indicating the sharp increase in coefficient of innovation score. This implies that for SMEs having average economic productivity, their innovations would contribute less to their economic performance as compared to those SMEs having high economic productivity. High-performing SMEs were able to make more use of their innovations for their economic performance. The variation of coefficient estimate for the innovation score for different quantiles is shown in Fig. 2.

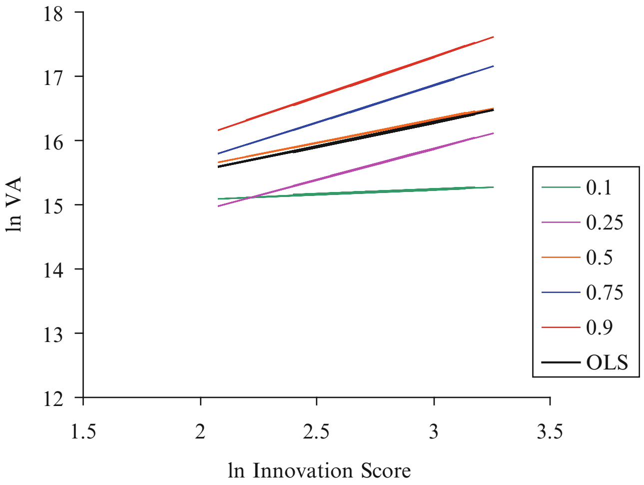
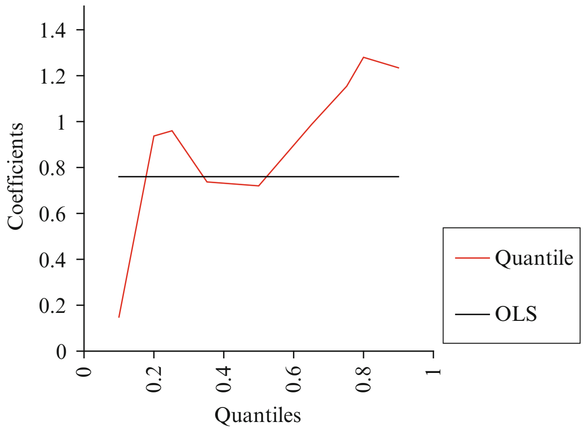


Fig. 1 OLS and quantile regression curves

Fig. 2 OLS and quantile regression estimates of ln innovation score



5 Conclusion

Accelerated process of globalisation has exposed SMEs of developing countries to intense international competition and at the same time, offers more opportunities to competitive SMEs to exploit international markets. This context calls for the need for SMEs, having their own strategic significance in any economy, to become highly competitive in all aspects of business. Small firms should recognise the need of continuous improvement of their innovative capabilities, which in turn can lead to better economic performance enabling them to become globally competitive. This chapter has analysed the nature of innovations carried out by Indian ancillary SMEs and the role of innovations in their economic performance.

Innovation of a small firm can be related to new product developments, product modifications, process improvements, informal R&D/NPD expenditure, informal R&D/NPD employees and raw material selection. The present study has assessed the firm level innovation of the sample firms in terms of these dimensions and found that these firms do innovate and their level of innovation is moderate. But the level of innovation in the areas of informal R&D/NPD expenditure and informal R&D/NPD employees is not high as compared to other dimensions of innovation, and this could be due to their resource constraints, being small in size.

Factor analysis using the data on innovation dimensions revealed that these dimensions can be reduced to three factors. New product development, product modifications and process improvements which are output indicators of innovation are loaded to the first factor, informal R&D/NPD expenditure and informal R&D/NPD employees which are input indicators of innovation are loaded to the second factor and raw material selection which cannot be exclusively attributed to input or output of innovations is loaded separately into a third factor. This implied that technological innovation of a small firm could be attributed to three factors: output of innovation, input of innovation and raw material selection.

Economic performance was assessed at the firm level with reference to the effective utilisation of various inputs in the process of gross value addition. Analysis using multiple regression model revealed the contributory role of innovation, along with the labour, for better economic performance of small firms. Analysis using quantile regression models clearly showed variation of the effect of innovation on the economic performance for SMEs having different economic productivities. Coefficient of innovation was having higher values for firms at the upper quantiles above median firms compared to those at lower quantiles, implying that innovations contributed less to the economic performance of SMEs having average and low factor productivities as compared to those which had higher factor productivities. SMEs having high economic productivity tend to make more of use their innovations for economic performance than SMEs with average economic productivity.

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Part 1.4
Technology and Sustainability

Survival and Growth Strategies for Small- and Medium-Scale Enterprises in India: A Key for Sustainable Development

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1 Introduction

The term MSME defines small-scale industrial (SSI) units and medium-scale industrial units. The MSME sector manufactures a wide range of industrial products such as food products, beverages, dairy products, tobacco and tobacco products, cotton textiles, wool, silk, synthetic products, hemp, jute and jute products, trade, crafts, wood and wood products, furniture and fixtures, paper and paper products, printing publishing and allied industries – engineering, appliances and apparatus, etc. The technological problem has emerged as a prime problem in the competitive era (Agarwal 2010). Study of Dr. D. Himachalam has emphasised the role of entrepreneurs and government programmes in the development of small scale sector. 'Entrepreneurship development in small scale sector revealed that entrepreneurship development and small scale industrial development are the obverse and reverse of the same coin'.

The enterprises in India can be classified as (Table 1):

Before independence, the small- and medium-scale industries represent the village and the urban cottage industry manufacturing items like machines, hardware, food processing, handicrafts, ayurvedic plants, handloom cloths, etc. These industries received recognition and support during the freedom movement as these industries play a prominent role during the freedom struggle to fight against foreign commodities (Ghatak 2006) in India. These industries played the part and parcel of life in society, and people were accustomed to traditional goods and services. The MSME sector is a nursery of entrepreneurship, often driven by individual creativity and innovation. The sector contributes 8% of India's GDP,

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Table 1 Classification of MSME in India, 2006

Type of enterprise	Engaged in manufacture or production of goods	Engaged in providing or rendering of services
Micro enterprise	Does not exceed 25 lakhs rupees	Does not exceed ten lakh rupees
Small enterprise	More than 25 lakh rupees but does not exceed 5 crore rupees	More than ten lakh rupees but does not exceed two crore rupees
Medium enterprise	More than five crore rupees but does not exceed ten crore rupees	More than two crores but does not exceed five crore rupees

Source: Development Commissioner (MSME) Ministry of Micro, Small and Medium Scale Enterprises (2006)

Table 2 Composition of MSME in India, 2011

Characteristics	Registered sector (%)	Unregistered sector (%)	Total SSI sector (%)
No. of rural units	44.33	56.8	55
No. of SSI units	65.55	38.75	42.26
No. of tiny Units	97.9	99.9	99.5
No. of women enterprises	10	10.13	10.11

Table 3 Financials of MSMSE in India, 2001–2010

Sl. no.	Year	Total MSME'S (lakh nos.)	Fixed investment (Rs. crore)	Production (Rs. crore)	Employment (Lakh person)	Exports (Rs. crore)
1	2001–2002	4.07	5.11	8.03	4.44	2.07
2	2002–2003	4.07	5.16	11.54	4.36	20.73
3	2003–2004	4.07	4.87	15.78	4.31	13.52
4	2004–2005	4.07	4.98	17.90	4.11	27.42
5	2005–2006	4.07	5.27	15.83	4.37	20.76
6	2006–2007	111.48	166.20	42.49	101.62	21.50
7	2007–2008	4.51	11.47	11.47	5.34	10.67
8	2008–2009	4.53	11.39	11.39	5.35	NA
9	2009–2010	4.53	11.59	11.59	5.47	NA

Source: Annual report (2010–2011)

45% of the manufactured output and 40% of its export. As per the estimates of fourth All India Census of MSMEs, the number of enterprises is estimated to be about 59 million persons in over 26 million units and provide employment to an estimated 60 million persons (Annual Report, fourth Census of MSME 2011). Out of 26 million MSMEs, only 1.5 million are in the registered segment, while 24.5 million are in the unregistered segment. The state-wise distribution of MSMEs shows that more than 55% of these enterprises are in six states, namely, Uttar Pradesh, Maharashtra, Tamil Nadu, West Bengal, Andhra Pradesh and Karnataka (Tables 2 and 3).

2 Detailed Objectives of This Chapter

1. To study the activities of micro-, small- and medium-scale enterprises in India.
2. To identify the challenges faced by MSMEs in the era of techno upgradation, transfer after globalisation.
3. The governmental schemes and its role to develop technological upgradation to improve the sustainable development in small- and medium-scale enterprises promoting research and development activities.
4. To explore the Cartel model and find new opportunities for MSMEs in India.

3 Activities of Small-Scale Industries in India

In India, the MSMEs play a pivotal role in the overall industrial economy of the country. The sector has shown admirable innovativeness and adaptability to survive the recent economic changes and recession. It contributes to around 40% of industrial production and exports. It manufactures more than 6,000 diverse products, ranging from low-tech items to technologically advanced products. The micro, small and medium enterprises (MSMEs) have been accepted as the engine of economic growth and for promoting equitable development. However, if we compare the growth of MSMEs in India with those in the neighbouring countries in Southeast Asia like Japan and China, we still lag behind due to lack of technology and research and development (Fig. 1).

Fig. 1 Characteristics of Indian small- and medium-scale enterprises (Plan 2007–2012)

The diagram describing the current characteristics of MSME and challenges they are facing in the globalised era.

There are some major hurdles; firstly, major hurdle for this sector is low credit availability. Secondly, major hurdle is lack of technological innovation. These units working at the base level still work on obsolete technology because of which not only the cost of production is high but also the product fails to meet market demand in terms of quality and appearance. Thirdly, the generic problem occurs such as technological obsolescence, domestic and global competition, fund shortages, rating of MSMEs and uncertain market scenario. Because of liberalisation and opening up of the economy, the MSMEs face high competition from imports and therefore need technological upgradation to manufacture better quality products at cheaper rates. The Techmart, a workshop on the concept of upgrading the industries which is held yearly, this year called as Techmart-2011, attracted a good response from trade and industry. 208 micro and small enterprises are representing from the states of Delhi, Punjab, Himachal Pradesh, Uttar Pradesh, Maharashtra, Kerala, Gujarat, Chandigarh, Haryana, Rajasthan, Hyderabad, Madhya Pradesh, West Bengal, Karnataka, Tamil Nadu, Chhattisgarh, Jammu and Kashmir, etc., including more than 45 units from North Eastern States participating in the exhibition to be informed with latest technological developments covering a wide range of engineering, manufacturing and allied industries. Though India ranks at top in terms of availability of human resource in science and technology, technology intervention in the small-scale industry sector is still very low, and as a result, the cost of production is much higher in India than other developing nations in Asia. The artisans, weavers, manufacturers, developers, etc., remain unaware of the latest designs and current market trend. They manufacture products of old designs which fail to attract new buyers. Therefore, there is a need to encourage engineers, fashion designers, professionals and entrepreneurs to work with the small- and medium-scale units which would be mutually beneficial and would help revive the unit.

3.1 Technological Shortcomings Identified in the Indian MSMEs

(a) Low levels of research and development
(b) Poor adaptability to changing trade trends
(c) Desire to avoid risk
(d) Non-availability of technically trained human resources
(e) Lack of access to technological information and consultancy service
(f) Isolation from technology hubs (Fig. 2)

Thus, there is a need to promote product development through governmental schemes, entrepreneurship, etc. Here, the techno entrepreneurs can play a key role to facilitate the development of new prototype models in these industries to

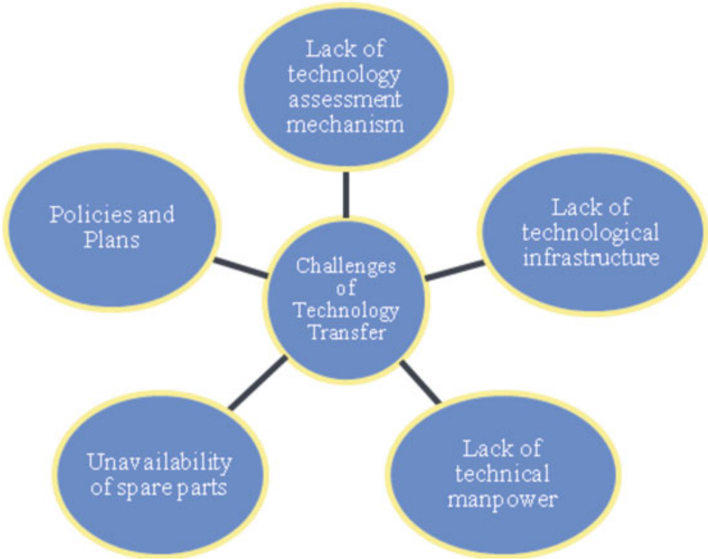

Fig. 2 The challenges of technology transfer in developing countries like India (Pradhan, February 2010)

promote sustainability. The main constraint is the challenge of technology transfer and adoption due to lack of technical manpower, lack of implementation of policies and plans and low infrastructure that retards the growth in the MSME sector.

4 The Role of MSMEs in India (Fig. 3)

4.1 The Ayurvedic Plants

In India, drugs of herbal origin have been used traditionally for treatment of wounds and major diseases. They worked partially commercially but practised their skills to treat the patient to come out of illness. Traditional knowledge had always contributed to modern medicine and health care. Moreover, with the commercialization of even natural resources, traditional knowledge, the sustainability has been hampered due to the issues of 'privatisation', 'alienation' and 'biopiracy', which have become the major areas for concern. In globalisation, these pressures have manifoldly increased on the innovator and the successor of these enterprises. Presently the West is adopting our traditional practices be it medicine, meditation or Yoga. To strengthen this, first, the government should take further steps to preserve, protect and promote the traditional cultures and knowledge of the innovators. Second, side by side, they should also be encouraged (rewarded) to

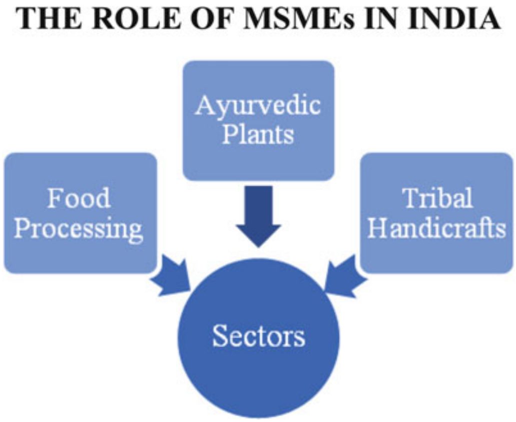

Fig. 3 The role of these three MSME in the technological upgradation and transfer

develop and opportunity be provided for education and scientific study. Third, another important aspect is to facilitate and educate concerned officials at the state and especially at the local levels to understand and respect the culture differences. Modern science can give a broader perspective to local sustainability, whereas traditional knowledge can provide in-depth experience. Fourth is to promote alternative means of livelihood products and services, including forest and agricultural products, herbal medicines, cultural heritage or traditional health-based tourism and ecotourism. Fifth, young people should be encouraged to learn more about their cultural heritage as well as tolerance and respect for other cultures and traditions.

4.2 The Tribal Handicrafts

The Indian tribes represent a part of Indian society with diversified language, culture, skills, traditions, livelihood, etc. They are rich in resources and skills that can be strengthened through preserving, honouring the characteristics of Indian tribes with maintaining their ancestral cultures and skills to make themselves self-sufficient and earn their livelihood. The Indian tribal has the strength to preserve their cultural heritage but lacks in funds and support to counter in present era. Handicrafts are mostly defined as ‘Items made by hand, often with the use of simple tools and are generally artistic or traditional in nature’. It includes domestic articles, smoking pipes, footwear, hunting arrows, combs, wooden and stone plates and textile items. The processing industry includes minor forest products and decorative items like jewellery, ankle bells, necklaces, head gears, head dresses, wall paintings, deities of wood, stone and artefacts. The cane and bamboo, woodcarvings, bell metal handicrafts, deities, flower vases, agarbatti stands and bowls are important handicraft of Chhattisgarh and Arunachal state due to availability in nearby forest area. Terracotta items like horses, elephants and flower vases are traditional handicrafts moulded by tribals of Chhattisgarh state (Planning Commission, Government of India 2006). Woollen shawls and scarfs are prominent among tribals of Uttaranchal due to availability of raw material. The women entrepreneurs can play a pivotal role in these industries and can be a rich source of employment and trade in India.

4.3 The Food Processing Industry

The food processing industry acts as a vital link between the agriculture and industrial segments of the economy. The Indian food processing has tremendous potential for the producers to enhance their entrepreneurial skills for making one self-sufficient and independent. There are a number of micro, small and medium enterprises like fruits and vegetables, grain processing, beverages, processing of meat, marine products, pickles, chutneys, edible oils, oil seeds, biscuits, high-protein food, specialised packaging and spices which require technology for their processing and storage. Here, the techno entrepreneurs can play a vital role for the freezing, preservation and processing of items for value addition. The Indian farmers and growers are skilled both in production and processing of food products and can create units at the household level to foresee the business opportunities.

Need for Technological Transformation of MSME in Present Scenario

1. Technical know-how to be promoted by government in MSMEs for standardisation and best practices in the enterprise.
2. Cost procurement at the subsidised rate for the MSMEs to promote their innovativeness in the enterprise.
3. Finance at concessional rate is given to them through efficient services of microfinancing, performance and credit capital subsidy schemes for technological upgradation, etc.
4. Mentors (through government schemes) should facilitate the products and services.
5. Production system at par with high-scale enterprises.
6. Marketing of the MSMEs product at lower rate as a part of market assistance given.
7. Promotion of information and communication technology in Indian manufacturing sector to adopt best and standardised business practices. The main aspect that drives growth in MSME sector is technology. It has recently introduced innovative schemes under the National Manufacturing Competitiveness Programme covering the entire gamut of manufacturing in the sector aiming to develop global competitiveness among Indian MSMEs by focusing on:
    (a) Marketing support.
    (b) Support for entrepreneurial and managerial development of MSMEs through incubators.

(c) Enabling manufacturing sector to be competitive through quality management standard and quality technology tools.
(d) Building awareness on intellectual property reforms to protect their skill and innovation.
(e) Promotion of information and communication technology in MSMEs to facilitate long communication with the buyers at nominal charges. The technology has facilitated the economy of money, time and resources in the unit leading in reduction per unit cost due to intervention of technology.

5 Opportunities for Research and Development in MSMEs

A question arises why Indian MSMEs innovate and focus on research and development. In the present globalised era, the Indian MSMEs use strategies, techniques and innovative processes to survive under the new technological regime. Therefore, MSMEs are required to develop or acquire necessary competitive resources like new technologies to compete with large national and foreign firms. The rapidly changing consumer preferences, shorter product life cycle and growing quality consciousness clearly call for MSME to upgrade their technological assets. This chapter basically focuses on in-house research and development activities of Indian manufacturing MSMEs during the period after 1991. Research and development is required not only to develop distinctive technological competencies but also to successfully absorb external technologies imported from foreign alliances and projects (Krishnaswamy et al 2010). The MSME (R&D) has undergone shift in its structure during 1999, and the share of stand-alone firms in total research and development became more than doubled to 55% in 2005–2008 from low of 23% in 1991–1994 for small- and medium-scale firms. The Indian MSMEs, which have no access to technological resources of business groups and foreign investors, are upgrading the scale of their research and development activities to meet the growing market competition. The research and development expenses by Indian small manufacturing firms grew by 33% between 1991–1994 and 1995–1999 from Rs. 325 million to Rs. 1,426 million. The technological development includes entrepreneurship, training and education, entrepreneurship development courses, skill development programmes, internship programmes, business development services, information and communication technologies, production technologies, technology incubators, E-business and portals, etc., for MSMEs growth in India. The Government of India has implemented many schemes for technological upgradation, modernization and protection of workers like infrastructure development, entrepreneurship development as well as increase in the investment limit (to Rs. 50 million) for small-scale units producing certain items. The Government of India has set up a new ministry in October 1999 to provide more focused attention to the development of the small-scale industries. Several expert committees had also been set up in the 1990s to assess the problems of the small-scale industries. Most of the recommendations of these committees relating to simplifying of loan application forms, launching of a new credit guarantee scheme, raising of composite loans, etc., have been accepted and implemented (Fig. 4).

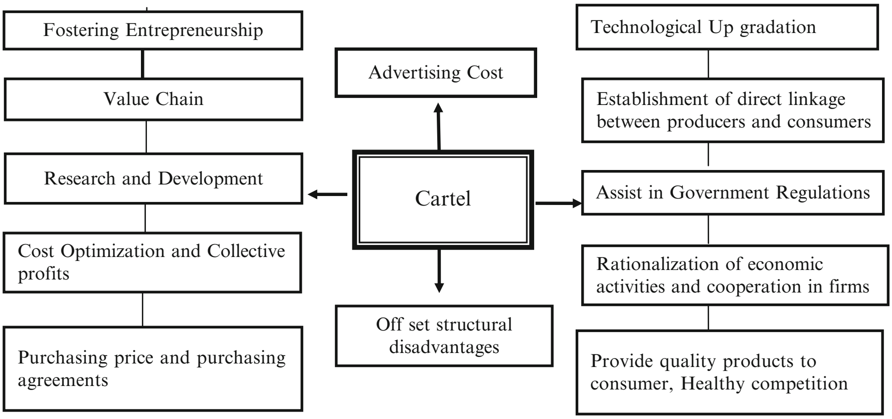

Fig. 4 Importance of Cartel model in MSME sector (India 2010, pp. 1–15; OECD 2005)

Here, the model explains the role of producers, consumers and retailers in the MSME sector. It emphasises on the significant contributions of Cartel in the economy.

6 Operations of the Cartel System in Food Processing, Ayurvedic and Tribal Handicraft Industries

The food processing MSME produces a variety of food products like jelly, achar, beverage, spices, oil, frozen fruits and vegetables. If the industry adopts the Cartel model, then the industries in the similar activities can club themselves for a common objective and can earn profits. The ayurvedic industry is also not able to publicise its product and add new innovations in medicine sector. Innovation is the prime factor for any industry to sustain competitiveness which can be facilitated through Cartel model. The model works on the concept of networking of units, allocating resources, utilising skills and managing funds. The tribal handicrafts have not yet achieved growth due to absence of link from the outer world. Here, the Cartel model can link them with other handicraft units which would provide support to their innate art and culture. The large-scale enterprises as mentioned have oligopolistic market, the same can be applied to the small- and medium-scale enterprises to encourage them, as a tool facilitating sustainability.

6.1 Working Aspect of MSMEs in India Through Focusing on Cartel Model

As defined by economists, Cartel is a group of formally independent producers whose goal is to increase their collective profits by means of price fixing, limiting

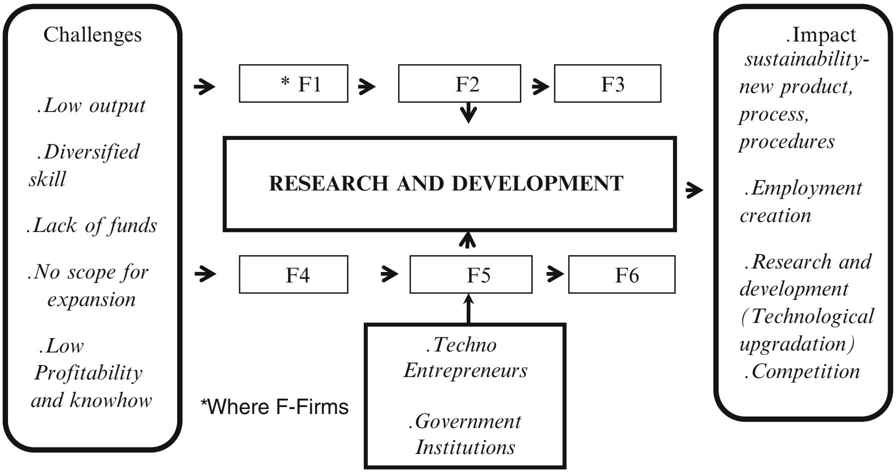

Fig 5 Working aspect of Cartel model in MSMEs (Barmecha, May 2007)

supply or other restrictive practices such as antitrust laws, and they usually occur in oligopolies and usually involve homogeneous products. To enable MSMEs overcome the mentioned issues and enhancing their access to new technologies for increasing their competitiveness in the international market, they should have a conducive environment, which includes formulation of appropriate national policies and programmes, building of technological capacity, knowledge flows and technology databases and then, finally, research and development. The MSMEs can be technically upgraded through technological cooperation with large enterprises such as R&D institution, academic institution and centres of technology development. After the independence, the scientific and technological base of the country has grown considerably. Today, it consists of a wide range of infrastructure in terms of laboratories, R&D institutions, the chain of institutions under CSIR, DST, DBT, ICAR, etc., besides academic institutions like IITs, NITs, etc. The third form of support to MSMEs, including technology upgradation, training, reskilling, entrepreneurship development, etc., comes in the form of schemes programmes by Ministries of Small-Scale Industries in Science and Technology, Textiles, Food and Agriculture, Labour and Employment etc.

The Cartel model is effective when the units are ready to work on a common platform in a cooperative way to face fierce competition. Since the late nineteenth century when the modern Cartel movement properly arrived with the rise of big business based on scale and scope, the term Cartel has spread worldwide and has more focused into big industries like petroleum, beverages, railways, telephone industries, post offices, textiles, etc., to create concentration of power among few players. In the 1980s, the Cartel system was much effective in various industries due to focus on localization. Key importance of Cartels is that they do not abolish competition but promote a network of companies working for a similar objective and require funds, technology, manpower and skills for their growth. The Cartels promote research and development activity beforehand, making them strong to face the perils of globalisation.

6.1.1 Issues in Cartels

Cartels appear among domestic firms first, before going international. A few international cartels appeared by the 1880s and the 1890s in steel rails, aluminium, textiles, apparels, cosmetics, publishing, electric lamp, explosives, rubber, synthetic alkali, petrol, diamond and shipping sectors. Food stuff cartels could also be run in food products such as cocoa, coffee, sugar, tea, bananas, wheat, tin, etc., and have a great scope as these are the most precious and sustainable industries for our economy in near future for alleviating poverty, promoting employment and sustaining the culture.

The model here shows that all the firms are networked, dealing with same products and services at the same place. They integrate the resources, funds, surplus, assets, technology and skills to have a positive impact on the working of the units and facilitation of growth and development as a whole. There are four pillars to run an enterprise in which infrastructure and technology simultaneously play a critical role in the growth and development of an enterprise. The single unit generally lacks in funds, skills, resources, technology, infrastructure, etc. Now, here, Cartel model aims at networking the producers and maintaining a similar competitive price in the market. They work on the strategy of oligopolistic market where sellers are few and buyers are many. The profits are enjoyed in the short as well as in the long run. Feasibility test includes the following:

1. There should be a competitive environment.
2. All the producers are willing to form a Cartel.
3. There should be supply control and restrictions.
4. No major player of that product in the market.
5. Working for a common objective.

Thus, these enterprises lacking in resources can adapt themselves for innovation, technological development through Cartel model, which can be a positive approach for growth in MSMEs. Here, research and development can be promoted in these units formed by cartel by investing a part of profits for managing change. The skills transferred by innovator to successor have to be updated to maintain competitiveness, standards, quality and performance.

7 Conclusion

Technology transfer means sharing of knowledge. Transfer does not mean movement or delivery but application at wholesome. Technological upgradation was introduced in April 1999 and has helped to overcome the technological disadvantage in the country to some extent. However, in the coming years, many small- and medium-scale enterprises have been established with foreign collaboration through foreign direct investment, joint ventures, projects, imports of machinery and equipment, technical assistance through human resource, etc. Thus, the foremost part of technology is survival which promotes sustainability in the environment. The skill transferred from innovator to successor needs technological upgradation to meet the present competitive challenges and reduction of total cost per unit for economy of resources. Thus, we can say that technology works as a facilitator for innovation and creative activities in the MSMEs to flourish in the present scenario.

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Technologies for Social Goods, Latest Trends

Neha Jain

1 The Study

The term ICT, acronym for Information and Communication Technology, embraces many technologies that enable us to receive, communicate, or exchange information with others. Youth is the enthusiastic emerging power of today and controlling authority of tomorrow. *It focuses on and attempts to highlight some exceptional advancement made by some outstanding administrators/teachers/educationists. As they, with the help of ICT, have opened new horizons and avenues for other institutions to follow them. This could be made real and possible by the leadership attributes in them and also with the zeal that they have to innovate the existing practices*. Leadership ability is not innate; it can be learned and developed in due course. To prepare more effective leaders, development initiatives must release tridimensional abilities – not only to lead business but also to lead oneself and others by means of technology. *The purpose of this study is to transform the youth into prime leaders for them to be globally accustomed and outstanding with the aid of technology*. The focus of development must shift from the training given to the youth in the classrooms to the reins of leading or pioneering their nation to progress and success.

For this purpose, two best practices chosen for this research study are mentioned below:

1. *Using ICT (Information and Communication Technology)* to bring the sea change in higher education system
2. *Mentoring sessions by teachers to know their students more closely*

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Driving the Economy through Innovation and Entrepreneurship,
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2 Objectives

(a) To improve higher education system with introducing innovative methods with the support of ICT, like attendance, work diary, conducting tests, internal assessment marks, messages to parents on mobile, and course and subject details
(b) To improve the teaching–learning standards in higher education by changing the roles and responsibilities of teachers into mentors with the aid of ICT
(c) To create an overall healthy teaching–learning-centered environment with the help of good higher administrative authorities and management, as they have the power to decide and implement innovative practices

3 Hypothesis

(a) The present study has the prior hypothesis, that ICT is the global and universal aspect which can bring about great changes in the present higher education system, institutional roles, and the student generation to make them hold the reins of leadership to create a better world.
(b) The mentoring system is the best way to change and mold the students to the best of their capabilities. This can also develop a healthy relationship between the teacher, students, and parents.

4 Research Design

4.1 Methodology

The study is basically both *empirical* and *exploratory*. An attempt is made in this chapter to identify the variables of ICT, which are critical and at the same time very popular among the masses. The study can be further regarded as exploratory as it would explore various new trends in *higher education for innovations and changes with ICT which can be the ideal examples for the future*.

4.2 Primary and Secondary Data

Both the primary and secondary data have been used to carry out this research. The primary data have been collected by collecting case studies I and II from the Seshadripuram First Grade College, Yelahanka, Bangalore, where these are considered to be the best and innovative practices.

The secondary data were collected from journals, magazines, books, Internet and brochures, and various related websites on mentoring.

4.3 Data Analysis

The data collected for this study are presented only after it was properly analyzed and thoroughly examined to be used for this research study. Also the data collected from both primary and secondary sources are based on factual information, and these case studies are the really practiced in the above-mentioned institution. *ACTS/IPOMO and mentoring* are the two innovative best practices, which this institution has pioneered in to achieve the better targets set for best higher education with innovation.

4.4 Technical Analysis

There is a technical team of ACTS/IPOMO in this institution always to take care of the technical updating and solving of any problems if at all it occurs to any faculty, for example, in submitting attendance or be it any related matters. The ACTS/IPOMO team is technically very sound and efficient to take care of not only helping faculty but also they regularly conduct workshops for teachers and students so as to train them to perform. Even the normal messages of meetings and circulars are sent through this ICT-based system, with the help of this technical team. Mentor contacts parents through ICT (ACTS/IPOMO).

The technical analysis is truly concerned with the gadgets of ICT available in the market now which are the modes of ICT which are connected to server. Initially past trends and the contemporary have been studied carefully to measure the effectiveness and access that ICT can have on the higher education system.

Also technical analysis is done to know the fastness that ICT has in reaching out to the masses in any part of the any part of city and even in the entire country if the teacher or student is travelling.

5 Case Studies I and II

The two case studies have been taken up for this research work. The best innovative practices have been portrayed in the systematic manner so as to understand the innovation used by this prestigious institution to improve higher educational teaching–learning standards.

(a) Case study I highlights the ICT-based innovative practice by the use of mobile technology. Later in the study, the finding and conclusion are drawn based on this technology. *This case study focuses on the external sources used for the better and simple conduct of teaching–learning pedagogy.*
(b) The second case study, case study II, on mentoring is the showcase of the inner attributes of the strengths of this institution. *This is taken up to focus on the internal powerful sources that can be adopted to improve the higher education system. The findings and conclusion are based on this mentoring system only.*

ACTS/IPOMO has developed this application not only for handling internal assessment and making attendance but also for career guidance. This innovative practice has attracted widespread attraction and acceptance in academic cracks and media coverage at parents for monitoring their wards progress.

ACTS/IPOMO also saves stationary as no registers are used to take attendance and also the records are preserved on day to day basis which can be used and stored at any point of time. The software installed in the mobile phones also has the capacity to save the entire course details pertaining to each course/stream, semester, or subjects separately so as to help the teacher click on the subject he or she is taking during that hour. The periods are also installed in the mobiles with an hour duration to specify the beginning and ending of one class indicating the exact time, for example, 08:30, 09:30, and 10:30 a.m. Lesson plans are also included in it. The tests of all the subjects for all the semesters are also conducted with the help of this sophisticated and commonly used device as the teachers have been trained and are only required to give the question papers in CD format. Hence, this practice is in itself benchmark in the country of its own kind and in the future may give birth to many more such technological experiments to bring about a drastic change in the existing norms in education.

6 Case Study I: ACTS/IPOMO

Best Example of Using Technology to Be the Leaders: Pioneered by Seshadripuram First Grade College, Yelahanka, Bangalore

This innovative mobile technology is *invented and pioneered by Seshadripuram First Grade College, an esteemed educational institution of the Seshadripuram Group of institutions in Bangalore, Karnataka*. In the age where mobile phones are banned in educational institutions completely, *Seshadripuram First Grade College* has been a *pioneer in inventing* the latest trend to use this *device (mobile)*, with the help of the installed software in it to help the faculties reduce their workload of taking attendance, consolidating it each month end, taking tests, doing corrections, and maintaining records of tests and its marks; not only this, it also saves tons of stationary. Also the parents are regularly updated of their wards presence or absence with proof as the data is available. This case study is the best precedence of proper use of ICT and technology for normal routine work that the teachers do in their institutions.

This is something which is the *very first of its kinds to happen in India or even in the entire world. This technology is named as ACTS/IPOMO (attendance and course tracking system/interactive platform on mobile).* SFGC has put into service the ubiquitous mobile technology to record and track students' attendance and to test their competence; internally, ACTS works on mobile-based registration software for student's information, individual student's account with log in and password, log in and password for principal to access/track student's information regularly, and SMS-based automated attendance making and attendance registers.

IPOMO is a next-generation technology company, committed to giving the mobile learning edge to today's students and institutions. *ACTS*/*IPOMO's* cutting edge technology in learning–teaching and evaluation methodologies will address the needs and challenges of the twenty-first-century learning.

6.1 Findings

IPOMO case study i-IPOMO is a new generation technology company, by former senior executives of Wipro and Infosys, committed to creating possibilities in mobile learning. With two patents (pending of grant) in mobile learning technology and 2 years of research in teaching–learning methodology, IPOMO is poised to bring in a much needed revolution in the education space.

6.1.1 Changes in Student's Roles with ICT

A shift from	*to*
Passive recipient of information	active participant in the learning process
Reproducing knowledge	producing knowledge
Learning as solitary activity	learning collaboratively with others

6.1.2 Changes in Teachers' Role to Create Better Students with ICT

A shift from	*to*
Knowledge transmitter	learning facilitator, collaborator, coach
Primary source of information	knowledge navigator and co-learner
Teacher controlling and directing	teacher giving students more options
All aspects of learning	responsibilities for their own learning

The changing role of teachers is aptly summed up in the quip that teachers have moved from being *"sages on the stage" to becoming "guides on the side." The teacher is no longer the all knowing authority*. The new role can be perhaps linked to that of a team coach or the conductor of an orchestra who tries to bring out the best performances in all players.

6.2 What IPOMO Offers?

HYPERLINK "http://www.ipomo.in/ipomocampus.html"

IPOMO Campus: Enabling Interactive Learning

- *Lesson Plan:* Teachers can upload the lesson plan for the current semester in their mobiles, which helps them to concentrate more on teaching effectively.
- *Parents are informed via messages about their wards progress, parent*–teacher meetings, attendance, etc.
- *Lecture status:* The lecture status is readily available on the teacher's personal mobiles as well as it is recorded to have the consolidated attendance of the class.
- *Work diary:* Technology is so advanced in IPOMO that teachers can prepare the work diary in it, which again saves time, is a very safe documentation for future records, and saves stationary too.
- *Assignments announcement:* Teachers can give assignments through IPOMO, which saves time, and also students get the message wherever they are; hence, no excuses are entertained later on that they were absent.
- *Institutional messages and notification:* IPOMO helps the institutional messages to be sent to the faculties with great ease and very quickly to entire staff and students, about any updates, meetings, seminars, etc.
- *Student feedback:* Even students are asked to give feedback on their teaching faculty and on other issues anonymously, so that things are not biased, which is possible only because of this great technology pioneered by SFGC.
- *Dash board:* It displays the status of classes going on in the campus and the classes let off due to any unavoidable circumstances. It also shows the details of various events happening in the college to everyone.

  In essence, *IPOMO Campus* is the interactive learning platform that creates a personalized, meaningful, and interactive teaching–learning and evaluation experience.
- HYPERLINK "http://www.ipomo.in/ipomostudent.html" *IPOMO TWEEK*: This is designed as "a friend and guide in the pocket!" It is an application on the mobile that connects a student to quality coaching/mentoring inputs for a competitive or academic exam he or she is preparing for.

IPOMO Campus Is a Solution Created Exclusively for Institutions. At Five Core Levels, It Improves the Following

1. Classroom productivity of teachers.
2. Assessment efficiency and speed.
3. Teacher guidance of students.
4. Parent–teacher engagement.
5. Students also can access his/her academic data, view attendance data, interact with lecturer.

Classroom Management Is Well Taken Care Off as Things Are Dealt with Technology Mentioned Below

1. Attendance and Internal Marks: Teachers take attendance, enter internal marks on the device, and submit for real-time consolidation.
2. Reports: Teachers can pull real-time report of a student anytime, anywhere. Consolidated reports can be obtained anytime, anywhere

Continuous Internal Assessment Can Be Recorded with Technology As

Conduct tests: Institute can conduct internal tests (objective type) using mobile phones Immediate results: Students can know their results immediately, identify learning patterns: helps in identifying slow and advanced learners objectively.

6.3 Concluding Comments of Case Study I, IPOMO

Globalization and technological change processes that have accelerated in tandem over the past 15 years have created a new global economy, "powered by technology, fueled by information driven by knowledge." The emergence of this new global economy has serious implications for the nature and purpose of educational institutions in creating globally competent leaders. Education patterns across the world are experiencing a sea change, powered by innovative technologies and possibilities. In fact, never before has technology influenced the quality and depth of learning as significantly as today. While at the student level, newer learning paradigms have created more empowered students, at the institution level, technology has vested in them power they never thought possible. Across schools, colleges, and institutions of higher learning, the focus today is on the quality of learning of the students. Here is the next-generation solution to enhance the quality of learning – in an interactive manner.

6.3.1 ICT Brings Exponential Growth in Information and Knowledge

Information and knowledge are the new forms of wealth and are driving force for development. The extraordinary expansion of knowledge is brought about by ICT, which has made it possible to generate, store, transmit, retrieve, and process information at vastly increased speeds. All this has implications for lifelong learning because educators now recognize that learning does not stop after formal education ends; critical challenges for educators are how to ensure equal access all to this global storehouse of knowledge and how to equip all citizens with the necessary skills for the new global environment, with youth leaders to take the lead.

For developing the leadership traits, ICT have the potential for increasing access to, and improving the relevance and quality of, education. ICT greatly facilitates the acquisition and absorption of knowledge, offering developing countries unprecedented opportunities to enhance educational systems, improving policy formulations and execution, and widen the range of opportunities for business and the underprivileged.

One of the greatest hardships endured by the poor, and by many others, who live in the poorest countries, is their sense of isolation. The new communication technologies promise to reduce that sense of isolation and to open access to knowledge in ways unimaginable not long ago.

6.3.2 ICT Will Be the Silver Bullet to Get Rid of All the Problems of Higher Education

If there is one truism that has emerged in the brief history of ICT use in education, it is this: It is not the technology but how you use it! Put it another way, "How you use technology is more important than if you use it at all… unless our thinking about technology changes along with the continuing expansion of the ICTs in the education then our technology investment will fail to live up to its potential."

Technology then should not drive education, rather educational goals and needs, and careful economics must drive technology use. Only in this way can educational institutions can effectively an equitably address the key needs of the population, to help them as a whole response to new challenges and opportunities created by the global economy. ICT alone cannot resolve educational problems as such problems are rooted in well-entrenched issues of poverty, social inequality, and uneven development.

7 Case Study II

Mentoring by Teachers at SFGC, Yelahanka, Bangalore

7.1 Introduction

"Mentoring is to support and encourage people to manage their own learning in order that they may maximize their potential, develop their skills, improve their performance and become the person they want to be." (Eric Par sloe, The Oxford School of Coaching & Mentoring).

In the Greek mythology "mentor" is the name of Ulysses' friend. He was asked to take care of Telemachus, Ulysses' son, during his wanderings. The goddess Pallas Athena used to transform herself into the shape of mentor to help Telemachus in times of troubles. The protection of gods is imposed on him by a mentor. This picture of "protection by gods" delivered by a mentor is a kind of dream about omnipotential guidance and help by a constant companion.

Sometimes, a mentor feels this kind of responsibility towards the mentee. Sometimes, the mentee expects miracles from the mentor.

7.2 Mentoring in SFGC

Sehadripuram First Grade College, Yelahanka, Bangalore, has adopted yet another innovative practice of mentoring done by the various teachers, for all classes. All students have a particular mentor for their entire 3 years in the college that they spend. To each mentor, some 40 students are allotted. The mentors job is to closely watch the students' performance, record it every semester, and have a track of their weaknesses and talents. Also, the mentor conducts regular meetings with students every month so as to know them, help them, and make them grow in a healthy environment. Each mentor is a role model and a friend, a philosopher, and a guide to his\her students. Mentor teachers operate all their activities also through ACTS/IPOMO. The below-mentioned activities are also carried with mobile to spread the information about anything to students and parents.

- Mentors mend the ways of their students if required. Also, they report to the higher authority about the well-being of their lot, regularly.
- *Mentors also conduct parent–teacher meeting regularly, twice a semester to update the parents of their wards growth.*
- *Mentors also deal with personal problems of the students along with the class–teachers and principal if required.*
- *Mentors maintain the profile of students for 3 years.*
- *Mentors and mentee report are submitted to the internal quality assurance cell (IQAC).*
- *Mentor's effective mentoring changes the students' behavior and performance immensely.*
- *Mentors also solve the problems that parents have with their wards and vice versa.*

7.3 Findings

Based on the above case study II, mentoring is a powerful personal development and empowerment tool. It is an effective way of helping people to progress in their careers and is becoming increasing popular as its potential is realized. It is a partnership between two people (mentor and mentee) normally working in a similar field or sharing similar experiences. *This relation is carried out through ICT*. It is a helpful relationship based upon mutual trust and respect.

With ACTS/IPOMO, that is, it is more effective. Technology is really worth if used correctly, for the social good and higher education improvement. These are the benefits to the mentees or the students. This can be defined as social goods which ICT may gift to all.

- A mentor is a guide who can help the mentee to find the right direction and who can help them to develop solutions to career issues.
- HYPERLINK "http://www.hepg.org/hep/book/104/SpotlightOnStudentEngagementMotivationAndAchievement" *Spotlight on Student Engagement, Motivation, and Achievements.*
- A mentor should help the mentee to believe in herself and boost her confidence. A mentor should ask questions and challenge, while providing guidance and encouragement.

- Mentoring allows the mentee to explore new ideas in confidence. It is a chance to look more closely at yourself, your issues, opportunities, and what you want in life.
- Mentoring is about becoming more self-aware, taking responsibility for your life and directing your life in the direction you decide, rather than leaving it to chance.
- Mentor is person focused. It is less of a formalized professional relationship and more of a partnership, more like a friendship. We provide guidelines and training for our mentors and mentees, but the issues discussed will vary depending upon the issues being faced by the mentee.
- Teach students to ask their own questions. Mentors rely upon having had similar experiences to gain an empathy with the mentee and an understanding of their issues. Mentoring provides the mentee with an opportunity to think about career options and progress.
- HYPERLINK "http://www.hepg.org/hep/book/130/TeachingAsAMoralPractice" Teaching as a Moral Practice: Sometimes understood as habits of mind, "dispositions" represents a new concept in teacher education. Conversations about professional dispositions in teaching often touch on issues such as attitudes, values, moral commitment, and social justice.
- Success: Teaching *Immigrant and Second-Language Students* draw on the work of teachers, administrators, and researchers to identify the practices that reach diverse students most effectively and easily with ACTS/IPOMO.

7.4 Concluding Comment on Mentoring

For more than a decade, clear and consistent research has shown that the quality of teachers is the most powerful mentoring-related determinant of student success. Capitalizing on this now-large body of evidence, many education leaders have begun to invest in new-teacher mentoring. It's a smart bet. *When mentors are well selected, well trained with ICT*, and given the time to work intensively with new students, they not only help average students become good, but good students become great. And because new students are most often assigned to the mentors, the most challenging students, instructional-mentoring programs provide a powerful lever for closing the teacher-quality gap and ensuring that all students, regardless of their backgrounds, have a real opportunity to succeed as ICT can reach out to anyone, anywhere; even if parents or mentees cannot meet the mentors in person, contact could be made through mobile tracking system.

Entire cohorts of beginning teachers have begun to foster student gains similar to or greater than their veteran peers' results. And mentors are reigniting their own passion for teaching.

When mentoring programs thrive, educational systems are also more likely to develop a comprehensive vision for assessing and supporting instructional excellence and to reconfigure their evaluation and tenure structures around that vision.

More important, they have a much greater chance of transforming their schools into vibrant learning communities capable of helping all teachers, and all students, succeed. ACTS/IPOMO with ICT has really made all these things very simpler.

7.5 General Conclusion of this Study

Innovation in teaching and learning is most likely to take place when:

(a) The innovator feels a degree of security within an understood community or cultural context, recognizes the need for change, and has encouragement or support from the head of department, dean, or other person in authority.
(b) The institution has a policy establishing parity between research and teaching and learning, including for purposes of promotion, and the policy is reflected in practice.
(c) Colleagues and people in authority show an interest in disseminating the outcomes of innovation.
(d) Resources are available through the department, an innovations fund or similar fund, and an educational development or learning support unit.

"Our country's dominant higher education policies have focused on expanding access for more than half a century – allowing more students to afford higher education. Yet changing circumstances mandate that we shift the focus of higher education policy away from how to enable more students to afford higher education with technology to how we can make a quality post-secondary education affordable and accessible. The challenge before the country also mandates a new definition of quality from the perspective of students – so that the education is valuable to them and that through it they improve their lives and thus improve the country's fortunes, too. And if a post-secondary education is fundamentally affordable – meaning lower in cost, not just price – this will also answer the question of how to extend access by enabling students to afford a higher education."

Hence, the two case studies prove that the initiatives are to be taken up effectively by the management of any teaching temple, in such a way that it only promises the growth of all with technology for social goods. . .latest trends. . .with ICT.

Analytical Approach on Economic Development in India Focusing on Strategies for Application of Technology

Nirmalendunath Ghosh

1 Introduction

Current socioeconomic condition in India covering states of different standards of economic system has led the researchers and planners to think about sustainable economic development strategies that will address to the issue of an equitable access to better services and availability of benefit out of economy resources to all section of the population across the country. There is inverse relationship between better socioeconomic condition and the resentment of people through different channels of expression. There is general perception on economic development in the country that corresponds to better living standard of the population within the ambit of better availability of services and income opportunities to entire population. Actually, the above perception in the perspective of current growth in economy contradicts the real scenario of society across the country. The findings of the NSS round survey of the Central Statistical Organization under Ministry of Statistics and Programme Implementation reveal that the density of low-income group population is more compared to high-income group in rural area, and the consumption level of the household in rural area is below all India average. Further, social indicators when analyzed in-depth reveal inadequacy of available infrastructure, specially in irrigation of agriculture, distribution of population to available health-care facilities, and access to education for achieving desired level of qualification in order to get gainful employment. All these issues aggravate the living condition because of the chain reaction in an economy system that comprises subsystems of service and economic resource. Analysis shows that input and output of any subsystem have linkage with other subsystems in the economy that validates the concept of relative economic development in the country. There are perceptible differences in socioeconomic development between urban and rural areas; existing well-developed infrastructures

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in services and economy resources support penetrating benefits of economic growth into urban sector, while lack of infrastructures is hardly conducive to diffuse such benefit in most of the rural area in the country. The other side of the economy system is the uncertainties in availability of consumable goods within the reach of average income level of population which depends on variation of price level in the market according to flow of supply and purchasing power of population commensurate with their employment level. In case of imbalance in supply and demand of the goods in the market system, purchasing power of population will be destabilized. The supply system depends upon various inputs that are vulnerable to uncertainties in availability of raw materials, transport, infrastructures, and policy issue on taxes in the states. The objective of this discussion is to achieve the goal of economic development by working out a strategy that is guided by technology-driven development process, embedded with the mechanism of synchronized activities in the economy system and evolving new policies to achieve a balanced growth of infrastructure in economy system that will be conducive to enhance access to benefit of services covering all classes of people in India. The concept of satisfactory level of economic growth is based on quality improvement by infusion of technology in the subsystems of basic services, while the subsystem of supplying consumable goods to meet the demand in market infrastructure needs satisfactory level of production through diffusion of agricultural technology, biotechnology, information and communication technology, automation in manufacturing and remote metering, and renewable energy technology. In order to bring out transparency in the logic of the discussion, an indicator, that is, access to benefit of services, has been evolved that is related to actual demand of services and the purchasing power of the population. The economies of the different selected states have been assessed on the basis of this indicator, focusing on the rural area where people mostly working in agricultural sector dominate rural population who are in lower economic level compared to population in urban area. The analysis attempts to unfold the impact of technology application on the development of subsystems for improved services to the people in India as well as focused on inherent characteristics of interdependence of subsystems to achieve perceptible development in economy system. Finally, the discussion highlights the policy measures for application of technology to bring about the development. The discussion starts with present economic scenario in India.

2 Present Economy System in India

2.1 Assessment on Development Criterion

The standard of living manifested through consumption of goods and access to services is on the line of demarcation between rural and urban economy based on natural resources, culture, changing trends of demography, and climate dominating the specific geographical location across the states in India. Rural population

Table 1 All India pattern of changing economy scenario between 2000 and 2009

Year	Growth of population (%)	Index no. agricultural productivity yield/ha	Net avail of food grain/ capita/day (gm)	WPI (2004–2005 = 100)	Avail. of elect/ capita (kWh)	Average MPCE (Rs.)	
						Rural	Urban
2000–2001		144.4	416.2		75.2	498	933
2005–2006	8.47	180.6	445.3	104.4	90.4	625	1,171
2008–2009	3.59	177.6	436	125.9	112.7	1,053	1,984

Source: Economic survey, Ministry of Finance and Central Statistical Organization

constitute 70–80% of total population in India, and out of total workforce in rural area, 64% male and 79% female are either self-employed in agriculture or as agricultural laborers (MOSPI). Therefore, the analysis starts with economy system in rural India that represents a realistic scenario of socioeconomic development across India. The application of seeds, fertilizer, and mode of irrigation on the input side and the productivity, transport system, road connectivity, and marketing infrastructure on the output side are the major issues that dominate the income level from agriculture and allied services. The farmer's investment capacity depends on the income from varying patterns of agricultural productivity – mostly depend on monsoon in major area because of lack of irrigation facilities – and the available infrastructure of marketing subsystem that is controlled through intermediaries. Then, there is financing subsystems providing loan to farmers that have linkage with uncertainties of farmer's income, capacity for investment, and debt payment. The populations need full employment in order to achieve purchasing power to meet bare necessities of life. There are dearth of basic infrastructures for institutions of vocational, technical training, and professional educational facilities in proportion to population in rural villages. The employed population of rural area in organized sector is less than the same category in urban area. In rural area, more persons are self-employed whose income is not regular to achieve purchasing power to meet bare necessities of life who are not getting of perquisites as available to regular salaried population in urban area. According to statistics (MOSPI 2011), there was marginal rate of improvement in unemployment level of 4.25% only during the period 2005 and 2010. In order to understand the trend of growth in rural economy, the data on the different parameters during the last decade are tabulated below in Table 1.

This observation implies that high percentage of rural population is in low-income group compared to the urban areas that in turn reflect on their low purchasing power capacity. Moreover, the impacts of high inflation cast a shadow of uncertainty in their living. Urban economy is more developed than rural economy because of better availability of infrastructure in education, energy, health, and communication subsystems. Equally, market price is sensitive to variation in supply of commodities from agriculture to manufacturing, which in turn depend on availability of transport and communication infrastructures. It is seen that net availability of food grain has declined corresponding to its lower productivity during the year 2005–2006 and 2008–2009. Consequent to rise in wholesale price index, the purchasing power of the HH remains at the same level even though productivity increased marginally and the poorest of population in rural and urban areas will have no scope to meet their bare necessities of living that are further aggravated due to high rate of population growth.

2.2 Linkage of Subsystem

Economy in India is an open system after trade liberalization that became vulnerable due to changes in world economy. Import and export of products and flow of FDI in different sectors' influence on the functioning of economy resources subsystem. So the competitive nature of the market need constant upgradation of technology to maintain the subsystems in good economic state. On the other hand, service utility's functioning depends on the economic resources. Therefore, there should be total harmony in functioning of economic resources and utility subsystem. This is possible by implementation of development activities with penetrating technology equalizing standard of service in all the subsystem activities.

2.2.1 Logic of Subsystem Functioning

The concept of the diagram (Fig. 1) that outlined whole economy system is explained logically. The following mathematical expression will clarify the logic of the subsystem functioning due to penetrating technology into the subsystem.

Let a, m, and s represent agricultural, manufacturing, and service sector resources, and utility subsystem and marketing infrastructures are represented by u and mr, where u represents combined utility service energy, education, health, and communication that are represented by q, e, h, and c, respectively; then, if δN is the penetration of technology in subsystem, the eq for stabilizing the total economy will be

$$\mathrm{a}\delta N1^{*} + \mathrm{m}\delta N2 + \mathrm{s}\delta N3 = (\mathrm{q} + \mathrm{e} + \mathrm{h} + \mathrm{c})\ \delta N5 + \mathrm{mr}\delta N4 \tag{1}$$

If contribution to market from economy resource is σm4, τm4, and ωm4, respectively, from agriculture, manufacturing, and service sector, then, Eq. (1) can be rewritten by

$$\mathrm{a}\delta N1^{*}\sigma \mathrm{m}4 + \mathrm{m}\delta N2^{*}\tau \mathrm{m}4 + \mathrm{s}\delta N3\omega \mathrm{m}4 = \sum (\mathrm{q} + \mathrm{e} + \mathrm{h} + \mathrm{c})\ \delta N5 + \mathrm{mr}\delta N4$$

On the other hand,

$$\sum \mathrm{er}\delta n\varepsilon = \sum u\delta n + \mathrm{mr}\delta N4 \tag{2}$$

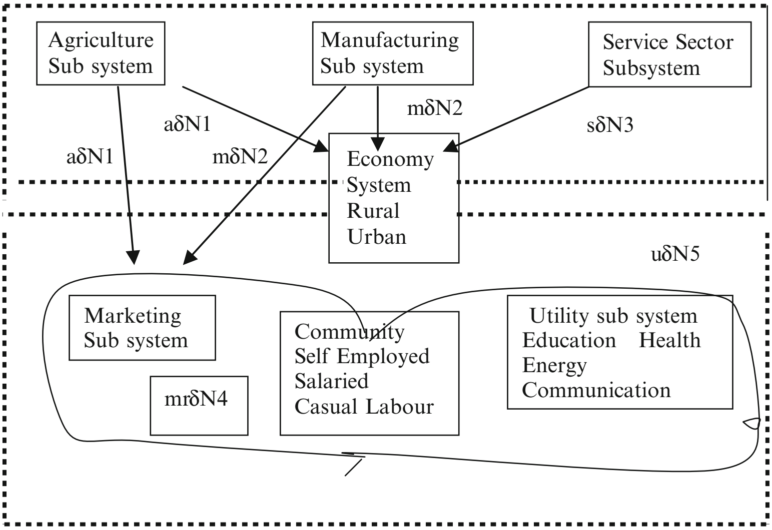

Fig. 1 Economy system in rural and urban India

The linkage of the subsystem has been shown in Fig. 1, where er, ε, and *u* are energy resources, contribution to market, and growth of services. Therefore, penetration of technology in economic resources, service sector, and marketing infrastructure is essential to achieve balanced development in economy system. The system linkage diagram, if studied in-depth, will reveal that reliability in functioning of energy subsystem is essential to drive development in other subsystem because of its prime necessities as basic input to all subsystems. The study is now directed to energy subsystem that is major input to different subsystems.

2.2.2 Energy Subsystem and Its Development

Though primary energy sources are oil, gas, and coal, the study focused on secondary source, that is, electricity that acts as major input for operation of other subsystems. According to research studies, economic development in the country is highly correlated to development in energy sector. Annual report of planning commission indicates that there is only 80.7% achievement in electrification of unelectrified villages and 56.1% of targeted BPL HH, respectively, till march 2010. Only 46% of HH in rural area have access to electricity compared to 99% HH in urban area. There is deficiency of 33.2% in achieving target capacity addition during 2009–2010. The shortfall in supply to meet peak demand and energy requirement that varies from state to state is in the range of 10–18% and 8.8–15%, respectively (Govt. of India portal). There is shortage in coal supply of around 11 BU in 2009–2010 compared to shortage of 1.6BU in 2005–2006. Moreover, there are some hindrances in supplying electricity to each HH of the electrified villages due to deficiency in purchasing power of lower income group HH. Another constraint to meet requirement of power is lagging capacity addition to targeted plan; this is observed from achievement in respect of installed capacity during 11th five-year plan period between 2007 and 2012. Power sector achieved capacity addition of 50,555 MW power plants as of 31.3.2012 against revised target of 62,374 MW during 2007–2012 (Planning Commission). Share of installed capacity for grid interactive renewable energy sources is only 12.27% of total installed capacity out of all resources during all the plan period. Before proceeding to assessment of agriculture subsystem, it is necessary to evolve an indicator as a measurement tool that is explained in next section.

3 Approach to Assessment of Development

3.1 Evolving Indicator: Access to Benefit of Services

A very perceptive assessment of growth of development is based on GDP growth in the country. Nevertheless, variation of this indicator is actually a virtual perception on the economic development because of its impact on outer level of economy system. The penetration of benefit due to economic growth into the grassroot level of the population depends on cascading effect of economy that may be obscured due to embedded counter activities in the subsystems. Access to benefit of services indicator (abs) has been evolved to assess the economic development in reality of the states. This is defined as the capacity of a family or individual in a HH to enjoy the benefit of available services or goods in the economy system according to his purchasing power that has linkage with his income and social environment. The justification on applying this tool to assess the development of state has been done by analysis of the basic economic resources. The study focused on – agriculture that is major economic resource rural population who constitutes 70% of total population in India. It has been observed that monthly per capita expenditure on food consumption of the population in rural and urban areas is almost 53 and 40% of total HH expenditure, respectively. Therefore, the analysis starts with access to food distribution services in rural area. Firstly, the states are selected for analysis according to its elevation or lowering in the order of ranking for performance in development during 2005 and 2010. The next step is to evaluate the development in the agriculture subsystem and allied services that are correlated to availability of food production. Thereafter, in the analysis performed on evaluation of food consumption trend commensurate with the purchasing power of the population in rural area across the country focusing on the states, considering its change in rank due to improvement in performance or nonperformance, 80% of the HH are dependent on agriculture and allied services. Nevertheless, it does not imply that performance in agriculture to stabilize food supply is the sole criterion for determining rank. The indicator abs has been evolved by the following mathematical relationship between purchasing power, income, and price of the goods and services:

$$\begin{aligned}&\text{Access to benefit of basic services/goods (abs)}\\&=\frac{\text{Purchasing power (pp)}}{\text{Actual demand of services/goods(ads)}}\end{aligned} \tag{3}$$

The value of parameter is in rupees, and the abs index signifies the variation of the living standard that is quite different from the assessment of living standard by GDP growth. This scale of measurement of the indicator is 0–1, lower and upper values indicate deficiency or adequacy in access to benefit of services.

Then,

$$\frac{\text{pp1}}{\text{pr1}}X1-\text{pr1}X2=I1\ldots \tag{4}$$

$$\text{and}\quad \frac{\text{pp2}}{\text{pr2}}-X1-\text{pr2}X2\ldots=I2\ldots \tag{5}$$

where pp1 and pp2 are prices of food and $X1$ and $X2$ are consumption quantities in HH at income levels $I1$ and $I2$, respectively.

If a sequence is X, (k) satisfies

$$MX(k+1)=NX(k)+b,$$

where pr is the price level of the goods or services and I is average MPCE taken as proxy to income of HH. $x1$ and $x2$ are the consumption levels in quantities that will balance income of HH. pp is the consumption value in rupees.

Then, applying Jacobi's method of evaluating the values of $x1$ and $x2$, replacing D for M and D − A for N, then,

$$\mathrm{D}X(k=1)=(\mathrm{D}-\mathrm{A})Xk+b(k=0,1\ldots)$$

Assumed zero vector as $X0$,

denoting figure in xk as ($x1$, $x2$) and x (k + 1) as 6$y1$, $y2$

$$\begin{vmatrix}\dfrac{\text{Pp1}}{\text{Pr1}} & 0\\ 0 & \text{pr2}\end{vmatrix}\begin{vmatrix}y1\\ y2\end{vmatrix}=\begin{vmatrix}0 & \text{pr1}\\ -\text{pp2/pr2} & 2\text{pr2}\end{vmatrix}\begin{vmatrix}x1\\ x2\end{vmatrix}+\begin{vmatrix}I1\\ I2\end{vmatrix}$$

$$\begin{aligned} Y1 &= (\mathrm{pr}1x2 + I1) * \frac{\mathrm{pr}1}{\mathrm{pp}1} \\ y2 &= \frac{(-\mathrm{pp}2/\mathrm{pr}2x1 + 2\mathrm{pr}2x2 + I2)}{\mathrm{pr}2} \end{aligned} \tag{6}$$

for $k = 0$, x (1) = (x1, x2) = (0, 0), then

$$X(1) = (y1, y2) = \left(\frac{I_1 * \mathrm{pr}1,}{[\mathrm{pp}1} \frac{I_2}{2\mathrm{pr}2]} \right) \quad \ldots \tag{7}$$

Substituting this values in (6),

$$(x2) = (y1, y2) = \frac{(-\mathrm{pp}2/\mathrm{Pr}2) * I_1 {*} (\mathrm{pr}1/\mathrm{pp}1) + 2{*}\mathrm{pr}2 * (I_2/2\mathrm{pr}2) + I_2}{\mathrm{Pr}2}$$

Then, the value ads is computed by substituting value of pr1, pr2 in

$$(x2) = (y1, y2) = [[-\mathrm{pp}2/\mathrm{pr}2^{*} I_1{}^{*}\mathrm{pr}1/\mathrm{pp}1] + I_2 + I_2]/\mathrm{pr}2 \ldots \tag{8}$$

ads = x2*(pr1, pr2) and taking the available consumption value of the goods/services as abs = $\frac{\mathrm{pp}1}{\mathrm{ads}}$

3.2 Validation of Indicator: Abs

This concept of abs is validated by substituting relevant data of MPCE value for rural and urban HH from NSS 66th survey 2010 for states selected on the basis of ranking for performance; abs and parameter value in the above mathematical expression (4), (5), (6), (7), and (8) were computed in Excel worksheet. Those values are tabulated in Table 2.

The price of food has been taken from the report of NSS, Central Statistical Organization. Assumed that consumption of food of different items is varied with the rise in purchasing power consequent to income rise and inflation effects. Similar exercise was performed for urban area HH, taking the values of monthly per capita consumption expenditure and price from NSS 66th round survey 2008–2009. The observation reveals that abs indicator value is in the lower side of scale 0–1 in respect of lower deciles, whereas top decile HH are in better position having value on the higher side of the scale 0–1, specially WB, Gujarat, Punjab, Karnataka, and Bihar. Abs value in urban area shows the urban economy in HH of lower deciles in most of the states is marginally better than rural counterpart; abs value is within the range of 0.39–0.58 in lower 20% deciles excepting Punjab, Gujarat, WB, and Tamil Nadu. The comparative study on the trend of development in food

Table 2 Evaluation abs value on food consumption in selected states – rural area 2009

Indicator	AP	MH	Kar	Jh	B	Ch	WB	Pb	Gj	TN
AbsL1	0.36	0.35	0.41	0.41	0.55	0.36	0.43	0.39	0.41	0.35
Abs L2	0.47	0.43	0.55	0.51	0.87	0.49	0.52	0.47	0.51	0.40
Abs L3	0.46	0.62	0.66	0.66	0.31	0.63	0.69	0.62	0.76	0.59
AbsL4	0.50	0.69	1.13	0.73	0.34	0.72	0.79	0.72	0.92	0.66

Note: $p1$, $p2$, $p3$, $p4$ are different prices of food products at increasing rate, that is, $p1 < p2 < p3 < p4$

AbsL1 = lower 0–10% deciles, absL2 = lower 10–20%, absL3 = top 70–80%, abs4 = top 80–90% deciles

Table 3 Evaluation of abs values on food consumption in selected states – urban area 2009

Indicator	AP	MH	Kr	Jh	Br	Ch	WB	Pb	Gj	TN
AbsL1	0.26	0.34	0.35	0.39	0.46	0.32	0.42	0.70	0.36	0.37
AbsL2	0.19	0.45	0.46	0.53	0.58	0.45	0.54	0.91	0.45	0.46
AbsL3	0.38	0.49	0.38	0.49	0.63	0.53	0.60	0.58	0.51	0.55
AbsL4	0.45	0.54	0.46	0.54	0.69	0.58	0.71	0.69	0.55	0.63 s

Source: Own

AP Andhra Pradesh, *Br* Bihar, *Gj* Gujarat, *MH* Maharashtra, *TN* Tamil Nadu, *Kr* Karnataka, *Jh* Jharkhand, *Ch* Chhattisgarh, *WB* West Bengal, *Pb* Punjab

distribution relative to abs has been shown in Fig. 2. It is observed that the trend of change in pattern of abs curve is consonant with change in pattern of MPCE curve during the year 2005–2006 and 2008–2009. It appears that status of states in respect of food distribution is almost the same except Bihar and Tamil Nadu. In the case of Tamil Nadu, abs is low compared to its achievement in agriculture by technology application. This implies deficiency in other subsystems that appear as constraint to improvement in purchasing power of rural population. This method, therefore, determines the hidden deficiency in system. Evaluation of abs in other subsystem likewise will reveal the real status of that subsystem regarding access to benefit of that service for the population to adopt remedial measures.

3.3 *Effect of Application of Technology in Agriculture to Assess Abs*

The study focused now on the states to assess the improvement of abs due to application of technology in agriculture (Planning Commission).

Andhra Pradesh: Implemented ICT and farm mechanization, productivity increased by 22.08%. Nevertheless, access to benefit of services in both lower and top deciles did not improve.

Punjab: Zero-tillage technology was implemented; 99% area is irrigated, and productivity is maximum. Both lower and top deciles are on the higher side of abs scale.

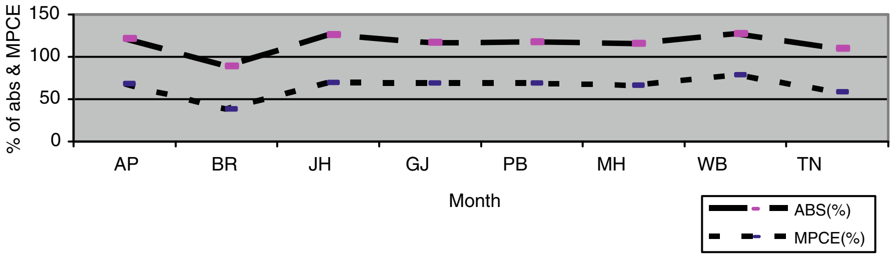

Fig. 2 Trend of growth abs (%) and MPCE (%) during 2005–2009

Maharashtra: Maximum area is irrigated, but soil conservation technology need to be adopted.

Top deciles and lower deciles of HH are on the higher and lower side of abs scale, respectively.

WB: Hybrid technology and use of organic manures were adopted, depending on monsoon. Top and bottom deciles of HH are in upper and lower side of abs scale.

Tamil Nadu: Drip and fustigation technology in irrigation, sustainable rice intensification, and remote sensing and hybrid technology were implemented. Both lower and top deciles HH are on mid-scale of abs.

4 Development of Economy Through Application of Technology

4.1 Core Issues for Development in the System

A framework of policy issues that covers all the subsystems is narrated here; a broad application of emerging technologies – in the form of efficient hardware, better organizational concept, and introducing new knowledge input – is a method to enhance efficiency within a dynamic system to enable rural population for better access to benefit of services. Since energy is major driving input to manufacturing, agriculture, education, health, and communication subsystems, it is essential to improve achievement for capacity addition against planned target by applying more weight age to set up network of distributed generation by renewable energy technology and modernization of grid structure, at the same time reducing demand by technologically improved energy-efficient end-use devices are essential. Application of real metering technology will reduce distribution losses with better revenue return. Adequate availability of energy will support technology application in the development of educational subsystem. Agriculture needs energy for water management, storage, and in production activities. The opening of more institutions of learning in distance education mode at block level utilizing information and communication technology for access to higher education and vocational courses for rural population will be possible if adequate supply of energy is available. The health-care systems in rural area need more health centers where better availability of energy with desired level of medical equipment of latest technology is essential. Optimum linkage of economy resources with major service sectors for its better performance is possible by ICT replacing age old system for faster economic growth.

4.1.1 Policy Measures Toward Technology Application

The following policy measures are suggested for application of technology in the system that covers all the economy resources and service sector:

1. R&D activities need be supported by the government for technology innovation at academic institutions by financial allocation at higher percentage of GDP, and networking between science and technology institutions, industries, and utilities should be improved toward mandatory application of their innovative technology in the field level within a stipulated time period from the date of its patent (Sharif 2008).
2. Socioeconomic studies based on reliable database need be undertaken to ascertain about acceptance of emerging technology by rural and urban people.
3. In the energy sector, efficiency improvement at supply side, capacity addition according to planned target, modernization of grid, optimum use of renewable energy resources for distributive generation in rural area, increased use of energy-efficient appliances in distribution, and real time metering should be done.
4. Modernization of manufacturing process in central and state sectors by diffusion of technology to bring stability in supply chain and allowing incentive to farmers in agriculture and allied services for access to technology on the basis of productivity and area of cultivable land are the required course of action.
5. FDI in economy resources and service sectors should be increased that aimed at technology transfer and creating competitive environment in this system as well as more grant-in-aid in technology education and vocational training at higher percentage of GDP in budget for financing students of LIG need be approved.
6. ICT enabled central monitoring institution to monitor technology application in the subsystems in close coordination with the states need be established for synchronizing progress of development and policy implementation in the country.

5 Conclusion

The economy system in India embodies subsystems of services and economy resources. The analysis of economy system clearly explained by diagrams and mathematical expression shows that functioning of each of the subsystems that contribute to whole economy system in India will deliver proper services to the population only if diffusion of technology in all the subsystems is synchronized to set the work on the right track of country's development. The discussion revolves around rural economy that counts on 70% of total population in India, touching briefly on urban economy to bring out the hidden gap between actual demand of services and actual access to benefit of services by an indicator – access to benefit of services (abs) as a tool of assessment on a sample agricultural subsystem. It has been justified by analysis with real data that abs is well below normal requirement on a scale of 0–1 among lower income group HH in rural area and marginally better in respect of HH in urban area across the states in India except for some economically developed states like Punjab and Gujarat. One's perception of economic development in an economy system based on the indicator GDP get sidetracked by this tool of assessment in order to know true scenario for country's economy. The living standard of people depends upon better availability of infrastructures in services together with better infrastructure for feeding inputs to economy resources and disposal of product through well-organized marketing subsystem; in last paragraph, possibility of applying suitable technology to each of the subsystems has been highlighted, ending with suggested policy measures to achieve goal of inclusive growth.

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Urban Land Management: The Retrospect of Three Metro Cities in India

Pooja Nigam and V. Devadas

1 Introduction

Today, most of the Indian metropolitan cities are beset with the problems of urban sprawl, unplanned growth and inadequate supply of serviced land for public purposes, especially housing, speculative holding of urban land, illegal settlements and slums. The major reasons which can be attributed to this is the ineffectiveness of the land management policies and legislations to coordinate the fast pace of urban growth and development, as evident in the past few decades. These problems are aggravated due to unregulated use of land, unauthorised developments and large-scale encroachments of public land. The land records, registration procedure and administration are also fraught with inadequacies, irregularities and malpractices. To deal with these problems related to urban land and to ensure a balanced sustainable development, economic viability, environment appropriateness and social equity along with efficient land management are required.

The basic measure for providing land management in the country is by designing a comprehensive approach to land policy. So far, most of the policies framed by the state governments have failed miserably to accomplish their goals to some extent or on whole. In addition, the government has instrumented some fiscal sources like taxation, stamp duty, surcharge on sale of property, betterment levy, etc., for providing revenue for their various functions and activities. A fiscal system needs to be framed so that land proves to be profitable to all, including the government and the public, and yet satisfies the social benefit. Technology can provide additional tools to tax administrators to observe and monitor individuals and transactions. Besides these, improvement in institutional management is required. Land record and information system which is the basis for all the experiments and innovations

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needs immediate reform so as to ensure clear property title, efficient and transparent land transactions, better evaluation of government land policies, etc. The institutional system needs to be strengthened in all areas, i.e. technical skill, personal management, work efficiency, etc. With the introduction of information and communication technologies (ICT) or e-governance, cadastral mapping with the help of GIS (geographic information system), the administration procedure can be ameliorated to gain better internal efficiency.

In this chapter, an attempt is made to analyse the major lacunae in the land management system of the Indian cities responsible for inefficiency and ineffectiveness in bringing out a planned development through ICT. Three case studies are selected, which have almost similar characteristics regarding their urban growth and development in the past decades, namely, Delhi, Ahmedabad (Gujarat) and Jaipur (Rajasthan), for quantitative analysis of their virtues and flaws. This chapter contains the review of existing land management in the fast-growing cities of a developing country like India in both conceptual and operational terms with the help of case studies and through deliberate study of the problems and critical analysis of the existing policy options within the administration available; interventions are suggested to disaggregate the problems.

2 Urban Land Management

Land management is the process of managing the use and development (in both urban and rural settings) of land resources (http://en.wikipedia.org/wiki/Land_management). An effective land management in urban context requires good governance or administration within the institutional framework and a strong interaction and understanding of the user group by the institution. 'Land administration' term is employed by the UN Economic Commission for Europe to describe the processes of recording and disseminating information about the ownership, value and use of land and its associated resources. All this in return needs institutional arrangements, legal frameworks, land information system, stakeholders' consultations, land markets valuation and finally technology for the processing part.

2.1 Land Record and Information System

Ideally, local governments including municipal bodies, special purpose sectoral development agencies and development authorities should have urban land records system for legal protection of their land resources and to facilitate the planning and development process which is the key point of sustainable development. For example, an up-to-date cadastral map defining boundaries of every parcel of land and an essential component of a land titling process would be extremely helpful in efficient transaction of properties and determining a fair tax base of properties. Also, such a system supplemented along with a land information system can be used for keeping complete information regarding location of all parcels of land in a specific area, their land use type, intensity of development and also for monitoring changes in their physical and socio-economic attributes and would eventually be very helpful in preparation of physical development/redevelopment plans. But unfortunately, in our country, land records are maintained in a very fragmented and sloppy manner.

Recording of land rights and their periodic updating is a prerequisite for an effective land policy. This not only ensures the avoidance of harassment of the urban poor and farmers by the private builders as well as the government land management agencies who generally tend to ignore the welfare of the poor during the process of land acquisition and disposal. An ideal land record and information system should have the following features:

1. Computerisation of plot-wise ownership and other important details for issue of timely and accurate ownership certificate to the landowners to avoid confusions and delays.
2. To achieve low-cost, easily reproducible and fast retrievable storage media, both in graphical and textual form.
3. The whole system should be consolidated and user-friendly and not fragmented and confusing.
4. The regular updation of the data at specified intervals of time should be easy and convenient and fast.
5. The data should contain not only the physical but also the social and economic attributes of the land parcels.

2.2 Land Registration and Transfer Process

The process of transacting sale/purchase of land, transferring ownership rights and getting it legally registered with the government is quite a difficult and cumbersome process for a common man. One has to go through a series of perplexing steps imposed by the government on the transaction of sale/purchase of properties slowing down the whole procedure. A land transfer/sale deed can be registered with the government only after certain clearances have been obtained and fee for registering the sale deed and transferring ownership rights has been paid to the concerned authorities. Also, as a consequence of all these restrictions and requirements of payments to the government including sellers, purchasers and the clerical staff, they learn to devise methods by which they can avoid the restrictions and payments. In general, we can state that the present land administration procedure is not only slow and inefficient but lacks transparency too, resulting in the growth of corruption and affecting the common man adversely.

2.3 E-Governance

The land records were earlier generated by employing manual labour and making use of inexpensive, approximate and sometimes outdated instruments. As the entire exercise was manual, completion of survey and mapping operations taking years, even decades, and by the time the maps and the land registers used to get ready for the use of public, they were already outdated to a great extent. Hence, though the computerisation of the land records maintenance is an essential task, but for making the required piece of information available to the public is even more essential. Here comes the role of e-governance in an effective way at the grass-roots level.

The sole objective of e-governance is to provide relevant information at the doorsteps of the citizens at a low cost through which they could save time and money without making them suffer by going through all the tiring and lengthy procedures of filling application forms and visiting the concerned staff in the agencies in person. The most widely accepted definition of the term e-governance is ‘e-government’ or electronic government referring to the use of Information and Communication Technologies (ICTs) by the government agencies in public favour for the following purposes:

1. Exchanging information with citizens, businesses or other government departments
2. Speedier and more efficient delivery of public services
3. Improving internal efficiency
4. Reducing costs or increasing revenue
5. Reducing manual labour of the clerical staff as well as the public involved
6. Increasing integration among the various branches and departments by avoiding confusion

3 Issues at Administration Level on Reality Grounds

3.1 Experience of Ahmedabad, Delhi and Jaipur in the Past Decades

Ahmedabad is considered as one of the most important centres of trade and commerce in western India and the home of several scientific and educational institutions of national, regional and global importance. The pace of development in Ahmedabad just like Delhi and Jaipur is very high, resulting into pressure on the urban infrastructure and services, hence requiring an efficient planning procedure for its growth in the future years. In Ahmedabad, town-planning schemes are a successful instrument for urban development. The preparation and implementation of TP schemes are done with usage of new advanced technologies. TP schemes involve computation of land value using computer-based GIS technique.

The plan of original plots and final plots along with existing structures clearly shows remarkable improvement in layout of street pattern and making the plots of regular shape with the use of computer-based technologies (Ballaney 2008). In India, Gujarat is the first state to apply GIS to fully plan, implement and monitor watershed management. Gujarat State Watershed Management Agency (GSWMA) has used technology to benefit 1,048 villages, 7.08 lakh hectares and 2.5 lakh farmers (www.geospatialworld.net).

Geographic information system (GIS) is a computer-based tool for mapping and analysing things that exist and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualisation and geographic analysis benefits offered by maps. These abilities distinguish GIS from manual system and make it consolidated, user-friendly and hence valuable to a wide range of public and private enterprises for explaining events, predicting outcomes and planning strategies (Mishra and Pal 2000). In the conventional mapping and recording procedure, the data is widely distributed. To retrieve any kind of information, different branches and sub-branches of land record department have to be contacted and traced, which is very time consuming. The GIS technology not only makes the data retrieving fast and easy as compared to the manual method but it also guarantees the availability of information since it is very easy to detect a missing piece of information through computers and fill the gap.

Delhi, the capital of India, leads among these three cities as far as the computerisation of land records for the planning purpose is concerned. Their system incorporates facility to dole out compensation and enhanced compensation information along with the legalities involved in their business process including scanning, digitising and geo-referencing of the village maps, layout plans, master and land use plan. In this context of automation of land records, spatial digital maps are generated with due authentication (Centre for Development of Advanced Computing 2008). Jaipur, though, has initiated the computerisation of land records like the other cities using the GIS technique for planning process is lagging behind the other two cities. Most of the time, the government authorities have to rely on private agencies for preparation of their development plans, even after getting their own staff trained in GIS. One common problem faced by both Ahmedabad and Jaipur is the coordination of the previous data which has been on papers from the last so many years to the latest data which has been developed on computers in the past few years. As a matter of fact, all these cities have poor land information systems with consequent financial and other costs to both the public and urban managers. This is due to the fact that the computerisation of records does not refer to simply the data regarding title and ownership of the land parcels in electronic database form. Urban development organisations are required to have good information on land, not only including ownership but also price, conditions on use, affordability in relation to shelter, land value increases in relation to overall inflation rates, etc.

3.1.1 Hurdles in Achieving an Ideal Land Record and Information System in These Cities

One should keep in his/her mind that, however pleasing and appealing it may seem from above, the computerisation of land records with the help of GIS or even in the basic electronic database format is not an easy task to achieve in these Indian cities. The TP schemes in Ahmedabad make slow progress. Some of the operational problems are delayed transfer of funds to the implementing authority, delay in development of need-based software, poor computer training facilities for the field revenue staff, non-availability of private contractors for data entry and lack of administrative focus. These problems are inherent in the cities of Delhi and Jaipur too. Computerisation only involves entering the available land record and enabling their printout. The regular updation of land records is a challenge in itself. Since the other departments of the government are also fraught with inefficiency and irregularities, it creates an impact on the working of the land department too. Regarding the land titling process, it is a common observation in the villages that persons in whose name the land is recorded are either deceased or do not possess that land. Among other problems, land data may not be available for public access; there may be unwillingness to share information on the part of government officials. The existing problems and their solutions through ICT have been summarised in Table 1.

4 Role of E-Governance at Institutional and Fiscal Level

4.1 E-Governance on the Reality Grounds

Awarded for best e-governance through three national e-governance awards in 2011, Gujarat is a frontline state in the implementation of e-governance policies and projects and setting up of key infrastructure for e-governance at a certain level. For the efficient management of increasing administrative responsibilities and the welfare activities, Ahmedabad Municipal Corporation had initiated a project on e-governance. A provision of Rs. 500 lakhs had been made for this project for 2002–2003 with the help of state government. This project, focussed on increasing computerisation in financial and property tax departments, linking all zonal offices with each other by electronic media and centralising collection of property tax, i.e., tax payment to be done at any zonal office, provided it falls under municipal corporation limits (Official Gujarat State Portal 2009). Under this project, a few civic centres having certain specific number of nodes in each zonal office had been set up, whereby total information is web-based and linked. One can calculate one's own tax online. Also, there is a complaint redressal department, which is an open system, meaning one can find out the status of his/her complaint.

Table 1 The problems existing within the land records and information system and their solutions

Underlying problems within the existing conventional system	ICT offered solution	Hurdles in ICT efficient system
Land records are fragmented in various departments	Single-window approach for physical, social and economic attributes of the land parcel	Poor interaction among the various departments and agencies
Boundaries of the land parcels are not defined properly	The GIS-based technique ensures accuracy	Lack of technical staff well versed in the software as well as other limitations like availability of electricity
Land titles are not clear	Electronic database mentions the titles clearly	Unwillingness and laziness to maintain the land records by the clerical staff
Missing gaps and errors in the information become evident at the time of planning or taxation process	Chances of errors become very less in computer-based system and can be easily rectified	Unwillingness to rectify the errors until and unless required in the 11th hour
Confusing and lengthy manual procedure	User/customer-friendly approach resulting into quick and easy processing	Unawareness of the common public about the latest technology and procedure followed or unavailability of sufficient computers and cyber cafes
Regular updation is not possible	Updation of data at regular intervals is much easier after monitoring the changes	The changes are not monitored regularly through field survey due to lack of staff or funds
Graphical version of the data is either unavailable or available in a very untidy manner	Soft copy of graphical data is easy to make available even on a massive scale to the public through web portals or other method	Non-acquaintance with the simple technology by the common public
Lack of transparency	Automated system leaves less chances of manipulation and faults within the data	Intentional fudging with the data due to political reasons

Delhi had planned a roll-out of 8,000 ‘government to citizen kiosks’ in 2008 through a project called Jeevan. While 23 departments and 104 services have been identified to be brought under the ‘Jeevan’ project, 45 priority services would be made available initially through computerised citizen service centres or portals with 264 online payment gateways. Services will include payment of utility bills, getting licences or certificates, issue of forms, etc., on a single online platform. Rajasthan government has also set up over 500 e-mitra (e-friend) service centres on public private partnership basis in 31 out of 32 districts including Jaipur with services including certificates, payment of bills, ration card, etc., with business process reengineering in linked departments and SARATHI (Stamp and Registration

Automation with Technology and Information) e-registration in an hour (E-governance and Best Practices 2008). This kind of set-up improves the internal as well as external efficiency of the urban local bodies and strengthens the bond between the government and the common public.

Most of the urban local bodies make most of the information available on their web portals. The exchange of information is a two-way procedure where the concerned person can not only see the specific information made available by the authority but also lodge complaint online and check the status of any application or complaint filed. E-governance allows the user to participate too in the procedure in the process of transactions, registration, etc., and providing feedbacks rather than limiting his/her role to a mere spectator in any institutional procedure.

4.2 Miles to Go in E-Governance

The aforesaid cities do not have a proper and complete computerised system of all the land records and information. In general, the revenue-earning departments like the commercial taxes, excise, most of the urban local bodies in Ahmedabad, Delhi and Jaipur, stamps and registration, revenue and land records, municipalities, etc.,have taken a number of important e-governance initiatives. All these departments have a highly informative website, downloadable forms, options for lodging complaints and giving feedbacks, procedures and timelines for procuring services, etc., on the Internet in Hindi or any other local language like Gujarati. The best part is the option where a customer can get his/her work done and check some information like status of complaint application, lottery result or even file a complaint through SMS service through his/her mobile. But still all this is like a drop in the ocean compared to the international standards. The administration can be made much stronger, transparent and user-friendly in terms of e-governance. Figure 1 illustrates the difference between the conventional and e-governance approaches for various land administration features or services for general public.

5 ICT in Tax Administration

5.1 Taxation

Tax administration, though a bit confounding in a general concept, is much duller in developing countries as compared to developed countries because of the lack of qualified staff, primitive style of record keeping along with half-hearted attempt for use of technology, absence of proper interaction among the governmental agencies themselves and to some extent the lack of political will to enforce good governance. A successful tax administration must be comprehensive, covering all aspects of tax administration, namely, coverage, valuation, collection, enforcement and taxpayer

Features/ Services	Conventional /Manual Approach	E-Governance Approach
MASTER PLANS, BUILDING BYE LAWS, ETC	• Personally go to concerned authorities to get a documented form by paying a heavy amount.	Available at web portals in downloadable format free of cost
LAND REGISTERATION AND TRANSACTION	• Go to office for applying and keep visiting for many months for enquiring about the status until the application is accepted.	Apply and pay the fees online sitting at home.
ISSUE OF NOTICE REGARDING LAND ACQUISITION OR DISPOSAL THROUGH LOTTERY SCHEME	• Keep checking newspapers and other sources for the information or go to concerned authority personally	Check and enquire only on the concerned agency's website.
COMPLAINT REGARDING ANY URBAN SERVICE	• Visit the office in person and go through cumbersome process and keep visiting the office for checking its status standing in quues for hours.	Lodge complaint online and enquire the status of the application
CURRENT STATUS OF PROJECTS AND DEVELOPMENT WORKS	• Keep checking the newspaper for any specific news or personally visit the different offices for enquiry. • No Guarantee of getting information.	Check on the web portal for the information free of cost.
TAX COLLECTION	• Wait for the bill and personally go to office to pay standin in long queues. • No transparency in the generation of bill.	Check and calculate bill online and even pay online.

Fig. 1 Comparison between the conventional/manual approach and e-governance approach for land management system

service. Municipal revenues account for 0.6 % of the country's GDP (Reforming the Property Tax 2004). So, there is enormous potential for enhancing and improving local revenue collection with the help of advancing technology. Looking at the pace of growth of our urban economy and demand for better efficiency in the government institutions, a strong institutional framework is required to exploit this potential and upgrade urban infrastructure and services. Institutional capacity building is very essential for efficient functioning of the government and hence effective delivery of urban services.

Due to ineffective taxation, the low income in municipal revenues is a cause for serious concern. Taxation has been recognised as one of the principal source of revenue generation in urban local bodies. Unfortunately, the tax yield is very poor, owing to the legal and administrative problems, lying within the whole of tax system. Now is the time to make this tax a highly productive instrument of revenue generation for local bodies. Since Ahmedabad is the leading city in e-governance, its tax collection rates remain generally the highest among all the cities. Along with Delhi, it was among 6 cities with high concentration of service tax assesses and major tax contribution, i.e. revenue of Rs. 8,827 crores (62 % of the total tax receipt) for the year 2004–2005, while Jaipur was at 12th position (Annual Performance Report 2004–2005). Jaipur ranks very low as compared to the other metro cities each year, as far as tax collection is concerned.

5.2 ICT as an Answer to Ineffective Taxation

An effective procedure to curb the inefficiencies in the taxation is discussed below:

1. One of the main reasons is the failure in citation and evaluation of all the properties lying in the metropolitan area. All these different aspects of land administration are interlinked and interconnected. The problem of land records maintenance and titling eventually results into an efficient fiscal set-up. A comprehensive and periodic maintenance with regular update of properties along with other socio-economic proper details will broaden the tax base coverage and increase revenue generation in tax administration. This can be achieved through carrying out field surveys, tax mapping and use of modern technology like Global Positioning System.
2. The taxation is considered complete only when the tax is actually collected after the assessment of the properties. Tax collection is particularly challenging in developing countries where payment of full taxes is not taken seriously by the people. Apart from this, the procedure is too slow to complete the taxation process. Earlier, bills were not always issued in time. However, computerisation of tax information in all the three municipal corporations has helped in speedy generation of tax bills. The existing problems within taxation and their solutions through ICT have been summarised in Table 2.

The main problem still lies within the comprehensiveness of the land records and management system. For example, while a development plan is prepared, the first task is to prepare a base map. When the plans are prepared, very accurate cadastral maps and landownership details have to be developed. The cadastral maps and records are required by the planning agencies to prepare maps and databases as well as the revenue department for taxation and evaluation. Both of these function separately, however, and they maintain and update their own records, resulting in considerable confusion and overlapping of details. Again, the spatial records are not linked with the databases. The lack of maps and the absence of databases hinder planning and management functions by different departments. Hence, while the plans are prepared, there is an opportunity as well as prerequisite to build a fairly accurate GIS-based base map and land record system that can be used by both the planning and revenue departments.

The problem is evident in all the three metro cities even in Ahmedabad, where preparation of TP schemes requires accurate land record data and information system, resulting in exercising the whole thing. Through the cases of Delhi and

Table 2 The problems existing within the taxation and administration and their solutions

Existing problems	ICT offered solution	Hurdles in ICT efficient system
Land records are not in consolidated form	Interconnection of all the graphical and text version of data through internal server within the government agencies	Poor interaction among the various departments and agencies within the government
Size and boundaries of the land parcels are not defined properly, resulting in confusion of area to be considered for taxation	The GIS- and GPS-based techniques ensure accuracy with minimum chances of errors	Lack of technical skill within the staff or even lack of funds within the agency
Land titles are not clear, and hence, their listing and assessment becomes difficult	Computers ensure clarity and ease the computation and calculation burden for taxation	Unwillingness and laziness to maintain even the electronic database of land records by the clerical staff
Overburden on the clerical staff due to lengthy manual procedure	Tech-friendly approach, resulting into quick and easy processing of data	Lack of technical skills among the staff
Lack of transparency within the taxation process	Options of online calculation of tax and filing of complaint sitting at home ease the process	Ill-maintenance of the web portals resulting into confusion

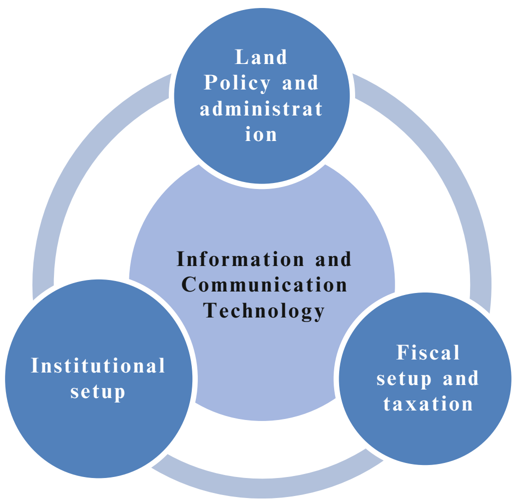

Fig. 2 Interrelationship between different aspects of land management

Jaipur too, it can be concluded that the problem lies mainly in the lack of interaction, and the ego clashes between the development authority and the municipal corporation since the task of planning and development lies within the development authority and the revenue generation within the municipal corporation. Thus, better e-governance would result into better institutional framework, hence better fiscal set-up and vice versa as evident in Fig. 2.

The present e-governance in Ahmedabad, Delhi and Jaipur provides the improvement in service delivery, making it quicker and easier as compared to the manual procedure, but for the complete transformation, it is essential to list out the various services provided by different departments and connect the similar services, i.e. single-window approach. For example, registration of property or its transaction must lead to an updation in the land records and hence calculation of tax; a connection of birth and death registration with the tax payer documents shall reduce the disarray within the system; GIS may help to have a better picture of the tax collection statistics within the area in graphical terms, etc.

6 Conclusion

In brief, this chapter shows the possible solutions for some of the hurdles in efficient land management through information and communication technology approach through the case studies. Though, it is comforting to see the initiation of technological approach in a developing country like India. But, still we need immense improvement to reach a certain level where technology can be utilised to its maximum potential for a better and efficient land management and administration. The cities have started using technological advancement as a tool to rectify their functioning. On the other hand, there are so many other remaining tools and techniques which can help the institutions and urban local bodies to improve themselves.

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Part 1.5
Technology and Market

Marketing Dynamics in Technology-Based Industries: Pioneering Advantage, Customer Experience, and Adaptive Pricing

Gurumurthy Kalyanaram

1 Market-Share Pioneering Advantage

1.1 Empirical Evidence

Empirical studies have shown that in most cases, being first to the market provides a significant and sustained market-share advantage over later entrants. Still, later entrants can succeed by adopting distinctive positioning and marketing strategies. Pioneers in most industries, once they have reached the status of incumbent, are powerful. Sometimes, however, they get complacent or are not in a position to cater to the growing or shifting demands of the marketplace. New entrants can take advantage of gaps in the offerings of these aging pioneers or find innovative ways to disrupt the customer preference and market structure.

There is a large literature documenting the importance of order of entry for early entrants in consumer packaged and other goods (Kalyanaram et al. 1995; Robinson et al. 1995; Karder et al. 1993; Kalyanaram and Urban 1992). Bond and Lean (1997), Berndt et al. (1995), Charles King et al. (2000), Ling et al. (2002), and Kalyanaram (2008)[1] have documented strong order-of-entry effects in the pharmaceutical drugs markets also.

Empirical generalization (Kalyanaram et al. 1995) leads to a simple expression to compute the market-share penalty for later entrants: the new entrant's forecasted market share divided by the first entrant's market share equals, roughly, to one

[1] The empirical results show "the innovator's market share in the prescriptions category (OTC category) dropping from 100% to about 58 (61) percent after the second brand enters, to 43 (47) percent after the third entrant, to 35 (39) percent after the fourth brand enters, and to 30 (34) percent after the fifth brand enters. Consistently, the market shares for the first entrant are higher by 3–5 points in the over-the-counter drugs category than in the prescription (Rx) drugs category."

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Table 1 Order-of-entry effect and relative market shares

Entry order	Urban et al. (1986)	Kalyanaram and Urban (1992)	Berndt et al. (1995)
First	1.00	1.00	1.00
Second	0.71	0.76	0.70
Third	0.58	0.64	0.57
Fourth	0.51	0.57	0.49
Fifth	0.45	0.53	0.44
Sixth	0.41	0.49	0.40

divided by the square root of order of entry of the new entrant. Therefore, if there are two players in the market, the first entrant will have a market share of 59% and the second entrant will have a market share of 41% (which is 70% of 59%). This formulation is derived from generalizations across studies including those illustrated in Table 1.

In this study, we illustrate the dynamics of technology-based industries with the evolution of the cellular industry in Europe. Kalyanaram and Gurumurthy (1998) examined the data from cellular industry in several countries in Europe. This data captures the early years of the wireless market in Europe, as the wireless service providers started entry into European markets in early 1990s. See Table 2.

Except for one case (in Britain), the data shows that the later entrants suffer a market-share penalty. This relationship is consistent and monotonic. Even in an aggregate computation across all the countries—Belgium, France, Germany, Italy, the Netherlands, and Spain—the average market shares of the first and second entrants are 58.5 and 41.5%, respectively. These figures are consistent with the results in Table 1 since the second entrant has about 70% of the pioneer's market share.

Pioneering market-share advantage is muted in some conditions. When consumer learning is limited, the pioneering advantage will be limited. Consumer learning becomes very difficult if the product becomes complex and technical. For example, when picture phones were introduced in the late 1970s, the market did not respond because consumers could not find occasions to use the product. The pioneering advantage is also limited in a cluttered market: if there are many available brands, consumers react by becoming confused.

1.2 Analysis of Early European Wireless Markets

An analysis of the evolution of wireless markets in Europe indicates that first entrants are also market leaders in all the countries (Table 2) Pioneers in cellular service establish a presence in the marketplace, build brand equity, and create an excellent distribution network. In light of the facts that the quality of service is primarily determined by coverage and that the first entrant's network infrastructure is generally superior, the first entrant's market-share advantage is evident. As the customers become used to enhanced coverage over time, the later entrants have to invest significantly to achieve this same coverage—an effort that is capital intensive and time consuming. All new networks have initial bugs that take time to fix.

Table 2 Wireless market in Europe, 1988

Country	Operator	Order of entry	Date of entry	Net annual market share (%)
Belgium	Belgium Mobile	1	January 1994	60
Belgium	Mobistar	2	August 1996	40
France	France Telecom	1	July 1992	55
France	SFR	2	December 1992	45
Germany	Mannesmann	1	June 1992	52
Germany	T-Mobile	2	June 1992	48
Italy	Telecom Italia Mobile	1	October 1992	68
Italy	Omnitel Pronto Italia	2	October 1992	32
Netherlands	PTI Telecom	1	July 1994	55
Netherlands	Libertel (now Vodafone)	2	September 1995	45
Spain	Telefonica Moviles	1	July 1995	61
Spain	Airtel	2	September 1995	39
Britain	Vodafone	1	July 1992	42
Britain	Cellnet	2	January 1994	31
Britain DCS 1800	One-2-One	3	September 1993	7
Britain DCS 1801	Orange	4	April 1994	20

Subscribers are just not willing to go through another learning curve when there is already a robust supplier of service. In light of switching costs and other parameters, consumers are risk averse. Accordingly, consumers prefer to stick to the choice that is already demonstrably functional.

Another frequent constraint in the wireless market is access to property to build the towers, since the first entrants have already seized the ideal sites for coverage. This, in turn, may require the later entrant to invest larger amounts in network infrastructure to gain similar coverage. Given these hurdles, it can take 2–3 years before a challenger achieves coverage competitive with the incumbent's.

In addition to coverage and related quality of service, another formidable barrier to entry for new entrants, till recently, has been the challenge of number portability. Customers would have to get a new cellular number when they switch carriers since they cannot take the same phone number with them as is done in landline networks. In general, customers do not like to change their phone number where customers receive calls in their mobile phones. The number portability issue now remains less challenging, though there is a cost involved. Thus, we see the inherent advantages to being first in the market in the wireless industry: control of ideal sites, freedom to evolve and fine-tune network coverage, building of brand loyalty by offering superior customer service, locking in customers by subsidizing equipment for an extended period under fixed-service contracts, and gaining control of key channels of distribution.

Pioneering advantage can be sustained through constant innovation. For example, in telecommunications industry, two obvious sources of differentiation are superior network infrastructure and customer service. In the wireless industry, customers are repeat purchasers, since their contract terms typically last for only

1 or 2 years. This situation offers an opportunity to the later entrants. A later entrant can lure some of the customers from the earlier entrant by a good network infrastructure and by gaining access to good distribution networks. This is evident from the fact that the incumbents in several countries have not been able to sustain their lead and the differences between early entrants and second entrants are decreasing rapidly. For example, in Britain, Vodafone had an 18-month advantage over its prime competitor, Cellnet, with similar technology. Three years after the launch of Cellnet, however, the difference in market share in annual net additions between Vodafone and Cellnet is only 11%. Vodafone has been able to retain its lead in the recent past only by fighting back efficiently on the customer service dimension and by developing creative service-bundling strategies (Kalyanaram and Gurumurthy 1998).

2 Competitive Strategies for Later Entrants

The order-of-entry market-share phenomenon has clear strategic implications for later entrants (Kalyanaram and Gurumurthy 1998). A preferred strategy for a later entrant may be to develop a superior product with either unique benefit features and/or a lower price (i.e., better positioning). Such positioning can be accomplished through substantial changes in either the product or promotion strategies. For example, the Chrysler Corporation redefined perceptions of its minivans by introducing caravan, a two-door van. The Ford Corporation's Windstar which was expected to be a marquee van lost substantial share to the caravan. When the General Motors Corporation decided to reposition its Oldsmobile, it changed not only its product but also its advertising copy. The new copy appealed to consumers over 30 years old, projecting the image of a younger professional woman via this voice-over: "This car is not only for your father's generation, but it's for you too."

A second route for later entrants is to discover creative ways to increase product trial. Kalyanaram and Urban (1992) have found that the market-share advantage for the early entrants comes from higher trial penetration. There are several possibilities. For example, limited demonstration of usage or prototypes in software products and test usage in automobiles are fruitful approaches. Also, distributing the product through new channels such as direct marketing (think of the Lands' End catalogue or the Mary Kay cosmetics parties) or a home-shopping-network channel placing the product in the hands of more consumers is another approach.

The later entrants can position themselves as variety enhancers, rather than as replacements or substitutes for the pioneers. An example is Orange, the late-entry cellular service provider in Britain, which successfully nudged aside the pioneers. Orange entered the market almost 30 months after the first entrant, Vodafone, and 9 months after One-2-One, and with technology similar to One-2-One's. Orange, however, has followed a very aggressive entry strategy. It not only invested heavily in the network over the first 2 years of introduction but also developed aggressive pricing strategies. Orange seized a third of Britain's total market's first quarter 1996 growth by offering about a 30% savings to end users, compared with Vodafone and Cellnet. The pricing strategy was effective enough to compensate for Orange's relatively poor network coverage.

Later entrants can also succeed by attacking high-growth markets particularly when there is a significant shift in the industry. Such shifts can be due to changes in regulation, or technological breakthroughs that improve the product, or breakthroughs that improve the process of manufacturing and delivering the product. The classic example is MCI's success in penetrating the long-distance market and winning a regulatory battle with the AT&T Corporation.

Another strategic option for the later entrant is micro-segmenting the customer base, that is, targeting high-value customers who are able and willing to pay a higher price for the product or service relative to the cost incurred in catering to that segment. For example, the competitive-access providers (now competitive local exchange carriers, or CLECS), in order to provide local telecommunications services, basically skimmed the best customers of the regional Bell operating companies by offering a lower price. This was possible because the regional companies had adopted an average price scheme partly dictated by the Federal Communications Commission.

Innovators have also been successful in entering markets with a significantly better technology. Usually, however, technological innovation gives a company an edge for only a time, since incumbents catch on fairly quickly. Given that this is the case, new entrants should support their innovations with effective positioning, appropriate pricing, and aggressive advertising. For example, IBM, a later entrant to the personal computer market, captured the lead in the 1980s by developing the technology and using its powerful marketing engine. Later, Compaq and Dell fundamentally redefined the business. Compaq reduced the cost by changing the manufacturing process and having superior logistics. Dell, in addition to using an efficient manufacturing process and superb logistics, invented the mail-order or direct channel to access end users, who by now were comfortable with personal computer technology. IBM was not able to react to these changes fast enough and lost its lead in the 1990s (Kalyanaram and Gurumurthy 1998).

3 Customer Experience

Urban (2005), Von Hippel and Thomke (2002), and others have addressed the importance of engaged customer and such engaged customer as the source of innovation. Customer "service" and "experience" offerings should go beyond the pure products-related offering (e.g., basic installation/maintenance service) to an extended set of offerings (e.g., post-purchase consultative facilitation, design of warranties). This set of extended offerings will create a *value-added ecosystem*, which will provide consumers both tangible and intangible benefits that go beyond the mere adoption/consumption/usage of the product. The *ecosystem* will enhance the total "experience" of the customer. We call these *extended offerings of the ecosystem as "customer service offer zones*."

As we move through "offer zones," the firm is presented with new and different opportunities and challenges to capture and maximize value using different business models. One should keep in mind the interactive effect of these "customer experience and service zone" offerings and core product. Understanding the interactive effect will enable optimal pricing and ability to capture value during a customer/product life cycle. For example, by pricing songs at iTunes at 99 cents, Apple has been able to generate more demand for iPods priced between $250 and $350. Another example is the cost of hardware versus ongoing maintenance and software upgrades. Companies can price the core product at a lower margin to capture higher margin and revenue from incremental services.

Customer experience, value, and service are important in all industry sectors and across product life-cycle stages. However, the type of experience and value would differ depending on the sector/product life cycle and the nature and delivery of that experience and service. We will first briefly discuss the strategic implications in the *mature phase* and then in the *growth phase* of product/sector life cycle. Our context for discussion is the high-technology industries and markets.

3.1 Mature Phase of Life Cycle and Customer Offer Zones

Several firms have shown the value of focusing on customer care and experience during the *maturity phase in a product/sector life cycle*. Such a strategy enables firms to think creatively beyond pure product rationalization and cost dimensions (business efficiency) to generate growth. The most oft-quoted example that fits this description is IBM's turnaround from the early 1990s. IBM has generated significant growth over the last 10+ years from the services business which accounts for over 50% of revenue today. IBM has truly created a new dimension of growth by leveraging customer service and as well as having redefined how hardware and software with services can be bundled to create unique value.

Another example of this trend is EMC which, as a firm, has transformed from a hardware-centric company to software-based holistic-offering (including hardware and software) company. HP is yet another company that has regenerated growth in a relatively mature market by enlarging and diversifying its services business (including online classes on digital photography and entertainment). We are likely to see emergence of a more customer services led strategy from other large hardware-centric companies like Sun.

In the telecommunications equipment industry, Ericsson has created a very large services-based business that now offers clear incremental value-added service that goes beyond the basic maintenance service. The services business has enabled the company to generate significant overall growth, and it has increased customer stickiness of its core hardware and software products as well. Thus, while there is substantial collateral benefit to services, there is also an increase in core product-related revenues.

3.2 Growth Phase of Life Cycle and Customer Offer Zones

When firms are in *growth phase*, the value of customer experience and service is likely to be viewed differently. Skype is a classic example of focus on customer service. The true driver of growth has been their ability to enhance customer experience by making relevant changes in their software strategy and in addition offering "wraparound" customer service. In the case of Skype, customer service is an embedded cost to increase adoption of its offering which, in turn, improves the overall value of the company.

Apple's iPod is another example of a company in growth stage which has focused on customer service and experience that is more enriching the standard user interface (for which Apple is well recognized). Apple provides information at points of purchase through well trained representatives at flagship stores and/or in the call centers. This has enhanced the overall experience and increased adoption of the service. Thus, typically in growth oriented stages, quality of service is important to facilitate faster adoption.

3.3 Managing Variability Introduced by the Users

When users become part of offerings of a firm, there is a greater variability introduced in the design of the offering. Managing this variability is critical and important for making an offering profitable. Customers introduce variability in many different ways. For example, the customers do not necessarily want the offering at times when it is most convenient for the firm. There is often a timing mismatch. In many service environments such as retail stores, call centers or physician clinics, such mismatch is often serious. Another form of variability is request by the users of an offering or attribute that is not under consideration. Of course, there is the subjective preference variability. That is, users vary in their reactions to an offering. For example, a miniature phone size might be well received by some users, while other users may find the operation of the phone difficult.

In light of this heterogeneity in preferences, it is important for a firm to set up strategies (such as micro-segmentation of users, queuing of requests, build redundancies) to retain productive user input and yet maintain profitability of the process.

4 Adaptive Pricing

One of the most important attributes of offerings is price. We posit that price, too, should also be user-driven. Adaptive pricing allows for this user-driven pricing. Adaptive pricing consists of two main elements: (1) letting the customer/user set any price he/she considers fair after the purchase/consumption experience, and (2) letting the firm/seller or a marketplace of firms track that price and use that information to determine whether to make further offers of that kind to that user/consumer in the future (Reisman 2010). Adaptive pricing "creates a dynamically adaptive cycle of offers, prices, feedback, and further offers that rewards those who pay fairly and cuts off those who do not (Reisman 2010)." Consumers become part of the decision-making, and thus feel empowered by added trust and flexibility.

For example, some music and downloadable games including Radiohead in 2007 have experimented with different versions of adaptive pricing and found moderate success. In case of Radiohead, while a reported 60% downloaders did not pay at all, enough did (paying an average of $8.05 in the USA and $4.64 elsewhere) to make that experiment modestly successful.

Empirical research (Kalyanaram and Little 1994; Kalyanaram and Winer 1995) has shown that consumers carry a reference price for a brand, and they adapt this reference price based on new information and experience. Reference price is an internal price that consumers form to assess the value of the product/brand of choice. The reference price is consumer and brand specific. The concept of adaptive pricing is analogous to constant updating of reference price through new experiential and market inputs. A parsimonious but elegant operationalization of reference price at time t is a concave function of reference price at $t-1$ and the price at t.

The adaptive pricing approach designed by a firm must take into consideration the cost structure. In technology-based industries, the costs decrease over time. For instance, it is a fact that products like digital cameras watches, color TV, personal computer, videocassette recorder, and hand-held calculators have had a sharp drop in (output) prices since the introduction of these products. Technological innovations and competitive dynamics cause reduction in prices.

Generally, while adaptive pricing can be practiced by a dynamic firm that innovates and takes care of customer needs or being customer centered, it has to balance this with the elasticity of demand for its product or service. The pricing must, therefore, also be carried out within the context of the type of industry—constant-cost, increasing-cost, or decreasing-cost industry. But the principal factor driving the pricing is the elasticity of demand. If a firm is able to expand its customers and sustain their loyalty, then the demand elasticity can become more inelastic—thus, as holding the customers to the product and the firm, the firm can have some dominant role in setting the price.

In summary, dynamic pricing approach is most appropriate for technology-based industries and products.

5 Summary

Technologies are constantly evolving. Managing technologies is, therefore, a dynamic process. Market entry, customer experience, and pricing dynamics constitute fundamental components of technology management. This chapter addresses and analyzes these three issues.

While we have shown that early entrants enjoy sustained market-share advantage and that this empiricism has strategic implication, two important questions are:

- What is the reason for this market phenomenon?
- Is there evidence of advantage in return on investment?

There are several economic (e.g., Schmalensee 1982) and behavioral (e.g., Kardes and Kalyanaram 1992) arguments for the market-share phenomenon. First argument is that consumers in general are risk averse. If a product or service provides enough satisfaction, consumers do not want to risk switching to a new product. Second, the pioneer becomes the prototype for the product category. Later entrants are compared to the pioneer and always somewhat unfavorably. Whenever consumers think of photocopying for example, Xerox is the name that jumps to mind. Third, consumers learn best the attributes of early entrants. More knowledge translates into more strongly held beliefs and great confidence in choice. And lastly, early entrants are able to secure the best positioning in the marketplace.

Does the pioneering advantage manifest itself in return-on-investment metrics apart from market share? Yes, after substantial research and development investments, being early in the market is rewarding. Research shows that the pioneers enjoy a higher return on investment in both consumer and industrial goods (see Tables 3 and 4). This research and development investment and continuous new product launch is also used as an entry barrier by several pioneers.

With regard to customer experience as a source of innovation, the evidence is overwhelming. Von Hippel (1994, 2005) and others (e.g., Anthony and Bettencourt 2008; Urban 2005) have shown that in many industries such medical technology, instruments about 70% of the innovations come from end users and customers. Therefore, an engaged and proactive customer is the most productive and efficient source of innovations. However, firms have to facilitate customer input. As an illustration, when medical instruments were modularized, the innovative consumer

Table 3 Return on investment and order of market entry, consumer goods

Consumer goods	Return on investment (%)
Market pioneers	25
Early followers	19
Late entrants	16

Table 4 Return on investment and order of market entry, industrial goods

Industrial goods	Return on investment (%)
Market pioneers	24
Early followers	19
Late entrants	15

experimented and improvised. But modularization was a necessary condition for this experimentation to happen.

Finally, adaptive pricing has been well documented in economics and marketing literature. Reisman (2010) has developed a patented algorithm to price adaptively.

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Changing Consumer Perception of Electronic Vehicles Through Branded Technical Components

Christian Linder and Sven Seidenstricker

1 Introduction

Today, a number of established manufacturers offer the first standard electric vehicles. At the same time, battery manufacturers are working on the latest generation of lithium-ion batteries with much wider ranges. With this new technology, one major change has happened to big automotive brands such as Volkswagen, Toyota, Mercedes and Renault. While consumers estimate them, in relation to component suppliers, to be relatively competent at producing cars with combustion motors, the know-how for electro- (e-) cars is seen to be held by suppliers such as battery or drive system manufacturers. So what we observe today is a switch in knowledge and competencies (PWC 2011). From a technical point of view, battery range is the biggest challenge. Today, performance is – due to energy density and power density – about 150 km per charge, and the number of rechargings is very limited. The total added value of an average battery to an electric car is around 30–40% (ACATECH 2010). The price in relation to the kilometre reading is, for many potential consumers, too high. So it is not surprising that, today, consumers are resolute and that the current sales volume in e-cars is relatively low.

But price is not the only thing that matters. E-mobility is a paradigm change in mobility and a clear innovation for the common car. Consumers' hesitation over buying e-cars can be described in terms of diffusion theory (Rogers 2003). It is well known that people do not adopt innovations instantly but instead pass through stages in the adoption process. Other than the early adopters, the majority of possible users wait before they make their buying decision. Diffusion theory asserts that the rate of diffusion is influenced by the perceived characteristics of the innovation, as well as by the structural characteristics of the organisation and the

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personal characteristics of the target audience. Further, it is known that consumer adoption increases if consumers have the chance to observe others using the innovation effectively (Rogers 2003). These major factors reflect the complexity between technological innovation and its commercialisation. For commercialisation, the concepts of technology push and demand pull are the driving forces in the process of innovation (Wonglimpiyarat and Yuberk 2005). The commercialisation complexity, or, in the case of e-mobility, how radical the new technology is seen as by potential users, has effects on consumers' trust in the promised advantages of e-cars compared to existing cars. Low trust requires a big push effort. Likewise, today, the battery (in terms of price, lifetime and range) is one of the characteristics which makes the decision difficult for potential users. Further, consumers have little experience of e-cars, as there is neither ownership nor experience of e-cars among family, friends or peer groups. Therefore, car manufacturers have to try hard to push e-mobility. This explains why nearly every country with ambitions in these markets has its own support programmes for the research, market development and financing of new e-mobility projects of many types.

In this study, we ask if the brand perception of such an ingredient-branding alliance can help to increase the adoption of e-cars. An increased acceptance would lead to lower push efforts and a higher consumer pull. Some studies (Swaminathan et al. 2011) indicate that such effects can be realised through ingredient branding (IB). Therefore, one must ask if the acceptance of e-mobiles can be increased through a strong component brand for critical parts, in particular the battery. Our findings include critical implications for car producers to help them improve the acceptance of their products through creating strategic brand alliances with component suppliers.

2 Theoretical Background and Hypothesis Development

2.1 The Ingredient-Branding Framework

Ingredient branding ('IB') is a special form of alliance that exists between two companies which co-operate in designing and delivering the product, with a particular emphasis on the possibility of recognising and identifying the components used in the final product (Kotler and Pfoertsch 2006). In other words, IB is a form of a business-to-business (B2B) branding strategy between a manufacturer and a supplier in which the supplier's end product becomes one of the components of the manufacturer's offering (Erevelles et al. 2008). IB happens when a component (battery) of the end product (e-car) is promoted to the final user.

The idea behind IB is that the ingredient or component brand forms an alliance with the end product brand in an effort to create brand awareness and generate pull effects through the value chain (Havenstein 2004). The push and pull concept is critically important to understanding IB and the motivations that guide it because IB can be seen as a solution to the aforementioned push and pull concepts in

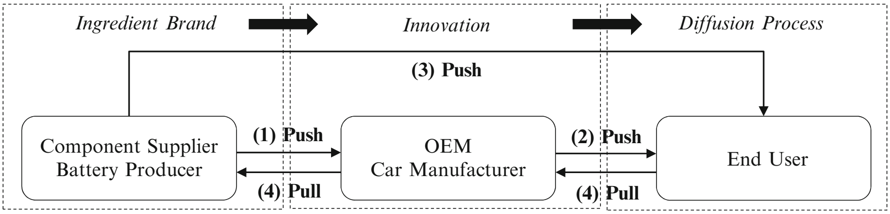

Fig. 1 The ingredient-branding technology innovation diffusion

technology innovation and the diffusion process. In the push strategy, the marketing strategy is directed towards the OEMs, whereas in the pull strategy, a direct appeal is made to the consumer to choose the final product that has the branded component. One important aspect of this view is that the marketing mix in an IB strategy involves both push and pull effects. The only factor that separates these effects is the distinction between consumer and manufacturer behaviour. It is the consumer behaviour that creates the pull and the manufacturer behaviour that creates the push. We can consider the push and pull effects as being effects of marketing mix decisions. Supporting pull with push increases the probability of adoption, and the combination of push and pull strategies creates magnification of the complete marketing mix.

The supplier typically offers a component or a service to his or her customer, who is generally the OEM. As a result, the supplier enters into a B2B relationship with the producer of a product such as an automobile or an electronic item. The OEM, on the other hand, makes a product that is to be used by his or her customer, who is the final user. When the final user buys the product or service from the OEM, he or she associates himself or herself with the OEM in a pure business-to-consumer (B2C) relationship. According to this principle (Pfoertsch et al. 2008), there are two separate stages of the customer relationship: the first stage between the supplier (here: battery producer) and the OEM (here: car manufacturer) and the second between the OEM and the final user. In IB strategy, we find that the two stages are interconnected (see Fig. 1): step 2 (communicating the component brand to the customer) follows step 1 (communicating the component brand to the OEM). Step 3 occurs when the supplier tells the final user that a particular ingredient is part of the final product offering, which makes the final user choose the product over other competitive offerings. Here, the component supplier anticipates the fact that the OEM also has a customer who, in the end, defines the demand. The pull of the final product which contains the desired component by the final customer takes place in step 4. This continuous process of push and pull will result in a high success rate if done appropriately.

The idea of IB as a brand strategy has been around for quite some time in marketing (McCarthy and Norris 1999). However, only in recent years has it gained greater prominence. Some examples of IB campaigns to create brand awareness about ingredients are ‘Intel Inside’, ‘Gore-Tex, Guaranteed to keep you dry’, and

'100 percent cotton'; these campaigns are for ingredients, such as computer chips or materials, which are contained within final consumer products, such as computers or clothing. To sum up, it is the popularity of the component among consumers that drives the demand for products that contain the branded ingredient. There has also been an argument that this demand then influences firms in the middle of the value chain to use these ingredients in their products. As a consequence, IB has been known to change the way firms interact in the value chain.

2.2 Hypothesis Development

This study investigates the effects of batteries as a branded component and their influence on the perception of the end product, the whole e-car. On basis of the IB concept, a review of relevant literature was undertaken with its primary focus being to define the research variables and the conceptualised relationships between them.

2.2.1 Trust

Innovations by definition are new and therefore incorporate risk because the user cannot refer to prior experience. The concept of trust comes into play as a solution for this specific problem of risk (Kim et al. 2008). Trust has been widely studied in marketing, especially in the literature about branding (e.g. Morgan and Hunt 1994). A brand can be understood as a trust mark for all intangible trust-generating activity in the absence of human input. Therefore, a brand is a symbol of quality and assurance in building trust (Keller 1987). It is known that customers perceive companies with a good reputation as more credible and trustworthy and as providing greater value, and the brand can be a symbol for such a reputation. Sahina et al. (2011, p. 1291) defined trust as: 'a consumer's confident belief that he or she can rely on the seller to deliver promised services'. The effect of the special trust in brands is the willingness of the average consumer to rely on the ability of the brand to perform its stated function. Scholars have identified several characteristics of a trustworthy brand (Morgan and Hunt 1994). Referring to these findings, we can see that it is important for a brand consistently to keep its promise of value to consumers, through the way the product is developed, produced, sold, serviced and advertised, even in bad times when some kind of brand crisis arises (Sahina et al. 2011). These brand characteristics lead to consumer loyalty – the deeply held commitment to rebuy or patronise a preferred product consistently in the future (Oliver 1980). Brands therefore create emotional connections between the consumer and the product. While a theoretical model of trust in component brands is still missing, several case studies have shown that trust also plays a role in IB (Kotler and Pfoertsch 2010).

Hypothesis H1a: High trust in the ingredient brand (IB trust) leads to lower perceived risk in the final product (car risk).

It is known that trust is directly built if consumers have a good and stable experience of the quality of a product over a long time. If consumers trust that the important components in the final product are of high quality, one could assume that they perceive the quality of the product to be higher.

Hypothesis H1b: High trust in the ingredient brand (IB trust) leads to high perceived quality of the final product (car quality).

2.2.2 Recognised Quality

The recognised quality of a product or an ingredient is defined as the customer's assumption about the quality of that product compared to the quality of another product (Aaker 1991). It is very close to the concept of trust. Recognised quality is an estimation of a product by the consumer. Therefore, it can differ from the real quality of the product. We have to consider that the recognised quality of the end product can be considered to be either lower than that of the branded component or higher when first evaluated by the consumer (Kotler and Pfoertsch 2006). This is a crucial point in the OEM's decision to commit itself to an IB partnership with a supplier. Identifying a suitable partner depends on the contribution of the component brand to the recognition of the total end product (Kotler and Pfoertsch 2010). So it can be expected that a component with high recognised quality leads to an enhanced recognised quality of the end product. This effect must be even greater if the consumer assumes that the branded component has a high importance for the functioning of the total product.

Hypothesis H2: High recognised quality of branded component (IB quality) leads to high perceived quality of the final product (car quality).

2.2.3 Relative Advantage

Relative advantage is a measure of the gain of the innovation over the existing market offer. It is a subjective assumption of the adopter (Rogers 2003). Studies so far show that there is a positive correlation between the perceived relative advantage and the probability of adaption of the innovation. The relative advantage can be seen as a result of a consumer's positive decision after comparing new features of the innovation with existing features of actual market offers (Bagozzi and Lee 1999). This decision process typically considers product characteristics, the possible field of application and the price performance ratio (Krafft and Litfin 2002). Rogers (2003) argued that the cost of acquisition, the prevention of mispurchase and the time savings in the buying process also play a role. Finally, as for IB, image is an important determinant of relative advantage (Moore and Benbasat 1996). If a consumer judges that a product, according to these aspects, is superior, the probability of him buying it is increased. This means that it is reasonable to assume a spillover effect of IB on the relative advantage of the final product. In other words, the perceived predominance of the component leads to a positive effect for the end product because the consumer is aware that at least the component's characteristics are above market standard.

Hypothesis H3a: High perceived relative advantage of branded component (IB rel adv) leads to high perceived quality of the final product (car quality).

If the component has a relative advantage compared to other market offers, the risk of the final product is reduced. This means, in terms of the battery and the e-car, that if the battery is perceived as superior to other offered batteries, the risk of buying an e-car which does not match the expected performance is lower.

Hypothesis H3b: High perceived relative advantage of branded component (IB rel adv) leads to low perceived risk of the final product (car risk).

2.2.4 Car Quality and Car Risk

There is an association between the way consumers judge the quality of a product and the risk they perceive of making a wrong decision because of lower than expected performance. In consumer behaviour literature, this relationship is widely analysed (e.g. Sánchez-Fernández and Iniesta-Bonillo 2009). The results show that the likelihood of purchasing a product goes up if consumers take advantage of a higher quality compared to alternative offerings. Based on these insights, we might also assume that a higher perceived quality of the e-car leads to a lower perceived risk in buying a bad vehicle.

Hypothesis H4: High perceived quality of the e-car (car quality) leads to low perceived risk in buying (car risk).

2.2.5 Adoption

Adoption is simply seen as the aforementioned concept of Rogers (2003). It includes the consumer's decision to buy the innovation. A risk perception is one of the aspects which influences the adoption process. It captures uncertainty with the innovation such as complexity, the ability to test the innovation and whether the innovation can be observed and principally means uncertainty arising from specific innovation characteristics (Rogers 2003). Risk perception also includes adopters' perception of the enormity of the potential negative consequences should adoption failures occur. Several empirical studies document the role that perceived risk plays in value perceptions (Chen and Dubinsky 2003) and therefore in acceptance of the innovation. We used 'adoption' here to mean the preference in principle for a certain e-car. We might assume that acceptance is correlated with the perceived quality of the e-car as well as with the risk associated with the buying decision. In cases where perceived quality is high and perceived risk is low, the probability of buying the innovation is increased, and therefore, the innovation has an enhanced adoption by consumers.

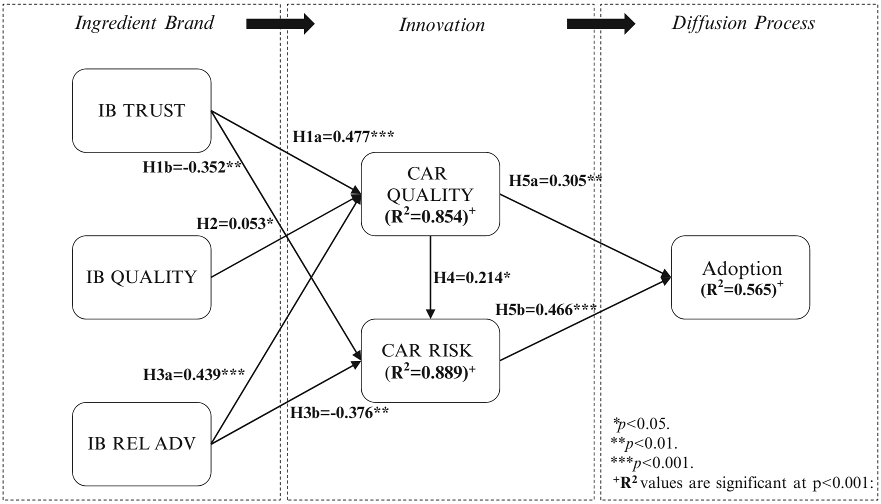

Fig. 2 Results for structural model

Hypothesis H5a: High perceived quality of the e-car (car quality) leads to a high adoption (adoption).

Hypothesis H5b: Low perceived risk in buying the e-car (car risk) leads to a high adoption (adoption).

3 Research Methodology

3.1 Sample and Research Design

The theoretical IB framework in Fig. 1 and the eight hypotheses were operationalised and transferred into the structural equation model (SEM) in Fig. 2. Each of the six constructs (see Fig. 2) is represented by a set of items (2–5; see Table 1), which were measured on a five-point Likert scale. Some of the measured items were reverse scored (see Table 1). We chose online questioning using a set of contact addresses which we received from car dealers. The survey was limited to Germany and took place in October 2011. In order to analyse the impact of strong component brands for batteries on the perception of the e-car, we modulated the impact of IB as antecedent and innovation assessment as consequence (IB → innovation). In the relationship between positive-presumed innovation and consumer adoption, we conceptualised innovation as antecedent and adoption as consequence (innovation → adoption). In the questionnaire, the interviewees were confronted with different battery brands and were asked to evaluate the characteristics of the component (IB trust, IB quality, IB

Table 1 Operational definition of constructs and results of measurement properties

Construct	Item	Operational definition	Factor loading	Cronbach's alpha	CR	AVE
IB quality	IBQ1*	Emphasised product reliability	0.827**	0.880	0.972	0.678
	IBQ2*	Component met our expectations	0.877**			
	IBQ3*	Emphasised high quality	0.722**			
	IBQ4*	Extent is satisfied	0.644**			
	IBQ5*	Supplier has good functionality	0.647**			
IB re adv	IBrA1*	Compared to similar items	0.946**	0.932	0.950	0.792
	IBrA2*	Relative to industry average	0.760**			
	IBrA3*	The best on the market	0.903**			
	IBrA4*	Better than the other	0.958**			
	IBrA5*	Has advantages the other did not have	0.870**			
IB TRUST	IBT1	Supplier brand stands for keeping promises	0.876**	0.890	0.819	0.697
	IBT2	This brand does not break faith	0.934**			
	IBT3	Brand stands for concerned about our quality	0.820**			
	IBT4	Brand shows that ... looks out for our interests	0.769**			
	IBT5	Brand has high integrity	0.763**			
Car quality	CQ1	Has high quality	0.902**	0.963	0.771	0.873
	CQ2*	No concerns with the quality	0.789**			
	CQ3	Satisfied with the final product	0.783**			
	CQ4	Quality is above standard	0.753**			
	CQ5	It is a quality vendor	0.882**			
Car risk	CRP1*	There is not much uncertainty	0.965**	0.933	0.949	0.792
	CRP2*	Level of overall risk	0.956**			
	CRP3*	I can handle the risk	0.939**			
	CRP4*	The normally acceptable risk	0.910**			
	CRP5*	It is nearly risk free	0.853**			
Adoption	ADO1	I am in favour of adopting	0.989**	0.977	0.889	0.917
	ADO2	I can imagine myself buying	0.989**			

*Reverse scored; ** $p < 0.001$

rel adv) (see items in Table 1). Similarly, the interviewees gave their estimation of a specific e-car with the branded component (car quality, car risk) and an impression of the likelihood that they would purchase such a car (adoption). This approach gives us a chance to identify the impact of IB on the perception of the e-car and its impact on adoption.

In total, 1,421 persons were contacted, and 177 (=12.5%) questionnaires were returned. We had to reject ten impractical questionnaires. Our sample therefore has an adjusted return rate of 11.7% ($N = 167$), which is average for comparable studies. The sample consisted of 121 males (=72.5%) and 64 females (=27.5%). None of them had yet purchased an e-car. Fourteen (=8.3%) said that they did not plan to buy a car with an electric engine in the near future. Thirty-two (=19.1%) of them already planned to change to an e-car within the next 5 years. The rest (121 = 72.2%) could imagine driving an e-car but planned to wait. The reasons for their waiting were, for example, the relatively high prices and the weak network of charging stations. These questions in the demographic part of the questionnaire were formulated as open questions. Fifty-three (=31.7%) interviewees had first-hand experience with e-cars, with most of them quoting their experience as a driver or passenger in an employer's car or at a business event, etc. The questions about the kind of experience were also open questions. One hundred and nineteen (=71.2%) saw themselves as well informed about e-mobility due to newspapers, internet and TV.

3.2 Research Approach and Software Used

Partial least squares (PLS), an SEM measurement, was used to test the proposed research model. SEM (Bollen 1989) includes a number of statistical methodologies for investigating a network of causal relationships, defined according to a theoretical model, linking two or more latent complex concepts, each measured through a number of observable indicators (Vinzi et al. 2010). There are a number of reasons for choosing PLS. This measurement can be used to investigate models that use second-order formative indicators (Chin 1998). Further, it allows the modelling of latent constructs under conditions of non-normality, and it is appropriate for small to medium sample sizes (such as $N = 167$) (Chin et al. 1996). It is certainly more appropriate when there is no elaborated theory and the research model is at an early stage of development or has not yet been tested extensively (Teo et al. 2003). We used the software SmartPLS 2.0, an SEM path modelling package, for the calculation (Ringle et al. 2005).

4 Results

The construct operationalisation for SEM differs for formative and reflective measurement models. There are a number of criteria which help researchers to decide which model is appropriate (Jarvis et al. 2003). None of the criteria for formative models were met by the six constructs, so we designed the whole model in a reflective way. The quality of a reflective measurement model is determined by convergent validity, construct reliability and discriminant validity (Bagozzi and Phillips 1982; Churchill 1979). On basis of the results of the measurement model, researchers can evaluate the explanatory power of the entire model as well as the predictive power of the independent variables. Therefore, the hypotheses can be tested, and statements about their adequacy can be made, so explanatory power and predictive power are used (Bagozzi and Phillips 1982).

Table 2 Intercorrelations among constructs ($N = 167$)

Construct		Mean	SD	Intercorrelations (a)	(b)	(c)	(d)	(e)	(f)
Car risk	(a)	2.34	1.13	–					
Car quality	(b)	2.99	0.98	0.8994*	–				
IB quality	(c)	3.43	1.19	0.6339*	0.6180*	–			
IB trust	(d)	3.09	0.88	0.9100*	0.8983*	0.6237*	–		
IB rel adv	(e)	2.65	1.24	0.9108*	0.8930*	0.6081*	0.8831*	–	
Adoption	(f)	3.87	1.08	0.7398*	0.7236*	0.4718*	0.7245*	0.7268*	–

*$p < 0.01$

4.1 Testing the Measurement Model

The results of the PLS component-based analysis, correlations matrix of constructs, alpha coefficients, PLS-computed variability for each construct and item-construct correlations are presented in Tables 1 and 2.

The convergent validity is a measure of the degree to which an operation is actually similar to other operations to which it theoretically should be similar. It is analysed by indicator reliability and construct reliability (Peter 1981). The indicator reliability is shown in Table 1. For all factors – except IBQ4 and IBQ5 – loadings were above the recommended 0.7 parameter value (significance tests were conducted using the bootstrap routine) and were significant at the 0.001 level. Construct reliability is an indication of the extent to which operationalisation of the constructs actually measures what the theory led us to expect. It is ordinarily tested by using two indices: composite reliability (CR) and average variance extracted (AVE). Table 1 shows that the estimated indices were above the threshold of 0.6 for CR (Bagozzi and Yi 1988) and 0.5 for AVE (Chin 1998) in the sample, and therefore, we had no restriction on our further analyses. Finally, discriminant validity, a statistical procedure to test whether concepts or measurements that are supposed to be unrelated are, in fact, unrelated (Campell and Fiske 1959), was applied. This index is analysed by looking at the item-construct correlation described in Appendix 1. The requirements for discriminant validity are fulfilled if the loading of each indicator is higher for the respective construct than for any other construct. If this is the case, indicators of different constructs are not related to each other. In our sample, discriminant validity was achieved.

Table 2 shows the intercorrelation among constructs. The degree of association between the exogenous constructs (IB trust, IB quality, IB rel adv) and the variance inflation factors indicate that there is no multicollinearity.

4.2 Testing the Structural Model

The data in Table 3 support the proposed structural model (see Fig. 2). Explanatory power is the ability of a model effectively to explain the subject matter to which it

Table 3 Results of hypotheses

Path/hypothesis	Path coefficient		
Hypothesised relationship	(p value)	T value	Results
IB trust → car quality	0.477	4.7786*	Supported
IB trust → car risk	−0.352	2.2518*	Supported
IB quality → car quality	0.053	1.5222**	Not supported
IB rel adv → car quality	0.439	2.0020*	Supported
IB rel adV → car risk	−0.376	7.9115*	Supported
Car quality → adoption	0.305	4.1651*	Supported
Car risk → adoption	0.466	2.9609*	Supported

*$p < 0.01$; **$p < 0.05$

pertains. To examine it, the squared multiple correlations (R^2) of the dependent variables have to be taken into account. All three values (car quality $R^2 = 0.854$, car risk $R^2 = 0.889$, adoption $R^2 = 0.565$) are encouragingly high. The estimated path effects, associated t values and p values, as well as the result of the bootstrapping approach to obtain statistical significance of path coefficients by using t tests, show that final product perception was significantly influenced by IB (see Table 3).

Predictive power refers to a model's ability to generate testable predictions, and it is tested by analysing the magnitude of the standardised parameter estimates between constructs, together with the corresponding level of significance; it is recommended that this should exceed the 0.2 level (Chin 1998). In the sample, only one path coefficient does not exceed this level (H2 = 0.053).

As Fig. 2 shows, the results of the bootstrapping procedure revealed strong significance (at the $p<0.05$, $p<0.01$ or even $p<0.001$ levels) of all dependent variables (except for H2 = 0.053; IB quality → car quality). As result, we can support six out of seven of our hypotheses. One has to be rejected from this study (see Table 3).

5 Conclusion and Discussion

Our key findings show that, on the basis of our data, perceived trust in the component brand has positive effects on the perceived quality of the e-car and lowers the assumed risk in buying such a car. Because trust is an important factor in purchase decisions, we prove that a strategic alliance with a supplier could add value to the OEM's offerings. Our results show that if e-car manufacturers decide to use a high-quality brand, in terms of brand trust and relative advantage of batteries in their final product, they can benefit from this IB alliance. These benefits affect product characteristics which are of central importance. Typically, car manufacturers compete strongly to present their products as being of high quality. Our findings show that it is possible for spillover effects to support this strategy.

Our research is limited in two main areas. First, our sample was restricted to Germany, a country with traditionally high ambitions in environmental protection and a strong automotive industry. For this reason, e-mobility is at the top of the political agenda, and potential consumers are highly educated. On the basis of our findings, we can make no prediction about buying behaviour in other countries because it has to be assumed that the basic characteristics of buyers may differ. As brand literature shows, brands and the emotions behind them are a complex field of study. Secondly, in this research, we only analysed three brand elements of IB, and we neglected the host brand. We have to take into account that it is not just trust, quality and relative advantage that characterise a brand. Further, the interaction of the component brand and the host brand is a field which, in IB literature, has not been fully investigated. The positive effect of IB quality (IB quality → car quality) on car quality is not supported in our study. This is surprising because it is contrary to previous research.

There are some implications of our study for both suppliers and manufacturers. We have shown that, especially in such a difficult new market as e-mobility, additional gains can be achieved if strategic alliances are built. Strategic alliances have positive effects for the e-car manufacturer as well as for the supplier. They can also foster the completion of new innovations in battery technologies because of the chance to create a superior component brand and so become a favoured partner of the OEMs. We assume that such partner strategies promote a shift in knowledge from the OEM to the supplier, in the eyes of the consumer, but we also see a chance for better competition between e-car manufacturers. For companies, a successful way of positioning themselves between these options will be a major issue of the future.

Today, we do not know much about the e-mobility market and the challenges it faces in the near future. There are a lot interesting questions left for research. First, from a marketing point of view, all possible brand effects have not yet been analysed and nor have the interaction between component and host brand. We only know about some particular influences of individual brand characteristics. This is too little to be able to develop the necessary approach for planning and structuring an IB partnership in practice. It is necessary to know more about the influence of value change, the innovation power of the component and public awareness and how these issues affect value creation for the end product.

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Dominance of Chinese Market: An Empirical Study

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In the 1950s, Japan held a prominent position as a low-cost manufacturer and gained abnormal profits through international sales. In a span of three decades, Japan became one of the world's pioneers of "quality" in products and services. However, in the last decade or two, China has gained a prominent position and has replaced Japan – in terms of low manufacturing cost – and has improvised its position from a low-cost provider to the pioneer.

With geographical area of 24 million square meters during Ming Dynasty from 1368 to 1644, China was the largest country in the world. During 1405–1433, the king of Ming Dynasty sponsored seven naval expeditions which led to enhanced international trade between China and Southeast Asia countries, making China the only super power in the world. Today, the USA with a geographical area of 9.6 million square meters is the world's fourth largest country after Russia, Canada, and China (9.7 million square meters), respectively.

End of Cold War, China started building relationships with Indonesia, Singapore, and Brunei. China gradually ended its support to the communist parties in the Southeast Asian countries and started establishing diplomatic relationships with ASEAN. It was evident after the 1991 ASEAN Foreign Minister's meeting that China was clearly on the way to make a formal ASEAN+1 relation. China started with as a ASEAN consultation partner in the year 1991 and moved to the dialogue

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partner position by the year 1996. The 1997 Asian financial crisis originating from Thailand spread to the other ASEAN countries. When the financial crisis and currency devaluation were threatening all ASEAN countries, China stayed still to hold its currency and provided financial help to Thailand and Indonesia and even controlled the ASEAN financial crisis by the end of 1997. The ASEAN-China free trade area (ACFTA) was proposed by China in 2001 and was subsequently signed in 2010. The ACFTA will bring trade and economic benefits to the ASEAN countries and China (Roland-Holst and Weiss 2004; Liu and Luo 2004; Tongzon 2005; Park 2007). This free trade zone consists of ten ASEAN countries.

This is not the first time that the world is facing a rising nation. This time, it is rising China and is different from the cases of the USA and Japan. When the USA and Japan rose to power, their populations were only 30 million and 100 million, respectively. However, this is the first time that the world is facing the rise of such a populous nation of more than 1.3 billion. ASEAN is the gateway for China to access natural resources and sea routes that bring necessary international trade and stable economic growth. Since 1978, China cautiously started the reforms and a cooperative approach with ASEAN nations. China has now replaced the USA and Japan to become the locomotive of the Asian countries.

The GDP of China was 228,600 million international dollar in the year 1820 and was number one in the world. The USA's GDP became number one in the world in the year 1895. Japan became the largest country in terms of GDP in Asia in the year 1968 (Maddison 2007). China started its reform in 1978, and its GDP is 5,878,257 million international dollar in the year 2010 replacing Japan to be the largest economy in Asia.

The export processing zones established in China in the 1980s initiated a complete transformation of China's coastal regions. The export processing trade, supported by a strong manufacturing base established in the 1950s and complemented by technology imported since the 1980s, progressively became a catalyst for China's economy. Following in the footsteps of other Asian catch-up countries, China's exports rapidly started moving up the value chain away from low-tech products to hi-tech products. Between 1992 and 2005, China's medium- to high-technology exports grew 22% annually, while high-technology exports grew by 32%. By 2008, 43% of China's exports were directly related to machinery, mechanical appliances, and electrical equipment, and China now dominates the global markets for these and other types of machinery.

In 1988, China's first high-technology zone was established in the Zhongguancun (ZGC) suburb in northwestern Beijing with government support. Such high-technology zones like ZGC were governed based on a model called "smaller government, more services." This strategy envisaged the creation of an organic link between scientific research and industrial production, giving firms and institutions an incentive to innovate. As a complement to this, growing numbers of state-owned enterprises (SOEs) converted to non-state ownership and commercial for-profit forms, and many government research institutions also branched out into business.

Significant progress had already been achieved with the strategic plan 2006–2020 (MLP, GERD) increased to 1.54% in 2008 from 0.57% in 1995. Occurring at a time

Table 1 China's science and technology (S&T) facts

	2004	2005	2006
Personnel engaged in S&T activities	3.48 million	4.13 million	4.96 million
Funding for S&T activities	\$63.4 billion	\$90.7 billion	\$104.5 billion
Expenditure on R&D, by output	\$28.7	\$43.9 billion	\$67.5 billion
Gross expenditure on R&D in relation to GDP	1.23 %	1.42 %	1.54 %
Total value of exports of hi-tech products	\$24.2 billion	\$41.2 billion	\$60.8 billion
Total value of imports of hi-tech products	\$23.6 billion	\$36.2 billion	\$50.0 billion
Total enrolment of engineering and science postgraduates	420,444	547,002	619,355

Source: China Statistical Yearbooks (2005, 2007, 2009)

when its GDP was growing exceptionally fast, China's GERD now ranks behind only next to the USA and Japan. The number of triadic patents (granted in all three of the major patent offices in the USA, Japan, and Europe) granted to China remains relatively small, reaching 433 in 2005 (compared to 652 for Sweden and 3,158 for Korea), yet Chinese patent applications are increasing rapidly. Chinese patent applications to the World Intellectual Property Office (WIPO), for example, increased by 44% in 2005 and by a further 57% in 2006. From a total of about 20,000 in 1998, China's output of scientific papers has increased fourfold to about 112,000 as of 2008, moving China to second place in the global rankings, behind only the USA. In the period 2004–2008, China produced about 400,000 papers, with the major focus areas being material science, chemistry, physics, mathematics, and engineering, but new fields like biological and medical science were also gaining prominence. Further, China took 12.3% of the world's total R&D spending in 2010, second only to the USA. China had 200,300 patent applications in 2008, which rank third next to Japan and the USA. Table 1 gives the facts with regard to science and technology in China.

One of China's biggest criticisms is on the role of FDI's in China's technology and growth. It should, however, be noted that China's growth began with a successful domestic market before China became the global manufacturing hub. Chinese firms began to taste success in many industries (there were of course industries which relied on foreign firms) within their own markets. Only after considerable success did they venture outside. This success coupled with the various policies initiated by the Chinese government lured FDIs to China. Though FDI's play a key role, it should also be noted that China will not fall over in case of a FDI's pull over.

The enhanced trade has also resulted in the deregulation, an integration of other emerging financial markets with China. Till recently, it was strongly believed that integration among the emerging economies was dominated by the USA with the emerging economies closely following the trend. The USA has dominated the economic and financial markets of the world for a long time, but the recent financial crisis has challenged the leadership position of the United States in the financial sector.

The focus of this chapter is to study the increasing dominating role of China in Southeast Asia especially driven by the enhanced trade, technology transfer, and strong and focused economic outlook. Though there are quite a few factors attempting to study the dominating role of China like technological and trade dominance, this chapter addresses only the dominance of the Chinese stock market over other ASEAN markets. The research also attempts to study the cointegration of China's stock market with prominent ASEAN countries like Singapore, Malaysia, Thailand, Indonesia, and the Philippines. The reason is that Chinese market seems to affect ASEAN markets due to its economic size and growth and its relationships with ASEAN countries by the ASEAN+1 policy. The US stock market is included in this chapter since a host of studies by Swanson (1987), Chowdhury (1994), Copeland and Copeland (1998), Janakiramanan and Lamba (1998), Jeong (1999), Ghosh et al. (1999), Darrat and Zhong (2002), Rim and Setaputra (2010), and Yoshida (2010) have all proved the dominance of the USA on the ASEAN emerging markets and also have provided evidence of integration of these markets with the USA.

It can be observed that the USA-ASEAN bilateral trade was \$130 billion in 2003, and during the same period, it was \$78 billion for China and ASEAN. But the scenario had changed by 2008 when China overtook the USA in terms of bilateral trade with ASEAN. In 2008, China and ASEAN saw a bilateral trade of \$231 billion, whereas the US-ASEAN bilateral trade was \$177 billion. This further leads to the fact that the dominance role of the USA on East Asian economies was decreasing and these economies were rather being influenced by other markets in the region. Economic trends have also provided evidence that China is the dominant factor in the region and is threatening the USA in terms of global dominance. China's GDP growth rate was about 10% in 2010 with increased consumption. This also increased China's imports and has positive impact on the Asian economies.

This chapter is organized as follows. In the next section, we present a brief review of the literature related to the relationships of US stock market, China stock, and ASEAN stock market before and after the 1997 Asian financial crisis. This serves as a rationale for this chapter. Next, the data and the statistical models in this chapter are presented followed by empirical result, and conclusion is the last section.

1 Literature Review

Prior to 1997 Asian financial crisis, daily returns of Asian stock markets were less correlated with the return of US stock market, and the weekly and monthly returns were highly correlated with the return of US stock market (Bailey and Stulz 1990). Monthly ASEAN stock index returns of Indonesia, Malaysia, the Philippines, Singapore, and Thailand were correlated with each other except Indonesia (Palac-McMiken 1997). Studies have observed that there was no cointegration between the Asian stock markets (Hong Kong, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand) and the US stock market (DeFusco et al. 1996).

During the 1997 Asian financial crisis, Asian stock markets did not have any evidence of cointegration but had significant short-run linkages (Roca et al. 1998). Malaysia stock market was significantly affected by the US stock market; Indonesia, the Philippines, Singapore, and Thailand were not affected by the US stock market (Ghosh et al. 1999). The long-run cointegration relationships and short-run causal linkages between ASEAN stock markets and the US stock market became stronger during the crisis (Yang et al. 2003).

After the 1997 Asian financial crisis, the ASEAN stock markets and the US stock market became more integrated (Yang et al. 2003; Chai 2003; Daly 2003; Park 2005; Fooladi and Rumsey 2006; Majid et al. 2008). From international parity condition point of view, though China and ASEAN have strong linkages with respect to good and service markets, the financial integration is still not significantly integrated (Laurenceson 2003). However, Rim and Setaputra (2010) find that for the whole period of 1992–2006, the US stock market influence remained strong on ASEAN markets, the integration between the US and ASEAN stock markets and among ASEAN stock markets had not increased, and there was no interaction between ASEAN markets. From November 1993 to July 2008, the stock markets of China and its three emerging market neighbors are not interrelated (Jayasuriya 2011).

With the development of the ASEAN plus China policy and the growth of Chinese economy, will the shifting population and economic centers, the international trade, and the spread of advanced production techniques change the financial markets casual relationships?

2 Data and Methodology

The primary focus of the study is to assess the level of stock market integration among the ASEAN countries and also the changing role of dominance from the USA to China. The focus on ASEAN countries was essentially driven by the free trade agreement between ASEAN and China in 2009. Though Vietnam, Brunei, and Lao being part of ASEAN singed the free trade agreement with China, these countries have been omitted from this study as they either do not have a stock market or the market is still in a very nascent stage. Therefore, the study is restricted to Singapore, Malaysia, Thailand, Indonesia, and the Philippines in the ASEAN region with China and the USA as the dominant partners.

In the last two decades, these regions have witnessed two essential impacts: firstly by the East Asian financial crisis in 1997 and secondly the 2008 subprime crisis. In order to avoid the effect of the East Asian financial crisis, the data used for the study is from January 1, 1998 to January 31, 2010. Stock market index data (Thailand SET – Thailand, Philippine SEI – the Philippines, Jakarta SE Composite – Indonesia, Shanghai SE A Share – China, Straits Times Index – Singapore, FTSE

Bursa Malaysia KLCI – Malaysia) for all the countries listed have been obtained for the entire 12-year period. The index data is restricted to major stock indexes of the country. Data was obtained from Yahoo! Finance. The data set is divided into two parts: one part prior to the subprime crisis and another representing the postcrisis or recovery period. Based on the market movements, the year 2007 has been identified as the year for structural break. Hence, the period from January 1, 1998 to December 31, 2006 is chosen as the period indicating the "period prior to China having a dominant role," and the period from January 1, 2007 to January 31, 2010 is chosen as the "period of China's dominance role." The index data for all the countries were obtained for the entire period.

Many financial and economic time series are not stationary, and it is rather difficult to model nonstationary processes as their coefficients are not stable over time. To achieve stationarity generally, the data will be differentiated one or more times for econometric modeling purposes. But differencing the series may result in loss of information pertaining to long-run trends. Cointegration is a statistical property exhibited by some of the time series data. If a pair of stock prices X_t and Y_t are cointegrated, it means that the two variables share common stochastic trends and move together in the long run. In other words, it implies that if X and Y are cointegrated, then for the system to return to long-run equilibrium, either X or Y should respond to the size of the disequilibrium. Two common tests employed for testing cointegration are the Engle and Granger (1987) test and Johansen (1988) multivariate cointegration test. Johansen's test is a more powerful test particularly in a multivariate context. It is robust to various deviations from normality and yields consistent results irrespective of the variable used as the dependent variable.

In this study, the price co-movements among the stock markets are tested in using the Johansen's (1988) test. This test uses maximum likelihood procedures to determine the number of cointegrating vectors among the variables. The Johansen's test is based on a vector-error-correction model

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-p} + \varepsilon_t.$$

X_t is a $(n \times 1)$ vector of prices, and is a $(n \times n)$ matrix of short-run dynamics, coefficients π is the long-run impact matrix, and ε is a $(n \times 1)$ vector of innovations. Johansen's methodology can be thought of as a multivariate generalization of the unit root tests. The test centers around the matrix π, partitioning it into two matrices α and β both of which are $n \times r$ such that $\pi = \alpha\beta$, where α represents the speed of adjustment to disequilibrium and β is a matrix of long-run coefficients. The rows of β may be defined as the r distinct cointegrating vectors, and looking at the rank of the Π matrix through its eigenvalues, cointegration could be confirmed. Two test statistics are used to test for the existence of r cointegrating vectors – trace statistic (λ_{trace}) and the max-eigenvalue statistic ($\lambda_{\max}$)

with differing assumptions about the alternative hypothesis. The test statistics are formulated in the following way:

$$\lambda_{\text{trace}} = -2\text{Log}(Q) = -T\sum_{i=r+1}^{n} \log(1-\lambda_i), \quad r = 0, 1, 2, \ldots (n-2), (n-1).$$

The trace statistic tests the restriction $r \leq q$ $(q < n)$ against the unrestricted alternative $r \leq n$; $Q =$ (restricted maximized likelihood ÷ unrestricted maximized likelihood).

$\lambda_{\max}$ statistic is given as under tests that there are r cointegrating vectors against the alternative that $r + 1$ exists:

$$\lambda_{\max} = -T\ \text{Log}(1-\lambda_{r+1}), \quad r = 0, 1, 2, \ldots (n-2), (n-1).$$

Johansen and Juselius (1990) provide critical values for the two test statistics. If the test statistic is greater than the critical value from Johansen's tables, the null hypothesis that there are r cointegrating vectors is rejected against the alternative hypothesis that there are more than r (for λ_{trace}) or that there are $r + 1$ (for $\lambda_{\max}$).

3 Empirical Results

The daily stock indices of Thailand (SET), Indonesia (Jakarta SE Composite), the Philippines (Philippine SEI), China (Shanghai A Share), Malaysia (FTSE Bursa Malaysia KLCI), the USA (S&P 500), and Singapore (Straits Times Index) are plotted in Fig. 1. From the figure, it may be noticed that all the markets crashed during the middle of 2008 along with western markets lead by the USA. But the Asian markets recovered and returned to the precrisis period before the end of the year yet the US market was still in the comatose mode. It appears that Indonesian market rallied substantially during 2004–2008, but this has to be seen against the background that Indonesian market was in doldrums around 1998 (post Asian crisis).

From the summary statistics, it was found that the distributions for all indices were able to reject the null hypothesis of normality according to the Jarque-Bera normality test. Next, we investigated the order of integration as nonstationarity has to be established before testing for cointegration. All the indices were transformed into natural logs, and tests for the unit roots are performed using the augmented Dickey-Fuller tests and Phillips and Perron tests. The selection of the optimal lags is determined based on Hannan-Quinn criteria.

Statistics indicated that the indices are nonstationary at their levels; therefore, the presence of unit root in all the series cannot be rejected. However, the ADF and PP tests for the first differences of the series reject the null hypothesis of unit root

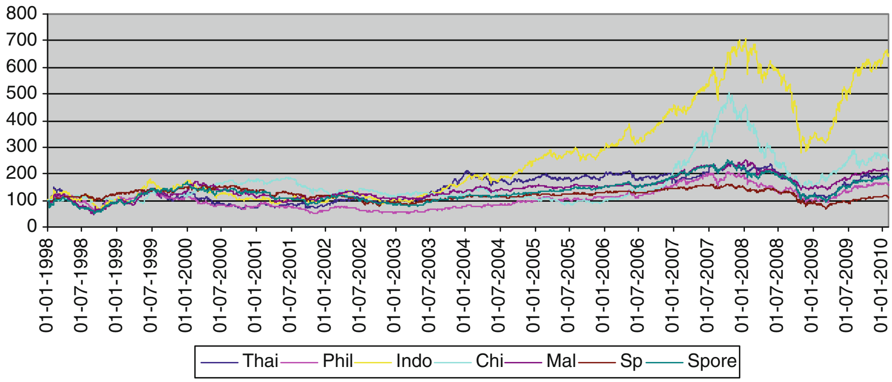

Fig. 1 Daily stock indices

Table 2 Tests for cointegration

Rank	Trace test	p value	λ_{max} test	p value
Full sample				
0	169.94	0.0002	67.108	0.0001
1	102.84	0.0937	47.804	0.0119
2	55.032	0.7599	25.857	0.5376
3	29.174	0.9421	10.455	0.993
4	18.719	0.7819	9.9652	0.8995
5	8.7542	0.6116	4.9932	0.8957
6	3.761	0.0525	3.761	0.0525
First subsample				
0	181.22	0	63.413	0.0004
1	117.8	0.0075	45.602	0.0239
2	72.203	0.1523	33.033	0.1392
3	39.169	0.5656	24.427	0.2535
4	14.742	0.9429	6.8019	0.9895
5	7.9403	0.6932	5.9708	0.8165
6	1.9695	0.1605	1.9695	0.1605
Second subsample				
0	216.83	0	84.029	0
1	132.8	0.0003	57.018	0.0004
2	75.782	0.0882	34.344	0.1002
3	41.438	0.4524	18.699	0.6601
4	22.739	0.5319	12.9	0.6958
5	9.8392	0.5036	7.2274	0.6916
6	2.6118	0.1061	2.6118	0.1061

for all the indices. Hence, it can be concluded that all the series are integrated of order 1, that is, I(1).

Johansen's cointegration test results are summarized in Table 2. The empirical findings indicate the presence of one cointegrating vector in the full sample and also

Table 3 Normalized cointegrating vector

	Pre		Post	
	China	The USA	China	The USA
Thai	2.6288	1.7083	2.1552	−1.1244
Phi	−3.2239	−6.7988	4.1127	0.16986
Indo	1.6828	−16.326	−2.9818	−2.3609
Chi	1	13.297	1	−2.7945
Mal	−1.6063	7.8294	−6.4429	3.5958
US	5.6916	1	−0.25915	1
Spore	−1.7128	25.217	1.1249	3.0185

in the two subsamples. Presence of cointegration among the markets indicates that the prospective price fluctuations in one market can be determined to some extent based on the price information available on other markets.

The normalized cointegrating vector for the two subsamples is presented in Table 3. The relative size of the coefficients indicates the respective influence of the individual stock markets in the system. In the first subsample, it may be noticed that long-run relationships of the South Asian markets with the USA are much stronger than those with China. While in the second subsample, the coefficients of long-run relationship of the South Asian markets are bigger in size with the Chinese markets than those with the USA. Further across the two subperiods, the size of the coefficients shows a gradual increase with Chinese markets and a decline in size with the US market. These trends suggest the growing influence of Chinese markets in the South Asian region and the gradual decline of the influence of the US market.

In order to get a quantitative measure of the changing short-run interdependencies between the stock markets of Asia and the USA, variance decomposition analysis is attempted. The variance decompositions reflect the proportion of the fluctuations in the dependent variables that can be attributed to their own innovations versus innovations to other variables. It also helps in understanding the magnitude of a movement in one variable that can be explained by other variables movements in terms of the percentage of the forecast error variance of that variable.

From the variance decomposition results for 1-day,5-day,15-day, and 20-day horizons, it was observed from the first subperiod the predominant role played by Thailand market followed by the US market in explaining the fluctuations in the regional markets, excepting the Chinese market which seems to be absolutely exogenous market. Further, the regional markets are almost uninfluenced by fluctuations in the Chinese market. In the second subperiod, the influence of Thailand and the USA is still substantial, but an important emerging trend is the growing influence of Chinese markets on other regional markets compared with the first subperiod.

4 Conclusions

This study aims to assess the level of dominance of China over other emerging Asian markets. The power of dominance was purely driven by the technological superiority and advancement it has achieved over the last few decades. The expected role of dominance was tested purely driven by the fact that China has become one of the largest manufacturing bases for the entire world. Further, the free trade agreement between ASEAN and China in 2009 triggers the growing economic ties between the ASEAN countries and China. The study examines the aspect of dominance from the perspective of cointegration among the stock markets of Thailand, Malaysia, Singapore, Indonesia, and the Philippines with China. The study employs Johansen's (1988) multivariate cointegration test conducted by dividing the data in to two subperiods 1998–2006 and 2007–2010. The empirical results indicate that the data are nonstationary in levels but are stationary in first differences. Hence, the cointegration method could be deployment in testing for market integration. The results indicate that the predominant role played by Thailand market followed by the US market in explaining the fluctuations in the regional markets, in the first subperiod and the Chinese market, seems to be absolutely exogenous market. However, in the second subperiod, the influence of Thailand and the USA is still substantial, but an important emerging trend is the growing influence of Chinese markets on other regional markets compared with the first subperiod. These trends indicate the growing influence of Chinese markets in the South Asian region and the gradual decline of the influence of the US market.

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Is Cloud Computing a Tipping Point for IT Innovation Leading to Next Wave of Business Growth in Developing Economies

Ramkumar Dargha

1 How GDP of Emerging Economies Expected to Shape Up in Future

Over the next 5–10 years, emerging markets (markets excluding developed markets) are likely to account for much of the economic growth. In order to compete in such an environment, businesses and companies in these emerging markets need to be prepared so that they are ready to make use of this enormous opportunity available in front of them. Technology preparedness plays a very important role in this endeavor.

Emerging markets are expected to have a major share in the global GDP by 2015 (The European Business Review). By 2015, the global GDP is expected to be 60,000 billion dollars (or 60 trillion dollars). The GDP growth during this period is expected to be around nine trillion dollars. Out of this growth of nine trillion, more than 60% of the growth is expected to come from emerging markets.

The summary of this growth pattern is depicted in the diagram below (Fig. 1) (The European Business Review).

Key points to note from the above diagram are:

1. Key importance and contribution expected from the emerging markets. These markets expected to contribute more than 60% of this growth.
2. These emerging markets themselves are expected to grow by CAGR of nearly 6% on an average, while a selected few emerging markets like India and China are expected to grow more than 7% CAGR in coming 5–10 years.

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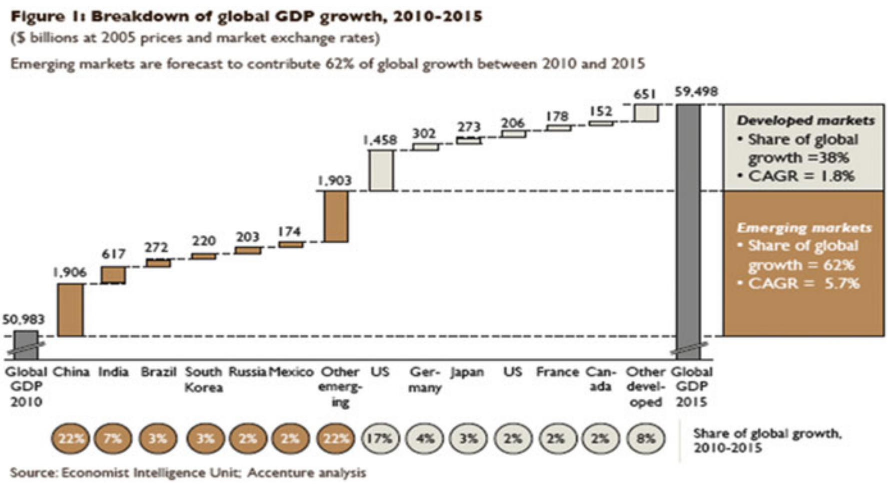

Fig. 1 Expected GDP growth pattern from 2010 to 2015 (Source: The European Business Review, Sep/Oct 2011 edition. All rights reserved (The European Business Review))

3. For these markets to grow at this rate, they need to focus on all the key enablers of growth.
4. Information technology investment is one of such key enablers. It is a well-established fact that, these days, without IT investment, no economy can expect to grow to its potential.

Let us have a closer look at the importance of IT as a key enabler for economic growth (to substantiate point number 4 above).

2 IT as a Key Enabler for Economic Growth

The diagram below depicts summary of importance of information technology and communication in the overall growth of society and hence leading to GDP (Fig. 2):

As depicted in the diagram above, IT and communication technologies play an important role in overall GDP growth and per capita income growth by enabling the following:

- Easier access to information
- Easier access to markets for producers of products and services including both domestic and international markets
- Enabling operational efficiencies of the enterprises as well as governments
- Providing better access to knowledge and hence better learning opportunities
- Better innovation possibilities through knowledge, automation, and productivity improvements

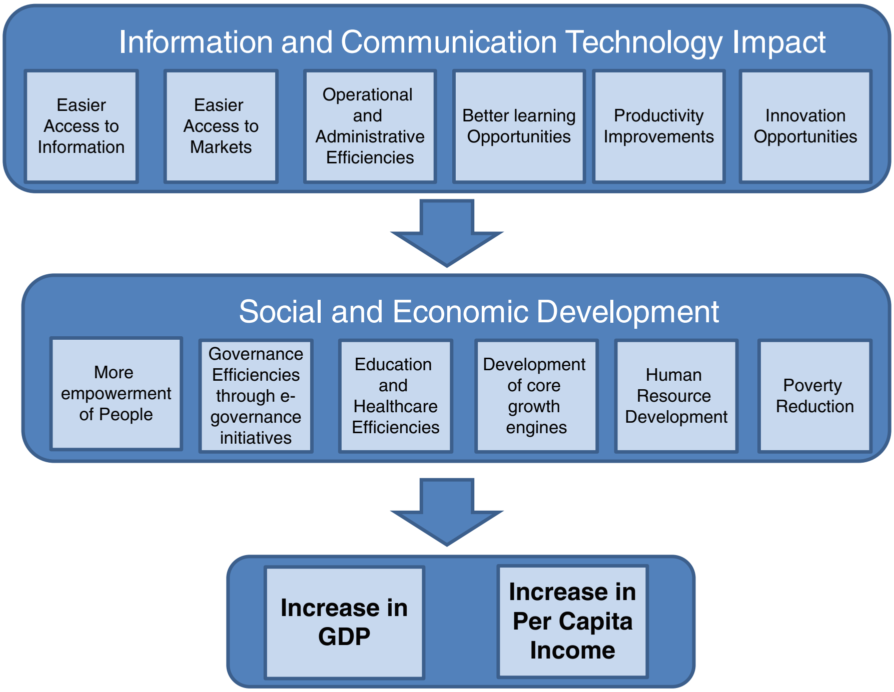

Fig. 2 Impact of information and communication technology on increase in GDP

In addition to IT, other key enablers also need to come together for the overall social and economic development like government fiscal and monetary policies, social policies, economic policies, and foreign relationship policies. However, IT is a core component for all these to come together and to make the economic growth in a country feasible.

Dos Santos et al. (Information technology: when it is worth the investment 2007) note that the IT investments have a significant impact on the outcome of a firm's internal activities and processes. Brynjolfsson and Hitt (Information technology: when it is worth the investment 2007) observed that the investments on computer capital and IT staff spending contributed significantly to firm level output. They also affirmed that the return on investment for computer capital was higher than the one for noncomputer capital.

Another study by Qiang (2009) (Alcatel Lucent strategic white paper information and communication technologies enablers of a low carbon economy) states that the overall growth affects of information technology and communications on low- and middle-income economies (like emerging economies) is significantly higher as compared to high-income economies (like developed economies). For instance, for every 10% point increase in Internet penetration, there will be a 1.12% growth in GDP in emerging economies as compared to 0.77% increase in GDP in developed economies.

It is thus clear that IT plays a very significant role in overall economic growth in a country including emerging economies.

3 Expected Spend on IT in Emerging Economies and IT Spend as Percentage of Revenue

Businesses in emerging economies would increasingly look to IT to help support the challenges of growth. They would need IT to support their needs to increase customer satisfaction levels, innovations in supply chain management, business processes optimizations, and in overall innovation in their businesses. These in turn will place enormous demands on the IT environment including infrastructure, software, networks, storage, middleware, etc. IT will thus be a primary driver of business growth in emerging economies in coming years.

How much percentage of revenue that each of these economies spends on IT today? This metric is one of the key metrics used to compare relative spend across markets and industries. As per Gartner IT Key metrics data (2006) (Gartner Key Metrics 2009), in the USA (an example of a developed economy), the BFSI sector spends the largest of about 12% of revenue on IT expenditure followed next by media, insurance, and telecommunications sectors. Overall average IT spend as percentage of revenue is about 4.1% of revenue.

However, if we look at the same metric in emerging or developing markets like India, the average IT spend as percentage of revenue is around 1.8% which is less than half of that in developed markets.

As we can see, there is a clear discrepancy in the amount of IT investments (measured as percentage of revenue generation) between developing and developed economies. Developing economies have quite a lot to catch up in this aspect. Add to this is the fact that the GDP these economies are going to grow by more than three times that of the developed economies. So clearly there is a need for the IT investments in emerging economies to grow by *more than six times* as compared to that of developed economies.

One estimate by Global IT research firm International Data Corporation (IDC) and Microsoft Corp (Contributions of IT Sector to Global Economic Recovery 2012) on IT Industry in India, states that IT spending in India is expected to grow to USD 37.6 billion at a compounded rate of growth of 11.8 percent. IT in India is expected to drive creation of more than 300,000 new jobs between end of 2009 and end of 2013. As per Gartner (Gartner Press Release 2012) the global IT spending will reach around 3.8 trillion US dollars in 2012.

4 Now the Question Is: Do Emerging Economies Have This Wherewithal to Spend on IT and Still Be Competitive in World Economy or Do They Have Better Options

As is evident from the above discussion, to keep with the pace of economic growth and IT needs of the businesses as well as to compete with global economy, the IT investment needs of emerging economies are quite huge. Doing a simple calculation based on increase of GDP in emerging economies by 2015 indicates that these emerging economies would need a total investment of around *1,500 billion USD* by 2015 (around 3% of 5,000 billion USD, which is the GDP growth from all emerging economies in absolute numbers).

Now the question is, do these emerging economies have the wherewithal to spend so much on IT and still be competitive in world economy, or do they have better IT options?

There would be many different parameters for IT decision making in an enterprise. These could be:

- Cost of IT
- Time to implementation
- Flexibility and scalability
- Existing IT landscape within an enterprise
- Brand of IT vendor, etc.

As per a recent survey by Zinnov Consulting (Cloud computing in India CIOs perspective), *IT costs seem to be a dominant factor for IT* decision making in Indian scenario (assumed as a representative of emerging economy in this chapter).

Now, let us look at cloud computing technology as a viable alternative for IT in emerging economies.

5 Cloud Computing as an IT Option

Cloud computing (Cloud computing key considerations for adoption. Infosys) refers to the technology that enables functionality of an IT infrastructure, IT platform, or an IT product to be exposed as a set of services in a seamlessly scalable model so that the consumers of these services can use what they really want and pay for only those services that they use (pay-per-use). A more formal definition of clouding computing as per Gartner is: "a style of computing where massively scalable IT-enabled capabilities are delivered as a service to external customers using internet technologies."

Cloud computing "technology" refers to the technology (including IT infrastructure, IT platforms, and IT applications) that enables the IT functionality to be exposed as services in a multitenant manner. The enabling technologies include (but not limited to) virtualization, grid technologies, SaaS-enabled application platform (SEAP), service-oriented architecture (SOA), metering tools and technologies, etc. Cloud "services" refer to those types of services that are exposed by a cloud vendor and that can be used by a cloud consumer on a "pay-per-use" basis. These services are exposed as industry standard interfaces like web services (using service-oriented architecture, SOA) or REST services or any proprietary (though rarely) services. The types of these services can be broadly classified as follows:

- Software as a service (SaaS): The applications like customer relationship management (CRM), e-mail, instant messaging (IM), and office productivity applications are offered as a "service" by a cloud vendor. For example, salesforce.com, SFA services, Google office productivity applications, or Microsoft Exchange Online, etc. Here, the consumers of the service (an enterprise or individual user) will use only those functionalities that they really want and pay for what they use. The vendor will host and manage the required infrastructure and applications to support these services. The consumers need not worry about deploying or managing the infrastructure required to host these applications.
- Platform as a service (PaaS): This can broadly be defined as application development environments offered as a "service" by the vendors. The development community can use these platforms to code their applications and then deploy the applications on the infrastructure provided by the cloud vendor. Here again, the responsibility of hosting and managing the required infrastructure will be with the cloud vendor. Some of the examples are Google App Engine, salesforce.com, Force.com, etc.
- Infrastructure as a service (IaaS): Here, the entire computing infrastructure is provided as a "service" by the cloud vendor. The actual computing infrastructure that is provided could be a storage environment, database environment, or a complete Linux environment. Here again, the responsibility of hosting and managing the infrastructure will be with the vendor. Examples include Amazon EC2, Amazon SimpleDB, and Amazon S3.

6 Is Cloud Computing a Savior for Developing Economies and Can This Technology Provide an Edge to These Economies

In order to meet the challenges faced by the emerging economies, these emerging economies will look for ways to get the best return on their IT investment and at the same time would want to satisfy all their core needs of IT technologies. Cloud computing is expected to enable emerging markets in developing innovative products and services. With cloud computing, emerging economies are expected to have better access to infrastructure, applications, and tools at a much lesser costs and more importantly on a pay-per-use model, which is particularly suitable for high cost-conscious businesses in emerging economies. Leveraging cloud services is expected to top business and software strategies in emerging markets. Cloud technology along with well-established business strategies is expected to speed up the creation of innovative products or services.

Some of the examples of recent projects initiated by the government of India (again used a representative of an emerging economy for our purposes) which could be good candidates for cloud computing technology are:

- The Unique Identification project (AADHAAR project): This project requires enormous amount of storage data and huge processing capacity. Owning and maintaining such large infrastructure in on-premise (traditional data centers) could be cost prohibitive.
- Indian Railways Online Passenger Reservation System: This project is a case of fluctuating demand as well as high capacity demand due to large number of users using this system daily. This calls for an IT solution which is flexible, agile, and yet cost-effective, which cloud technology can potentially provide.
- India's right to information act requires digitizing databases and storing huge amounts of data in a cost-effective manner.

The governments would need lot of computing power, storage capacity, flexibility, and agility (flexible IT to satisfy fluctuating demand, ability to scale up based on need) but yet in a very cost-effective manner. Cloud computing could thus be one of the viable options.

We also need to find key IT goals of emerging economies, and see if how some of these goals can be addressed by this cloud computing technology. Some of the key current IT goals as per a survey conducted by Zinnov Consulting (Cloud computing in India CIOs perspective) are:

1. Agility and flexibility of IT
2. OPEX models
3. Reach and customer engagement
4. Efficiency enhancement
5. Best of bread

Cloud computing technology has potential to satisfy each of these goals.

7 Expected Cost Benefits of Cloud Computing

There are many benefits of cloud computing. Summary of these benefits are:

- Cost savings
- Faster time to deployment of IT
- Reduce IT management burden
- Flexible payment models through pay-per-use Opex model
- Less procurement time
- Lower the barrier of entry

While there are many benefits of cloud computing as described in previous section, let us take cost factor as an example (since cost seems to be one of the major factor for cloud adoption), and see how this technology is expected to be more beneficial cost wise.

IT costs in a typical enterprise can be divided into three main categories:

1. Infrastructure costs which typically account for nearly 50% of the total IT costs

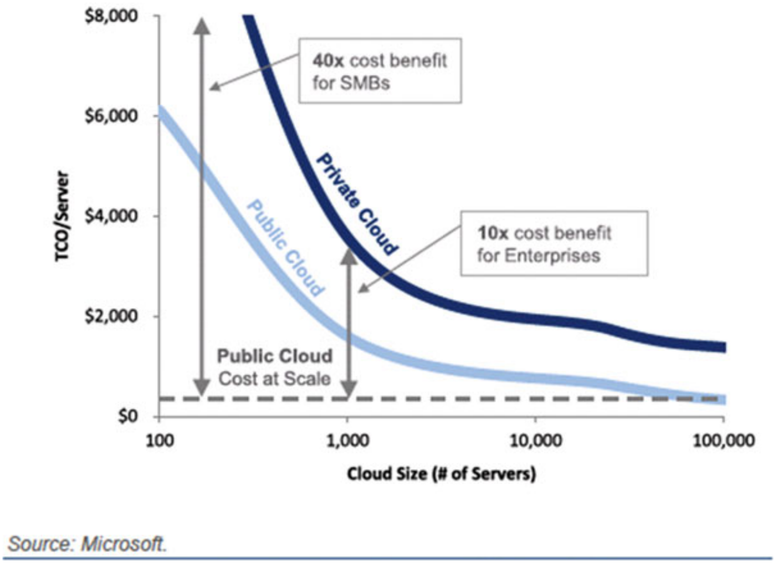

Fig. 3 Expected cost benefits from public cloud and private clouds based on number of servers (Source: Microsoft Corporation (The economies of cloud from Microsoft))

2. Existing application maintenance costs which account for nearly 35% of the total IT costs
3. New application development costs which typically account for nearly 15% of the total IT costs

Since cloud computing environment leverages the concept of "economies of scale" to cut down costs for all users, we can expect significant savings in the above costs, particularly the first item above. As depicted in the diagram below, one study from Microsoft (The economies of cloud from Microsoft) indicates that SMBs (small and medium businesses) can experience nearly 40 times cost benefit (cost per server) whereas large enterprise can experience nearly 10 times cost benefit (Fig. 3).

8 Are Emerging Economies in a Better Position for Leveraging Cloud Computing Technologies Compared to Developed Economies

Now, let us ask this question, "Are emerging economies in a better position for leveraging cloud computing technologies compared to developed economies?"

One way to answer this question is to look at some of the key inhibiting factors for cloud adoption for large enterprises, and see if these inhibiting factors in fact are kind of advantageous as far as small and medium business in emerging economies is concerned.

Some of the key inhibiting factors for large enterprises in developed economies are:

- Existing legacy systems: This means the large enterprises will be reluctant to get away with the existing infrastructure and systems due to the presence of "history" in these systems. For companies in emerging economies, this issue does not arise since these economies currently have low levels of existing IT systems and are implementing IT from ground up. Hence, they can leap frog into newer technologies like cloud computing without much issue due to legacy systems.
- Internal institutional resistant to change: This is again very much prevalent in existing large enterprises in developed economies. Whereas in companies in emerging economies, since the current institutional capacity is limited, this issue almost is nonexistent.
- Existing rigid and complex procurement systems: Large existing enterprises in developed economies would already have existing procurements systems which could be inflexible for changes and hence may not be amenable for flexible procurement models provided by cloud technology. This is not an issue with companies in emerging economies.

Due to the above reasons, in fact the emerging economies are in a better position to leap frog into cloud computing models to drive efficiencies due to cost. In addition, by adopting the cloud technologies, these companies in emerging economies can almost nullify the IT-based competitive advantage of the large enterprises which they were enjoying so far.

9 Conclusions

In this chapter, we have looked at how world GDP growth is expected to shape up in near future and how GDP growth is related to IT investments. We then looked at some of the IT challenges emerging economies may face when their economies would grow. We also analyzed the current IT spend as percentage of revenue and compared the same between companies in emerging economies and large enterprises in developed economies. Given the gaps in current IT spend and also given the fact that the emerging economies are expected to grow at a much faster rate, there will be enormous pressures on IT investments in these emerging economies. In this backdrop, we analyzed how cloud computing technology could be a savior for these emerging economies for their future needs.

Based on this analysis, we can conclude that cloud computing technology has very good potential in these emerging economies and sometimes much more as compared to the developed economies. This would be like a win-win situation for both the emerging economies and for cloud vendors.

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Advanced External Counter Pulsation: A Solution for Healthy Heart

Mohammed Ismail and S. Sookthi

1 Introduction

Technology for survival and growth: Someone from a middle class family started with an idea to set up an organization of high calibre, which will address the burning issues of the nation. Projects identified were the following:

1. Separation of antibiotic from milk
2. Help common man to live long with a healthy heart
3. Produce low-voltage, room temperature plasma for miraculous healing

This required capital investment. When he was in the final year of engineering, his father passed away. He did not have anyone to invest on his ideas. In fact, people started laughing on his ideas and discouraging him. He was working with one of the MNC in the field of sales and marketing. He never lost hope. For setting up a research-based organization, he decided to set up a system for wealth creation. He knew this was possible only upon successful management of:

1. Technology
2. Innovation
3. Change

As we all know, technology is the most influential factor in the wealth creation system. In simple words, it is considered as a seed of the wealth creation system.

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Driving the Economy through Innovation and Entrepreneurship,
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With proper nourishment and exposure to good and healthy environment, a seed grows to become a healthy tree. A challenge was selection of right technology to generate capital. Here, the purpose of wealth creation was to set up research-based profitable organization that will contribute to the nation, society and mankind. Finally, one fine day process began.

Objective: Set a system to generate capital for research-based organization with proper utilization and management of human capital.

Search: With lots of market research different technologies identified. Main objective was to identify a technology that can also support the organization in the process of product development. Identify and analyse information required for a business plan, design and present business, financial and marketing plans based on a budget and design an action plan.

Select: Technology-based services related to professional staffing were identified as most reliable and affordable technology. Selected and formulated an ethical framework for operational plans, established business, financial and operational goals and objectives.

Implement: Birth of Asrah Technologies India Limited. Registered as a public-limited company under Companies Act 1956 on 1 Jan 2010. Identified verticals for business. Set up business premises, set up operational systems, implement financial systems, calculated the risks of a new venture.

Capture: Went all out in the market place by positioning

> "Engineers recruit Engineers"
> "Touch your future"

With a focussed approach, Asrah could make a good breakthrough by getting good and dependable clients. Now, the business started prospering and funds started flowing in.

In the organization, most of the employees were fresh engineers who worked on recruitment services at the same time supported for product development. The company has a positive employee development policy. Each person has a job profile and a training plan is arranged accordingly. There is also considerable attention paid to quality management and leadership training. The company got certified as ISO 9001: 2008 and ISO 13485: 2003.

Technology intelligence: Asrah had identified three projects to be taken up. Financial situation of the company allowed them only one at a time. Technology intelligence provided them an understanding of current and potential changes taking place in the environment. The value of technology intelligence was not merely in the information but in the process of generating it. They could identify most viable project based on current financial situation, time compression, existing infrastructure and availability of existing human resource.

Herring model:

1. *Need assessment*: Based on the current financial situation, which is the most viable project? Asrah can't afford long term project immediately. Asrah can't afford expensive resources. This project has to generate funds for next project.
2. *Planning*: How are we going to find the answers for these questions? Identified sources for basic and secondary information.
3. *Collection*: The major strength of Asrah was they were into recruitment services and they had huge data base of candidates across industry and levels. Reaching any technical or managerial profession from any industry or organization was very easy for them. Approached different educational institutions.
4. *Analysis*: Collected data was organized in a meaningful way to create a new insight and conclusion.
5. *Presentation*: Analysis is presented to the management and advanced external counter pulsation was decided as most appealing system.

2 Systems Analysis

The name of the system: Advanced external counter pulsation

Top ten causes of death in India (Age 25–69 as percentage)

Rank	Causes of death	Total
1	Cardiovascular diseases	25
2	COPD, Asthma, Other Respiratory Diseases	10.2
3	Tuberculosis	10.1
4	Malignant and other neoplasm	9.0
5	Ill-defined conditions	5.3
6	Digestive diseases	5.1
7	Diarrheal diseases	5.0
8	Unintentional injuries	4.6
9	Intentional self-harm or suicide	3.0
10	Malaria	2.8

Sources: (Sharma 2010) India Today, New Delhi, April 12, 2010

The purpose of the system: Heart diseases have emerged as the number one killer in both urban and rural areas of the country.

Heart diseases have emerged as the number one killer in both urban and rural areas of the country. The largest ever study of one million deaths shows cardiovascular disease has replaced communicable diseases as the biggest killer in India.

Summary – Report on Causes of Death: 2001–2003 in India from Census India

Preliminary results from the largest study (prospective study one million deaths in India – RGI-CGHR Prospective Study Collaborators, yet to find out the exact causes of mortality in India) have revealed that heart ailments take most lives in both urban and rural areas. The results are surprising because they indicate a reversal in disease patterns in the country from communicable diseases to non-communicable or lifestyle diseases. "What we have found is quite provocative. If you look at rural areas of poorer states like Uttar Pradesh and Bihar, the leading cause of death among middle aged males is cardiovascular disease. Heart attacks are killing people not just in urban areas," said Dr Prabhat Jha, director of the Centre for Global Health Research at the University of Toronto and lead researcher of the study. The study is being carried out in collaboration with the Registrar General of India (RGI) and the Indian Council of Medical Research (ICMR). (Sharma 2010) India Today, New Delhi, April 12, 2010.

3 Cardiovascular Disease as a Threat to Economic Stability

> "When the heart is set right, then the personal life is cultivated. When the personal life is cultivated, then the home life is regulated. When the home life is regulated, then the national life is orderly: And when the national life is orderly, then the world is at peace."
> –*Confucius*

The economic implications of cardiovascular disease are vast. In developing countries, heart disease has historically affected the more educated and higher socioeconomic groups, but this is changing.

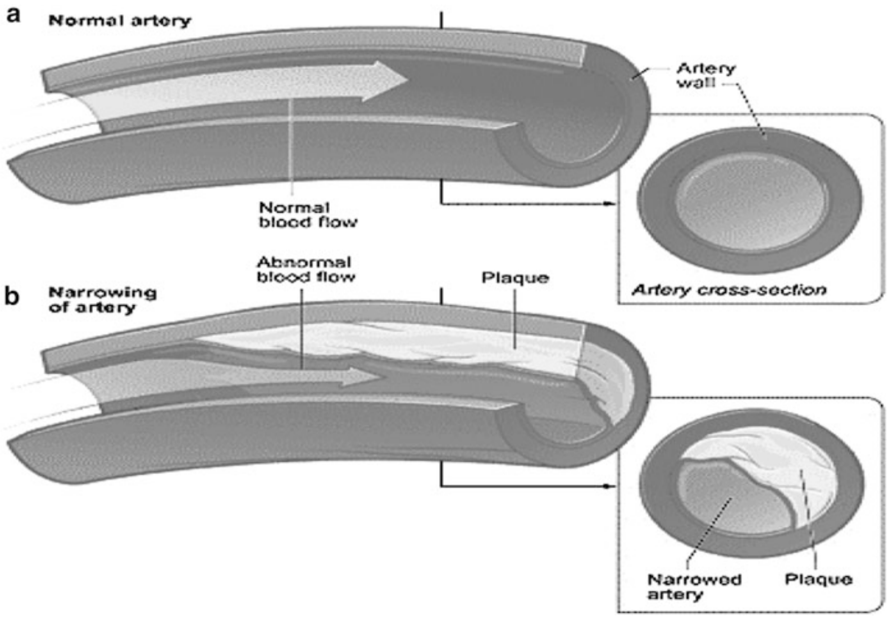
What researchers are finding is that in developing countries, cardiovascular disease disproportionately affects working-age adults from lower socioeconomic groups. Also, people from lower socioeconomic groups fare worse if they develop heart disease; their mortality after a heart attack is higher than someone from a high socioeconomic group. This has led researchers to claim that if the global epidemic of heart disease continues, it will have an impact on the viability of a number of countries' economies. Already, researchers estimate that between the developing economies of Brazil, India, China, South Africa and Mexico, 21 million years of future productive life are lost each year because of cardiovascular disease.

The economic impact is felt both as a cost to the country's health system as well as the loss of income and production of those affected either directly by the disease or as caregivers to those with cardiovascular disease, who cease to work.

As the world's largest democracy and a rising power, India has gradually begun to play a larger role on the international stage, at the same time, according to BPL Tendulkar committee report, 32.7% of population (410 million) are below poverty line (earning less than \$1.25/day). As per the executive summary report of the census 2011, 68.83% of the Indian population lives in about 640,867 villages.

4 Coronary Heart Disease

CHD is the most common type of heart disease in adults. It occurs if a waxy substance called plaque builds up on the inner walls of your coronary arteries. These arteries carry oxygen-rich blood to your heart. Plaque narrows and stiffens the coronary arteries. This reduces the flow of oxygen-rich blood to the heart muscle, causing chest pain – angina.



Angina is a symptom of coronary heart disease**.** Plaque build-up also makes it more likely that blood clots will form in your arteries. Blood clots can partially or completely block blood flow, which can cause a heart attack. There are many known CHD risk factors. You can control some risk factors, but not others.

Risk factors you can control include:

- High blood cholesterol and triglyceride (tri-GLIS-er-ide) levels (a type of fat found in the blood)
- High blood pressure
- Diabetes and prediabetes
- Overweight and obesity
- Smoking
- Lack of physical activity
- Unhealthy diet
- Stress

The risk factors you cannot control are age, gender and family history of CHD.

Following a healthy lifestyle can help you and your children prevent or control many coronary heart disease risk factors. Because many lifestyle habits begin during childhood, parents and families should encourage their children to make their heart-healthy choices. For example, you and your children can lower your risk of coronary heart disease if you maintain a healthy weight, do physical activity regularly, follow a healthy diet and avoid smoking.

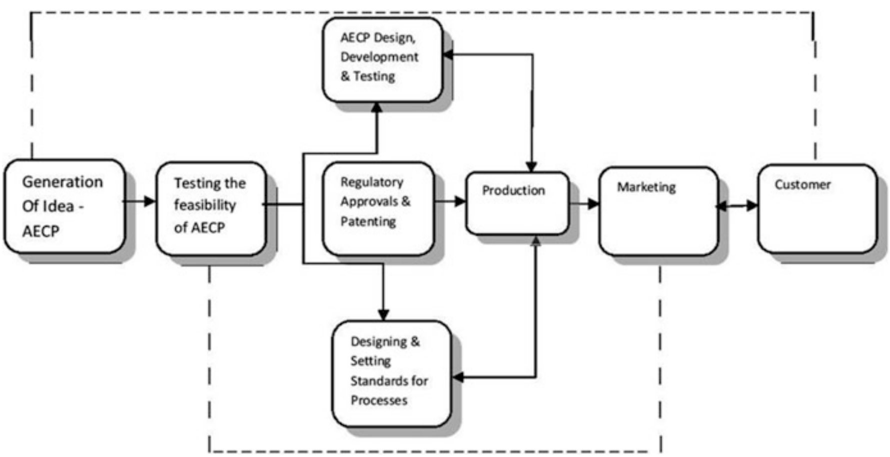
On average, people at low risk of coronary heart disease live nearly 10 years longer than people at high risk of coronary heart disease.

If you already have coronary heart disease, lifestyle changes can help you control your risk factors. This may prevent coronary heart disease from worsening. Even if you are in your 60s, 70s or 80s, a healthy lifestyle can lower your risk of dying from coronary heart disease.

4.1 Current Treatment for Angina

Angina is a symptom of CHD. Treatments include (1) drug therapy beta-adrenergic blocking agents, nitrates and calcium channel blocking agents in single or in combination; (2) revascularization by either coronary artery bypass grafting; or (3) percutaneous transluminal coronary angioplasty. Further research for more therapeutic options for chronic angina has yielded a wide range of new treatment modalities in various stages of clinical evaluation, which includes (1) transmyocardial laser revascularization, (2) spinal chord stimulation, (3) transcutaneous electrical nerve stimulation and (7) external counterpulsation. In the USA, experience with external counter pulsation and modified version of external counter pulsation was successful in relieving angina, reducing reversible perfusion defects in radionuclide scans, and improving exercise tolerance is based on series of case studies.

5 AECP Technological Innovation Model



6 Advanced External Counter Pulsation (AECP)

A modified version of ECP with added features is non-invasive, outpatient treatment for coronary artery disease with angina refractory to medical and/or surgical therapy.

Asrah considers the use of ECP for all other conditions (e.g. erectile dysfunction, heart failure, hepatorenal syndrome, restless leg syndrome, retinal artery occlusion, rotational vertebrobasilar insufficiency, stroke and sudden deafness) experimental and investigational.

7 Why Advanced External Counter Pulsation (AECP)

A common man with heart disease will not face an urgent medical crisis and can comfortably delay surgery. For many patients, the diagnosis seems to come without warning and heart attack occurs when there is a sudden and complete blockage in a coronary artery, leaving an area of the heart without blood flow.

In our country where 410 million people are earning less than 20,000–22,000 rupees per year, if they come across this situation, how are they going to face this crisis? They will have no other option than to either borrow money or to sell off their property. Cause people with so less earning will neither have anything to save for their future nor covered with health insurance. If they do not have any alternative, then death is the final solution for them.

The people who can afford this end up spending a huge amount on angioplasty, stenting or bypass surgery. But this is not the end. Research in recent years has provided clear evidence that heart disease is not a plumbing problem, defined by blockages in the arteries that bring blood to the heart. Eight percent of bypass surgery patients, 20% of stenting patients and 54% of angioplasty patients repeat procedure within a few years. Heart attack occurs even after these blockages have been fixed. We now recognize that cardiovascular disease is a chronic, system-wide illness in which poorly functioning blood vessels weaken circulation, precisely in and around the heart. Majority of the factors which damages these blood vessels are:

1. Inflammation and autoimmune conditions
2. Chronic infections
3. Genetic predisposition
4. Lifestyle habits

These factors create an atmosphere where blockages can develop and flourish. So Cardiovascular disease should not be defined as just by blockages, but it should be by its underlying cause, damaged blood vessel that inhibits blood flow. Bypass surgery, stents and angioplasty target individual blockages only, not the underlying disease.

Heart disease progresses slowly and blockages take many years to develop. Just because a diagnosis has been made and blockages have been identified does not mean operating on them is a dire emergency. In most cases, you have time to take a breath, educate yourself, weigh your options and make a careful decision. One study conducted at Harvard provided a powerful illustration of this lack of urgency. Of 88 patients who had been advised to undergo bypass surgery, 74 patients (84%) received second opinion contradicting that recommendation. Sixty of seventy four Patients (68% of total) chose to indefinitely delay the operation. None of the patients who opted against bypass died during the nearly two and a half years of follow-up. The study concluded that the number of surgical interventions could be reduced by as much as 50% among patients who receive a second opinion that removes the sense of urgency from their decision-making process.

Some doctors simply do not accept the irrefutable science that has redefined heart disease. Although they know the old "heart disease is about blockages" model no longer holds, they still base their practice on it and continue to open blocked arteries anyway. In a candid expose on 21 March 2004, New York Times, Dr. Eric Topol, an interventional cardiologist at the Cleveland Clinic, stated bluntly: "There is just this embedded belief that fixing an artery is a good thing." In the same article, Dr. David Hillis, an interventional cardiologist at the University of Texas Southwestern Medical Centre, offered a possible explanation for this mentality, suggesting business plays a significant role. "If you are an invasive cardiologist and joe Smith, the local internist, is sending you patients, and you tell them they don't need the procedure, pretty soon Joe Smith doesn't send patients anymore." He explained, "Sometimes you can talk yourself into doing it even though in your heart of hearts you don't think it is right" (Braverman 2005).

Dr. Hillis cited another possible explanation, "a patient may come into the doctor's office convinced that an invasive procedure is the right course of action." "Americans want a full-court press," Dr. Hillis said. I think they have talked to someone along the line who convinced them that this procedure will save their life. They are told, "If you don't have it done, you are… a walking time bomb." The Times article included this summation from Dr. David Waters of the University of California. "(Coronary Artery Disease) is a systemic disease. It occurs throughout all the coronary arteries. If you fix one segment, a year later it will be another segment that pops and gives you a heart attack so systemic therapy has the potential to do a lot more." But, he added, "There is a tradition in cardiology that doesn't want to hear that" (Braverman 2005).

Not only does traditional cardiology not want to hear it, but since most patients rely on their doctors to educate them about their disease. Many heart disease sufferers do not get the information they need to make appropriate treatment decision (Braverman 2005).

8 Asrah's Advanced External Counter Pulsation System

It is to treat heart disease by alleviating their symptoms, preventing complications such as heart attacks and maximizing their quality of life. Our treatment would take a systemic, rather than a localized approach. Advanced external counter pulsation helps in increasing coronary perfusion, increasing diastolic perfusion pressure, decreasing ventricular load, increasing venous return, increasing coronary collateral flow to ischemic regions of myocardium, eliminating toxins such as carbon dioxide and lactate and supplying more nutrients such as oxygen and glucose.

9 Our Objective

Current Invasive treatment cost: Rs. 2–5 Lacs (Burden is too heavy for common man.)

Current Non-invasive treatment cost: (35 sittings × 1 h) is between Rs. 70,000–120,000 at different heart care centres.

There are approximately 250 ECP and EECP installations in India. Major supply is either from the USA or China.

Approximate cost of US-made systems ranges from Rs. 20–48 Lacs plus tax.

Chinese systems cost Rs. 10–18 Lacs plus tax.

Our objective is to drastically reduce the treatment cost by reducing the system cost. We are working towards helping 32 % of my country people who are below poverty line.

Our objective is to transform the lives of the patients whose heart disease is so advanced that they cannot eat or do normal activity without severe symptoms, making them return to activities they had given up.

Our objective is to help the nation by making every heart a healthy heart.

The inputs to the system:

1. NIBP
2. ECG
3. SPO2
4. Respiration
5. Pressurized flow of air

The system's outputs:

1. Inflation
2. Deflation

The subsystems or components of the system:

1. Air compressor
2. Patients bed
3. PLC based system
4. Cuffs
5. Solenoid valves
6. Precision regulators
7. System software

The feedback used by the system: A series of four compressive air cuffs which inflate and deflate in synchronization with the patient's cardiac cycle via microprocessor-interpreted ECG signals are wrapped around each leg and on hand: one at calf level, another slightly above the knee, third on the thigh and fourth on the fist. The three cuffs are larger versions of the familiar blood pressure cuff and one is a little smaller. During diastole, the four sets of air cuffs are inflated sequentially (distal to proximal) compressing the vascular beds within the muscles of the calves, lower thighs, upper thighs and fist. This action results in an increase in diastolic pressure, generation of retrograde arterial blood flow and an increase in venous return. The cuffs are deflated simultaneously just prior to systole, which produces a rapid drop in vascular impedance, a decrease in ventricular workload and an increase in cardiac output.

In the short-term, this method of therapy is thought to deliver more oxygen to the ischemic myocardium by increasing coronary blood flow during diastole, while at the same time, reducing the demand for oxygen by diminishing the work requirements of the heart. Long-term benefit is expected to result as coronary collateral flow to ischemic regions of the myocardium is increased. The nerves in the hands are stimulated. These nerves carry the signals to the brain, particularly to parts that are concerned with emotions. The piled up mental energy due to stress is released. This relaxes the mind. It improves the blood circulation and helps in supplying more nutrients such as oxygen and glucose. It also eliminates toxins such as carbon dioxide and lactate. A full course of ECP typically involves 5 h of treatment per week, delivered in 1- to 2-h sessions for 7 weeks, for a total of 35 h of treatment.

Since this product is under patent application process, so we would not be able to discuss in detail.

10 Lab to Market

The government can support biomedical industry bringing innovation and technology to market in a variety of ways:

- Design instruments that promote private risk-taking and stimulate markets for private risk capital
- Government interventions should be designed to promote risk-taking and stimulate the private risk capital market.
- The government needs to align carefully its provision of support for innovation throughout the entire commercialization cycle with different policy instruments at different stages: early stage, growth stage and mature stage.

Effective sequencing should aim at building significant deal flow of early-stage projects before supporting venture capital.

11 Conclusion

For all of us across the world, the heart is much more than a fist-sized muscle, working efficiently from birth until death, pumping blood continuously about 70 ml per beat, and it usually beats 70 beats per minute, 100,800 times in a day, and nearly one million barrels of blood in an average lifetime! The heart holds a deep emotional and spiritual significance for us. We thank people from the bottom of our heart, love and heart are almost synonymous for us, and we even suffer heartbreaking losses. So when this wonderful organ starts giving up, we lose heart. Sadly, we ourselves are the cause of its abuse by appalling lifestyles.

Institutes across India suggest that 90% of heart cases coming to them fall under lifestyle category. The less healthy hearts still beat, but they are not strong enough for living and enjoying a good quality of life. Apart from giving a wide range of side effects, most presently used treatments for heart diseases transfuse enormous fear in body cells, which react by releasing large amounts of the stress hormones. This by itself can threaten the healing system. Until lately, these treatments were conceived to be more or less safe but are now distinguished by leading heart centres and resources to be the primary cause of a new ailment known as chronic heart failure. Chronic heart failure is a gradual death-experience that has attained epidemic ratios. This has emerged as the number one killer in both urban and rural areas of India causing economic loss to the country. Heart disease continues to claim one American life every 34 s. While we apply old rules to treat it, it is the leading killer, the most costly disease and the primary cause of disability in most of the countries, but we have the ability to quickly change these facts. This is only possible by educating our self, changing our thoughts and changing our interpretations. The need for AECP has never been greater, and as our population ages, the need will continue to rise exponentially.

Experiencing the treatment and making it widely available would change the entire face of the condition. It is the only way to knock heart disease off its perch as our most deadly and expensive illness. It is the only human choice. The power of human choice is dramatically demonstrated by the Indian freedom movement. It was not the power of arms or revolution that got us freedom. It was the power of choice. When India’s leaders decided the country must be free and succeeded in convincing the people to will and work for it, there was no force on earth strong enough to keep the country under foreign rule. India was freed by the collective decision of its people. Today, once again, we need a collective decision to free our heart from coronary artery disease. Hundreds of thousands of lives and hundreds of billions of rupees are at stake. This is a public health issue, an economic issue and a bioethical issue.

“Your life is important to your loved ones. They can’t afford to lose you”

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Managing Technology for Marketing Success

Prafulla Kumar Das

1 Introduction

Kotler et al. (2007) while discussing on today's marketing communications mentioned that marketing communication would increasingly occur as a personal dialogue between the company and its customers. From the point how a company would reach its customers, they felt that the company would be forced to find out how the customers could reach the company effortlessly. Technological advances have allowed people and the company to communicate with each other through the Internet, fax machines, cellular phones, and other wireless appliances. Personalizing communications and creating dialogues by saying and doing right things to the right customers at the right time would become critical for the marketer, Kotler et al. thought. Ansari and Mela (2003) mentioned that the exchange process in the information age became increasingly customer initiated and to an extent, customer controlled. Marketers and their representatives would have to wait until customers agreed to participate in the exchange. Even the marketers entered the exchange process; customers would define the rules of engagement. They would insulate themselves with the help of agents and intermediaries if they so chose. The authors were of the opinion that even the customers had started to define what information they needed and what offerings they would be interested in.

Elliot and Percy (2011) thought that brands were cocreated by its customers and the organization's employees. In the process of cocreating the brand, employees may have to take the help of easily available and affordable technology.

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But, managing technology in an organization would be to understand the value of certain technology for the organization. Continuous development of technology is valuable as long as there is a value for the customer. Therefore, the technology management function in an organization would be to argue when to invest on technology development and when to withdraw, the authors thought. In this study, an attempt was made to utilize easily available technology to improve marketing function in the operating level of the field in the pharmaceutical industry.

2 The Uniqueness of Pharmaceutical Selling

Pharmaceutical selling is different from all other types of selling. Here, the customer himself is not the consumer, and the consumer, on the other hand, has got no say in deciding the product he would purchase. Therefore, companies personalize the marketing communications for more impact. This ethical, high-involvement product is sold by the prescriptions of doctors, who, in turn, decide the types of medicines to be used after thorough checkup. Therefore, the products are not generally advertised in TV or radio. Personal selling has been the most effective medium of communication. Print media are used for specific journal discussions, advertisements, and information through medical index books like MIMS (monthly index of medical specialties), CIMS (current index of medical specialties), IDR (Indian drug review), and Drug Today. Some of the companies have been using reputed daily newspapers to write advertorial columns on approaching new pharmaceutical products. It is probably for inducing word-of-mouth (WOM) communication amongst the readers. In some cases, advertisements are given in reputed (Note: In the paper, product and brand are used synonymously.) local dailies before the formal launch of a product. It is perhaps with the intention of informing a particular segment of doctors on the arrival of a new preparation. Integrated communication approaches such as CME (continued medical education), journal and textbook extract handouts, sponsoring conferences, release of website, gifts like books, articles for better diagnosis, samples, reminder articles of use, visual aids, and in rare cases, panel discussions by accepted subject authorities are used in various degrees by pharmaceutical companies. In an overcommunicated society like ours, getting, keeping, and growing customers has become difficult. In this process also, companies incur wastage in terms of money, man, and machine utilities. If the use of day-to-day, affordable technology could help identify, organize, and use available data for marketing productivity, it would probably help managing waste in Indian context.

The days of “sell,” “sell,” and “sell” by the sales force are gone (Kotler et al. 2007). They are to know how to diagnose a customer’s problem and the corresponding solution for him to earn higher profit. Companies are to define specific sales force objectives, time to spend on current customers, time to devote for the prospects, time to spend for the established brands as well as for new brands, and gap to meet different types of stakeholders like doctors, chemists (drug retailers), and stockist who work for them. Ordering pattern, settlement of dues, minimum order amount, payment duration, and penalty in case of delayed payment are to be defined explicitly. Training activities for keeping employees knowledgeable and motivated, incentives for retailers and stockist, and timely managing public interfaces in case of difficulties would also become the responsibilities of the management for smooth performance. Kotler et al. (2007) found out that regardless of selling context, sales people would generally do one or more of the following specific tasks:

- *Prospecting*: Searching for prospects or leads
- *Targeting*: Deciding how to allocate their time amongst customers and prospects
- *Communicating*: Informing the customers about the products and services
- *Selling*: Approaching, presenting, answering queries, overcoming objections, and closing sales
- *Servicing*: Providing various services to customers—consulting on problems, providing technical assistance, arranging finance, and expediting delivery of goods
- *Information gathering*: Conducting market research
- *Allocating*: Deciding which customer will get how much scarce products during shortages

Sontakki (2000) mentioned that the sales or selling process would refer to the sequential series of actions taken by the salesman. That would lead toward a prospect taking a desired action and would terminate with a follow-up to ensure purchase and post-purchase satisfaction. The commonly accepted stages in the sales process are the following: *prospecting, pre-approach, presentation and demonstration, overcoming objections, and closing the sales*. It is to be remembered that these steps are not stand alone but interdependent. Sontakki identified few questions to qualify a “suspect” to a prospect. These questions were:

- Does he need my product or service?
- Does he perceive a need or a problem that may be satisfied by my product or service?
- Does he have sincere desire to fulfill the need or to solve his problem?
- Can my product or service convert his desire into belief?
- Does he have financial resources to pay for?
- Does he have the authority to buy?
- Will his purchase be large enough to be profitable?

3 Database and Technology Application for Better Performance

Keeping all these requirements in mind, a table may be prepared as given in the Table 1 on an Excel sheet. Additional information about the birth day and marriage date of the qualified prospects would help call planning. It would also help build and continue relationship with the customer.

From the information, identified numbers of qualified prospects (as per the strategy) would be picked up for promotion. A prospect may be dropped after three calls if he did not respond to the promotion. A list of actual buyers of the product would be prepared by calling on the nearby drug retailer and looking to the actual dispatch from the stock point. Table 2 would provide necessary insight to the field person on the actual performance of the brand X vis-à-vis competitors. When placed on the excel sheet, the potential prescribers may be identified on the basis of their contributions to the company's kitty. From that identified list, most important customers may be selected for special promotion as or when called for. While collecting the data, a notebook, or a diary, or a tablet PC with the format would help identify the prospects and their standing for the company on monthly basis.

With the increase in competition, the fortunes of brands are changing very fast. New products in the category, new companies, and new products with better value propositions keep on flooding the market. It is also found out that about 95% of brands do not see life beyond 1 year (Verma 2006). It has also been found out that break-even for an identified product would be achieved after 3 years. In such a complex situation, keeping track of the performance of a brand and its competitors would be useful. The table below would help identify the movement, strategy, and coverage of the brand on study against its competition. These information would probably help the management formulate tactical moves to defend and increase market share. A diary, a notebook, or a tablet PC would organize the data for current and future use (Table 3). Asking the stock outlets for better coverage and designing of visit plan may help in this direction. In spite of that, if the company fails to cover the market properly, it may think of appointing a sub-wholesaler. On the other hand, the names of the identified wholesalers may be kept in the mind for future expansion.

It would be wise to keep track of the presently performing brands which contribute about 80% of the business. In general, 4–5 product categories contribute to most of the business for any given company. Authors like Kotler et al. (2007) recommend that at least 80–85% of time and money may be invested for those product categories. But, in the Indian competitive scenario when more than 4–5 products are being introduced by even a medium-level concern, investing that amount of time and money for established brands would be difficult. Further research would probably be required to find out whether it contributed to brand failure. But, keeping the practicality in view, at least 50% of time may be chalked out for the established brands, and the rest 20% may be kept for two rising new brands. Table 4 provides an organized approach to identify the prescribers of best five and rising two product categories to keep their names and approximate business contributions in mind for business investments. The share of high-profit products may be considered to increase through special promotion for optimizing profitability.

If the prescriber base for any or more of these products was found to be narrow, slow expansion to identified noncontributing prospects would be useful. Direct dialogue would certainly help in this direction. The increase in customer base

Table 1 Format for preparing database of prospects

Sl no.	Potential prescriber (suspect)	Prescribers of the same molecule	Prescribers of the competitor molecule	Early adopter/ prescriber?	Price conscious?	Committed to competitor?	Final list	Best time to meet	Birthday	Marriage date
1.										
2.										
3.										
-										
n										

Table 2 Format for preparing the prescribers' list

Retailer	Name of the prescriber of the brand	Frequency (H/L)	Business amount approx.	Prescribers of the competitor 1	Frequency (H/L)	Business amount approx.	Prescribers of the competitor 2	Frequency (H/L)	Business amount approx.
1.	a.			a.			a.		
	b.			b.			b.		
	c.			c.			c.		
2.									
3.									

Table 3 Market survey format

Sl no.	Name of the retailer	Competitor and its product	Price	Frequency of visit of MR	Whether on special promotion?	Scheme	Frequency of promotion	Stockist and coverage frequency	Business amount of the category approx.
1.		a.							
		b.							
		c.							
2.									
3.									

Table 4 Format for market-wise prescribers' compiled list (Best five and second-best two products)

Retailer	Name of the doctor	Product C*1 (H**/L)	Product C2(H/L)	Product C3(H/L)	Product C4(H/L)	Product C5(H/L)	R1 (H/L***)	R2 (H/L)
1.	a.							
	b.							
	c.							
2.								
3.								

*C** Core product, *R* Rising product, *H*** High, *L**** Low

Table 5 Format for prescribers' compiled list (Best five and second-best two products)

Code number of doctor	Name of the doctor	Product C*1 (H**/L)	Product C2(H/L)	Product C3(H/L)	Product C4(H/L)	Product C5(H/L)	R1 (H/L***)	R2 (H/L)

*C** Core product, *R* Rising product, *H*** High, *L**** Low

would contribute insulating the brands from quick erosion. A notebook or a diary may help while collecting the data. Transferring the data to the computer through excel sheets would immediately help organize information to give direction to promotion. When the entire list of doctors with their prescribing habit would be prepared in one sheet per area, it would give direction to the promotion for consolidating the existing customer base and for gradual expansion. This may be done by putting products in the *x*-axis and list of doctors with their code numbers in the *y*-axis (Table 5). The report would immediately separate noncontributing customers. They may be considered for business improvement, and when not possible, the investment may be reduced for managing cost. A master file mentioning the month-wise visiting date and investment may be kept handy for reference. The details may be put in an excel sheet. Chemist audit may be done before calling on the customer. It would certainly add strength to presentation and investment (Table 6).

It has been an accepted fact that 20% of customers contribute to 80% of business. In that logic, maintaining the list of core customers like doctors or chemists with personal details would help organizing and getting business from them. Tables 7 and 8 would help not only visualizing the market trend; the marketing performance of the field staff would immediately be reflected when one sees the visiting pattern. Sending birthday and marriage cards even through e-mail and reminding them with scheme, introduction of new molecules, and latest report on product performance (from reputed journal publications) would help the customer take better decisions. It may so happen that the field staff would not be able to call on the core customers at identified intervals. But, this gap may be fulfilled through electronic reminders. Use of simple technology like pen drive may help transfer the product information for future use in case the Internet is not available.

Table 6 Format for month-wise investment details on doctors

Code no. of doctors	Name of the doctor	Prescribed core product code (H/L)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		C1												
		C2												
		C3												
		C4												
		R1												
		R2												

A chemist database of top retailers and their purchasing pattern always strengthens the position of a company. Tables 8, 9, and 10 would help compile chemist and stockist data for organizing the action plan.

There is a word in the business circles that the sale is complete when the payment is realized. Capital being the elixir of life for a business, it would be important to see that the money is realized in time. Table 11 would provide the guideline for the details of payment position for an area. A reminder to the stockist through e-mail or mobile messaging before 2 days or a day before and direct telephonic talk on the same date would probably fetch payment from him. As delay in payment may delay in the placing of fresh order, it assumes great importance. Rising union activities amongst stockist and sub-wholesalers would not allow the company to collect interest for delayed payment. It would be wise on the part of sales people not to book excess of new and slow moving items. An eye to the product performance and booking of fast moving products would help the company to be in the right path to control the business. In case, a stockist hesitates to place order according to the agreed norms, this table would help guide the field operator to show him the actual paid-up stock held by him (as per the agreement one stockist would keep 1 month's paid-up stock).

Settlement of breakage and expiry goods has been the bone of contention for most of the business deals. Table 12 would guide the field operatives (including managers) to keep an eye to this issue so that the C&F agent does the settlement in time. Timely settlement of dues also enhances the respect of the company as well as field personnel amongst the stockist. If a fixed time gap is agreed upon, this table would guide the managers to discuss with the C&F agent where he went wrong. In order to control the expiry amount amongst the promoted goods, discussion may be initiated with the field staff to contain the expiry level to the agreed point. Table 13 discusses about both expiry and breakage as sometimes, expiry goods may be shown as damaged/broken stock. Therefore, taking them together would probably help contain the amount to the agreed level.

It is the consistent performance of brands that is vital for the good health of an organization. Month-wise movement of core products (Table 14) would give sufficient hint on the actual performance of the company. Before the windfall, measures may be initiated to stop the slide. In order to control the performance

Table 7 Format for core-doctors' personal data-base

Sl. no.	Name of the doctor	Birthday	Marriage day	Phone no.	Mobile	E-mail	Whether interested to get information through mail/message	Best time to meet	Present prescriber	Past prescriber
1.										
2.										
3.										

Table 8 Format for chemist data-base

Sl. no.	Name of the chemist	Stockist from whom purchasing	Mode of payment (cash/credit)	Phone no.	Mobile	E-mail	Whether interested to get information through mail/message	Best time to call on	Interested for scheme	Purchase amount limit
1.										
2.										
3.										

Table 9 Format for individual stockiest business data

Sl. no.	Name of the products	Package	Price/ unit	Secondary sale[a]	Total amount	Business last year same month	Progressive business current year	Progressive business last year
1.								
2.								
3.								

[a]Actual sale of products at the stockist counter

Table 10 Format for combined stockiest business data

Sl. no.	Name of the products	Package	Price/ unit	Combined secondary sale	Total amount	Total business last year	Growth	Business year before last year	Growth
1.									
2.									
3.									

Table 11 Format for month-wise payment and purchase details of parties/stockiest

Sl no.	Name of the stockist	Bill no.	Amount	Payment date	Transporter	Bank	Bank sola no.	Date of actual payment	No. of days of delay	Interest amount
1.										
2.										

of a territory, it would be important to know, on a single sheet, how all the stockist are doing and what would be the individual stockist contribution to the territory performance (Table 15). This may help discussing the business with the individual stockist, manager, or field staff while analyzing performance vis-à-vis the competition. This would certainly drive home the point (required performance to the actual performance) for which people are paid. Table 14 may be used for the entire range of management personnel to control the product performance. A pen drive, laptop, or a tablet PC would be useful to carry the data for discussion.

4 Conclusion

Companies across the world are forced to change their offerings to suit the market needs. Changing customer preferences, technological changes, and altering government policies are some of the major factors which fuel new product development (Chunawalla 1998), but risks associated with new product development is often high (Kotler and Armstrong 1996). The authors conducted a study on

Table 12 Format for breakage/expiry details of an area

Sl no.	Name of the stockist	Product name	Batch no.	Expiry date	No. of units	Bill no.	Date of billing	Scheme amount	Date of bill settlement	Date of submitting to C&F agent	Date of breakage/ expiry settlement
1.											
2.											

Table 13 Format for loss due to breakage and expiry

Sl no.	Name of the stockist	Expiry amount	Breakage amount	Total amount	% to total sales	% last year	% year before last year
1.							
2.							

consumer packaged goods (comprising mostly line extensions) to find the failure rate at 80%. Verma (2006) found that the new product failure across categories even in the European and American countries was as high as 95%. In the process of developing new products, old and established brands are being relegated to the backseat. But, a company has to keep a balance between yesterday's breadwinners and tomorrow's breadwinners to remain successful in the market. In this complex situation, pinpointing the exact causes for brand failure and developing suitable strategies for greater success would be difficult.

A company, on the other hand, has to develop a profitable marketing strategy for improving stakeholders' value. While developing strategy, it has to rely on balancing the company's competencies with market opportunities. Marketing expenditure must also be optimized to achieve greater success at the marketplace. In the fast-changing world, marketing can no longer remain the premise of the marketing department alone. Operations through TQM, customer satisfaction through managing customer database, sales management through CRM, and finance through customer profitability analysis are the areas where technology could play a significant role. Technology is changing and becoming accessible on every passing day. It would be the responsibility of every management to utilize affordable and easily accessible technology in innovative ways for deriving necessary mileage from the market. It would be useful not to forget the words of Al Ries and Jack Trout (2003), "When people become successful, they tend to become less objective. They often substitute their own judgment for what the market wants."

Table 14 Format for recording month-wise business performances

Sl no.	Name of the product and package	No. of units	Price	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1.																
2.																
3.																

Table 15 Stockiest-wise performance for a month/year

Sl no.	Name of the product and package	Price	Stockist 1	Stockist 2	Stockist 3	Stockist 4	Stockist 5	Total units	Total amount in Rs.	Total units last year	Total amount in Rs. (last year)
1.											
2.											
3.											

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Part 2

Part 2.1
Innovation Management

Review of Corporate Management Model for Defense R&D Programs

K. Ajith Kumar and V.P. Jagathy Raj

1 Introduction

During the early decades, the entire engineering industry was technology driven, and great inventions and discoveries lead the new product development process. However, things have changed, and today in competitive business and engineering industry, we have both technology-driven business and business-driven technology. Under the present circumstances, strategic decisions on selection (Thamhain and Wilemon 1975) and proper implementation of projects/program by corporate managements are very important in any industry.

R&D is a creative activity carried out by qualified scientists, engineers, etc. Technology on the other hand implies theoretical as well as practical knowledge, skills, and techniques which help in realizing processes and systems for conversion of inventions, discoveries, etc., to products and services. The competitive world has brought in a change in this pace as well as approach, and the emphasis is on early conversions of inventions and technology into products.

Major R&D programs of strategic importance are undertaken by the government particularly in the defense and space sectors. Each of these programs is multidisciplinary, technologically challenging, and cost and resource intensive aimed at bringing the country to the forefront in scientific and technological research. Identification of critical success factors of a project and the role of the parent organization in control and implementation of these factors are very important (Buell 1967).

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Also, selection and managing similar programs and projects and achieving the required results are challenging tasks, and how the corporate management meets/ should meet this very important function is the point of discussion in this chapter.

2 Role Definition: Corporate and Technology Management

The corporate function of R&D is to provide the decision makers the right information to link R&D and business such that the organization sustains a competitive edge in the market. To realize new, better products and services requires inputs of corporate resources which includes capital, manpower, materials, etc. A schematic representation is shown in Fig. 1.

The role of corporate management here is to feel the pulse of business. It has to allot the required resources which include capital and manpower to see that the output of R&D is timely developed to marketable products and processes. Also, the organization structure should be geared to aid program management by way of monitoring, resource support, and control.

Technology management is equally important in R&D. Efficient management of technology is required to position any organization be it business or otherwise in a highly competitive environment (Buell 1967). This is more important in the case of high-technology research where the expenditure involved is also quite large. Technology management primarily consists of two tasks:

(a) Monitoring and studying research activity within the organization and identifying those technologies which can realized into systems with some definite business value.
(b) Understand the requirements of the customer and also study contemporary systems elsewhere. Also identify business opportunities and initiate R&D work.

Thus, a typical corporate management model for strategic programs currently followed by public-funded research organizations is given in Fig. 2 (Fernandez and Navarro 2004).

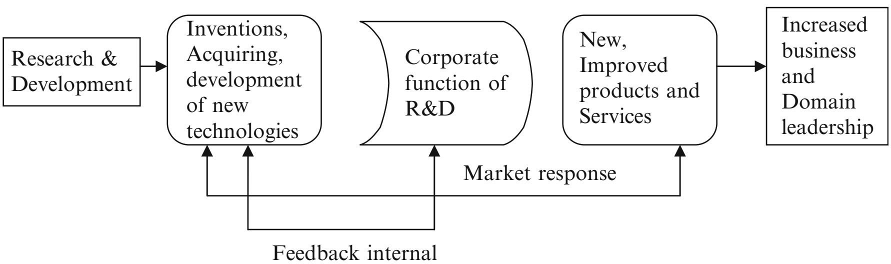

Fig. 1 Corporate function and management of R&D – conventional model

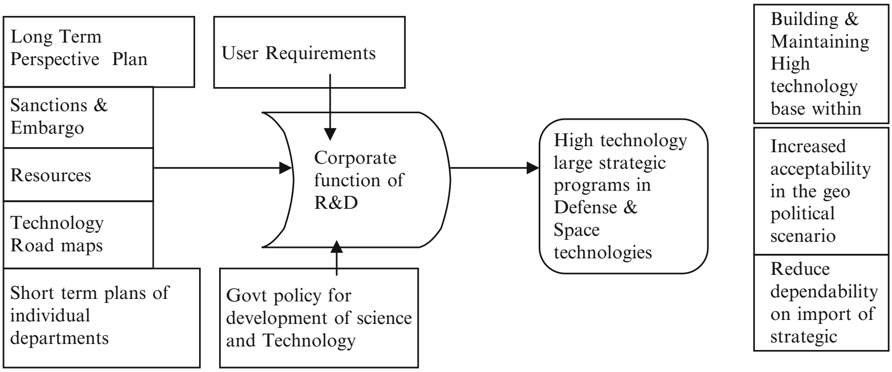

Fig. 2 Corporate function and management – strategic programs

3 Problem Definition and Research Methodology

3.1 Need for a New Corporate Management Model

Strategic programs undertaken by public-funded research organizations are multidisciplinary, technologically challenging, and cost and resource intensive aimed at bringing our country to the forefront in scientific and technological research. Factors causing project failures and delay are different in the life cycle of the project specifically front-end planning stage and project execution stage (Pinto and Mantel 1990; Pinto and Prescott 1988; Thamhain and Wilemon 1975). It is also worthwhile to analyze the macro organizational structure and its influence on program management. Typical factors for analysis include speed, support, flexibility, innovation, leadership, and control. The following queries are pertinent while proposing the new model and structure:

(a) What structures make for fast decisions and delivery of product ahead of competitors?
(b) What structure will minimize bottlenecks without incurring risk?
(c) What structure will maximize flow of knowledge and information throughout the organization?
(d) What is the best balance between centralization and decentralization?
(e) What levels of autonomy, accountability, and participation go with each of the potential structures?
(f) How well do the relationships between individual work centers and between work centers and headquarters work?
(g) Which structure will best support the desired organizational culture and values?
(h) How will the balance between local and central control be attained?

A comparison of some of the parameters of interest for strategic program management with respect to existing organizational structures is summarized below (Stanford 2007).

Parameter	Functional	Divisional	Matrix	Cluster
Program resource efficiency	Excellent	Poor	Moderate	Excellent
Time efficiency	Poor	Good	Moderate	Excellent
Adaptability	Poor	Moderate	Good	Good
Accountability	Good	Excellent	Poor	Good
Program/project environment	Stable	Heterogeneous	Complex with multiple demands	Fast paced

Taking into consideration all the factors listed above, it is felt that the present corporate management model needs to be studied to identify factors and reasons and suitably modified to avoid project delays and subsequent failures.

4 The Study

4.1 Sample

Two system-level projects were chosen for the study, both of which are now in the tactical evaluation phase (Pinto and Mantel 1990). A survey questionnaire assessed the present model with respect to its usability, efficiency, and limitations (weaknesses and challenges). The questionnaire on a *summative Likert scale format* (Pinto and Prescott 1988) was used to collate information. Responses were received on key project management issues starting from the genesis of the project, understanding of R&D goals and objectives, key performance indicators (KPI), organizational support, etc.

4.2 Measurement Instrument

The questionnaire was developed as a research/diagnostic instrument to enable the project directors of the two projects to assess the status of their respective projects through answering a series of questions related to project management issues. In this research, the survey required the two respondents to use a 5-point Likert scale to indicate the degree to which the responses can be categorized under key project management issues. The full instrument, then, was composed of about 250 questions under 5 sections, and the instrument's measure of the adequacy of the model is an aggregate of the total responses received under each of the key project management issues.

4.3 Procedure and Analysis

The questionnaire asked participants to respond to a series of questions pertaining to the selection, execution, and validation of the project they are handling.

Respondents were given considerable latitude in choosing their own criteria to respond on the adequacy and efficiency of the existing model. The project handled by the respondent then served as the frame of reference while completing the questionnaire. The two chosen projects were similar projects and were having identical phases in the project life cycle.

The complete survey questionnaire and detailed analysis data are omitted for reasons of brevity. However, the analysis brought out the following key information on the present corporate management model being followed in the organization.

4.4 Results: Weaknesses

1. Lack of focus: The research programs undertaken are diverse and many times do not follow a unified road map which is acceptable to the different stakeholders including the users. Need for peer review at sanction level.
2. Project performance management: The productivity of an industry (DeCotiis and Dyer 1979) can very easily be measured in tangible terms by the profit generated or increase in turnover, whereas research outcome of most of projects of the public-funded R&D organizations are ambiguous.
3. Project execution methodology (Balachandra and Raelin 1980) being followed does not suit the present standards of other contemporary organizations. The private industry and other business organizations continuously change with changing political and economic scenario. However, the same is not true in the case of the public-funded research organizations.
4. The R&D–industry–academic collaboration is very weak specifically in public-funded research, and the survey pointed to numerous areas where technology gaps can be successfully handled by R&D–industry–academia collaboration. The successful industries doing high-technology work are mostly in the private sector.
5. The research organizations do not create much business in the new development scenario, and it will not break even to support high-technology skill and infrastructure development within the industry. Subsequently, new technologies and new skill already developed are also not channelized properly.
6. The development contract/purchase management procedures of the research institutions are not conducive for timely completion/execution of projects.

4.5 Results: Challenges as Envisaged for Future Projects

(a) Creation of a sound and successful technology base: An organization having a sound technology base will be capable to take up new technology development work. Those organizations that build technology base promote technology consciousness among the different levels of work force. Thus, they develop a sound technology culture. An example is the case of the Japanese industry. Their technology base is well developed, and today, they have the prowess in innovation and entrepreneurship.

(b) Identification of core competence and developing it. All organizations have core competence. The challenge is to identify it, nurture it, and fully develop it. C. K. Prahalad and Gary Hamel have described core competence as the collective learning in an organization. It is the ability to coordinate diverse skills and integrate various technologies.

(c) Realization of a research charter: This calls for a total change in the way high-technology system projects are undertaken by discussing with people outside the organization. It is essentially efforts required to realize a common research charter. A research charter is an expression of shared understanding of the goals of research of a project or program. The focus is on broad scope and not on specifics.

(d) New challenges and outlook: High-technology projects essentially carry high risks. Long time horizons, uncertainty of research outcome, etc., make management of high-technology projects extremely difficult. The present trend of globalization has led to joint R&D programs. Also, the magnitude and speed of technological change has also favored joint R&D program. Thus, strategic alliance in R&D has emerged. A strategic alliance interacts with competitive environments through optimization of combined objectives.

5 New Framework for Corporate Management of Defense R&D Programs

A new framework for corporate management of strategic R&D programs/projects specifically in the defense sector is proposed which has a layered and networked architecture covering program/project sanction and governance and regulating authority and implementation levels. The following key attributes are identified for the new framework which shall help in successful selection, sanction, development, and production of key defense systems and technologies for the armed forces.

5.1 Key Attributes

(a) The objectives and scope of the program are perfectly matched in line with the national science and technology policy, defense acquisition policy, defense services road map, etc. This is verified by a high level expert committee.

(b) The scope feasibility, technology feasibility, and evaluation are carried out by an interdisciplinary expert committee.

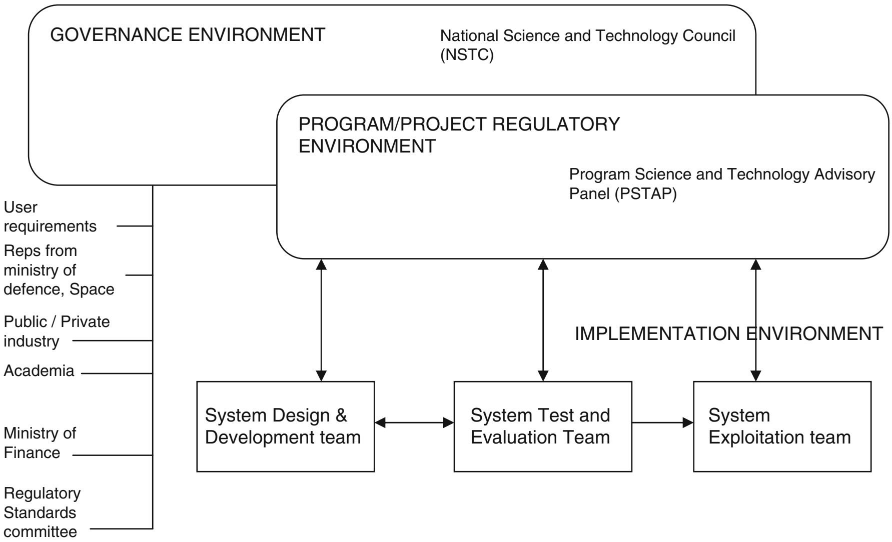

Fig. 3 New framework for corporate management – defense programs

(c) It is ensured that the technology is available within the country or shall not be a constraint for the project.
(d) It is also ensured that the adequate industry support and infrastructure is available within the country or abroad
(e) The program is initiated, implemented, moderated, and governed by a regulating body.
(f) The working level in the network model shall be responsible in initiation, implementation, and completion of the project/program (Fig. 3).

Since multiple agencies and departments are participating in the networked mode, an "apex council called National Science and Technology Council" (referred to as NSTC in further discussions) needs to be formed with selected council members from each of the participating agencies and departments. When determining the representation from different departments, care must be taken to ensure that all activity areas are covered starting from program concept to realization and utilization. For each strategic program, a Program Science and Technology Advisory Panel (referred to as PSTAP in further discussions) which is a subset of NSTC is formed in a similar fashion from the apex council members of NSTC. This shall be the official regulatory body for the selection, design, development, implementation, review, configuration management, evaluation, and utilization.

Apart from NSTC and PSTAP, there are multiple executing groups for each of the program implementation tasks. The constitution of these groups is function dependent like design, analysis, production, evaluation, etc., and experts are inducted into the group as and when required.

6 Implementation of the Proposed Framework

6.1 Roles and Responsibilities

An overview of the roles and responsibilities of all the key levels in the proposed framework are listed below with respect to six key domain areas. The key domain areas are:

1. Selection of strategic program
2. Envisaged value – tangible and nontangible
3. Resource management
4. Predicted outcome – commercial and noncommercial
5. Program progress measurement
6. Performance measurement

6.1.1 National Science and Technology Council (NSTC) (At Organizational Headquarters Level)

The National Science and Technology Council is formed at the organization headquarters and is the apex body governing the research program. It is the top most level in the networked model and has a very important role in identifying, sanctioning, and implementation of programs and projects within the organization. The constitution of the NSTC consists of senior officials and technocrats from central research organizations, academia, key ministries of the government, planning commission, representatives from the public sector and private sector industry, etc. The NSTC policies and proposals shall be in line with the science and technology road map, concerned technology road map, acquisition policy if any, etc. The major role of NSTC shall be:

1. Program identification and need study
2. Program scope development and governance

Apart from that, we are proposing the following major initiative which shall be useful for all technology critical projects and programs. This needs to be administered and monitored by the NSTC.

3. National technology resource assessment

National technology resource assessment (DATE manual of the DRDO) consists of estimation of both knowledge and infrastructure resource assessment.

(a) Knowledge factor: This is a function of core technology base available within the organization and also what is available with other central R&D institutions within the country, Indian industry. This can be rated as an integer on a 1–10 scale.

(b) Infrastructure factor: This indicates a measure of infrastructure and facilities available within the R&D organizations and also elsewhere within the country. This also can be rated as an integer on a 1–10 scale.
(c) The technology resource index is a composite parameter and is a function of both knowledge factor and infrastructure factor. Many a time, one of these factors has more relative importance compared to the other. Thus, technology index can be derived as follows:

$$\text{Technology resource index} = \frac{\alpha(\text{Knowledge factor}) + (1-\alpha)(\text{Infrastructure factor})}{10}$$

Technology resource index needs to evaluate for core technologies that are applicable to major public-funded R&D programs and projects. NSTC needs to compile technology index values for core technologies as well as subtechnologies and periodically update and maintain. The above principle is demonstrated with the following example.

Example Project: Underwater Sensor System

The core technologies are acoustic transducers (knowledge factor – 7, infrastructure factor – 8, $\alpha = 0.8$). Similar estimations are carried out for other core technologies applicable for underwater sensor systems like ASW oceanography, digital signal processing, underwater engineering, etc. In each of these core technologies, subtechnologies are also identified and resource index evaluated. For example, core technology digital signal processing can be further subdivided into:

1. Spectrum estimation
2. Time frequency analysis
3. Spatial signal processing etc.
4. Adaptive beam forming techniques
5. Signal auto correlation for classification

6.1.2 Program Science and Technology Advisory Panel (PSTAP)

The PSTAP is a subset of NSTC but can be located at the headquarters level. This group shall be responsible for the following important functions starting from finalizing the scope of the project to the project closure and client interaction. Program performance management by continuously monitoring schedule variance and cost variance and also decisions on project sanction and project period extension comes under the purview of the PSTAP.

The major activities are listed below and include:

1. Scope design
2. Program review
3. Implementation

4. Program progress review
5. Resource usage
6. Program performance management
7. Program closure
8. Program effectiveness analysis

6.1.3 System Design and Development Team

The system design and development team is the project team at the nodal laboratory/work center level for the selected program and headed by a project or program director. This team shall be responsible for the design, development, implementation, progress review, configuration management, and performance of the system.

The project director is guided by the PSTAP and is empowered to take all decisions with respect to the project/program. The project director is also responsible for the project outcomes as well as for the delays in completion. The project director is the approving signatory for all decisions and transactions in the project. The project director shall have project managers working under him in each of the functional streams.

6.1.4 System Test and Evaluation Team

The system test and evaluation team at the nodal laboratory level is responsible for finalization of acceptance test criteria for the evaluation of the system in consultation with the user group. This is an important activity since the test schedules and methodology need to be finalized based on the acceptance criteria and the original quality requirements for the system. The modality of conduct of evaluation is also finalized where it is mentioned at what stage each function or property of the system is going to be demonstrated.

6.1.5 System Exploitation Team

The prototype system needs to be exploited under the actual conditions, and its efficacy needs to be validated. Also, reliability and maintainability figures are to be logged for improving upon the system performance in the production versions.

6.2 New Program/Project Initiation Under the New Framework

1. The organization in consultation with the NSTC shall initiate the new projects and programs for sanction. NSTC to in principle approve the proposal before the project definition document is prepared.

2. Project definition document (PDD) is prepared and approval sought from the users. The approved PDD is submitted to NSTC for detailed analysis and vetting.
3. Once the NSTC clears the PDD, PSTAP is constituted and action initiated for both administrative and financial sanctions of the project at headquarters level.
4. PSTAP intimates the nodal laboratory of the final sanction of the project and requirement of formation of system design and development team.
5. PSTAP to guide the system design and development team in completing the major activities of the project like preliminary design, technology assessment, vendor identification, critical design reviews, planning, controlling, and execution of the project.
6. The PSTAP oversees the formation of system test and evaluation team at the nodal laboratory level and ensures that the system is formally handed over with complete information including documentation.
7. The test and evaluation team shall carry out the detailed evaluation of the system including factory acceptance tests and field evaluation trials.
8. PSTAP shall recommend closure of the project based on the reports of the test and evaluation team. It shall also receive periodic reports from system exploitation team.

7 Discussions

The concern with the adequacy of the methodology being adopted by the public-funded research organizations in executing nonsuccessful large value projects stems from the same roots as concern with the problem of selecting the right project for execution. Most of the research on project management focuses the issue of selection, failure study, and termination decisions and is generic (Buell 1967; Avots 1969). Our study shows that there are some important contingency factors that force us to relook the existing model and recognize the role of different stakeholders at different stages in the project life cycle. The new framework adopts a holistic approach in selection and execution of high-technology defense projects. Follow-up interviews with some of the respondents confirmed the idea that the new framework shall aid in horizontal integration of projects within an organization since the members of NSTC and PSTAP shall be common.

8 Limitations and Conclusions

This study has some limitations. One major limitation was the limited sample size of the study conducted. As indicated earlier, the mode of execution of mission mode projects, technology demonstration projects, and science and technology projects is all different, and hence, the study focused on the mission mode projects only. The study and analysis focused only on some of the issues of corporate management and omitted environmental factors which are beyond the control of the corporate management. Technological obsolescence, superior technology alternatives, etc., are examples. Our focus has been on factors over which the corporate management can exert some change and exert control.

Even with these limitations, the study has important implications in understanding the role of corporate management in undertaking technologically challenging defense projects. (1) The projects are not initiated and approved in isolation by individual laboratories. (2) Headquarters of the organization has a more involved role with formation of NSTC and PSTAP as compared to the present administrative role. (3) PSTAP can administer performance management with the crucial decisions including terminating the project. A new framework is proposed for strategic high-technology programs of national importance. Program implementation using this model is discussed with the assumption that this model shall be more suitable because of the various advantages over the present model.

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Utilities' Technology Management of Smart Grid Innovation and Implementation

Torben Tambo

1 Introduction

Smart grid is high on the technological and political agenda in most countries, and the term expresses much of today's governmental and entrepreneurial efforts made in response to the environmental challenges of the twenty-first century (Wissner 2011). Smart grids are intended to match energy-consuming devices with energy-producing devices for the purpose of balancing supply and demand in a world with less available fossil fuels and an increasing reliance on the more volatile character of renewable energy. Smart grids encompass information and communication technologies (ICT) in the power network, and they are able to control both the supply and demand side with especially electric vehicles and heat pumps for accumulation of asynchronous energy. The development trajectory runs at least until the year 2050 (Regeringen 2011) and relies on heavy innovation efforts (Tambo 2011) at all component levels, including consumer attitudes and expectations. Large investments in smart grid are foreseen worldwide (Bhanhoo 2010; Joosting 2010).

Electricity companies are touted to take the lead in implementing (Goodman and Griffith 1991) and designing the infrastructure for smart grid innovations (Järventausta et al. 2010; Kiesling 2010; Ilic 2010). In this connection, the electricity companies must accept, adopt, promote, operate and manage different constituting technologies, each dependent on a full line of innovation activities stretching 5–40 years ahead. The purpose of this chapter is to give an account of the technology management process (Bengtsson and Ågerfalk 2010; Foxon and Pearson 2008; Gamser 1988; Garrity 2009; Meeus and Saguan 2011) facing electricity companies acting on behalf of consumers and society in their endeavour to transform the global impact of energy. This chapter studies the possibilities for smaller electricity companies to comprehend, select and prioritise among a host of standards, products and solutions.

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The raison d'être of this study lies in its use of a management of technology approach (Tidd et al. 2008) for understanding innovation and implementation in smart grids (Magnusson and Martini 2008; Snow et al. 2010). Strong optimism has enveloped smart grid innovation as a determining factor in managing the transition from fossil to renewable/non-fossil energy (Shum and Watanabe 2009; Tsoutsos and Stamboulis 2005). Deregulation, however, has forced electricity companies to reduce the size of their organisations and probably also their capabilities within management of technology (Jamasb and Pollit 2011; Kiesling 2010; Switzer and Trout 2007). The views and suggestions of this chapter are expected to be useful for strategic planners in the energy sector and environmentalist policy makers.

2 Method

In terms of methodology, this chapter is based on a mixed approach encompassing both qualitative and quantitative elements. The dominating qualitative element employs an interpretivistic, sociologically inspired research lens. The quantitative part includes a series of technical feasibility-oriented studies, among them follow on technical process studies. Methodological study of innovation systems is inspired by Carlsson et al. (2002).

This chapter is based on studies of a number of energy companies – two trading and service companies as well as six studies in five distribution companies – in relation to national and international initiatives. The company approach has been within the frame of university-enterprise relationships, and the qualitative observations are based on strategic, technological assignments set by the companies and given to the university. A literature study includes recent contributions on smart grid and management of technology in the cleantech/electricity sector. The view on innovation theory is mainly drawn from the field of management of technology (Tidd et al. 2008; Schilling 2008).

3 Theory

The urgent necessity of transforming the energy system and the expectation that smart grid technologies should be the controlling component in that connection imply that the theoretical approach of this study must be to examine how innovation efforts are to be organised around the desired technologies and their inclusion into spheres of application.

Optimisation of the energy system is a scientific and engineering challenge requiring insight, foresight (Koch et al. 2008; Vanston 2003) and identification of opportunities and threats (Lichtenthaler 2006). Occasionally, users have been engaged by means of general awareness campaigns or indirect economic incentives. As this study is a part of a larger, more techno-centric project, we have chosen to narrowly focus on the innovation and organisation perspectives. Authors like Vergragt and Brown (2007), Herring and Roy (2007), Ornetzeder and Rohracher (2006) and Gamser (1988) suggest looking at broader innovation and engagement potentials than traditional technical solutions. Market pull and technology push in innovation management is suggested by Brem and Voigt (2009).

Formerly, there was a direct relationship between manufacturing, distribution and sale of energy. Deregulation and liberalisation have split the unity into independent organisations (Switzer 2007; Hämäläinen et al. 2000). Independent traders are allowed to sell energy using any network, making this the actual point of sale for deciding whether to go with a more or less green energy solution; in effect, eco-labelling of energy imposes challenges of credibility (Banerjee and Solomon 2003). Traditional distribution companies are granted a monopolistic status and remain regulated, bound to a public service obligation (PSO) regime that limits funding, investment and economic potential for innovation (Jamasb and Pollit 2011). The partial deregulation affects only a select few issues, leaving the remainder highly regulated (Carpio and Margueron 2009; Olsen et al. 2006); governmental control mechanisms are prevalent throughout the energy system (Luiten et al. 2006).

The introduction of ICT reshapes the electricity grid and realises the 'smart' element in 'smart grid' (Bengtsson and Ågerfalk 2010; Jenkin et al. 2010; Järventausta et al. 2010; Sisley 2007). The ICT technology stack is thus an enabling technology for smart grids, merging communication and information. The studies described below seek to identify the interrelations of these technologies. Low-power short-range communication and distributed databases are of interest. Sustainable ICT ('green IT') and ICT for application in sustainable contexts are often confused, but a strong sharing of concepts and technologies exists between these two notions (Harmon et al. 2010).

Within the context of innovation, fundamental questions are how to define innovation, the targets and scope of innovation, the drivers of innovation and the system of innovation. Schilling (2008) describes the strategic nature of innovation. Nonaka and Takeuchi (1996) propose to view innovation as a matter of organisational knowledge creation. Davenport (1993) discusses the process of innovation. The system of innovation is brought to the front, since the broadest conceivable form of engagement and impact is present: the whole society. Carlsson et al. (2002) and Edquist (2006) contribute to the detailed understanding of the systems of innovation. In their discussion of cleaner technologies, Foxon and Pearson (2008) explore deeper the drivers of and barriers to innovation. Kiesling (2010) deals with the specific promotion of innovation in the electricity industry.

The time aspect of innovation (Luiten et al. 2006) and the character of the innovation continuum characterise success potentials, success criteria and organisation of the management of technology. Tidd et al. (2008) describe successful management of technology based on modernistic, collaborative forms of companies and organisation of work. Mirata and Emtairah (2004) unfold a case study of continuous innovation in cleantech, initiated and sustained through a regional industrial cluster. Magnusson and Martini (2008) propose to see organisations in this area as having a dual competency in operations and innovation. In the development of the electricity industry, this might indicate a key focal point as this is exactly the expectation held by consumers and regulators. Looy et al. (2005) support the view of the dual competency, but they replace the term dual with ambidextrous, thus, emphasising that innovation and operations are not parallels, but a matter of deeply rooted competencies.

Management of technology (Nill and Kemp 2009) discusses radical innovation in sustainable energy innovation and suggests three models: (1) strategic niche management, (2) transition management and (3) time strategies. Further on in this chapter, management of technology is the key notion as (1) smart grid is pervasive and not a niche, (2) history of green energy has an intrinsic prolongation that couples more to continuous approaches than clear transition and (3) time strategies are generally superseded by financial constraints. This does not fully rule out the possibility of disruptive innovation, but the empirical studies below do not currently indicate that a major breakthrough is imminent. The host of technologies can be observed and managed as a portfolio (McNally et al. 2009).

Additionally, with respect to the extended time horizon of the depicted innovation object, technology roadmapping is expected to be a supporting discipline (Harmon et al. 2010; Petrick and Echols 2004; Phaal et al. 2004). Systematic prioritisation of the innovation effort is expected to be accomplished by means of financial planning, innovation load, consumer adaption, business partner readiness and management of changes to the 'master planning'. Uncertainty seems strong and the roadmapping must take care to include different scenarios.

Innovation and drivers for technological change are traditional areas of study within the electricity sector (Hughes 1983). Life cycles for large electricity infrastructures typically span 10–20 years for planning and construction, and the operational life is typically 30–50 years. In the context of smart grid for smaller energy distribution companies, much product innovation is expected to take place within suppliers and to be promoted by governmental incentives (Hendry et al. 2010). As the companies are left with technical rather than technological solutions, innovation is assumed to be directed towards screening, financing, implementation, operation, marketing and life cycle management. Tidd et al. (2008) contribute to the understanding of context definition, search, selection and implementation. Moreover, they highlight the issue of 'capturing the benefits of innovation', which in this case is remarkable as the companies only marginally reap the benefits of the innovation. Companies might be regarded as contractors acting on behalf of society and emphasising the governmental role.

4 National and Industrial Cases

Most electricity companies in Denmark are SMEs. Smart grids are orchestrated by a central, governmentally controlled organisation, but local companies can pick and choose from the technology stack. One overall system-responsible organisation has issued this roadmap for top-level innovation and activities maturing over the next 10–40 years (Table 1):

Table 1 Governmental roadmap for Smart Grid in Denmark (Energinet.dk (2010))

Phase	First: facilitation 2010–2012	Second: establishment 2013–2020	Third: commercialisation 2021–
Change in society	Heat pumps (HP) gain momentum First versions of EVs	HP common Small sales of EVs	HP dominant EV common
Aim	Mobilise actors Agree on standards	Basic infrastructure Diffuse solutions	Balance power grid using smart grid
Key activities	ICT standards Roles and responsibilities	Smart grid market mechanisms Commercialise smart grid	Smart grid in everything Optimisation

Heat pumps and electric vehicles are major factors because of their ability to store and release fluctuant wind power. No particular approach to or explicit reflection on management of technology is stated at Energinet.dk (2010), only an underlying assumption of a necessity for change and development is perceptible. Listed below are the cases where different local electricity companies are working to respond to the challenge.

Forming part of a university-enterprise collaboration programme entails the completion of a series of smaller feasibility studies. The aim of the individual studies was to identify future perspectives in the electricity supply related to smart grid – particularly networked technologies. The main business area of all the companies is that of trading, selling or distributing electricity; most companies distribute electricity, but some only sell (Table 2).

Most companies have less than five employees working directly with development and planning of future technologies. There is a strong tradition throughout the organisation of ongoing optimisation of existing and aged systems and components in line with the continuous improvement discussion by Cole (2001).

The SW, SE, ED, MU and MI studies have a strategic and innovation-oriented scope. SY, SE, SF and NR are more technical. As such, the studies represent a dual approach in the understanding of the reality of the companies that have to face intertwined technical and business/strategic issues. None of the companies see themselves as ambidextrous. However, niches are found within the companies insofar as very small teams work more holistically with selected aspects, such as photovoltaic or farm biogas-powered electricity.

The companies find themselves at a very early stage of a very long and generally very unclear technological and commercial trajectory. A quote from NR: 'We have now spent 40 years stabilising and cost-reducing the network. Now we are looking at spending the next 40 years making the network more volatile and at higher costs'.

Mixed signals from governmental and regulatory bodies along with (fear of) wrong or unclear technological decisions have the following consequences:

- No clear and specific national technological mandate exists.
- Feasibility studies are managed by the electricity companies by applying for central funds – with no obligation to make permanent solutions, more meeting demonstration purposes.

Table 2 Empirical cases from the university-enterprise collaboration

Company	Study orientation	Management of technology emphasis
SE N/A	Electricity in partially deregulated markets is a consumer product that needs to be sold to customers reflecting customers' buying behaviour. Smart software solutions from the mobile virtual network operator industry can support younger, web savvy customers and improve business processes	New technology for sales and business integration
SW 65.000	The company needs guidelines in terms of how to balance between electricity from wind turbines, garbage combustion, biomass combustion, photovoltaic, biogas, natural gas and externally produced electricity	Multi-source energy management
SF 9.000	Reviewing communication protocol selection for automatic metre reading. A host of wired and wireless communication protocols in various frequency bands (~bandwidth, ~interactivity) has been tested and evaluated. Wireless M-BUS seems to be the right choice despite little operational track record	Establish wireless metres and infrastructure
NN 30.000	Automatic metre maturity analysis. In-house network technologies, access Net and backbone network technologies have been evaluated and tested in a multi-parametric approach. Recommendations have been issued as to supplier and network management	Metres and communication technologies in shaping of the future
NR 150.000	Capability review of information infrastructure and proposal for long-term redesign of the consumer-grid integration. NR lacks infrastructure for the next step in billing systems. The review points to solutions similar to those of the SE company above, but NR is constrained by older IT systems	Business process integration and infrastructure adaption
ED N/A	Larger consumers are critical in adapting to the volatility of a renewable power source, especially wind turbines. Since most large consumers are already well optimised from a technical viewpoint, new methods must be used to ensure continuous improvements and adaption to flexibility.	Strategic sales and marketing using technology
MU 150.000	Assuming that heat pumps are critical to the inclusion of residential consumers in the smart grid, the study aimed at assessing scenarios for marketing, sales and service of heat pumps for residential use	Creation of business plans for heat pump marketing
MI 150.000	Screening for smart grid enablers and components in a distribution network. Infrastructure is assessed and found adequately sufficient for the early phases of pragmatic smart grids, also with	Designing full scale 'prosumer' integration

(continued)

Table 2 (continued)

Company	Study orientation	Management of technology emphasis
	observations of customers acting both as consumers and producers ('prosumers')	
SY 250.000	As power line communication has become commonplace in automatic metre reading, various new issues influence the quality of the reading process, e.g. outages and unavailability stemming from load shift and phase changes	Early mover technology development and optimisation

– 'Unregulated' competition among traditional and new suppliers of IT, infrastructure, network equipment and metres increases the potential for making wrong choices.
– Prohibition on adding charges to consumers or traders from distribution companies; thus, smart grid enabling must be funded from operational income.
– Investments in domestic fibre-optic networks did not benefit smart grid enabling.

In management of technology, reluctance seems to prevail among companies that see themselves as about to start or just having started with smart grids. Solid and detailed long-term roadmaps sparsely exist, with political uncertainty. Sudden events can also induce major changes, e.g. public acceptance of nuclear power plants, environmental impact of onshore wind turbines, carbon capture and storage technologies.

5 Discussion and Proposals

As an instrument for reducing the environmental footprint, smart grid is a critical issue for both society and the utility enterprises. Central in this respect is the utility enterprises' ability to solve the issue. The case studies all include a broad network of suppliers, and the companies are highly aware of the fact that innovation at product and product system level is largely supplier-driven. Other types of innovation include and (some) engage the customers. Neither of the projects takes consumers' requirements and expectations into account. The broad definition of innovation indicated in Vergragt and Brown (2007), Herring and Roy (2007), Ornetzeder and Rohracher (2006) and Gamser (1988) seems to be reflected in the studies.

This study has found that the electricity companies are struggling to keep up with societal policies on energy technology innovation. Companies strive for stabilisation and regularity. Now they have to support far more diverse technologies while coping finances and organisation. Also, several dead-end technologies are continuously emerging and need to be kept 'harmless'. The key finding is that the companies have to free smart grid innovation from the embrace of dealing with everything and instead focus on an innovation management process only dealing with high-prioritised technologies. Seen from the viewpoint of the companies, the majority of which are consumer-owned; the problem is not so much a lack of innovation in the industry, but far more a lack of methodologies suitable for managing innovation. The electricity sector is divided into distribution, sales and production of energy, making it even more difficult for the distribution companies alone to manage the interlinking and infrastructure provision between the two other parties and the consumers.

The findings are mostly applicable for smaller (SME) electricity distribution and trading companies (<250,000 households) in industrialised areas potentially with strong legislative regulation, monopolistic or public service obligations (PSO) in casu Denmark. The selling of electricity to deregulated markets, as done in the cases of SE and ED, adds further complexity, as SE and ED are owned by the (small) monopolistic distribution companies (Switzer and Trouet 2007; Hämäläinen et al. 2000).

The cases demonstrate reliance on active participation in innovation ecosystems (Snow et al. 2010), including university collaboration. Collaboration also exists with national interest organisations and with selected groups of geographically similar companies. Suppliers represent a very technically credible ecosystem but tend to lock in on or be biased towards a specific technology and fail, for instance, to fully comply with open standards. The collaboration approach adds an entrepreneurial dimension to smart grids in line with Miles et al. (2005) in sustaining continuous innovation.

Business implications of smart grid innovation are expected to show us the difference between winners and losers on the global energy arena; the social implications of success, failure or reluctance might be devastating (Sharma and Ruud 2003). The general assumption is that a modified and outspoken position on dynamic prioritisation of technologies is required within management of technology in the energy sector.

Solutions can be found by actively including smaller and larger consumers in the smart grid development and by excluding distribution companies. Consumers can be offered various incentives for using energy in a more green manner, e.g. by buying eco-labelled power, using electric vehicles and heat pumps that poll central data sources and subscribing to elevate levels of transparency with metre reading technologies. The study described in Schultz and Tambo (2011) shows how larger consumers can redefine their consumption profile – not as a technical project, but by implementing a distinct organisational innovation system engaging a range of company-internal competencies.

The study indicates that electricity distribution companies are able to improve the utilisation of resources required for sustaining the management of technology in smart grid by means of a series of potential initiatives, e.g.:

– Strict prioritisation of supported technologies
– Clear roadmapping of supported technologies and associated support systems

– Shift the responsibility of making critical decisions onto the regulatory bodies
– Distribute responsibilities downstream to the consumers
– Support alternative vendors that have systems bypassing the electricity company
– Embrace a clearer dual self-perception in the innovation and operation activities
– Decide clearly on internal or external innovation and vendor roles

The argument emerging from the discussion above is that management of technology is a requisite element of smart grid innovation. Nill and Kemp (2009) also suggest taking into consideration radical or disruptive innovation possibly relating to some aspects of smart grid innovation, e.g. certain network product technologies or agreed standards. The cases, however, indicate a breadth and a time extent of implementation, marketing, financing and support, making at least the non-product innovation call for management of technology approaches. The roles played by government may blur the picture (Hendry et al. 2010) as it (1) can provide direct funding, (2) by legislation may enforce certain groups to finance the innovation, (3) as a regulator is in a position to withdraw monopoly licences and pass the licences to stronger market actors and (4) can set up legislative frameworks for both producers and consumers for how green the energy should be. If the role of the government is this strong, then an aspect of 'enforced management of technology' gains relevance. This contradicts with a benevolence of the technology.

Companies are found to be highly aware of their task and of the innovative character. Collaboration is widespread, but not 'ideal' and equal, as government and suppliers are taking the lead. The idea of management of technology is attractive but troublesome for the smaller and/or the financially troubled companies. The innovation types are centred around the product system, but there are indications of, e.g. marketing (MU) and customer internal innovation (ED) being potential alternative innovation types. The companies' organisational innovation system has not been detailed in this study, but this system would tentatively be expected to drive the management of technology: As this chapter focuses on smaller companies, innovation systems for management of technology have not been easily identifiable as they tend to be deeply embedded in the organisation. The idea of embeddedness leads to the relevance of observing the whole company as having dual or even ambidextrous competencies (Magnusson and Martini 2008; Looy et al. 2005).

In terms of suggestions for further work, it would primarily be interesting to look into the outcome of the specific projects in relation to the use of explicit management of technology tools. In this connection, it would be interesting to observe the performance of the smallest versus the largest of the companies with respect to the transformation of experimentation into operations and their respective abilities to deliver the environmental promises of smart grid. As with the timeline in Table 1, there are high expectations but vague recommendations in many years to come. The internal versus the external drive and yield of innovation would also be interesting to monitor.

6 Conclusion

This chapter has discussed smart grid as a management of technology object for utility enterprises – primarily electricity. Smart grid's institutionalisation into national and international standards, encompassing a wide range of different geographical and demographical conditions, might make it highly difficult to implement at local levels. The fact that there are about 100 rather autonomous electricity companies in a relatively small country makes smart grid innovation and adoption a challenge. Nevertheless, 22% of all smart grid projects are carried out in Denmark (JRC 2011). The studies presented in the case section indicate a piece-meal and pragmatic approach.

With a global and national push on greener technologies, smart grid is an excellent case of mandated innovation transferring into a management of technology complex. It is driven by political and environmentalist initiatives influenced by financial and market aspects. This chapter suggests a stronger and more explicit management of technology policy formulation at both national and local level. At an intermediate level, it would be beneficial to develop from 'random' experiments to a higher degree of systematic transformation.

This chapter has studied smart grid innovation under the lens of management of technology. Smart grid innovation would strongly benefit from the inclusion of a more distinctive adherence to the use of management of technology, with individual companies and ecosystems as the critical factors. Management of technology theory provides an applicable framework for organising and structuring smart grid innovation. With this conclusion, smart grid has just embarked on a journey pointing at least 40 years ahead, a journey that requires constant momentum. The companies are certainly on a new path with speed and a magnitude comparable to the electricity innovation of the early days as described by Hughes (1983).

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Towards Patients as Innovators: Open Innovation in Health Care

Christoph W. Kuenne, Kathrin M. Moeslein, and John Bessant

1 Introduction

While other big industries have adopted the advantages of the information technology age since the 1980s (Von Hippel 1988; Schepers et al. 1999), the health care sector has been quite hesitating to do similarly, especially in support of coordination and cooperation between institutions. Now the influence of technological advance on health care is likely to further increase (Randeree 2009). One of the recent developments in the health care sector, termed *Health 2.0*, has been the use of Internet or Web 2.0-based technology in health care (Van De Belt et al. 2010; Oh et al. 2005). Recent studies give evidence that the number of Internet users worldwide that go online for health-related purposes is growing significantly (Kummervold et al. 2008). Over the past few years, many online platforms for consumers of health care have arisen to give information about disorders and to facilitate networking with like-minded sufferers. The implemented functionality ranges from simple information distribution and general

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health advice to highly active patient communities specialized on rare conditions. Also, some of the platforms integrate elements of open innovation – if it is bringing people together who have not exchanged ideas and knowledge before – or solution-oriented discussions around users' problems. Some reports herald that Web-based tools in health care are powerful and radical means to changing current roles of health care consumers as well as professionals and medical practice (e.g. Christensen et al. 2009).

Surprisingly, given recent trends and challenges in the areas of health care, notably Health 2.0, and innovation management, notably open innovation, the innovation potential of Health 2.0 is still under-researched. The aim of this study is to further knowledge in the area. This chapter provides the essential systematization of online platforms in the Health 2.0 space and goes beyond existing knowledge by applying an innovation perspective. The research presented here starts to build knowledge in the field, led by the following research questions:

1. *How can Health 2.0 platforms be systemized within an innovation-oriented taxonomy?*
2. *What are preliminary learnings from a large-scale open innovation pilot in this field?*

In the following section, we start answering the questions by presenting the state of knowledge in the field. Then, we describe the methods of our empirical study (cf. Sect. 3), followed by the presentation of findings (cf. Sects. 4 and 5). A discussion of results, limitations, and future research closes this chapter.

2 Setting the Scene

2.1 Web 2.0 in Health Care

Compared to Web 1.0, the so-called first generation of the Internet, the difference of Web 2.0 is foremost about user participation, openness, and network effects (Musser and O'Reilly 2007; O'Reilly 2005). Users can more easily create, add, and publish information and content to the Web. For that reason, Web 2.0 has also been called 'social Web', and the amount of user-generated content has increased enormously (OECD 2007). This recent trend has also shown impact on health care-related online offers which is then described as *Health 2.0* (Van De Belt et al. 2010; Eysenbach 2008; Hughes et al. 2008). There is still no general consensus regarding the definition of Health 2.0. Van de Belt et al. (2010) performed a systemic literature review and came up with 46 unique definitions of which 9 definitions were found in scientific literature, while the rest originated from grey literature. They conclude by finding seven leading themes within all definitions (see Table 1).

Table 1 Recurrent themes within definitions of Health 2.0 (Van De Belt et al. 2010)

1. Web 2.0 technology:	Web 2.0 as the underlying technology for communication and information sharing
2. Consumers involvement:	Increased participation or empowerment of patients or consumers of health care
3. Professionals involvement:	Apart from health care consumers only, increased participation or empowerment of health professionals or other stakeholders, e.g. payers, providers, researchers
4. Communities:	Emergence of online communities and social networking in Health 2.0
5. Collaboration:	Improving collaboration between patients and health professionals
6. Health data:	Stronger focus on health information and content, one that is patient-driven or user-generated
7. Change of health care:	Positive impact or change on the health care system in terms of higher quality and efficiency in health care

2.2 Imperative for Open Innovation

One approach, advocated in the UK-based Wanless report (Wanless 2002), placed considerable weight on the role of the patient as a key architect in developing health care systems for the future. It emphasizes that better access to information can help patients to be fully involved in decisions, not just about treatments, but also about the prevention and management of illness. With user involvement gaining more importance, the role of the patient is moving beyond an 'informed consent' to an 'informed choice'.

This mirrors the wider moves towards what Von Hippel calls *the democratization of innovation* and implies much higher levels of user engagement in design and development of customized solutions matched to local and specific needs rather than a generic 'one size fits all' approach (Von Hippel 2005). Related to the increasing need for innovation in health care, there is a paradigm shift in managing innovation. Often referred to as *open innovation* (Chesbrough 2003), this approach is about achieving and sustaining a higher degree of innovation by opening up the traditionally closed innovation process. It suggests that the process of product and service development should better integrate and leverage external knowledge resources provided by a wide range of external actors, such as customers and users. These external actors enable the innovating organization to learn more easily about their needs and to benefit straight away from their solution proposals for specific problems they might already have in mind.

Clearly there is considerable potential in approaches which mobilize a wider community, including patients and carers as part of the 'innovation front end' in health care. One powerful set of tools, already widely used in industry to enable *open innovation*, are those which mobilize the enormous reach of the Internet to create platforms on which shared exploration of health care challenges can take place involving a wide community (Bessant et al. 2012). The emergence of interactive capabilities in the online space can be an effective source of jointly constructed and shared knowledge through participation of patients, caregivers, health professionals, researchers, and others.

3 Method

As practice and research in the field of Health 2.0 is still recent, we chose an exploratory approach to study contemporary real-world innovation practices[1]. Data collection and analysis is based on the following four steps. *First*, we identified several hundreds of health- or medicine-related online platforms while focusing on English or German language websites only. This search process mainly employed (1) cases found via Google Web search, (2) referenced cases mentioned in the literature, and (3) referenced cases mentioned during the practitioner-oriented Health 2.0 conference series 2011. With this at hand, we created an empirical set of 122 health websites that follow the Web 2.0 criteria. Purely static health websites with no interaction functionalities for the users were disregarded. *Second*, we conducted linear analytical in-depth case studies on the sites functionalities (Yin 2003). Collecting data followed the same procedure for each platform: after registering a user account, relevant information, and key characteristics were compiled from public and member areas. As a result, we created case vignettes for each of them. *Third*, we derived a systematization according to the pattern-matching approach (Yin 2003). At this point, we create a taxonomy which identifies recurring types of Health 2.0 platforms. *Fourth* and lastly, we present experience and preliminary findings from design-oriented research: under the leadership of the second author, a large-scale research pilot in the focus area of rare diseases has been implemented and evaluated to gather first-hand experience from integrating patients as innovators in an open innovation environment.

4 Classifying Health 2.0 Platforms

In the following, we propose possible dimensions of a classification approach for Health 2.0 platforms. It is taking an innovation-oriented perspective while leaning on the groups of innovators involved as well as the expected innovation outcome (Kuenne et al. 2011).

4.1 Groups of Innovators

With the recent shift towards *open innovation*, innovation processes have to integrate three distinct types of innovators: core inside innovators, peripheral inside innovators, and outside innovators (Neyer et al. 2009). Traditional research and development (R&D) departments, classified as *core inside innovators*, hold a

[1] This paper builds on and advances previous research that has been submitted to the 2011 World Conference on Mass Customization, Personalization, and Co-Creation (MCPC).

central responsibility on filling the innovation pipeline with promising ideas. Employees from other departments than R&D are named *peripheral inside innovators*. This group is not directly responsible for innovation. Through their daily job though, they gain relevant experience and knowledge that can be a valuable contribution to the innovation process. Beyond the organization's boundaries, *outside innovators* represent all external players like customers, users, retailers, suppliers, and competitors. When they participate in the innovation process, their heterogeneous backgrounds and the outside-in perspective can create enriching contributions.

Hence, one way to classify Health 2.0 platforms is to look at the groups of innovators involved in health care. The patient stands at the end of a complex industry whose leading rationale is to improve health care. The patient is both actuator and receiver of all health-related efforts. Accordingly, the differentiation of the three types of innovators introduced before needs to be adjusted and led by a patient-centric perspective.

From the perspective of a patient, there are numerous relationships to problem solvers who can deal with the patient's health problems. In the first place, it is the patient's relationship to any sort of care providers, such as a dedicated general practitioner who typically has the best overview of the patient's health status. In the course of medical treatment, the GP might send the patient to medical specialists for further examination. In addition to the GP, the patient could consult other health professionals and medical experts on a one-to-one basis, ranging from technical encyclopaedia to health counsellors from industry partners. We consider the different instances of medical experts described here as *core inside innovators* – they all share a direct and very close relationship to the patient while acting as qualified problem solvers for the patient's health issues.

As a consequence of Health 2.0, the traditional one-to-one relationship between doctor and patient is supplemented by a number of new relationships with like-minded people. Here, one major group consists of fellow patients who suffer from a similar disease pattern and also their caregivers and family relatives who suffer indirectly. They all have acquired relevant experience and knowledge in the same field. As fellow sufferers are less familiar with the patient's detailed situation than the supervising GP but still can share relevant experience, this group could be considered as *peripheral inside innovators* from a patient-oriented perspective. Other stakeholders who do not directly share disease experience with the patient make up a third type of innovator. They can contribute specific technical knowledge in order to solve, or at least facilitate dealing with, the patient's health problem. These could come from the afore-introduced side of suppliers, payers, and regulators. Typical examples are industry partners like medical device manufacturers or service businesses specialized on a particular aspect of medical care. According to the previous logic of patient-centric perspective, we consider this group as *outside innovators*.

To conclude, one approach to classify Health 2.0 platforms is about patient-related innovator groups consisting of three clusters: (1) medical expert-to-patient relationships, (2) patient-to-patient relationships, and (3) other

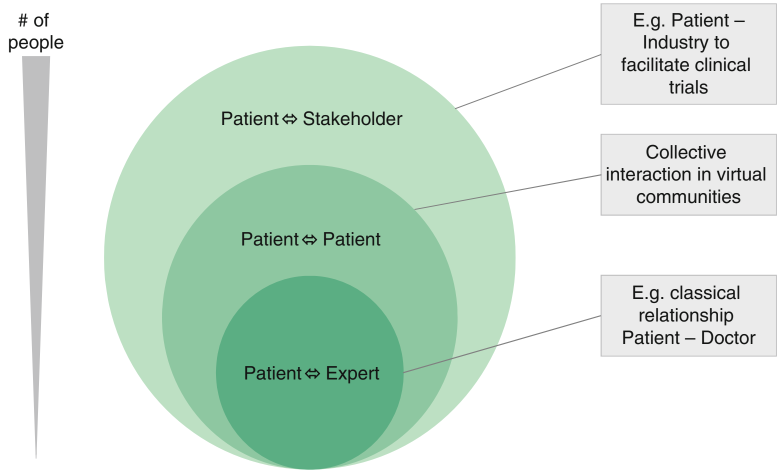

Fig. 1 Classical relationship patient-doctor enhanced by relationships created in virtual communities

stakeholder-to-patient relationships. It is conceived as a shell model, which means that, for example, patient-to-patient relationships are consecutively based on expert-to-patient relationships (see Fig. 1).

4.2 Degree of Innovation

An important aspect of innovation is the *degree of novelty* involved. Obviously, upgrading minor details of a product like improving medical care through new ways of servicing is not the same as finding a formula fighting an HIV infection or a rare disease. There is a continuum reaching from incremental improvements to radical changes (Garcia and Calantone 2002; Tidd et al. 2005). *Incremental innovations* are more widely seen in practice than 'new to the world' products. The cumulative gains in efficiency which come along with incremental changes are often larger over time than gains from occasional radical innovations. In contrast to incremental improvements, *radical innovations* change the 'rules of the game' and challenge the boundary conditions (technology, markets, social, regulatory, etc.), but they enable a totally new opportunity space for innovation (Foster and Kaplan 2001; Francis and Bessant 2005). Radical innovations account for only 6–10% of all innovation projects (Ettlie 1999). Yet, it is important to note that it is the *perceived* degree of novelty which matters (Tidd et al. 2005).

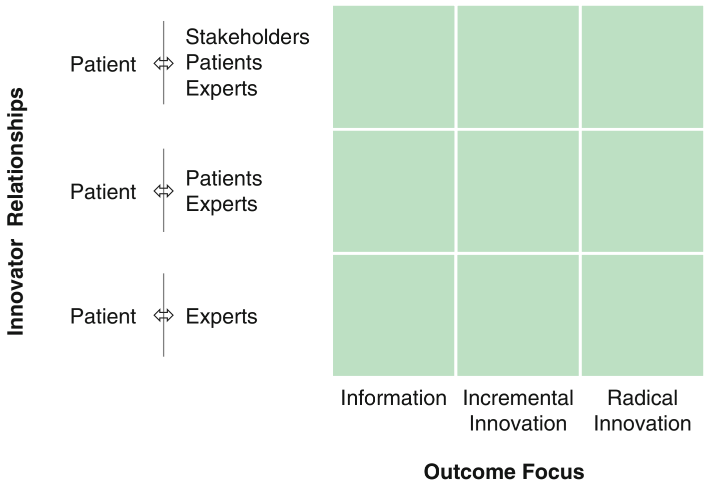

Fig. 2 Innovation-oriented taxonomy for Health 2.0

Another way to classify Health 2.0 platforms is the outcome focus of Health 2.0 platforms. The online platforms currently available in the Health 2.0 space differ widely in their mission statements. When we look at it from a dedicated innovation standpoint, we narrow the focus down to the impact such a site can have on the emergence of innovation. More specifically, due to the relative novelty of a number of sites, the focus sits on the *anticipated* outcome. Classification may be done through declared intention by platform operators as well as assessment by innovation researchers.

On the one hand, there are online sites which do not, or at least not to a recognizable extent, have a dedicated innovation focus but which still operate successfully in the health segment. These are mostly sites characterized by unilateral information dissemination, for example, on general health advice, or sites providing basic functionality on managing one's personal health record electronically (without connecting to a community). On the other hand, online platforms stating a clear innovation focus can be classified along the degree of change that an innovation may invoke. The change can be of incremental or radical type. For example, a typical online self-help group with forum character certainly has the potential to create incremental innovations. In contrast to that, rewarded innovation contests like the Archon Genomics X Prize (http://genomics.xprize.org) are more likely to come up with radical innovations.

To conclude, another approach to classify Health 2.0 platforms is about the outcome focus of Health 2.0 platforms. It consists of three clusters: (1) focus on information, (2) focus on incremental innovation, and (3) focus on radical innovation. The resulting three-by-three matrix which allows classifying Health 2.0 platforms is depicted below (see Fig. 2).

4.3 Qualifying the Taxonomy

Popular examples of health-related sites in the USA are, for example, *WebMD* (http://www.webmd.com), *Yahoo Health* (http://health.yahoo.net), and *Revolution Health* (http://www.revolutionhealth.com). These sites are mainly one-way information resources for health seekers, ranging from general health advice to more troublesome disorders like cancer or heart disease. Each article is reviewed by one or more physician editors before publication. *Revolution Health* also uses patient chat groups to multiply results, but the perspective remains centred on the single consumer. The outcome focus of these three sites certainly does not lie on innovation creation, but information dissemination. So we propose to classify *WebMD* and *Yahoo Health* into the lower-left field of the taxonomy, and *Revolution Health* due to its additional forum approach into the middle-left field.

Established patient support groups can be found on, for example, *DailyStrength* (http://www.dailystrength.org) and *CureTogether* (http://www.curetogether.com). Focus lies on sharing knowledge, experience, and support in active discussion boards, which eventually leads to incremental innovation. We consider these examples to be located in the very middle field of the taxonomy. A further advanced example is *PatientsLikeMe* (http://www.patientslikeme.com), an online community for patients with life-changing diseases. At *PatientsLikeMe*, physicians are not directly involved in the interactions taking place on the site. But still, there are medical experts. It needs thorough understanding of each supported condition to create structured profile masks enriched by meaningful metrics and graphs as available on *PatientsLikeMe*. The expert knowledge lies in there. More obvious is the interaction between patients which needs no further comment here. Industry or non-profit partners are able to create subpages on the site and, thus, can reach out to patients for, for example, trial recruitment, education purposes, or sentiment analysis. Furthermore, the site presents radically new ways of exploiting patient-reported health data and accelerating research. For the above reasons, we rank *PatientsLikeMe* in the upper-right field of the taxonomy.

Another innovatory example is *GemeinsamSelten* (http://www.gemeinsamselten.de), mainly an open innovation platform and community for patients and affected people of rare diseases. This platform connects patients to a multitude of possible problem solvers like caregivers, researchers, engineers, and other patients. Unlike *PatientsLikeMe*, this site has an almost exclusive focus on innovation creation through the open collection of problems and ideas for potential solutions and the support of a joint development of innovative solutions. Other studies have already reported about user innovation and its contribution on radical innovations (Lettl et al. 2006; Piller and Walcher 2006). Hence, we assume similar potential for GemeinsamSelten and position it in the upper-right field of the taxonomy. All above-mentioned platforms are rendered in the taxonomy below (see Fig. 3).

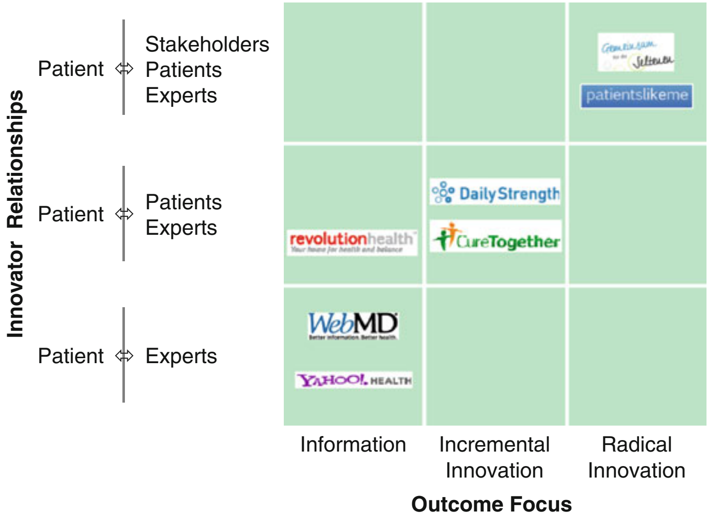

Fig. 3 Selected Health 2.0 cases populated into the taxonomy

5 Piloting Open Innovation in Health Care: The Case of GemeinsamSelten ('Together Rare')

5.1 Pilot Description

On the platform *GemeinsamSelten* (http://www.gemeinsamselten.de), users can initiate and participate in finding ideas and solutions that help people affected by a rare disease. The site, which has gained over 180,000 visitors, more than 1,100 members that are engaged in more than 200 problems and innovative solutions since its launch in March 2011, and that addresses so far a German-speaking community only, accommodates three main functional components: a social network, a marketplace for exchanging problems and ideas for potential solutions, and an open innovation initiative based on a series of contest-like challenges.

The platform strives to collect problems of rare disease patients and ideas for potential solutions and, thereby, increase public awareness. The collective aim of people engaging in innovation activities on the platform is to jointly develop innovative solutions for the patients' reported problems. Across the great variety of illnesses, patients and their families are often confronted with similar types of problems. The site targets people who know about the daily troubles of rare disease patients – may it be the patient himself or persons concerned. These people might have thought about tricky problems, possible solutions, and even practical implementations. However, in order to become a participating member, interested people do not have to possess experience on rare conditions. The intention of the site is to bring people from diverse backgrounds together – if they are caregivers, health workers, physicians, and nurses (i.e. core inside innovators); family members, friends, and fellow patients (i.e. peripheral inside innovators); or researchers, engineers, product managers, and civil servants (i.e. outside innovators).

The research group behind the platform organizes so-called *challenges* in which participants can compete for the best ideas for potential solutions. During a challenge, which lasts approximately 3 months, participants can present unsolved problems, submit solution proposals, and collectively work on refining ideas and concepts. At this point, the social community features of the site enable members to create a personal profile, connect to others, discuss ideas, and comment on others' contributions. Proposals for solutions on *GemeinsamSelten* can cover descriptions on technical aids and products, medical and caregiving services, medical-technical services, or housekeeping and social services. After the closing date of each challenge, a jury of multidisciplinary experts evaluates submitted concepts and nominates the most promising ones.

GemeinsamSelten is part of an overall initiative of the German Federal Ministry of Education and Research. The term 'Gemeinsam fuer die Seltenen' can be translated as 'jointly fighting rare diseases' or 'together rare'. It shall illustrate the point that the many are collaborating to support the few. In brief, the platform has three distinctive features: it (1) creates a community with people from diverse backgrounds to promote knowledge exchange and collaborate on innovative concepts, (2) collects patient's problems, needs, but also ideas for potential solutions in a central place, and (3) organizes a series of innovation contest-like challenges to find promising solutions for improving the quality of life of rare disease patients.

5.2 *Preliminary Pilot Results*

It is a designated goal of the pilot to attract participants from different backgrounds, such as suffering patients as well as the interested public. While registering to the platform, new participants can indicate one out of nine different roles. An analysis on the distribution of roles is shown in Table 2 for the period from March to June 2011 (Bullinger et al. 2012). Clearly, most participants chose the role 'patient' which corresponds to initial expectations given the design of the platform. More surprisingly, the role 'interested person' constitutes the second largest group representing roughly one third of all participants. As a preliminary indication, it seems that the well-disposed public has a genuine interest in being more actively integrated in finding ways to better health care.

Furthermore, only 'patients' and 'family members' were allowed to specify their disease pattern during the registration process. Out of total 450 'patients' and 'family members' (see Table 2), 191 of such participants indicated an affiliation with 145 different diseases. As the analysis on the distribution of different diseases unveils (see Table 3), 82% of all diseases being reported only occur once (Bullinger

Table 2 Roles of participants

Role of participant	Number	Percent (%)
Patient	358	45
Interested person	283	35
Family member	92	11
Innovator	19	2
Health care employee	16	2
Researcher	16	2
Supporter	9	1
Caregiver	5	1
Physician	5	1
Total	**803**	**100**

Table 3 Diversity of registered diseases

Recurrence of registered diseases	Number	Percent (%)
1x	119	82
2x	17	12
3x	3	2
4x	3	2
5x	1	1
6x	2	1
Total	**145**	**100**

et al. 2012). Due to the fact that the pilot platform addresses all rare diseases while not making any further restrictions, this diversity among registered diseases is in line with initial expectations. It could be interpreted as a large diversity of experiential and clinical backgrounds as well.

6 Discussion and Conclusion

One fruitful direction for many public and private sector organizations has been to seek the ideas and involvement of their users – and the potential certainly exists for doing so within health care. There are many examples where patients have played a key role in developing solutions to their health care challenges – and there is evidence that this process is accelerating. In this chapter, we have tried to focus on one of the new avenues along which such engagement might take place – the growing use of online and interactive platforms in the health care sector, often termed as Health 2.0.

Health 2.0 platforms with a strong innovation focus seem especially promising for two reasons. Firstly, Web 2.0 technologies offer a growing number of ways in which patients can acquire a voice on the Internet – and through which it can be heard by others, and the conversations move towards shared solution generation. Secondly, patients and other stakeholders that get involved as innovators provide important information on needs and potential solutions. In peer-led patient communities, this means that patients (and their carers) can not only provide each other with knowledge and support – they can also jointly engage in the development of innovation concepts and innovative solutions in the context of the respective disorder. Such communities, characterized by a high degree of interaction between users, and reciprocal exchange of information have been shown to be powerful engines of innovation.

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Does "Strategic Patenting" Threaten Innovation and What Could Happen If It Did?

Bernard Girard

Recent buyouts of Nortel's patent portfolio (6,000 patents) by Microsoft, Apple, and Sony for US$4.5 billion and of Motorola Mobility's (14,600 patents accepted, 6,700 in tutorial) by Google for $12.5 billion have focused attention on the role of these portfolios in the business world and on their high value. These developments raise several questions: is the number of patents still a good indicator of technological progress? Was it a good idea to extend the scope of patentability? Is the strategic use of patent portfolios an opportunity or a threat to science and technological progress?

In the first section, we document the main evolutions of this market: the wild growth of patenting and licensing, the degradation of patent quality, the continuous rise of their prices, and the spreading of strategic patenting and of portfolio management. In the second section, we examine the impact of these evolutions on innovation and invention.

1 Patents, Licensing, and Litigation: A Wild Growth

The world of industrial property has been marked, these last few years, by the sizable expansion of filed patents. Today, more than 350,000 patents are filed each year in the United States, and nearly 200,000 are accepted.[1] The same is true in Europe and Asia. This phenomenon is related to a few major events: the

[1] The data used in this chapter are all of US origin. This choice is justified because the changes described here took their source in the United States. It is in this country that emerged a market for patents, and it is there that most of its specialists work: 72 % of brokers are installed in the USA (Monk 2009). This is due to the size of the US market and to the specifics of its legal environment.

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globalization of the economy, the extension of the scope of patentable inventions, the multiplication of licenses, and finally, the development of strategic patenting.

Due to globalization, international firms look for patent's protection in all major markets. That was not always true. In the early 1990s, Apple filed in Europe only a selection of its patents. Today, it files all of them in all major European countries, despite the very high costs of translation. All major international companies do the same. According to the USPTO (US Patent and Trademak Office), only four of the top ten recipients of US patents in 2010 are based in the United States, and 51% of all patents granted in the USA are of foreign origin. In the 1990s, foreigners were usually granted around 45% of all US patents.

In recent years, the scope of patentable inventions spread to new areas: biotechnology, software, and business methods.[2] USPTO started patenting living products (bacteria), software (that had long escaped the patentability), production, and management methods of doing business. Nothing being previously patented in these areas, early entrants sought property rights for almost everything, including obvious "innovations" like the "one-click" that allows a customer to make a purchase on Amazon. Presumably, the idea would have come to anyone interested in this business.

This explosion in patenting coincided with a more systematic use of licenses that became a significant source of revenue for companies with a strong patent portfolio (Kamiyama and alii, McGrath…). Far from being just a tool to protect technology, patents give property rights that one can market, rent, or sell. Nationwide, an estimated $120 billion is each year generated from patent licenses, up from $15 billion in 1990. Income from licenses contributes to a large extent to the profits of numerous companies (Zunica 2009). According to Levine, IBM's fees from licensing and custom-developing intellectual property for other companies were on track to top $1.1 billion in 2009. Qualcomm collects almost all its revenue—$10.4 billion in 2009—from selling licenses and making the chips containing its patented 3 G mobile phone technology, known as CDMA (Levine 2010).

Some companies have long identified this source of income. Roger Smith, head of industrial property of IBM in the early 1990s said: "You get value from patents in two ways, through fees, and through licensing negotiations that give IBM access to other patents. The IBM patent portfolio gains us the freedom to do what we need to do through cross-licensing—it gives us access to the inventions of others that are the key to rapid innovation."

This proliferation of licenses is, in part, due to changes in technology that makes an increasing use of standards and interoperability: products of different companies cooperate and must, thus, use the same technologies. But it also comes from changes in regulations. In 1996, the Supreme Court issued a patent for business methods "making it increasingly impossible to manufacture an electronic device without receiving a cease and desist letter or other notice from a patentee demanding a large royalty or threatening an injunction" (Nielsen and Samardzija 2007).

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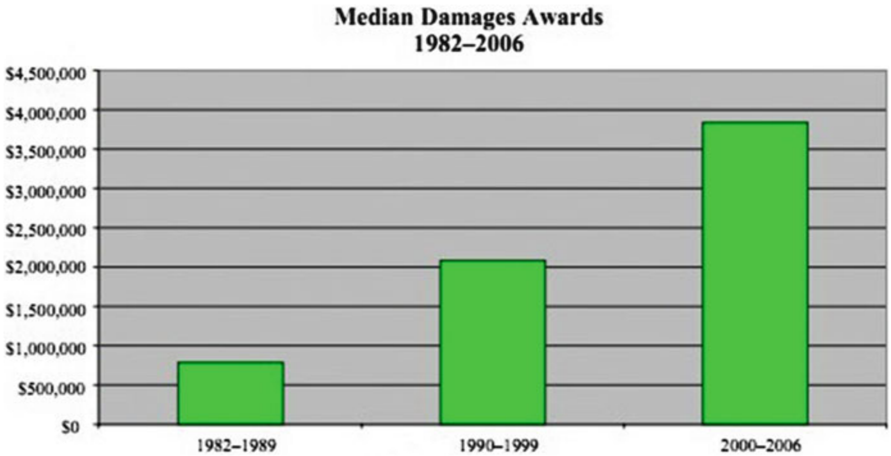
[2] And may continue to do so as US courts opened the door to the patentability of diagnoses as in Mayo v. Prometheus Labs.

Many companies took advantage of the need to operate patents they own to develop practices which border on predatory. Monk cites the case of a company whose patents portfolio tripled following the intervention of its lawyers that wanted to build a shield against possible prosecution by competitors (Monk 2009). Recently, Microsoft accused the manufacturers of Android smartphones and tablets of infringing 25 of its patents. What could they do? Challenge the patentability of some of these inventions? It is the promise of a long legal battle. Buy licenses? This is what Amazon and HTC chose to do (Gutierrez 2011), but it can only encourage attacks by predators of all kinds, including NPE (non-practicing entities) or patent trolls (Layne-Farrard 2010), companies who make their living out of lawsuits for patent infringement.[3]

With so much at stake, patent disputes are increasingly ending up in court at the expense of the patent holders. In the 1980s, US courts dealt 1,000 patent litigations. These disputes have multiplied as US courts are quite severe with the trespassers. They generally ask the licensee to pay a royalty rate of 25% of its expected profits for the product that incorporates the infringed patents. And they continue to do so despite the ruling Uniloc Inc. vs. Microsoft Corp. "that held that the 25% rule of thumb is a fundamentally flawed tool for determining a baseline rate in a hypothetical negotiation" (Dallman 2011). In fact, this level of royalties is so high that a company may have to stop the manufacture of its product even if it is innovative.

These cases are always very expensive. It was calculated that each party in a trial spends an average $4.5 million. Even when patents are very similar, one must sue each patent separately, which greatly increases costs that are generally included in R&D budgets. Instead of financing research, companies pay lawyers.



(Source: McGraph)

[3] These companies are more numerous that one can imagine, and not just American. They have grown since one of them got, through transaction, $162 million from RIM, the Blackberry producer. A specialist in these issues identified 51 NPEs in the US (Shestra 2010).

2 A Notable Degradation of the Average Quality of Patents

These developments went with a significant diminution (at least reported by all professionals) of the average quality of patents. IBM's former Director of Licensing, Emmett Murtha, estimates that 97% of all US patents have no economic value: "I think the majority of patents are not licensed because the technology they embody is not really useful, not feasible to commercialize, or simply not marketable for a variety of reasons" (M-CAM 2003). A figure that a specialist quoted by the New York Times confirms: "Good companies use only 20% of their patents," said Sam Khoury, the president of Inavisis International, a consulting firm that appraises patents, trademarks, and related corporate assets. "Badly run companies use only 10%" (Feder 2002). And an expert calculated that approximately 50% of patents are not considered valid after a legal dispute (Reback 2006). This decline in quality does not prevent companies from exploiting their portfolio. Apple was able to prohibit the marketing of Samsung's tablets in Germany, thanks to patents that described its own tablets in a way that could apply to any similar product: a rectangle with icons that can be activated by passing the finger on it.

Several reasons can be cited for this decline. The most common is the increased workload of the patent office that leads to less rigorous controls.

Professionals regularly complain, as evidenced by this letter that examiners from several offices have sent their leaders in 2007: "Unfortunately, in many patent offices, the pressures on examiners to produce and methods of allocating work have reduced the capacity of examiners to provide the quality of examination the peoples of the world deserve" (The 271 Patent Blog, 2007).

3 Prices: A Very High Inflation

Because they are so often of a poor quality, patents that give a competitive advantage to their owner are not so frequent. Yet their value is increasing. Assuming, as all commentators explained when the deal was done, that Google acquired Motorola Mobility for its patent portfolio and only for this, each patent was valued at just over $510,000, which is the exact price at which Novell sold, according to Frost & Sullivan's Craig Carter, 882 patents a few months earlier. Microsoft, Apple, and Sony have paid more (in the range of $750,000) for the patents they bought from Nortel, and RIM is said to have paid $173 million for 65 patents from Philips (Monk 2009). It is as if a particularly high market price was being created through these various transactions.

This inflation of prices has objective reasons. The most obvious is the desire of companies to protect themselves in all major markets. The cost of filing a patent in two countries is about $17,000; the filing in fifteen countries is about $120,000 (WIPO 2008).

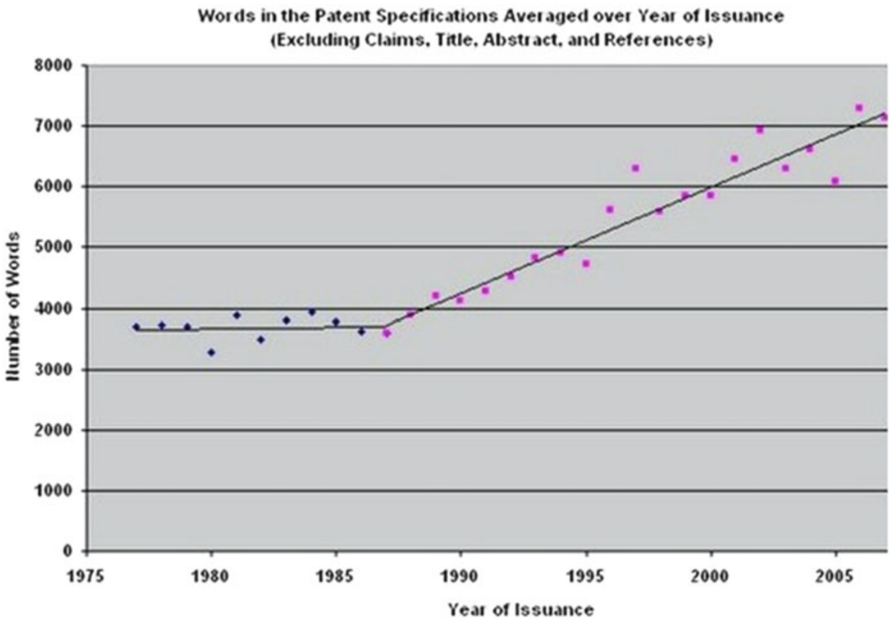
Other factors contribute to this increase of prices, such as the required translation into several languages for European patents.[4] More significant are endogenous factors such as an increasing complexity that can be measured in several ways. Education is one: patent's authors are increasingly PhDs. This appears in the US statistics but even more in the European surveys.

	% of female inventors	Average age of inventors*	% of inventors with tertiary education	% of inventors with PhD degree	% of inventors who changed employer after innovation
Electrical Engineering	2.0%	43.3	82.3%	19.1%	27.04%
Instruments	2.7%	44.6	82.0%	33.4%	25.42%
Chemicals & Pharm	7.4%	44.5	91.8%	59.1%	19.99%
Process Engineering	2.1%	46.6	72.7%	22.4%	21.20%
Mechanical Engineering	1.1%	46.2	66.3%	9.3%	21.54%
Total	2.8%	45.4	76.9%	26.0%	22.47%

Number of observations differs across columns, between 8,861 (age) and 8,963 (gender).

Based on a survey of 27,531 European inventors, Giuri et al. (2006)

This complexity of patents can also be measured by the increasing size of patents measured by the number of words.

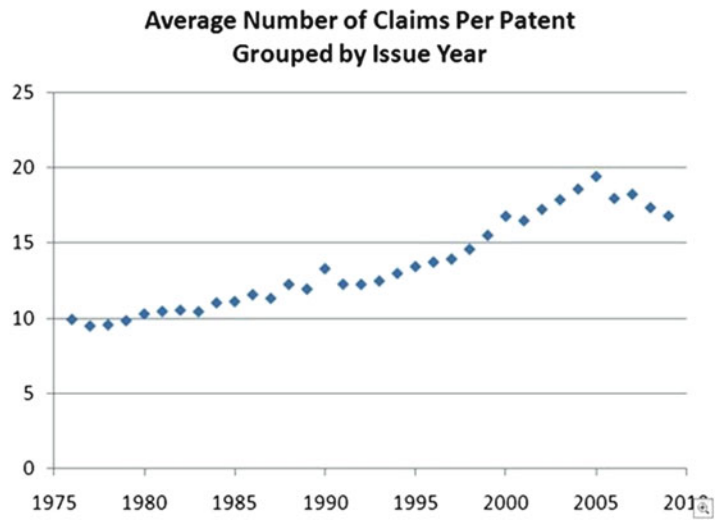


Patents are longer, more complex, as suggested by this graph done on a sample of 10,000 patents up by Patenlyo. The inflection of the curve in the 1980s coincides with the opening of new patentable domains and the creation (in 1982) of the

[4] Once a patent is granted by the European Patent Office, it must be validated in each country in which the applicant seeks protection. It usually means translation in the national language.

US Court of Appeals, which has streamlined and secured intellectual property. Its creation was followed by a sharp increase in the number of patents.

The number of claims has also increased. Each claim being subjected to billing the cost of a patent grew. It can reach extravagant sums: the 13,000 claims the owner of the US2005/0182468 patent requested cost him 1$.3 million. The more a company has paid to get a patent, the more it will be tempted to value it highly even if it does not use it.



This increasing number of claims is related to the growing complexity of patents, to the nature of inventions, but also to changes in the legal context in the mid-1990s: US Supreme Court ruled in 1996 (Markman vs. Westview) that the interpretation of a patent was a matter of law and not a question of fact, which leads to a more restrictive interpretation of the scope covered by each claim, therefore the temptation to multiply them to keep the patents as inclusive as possible. In fact, the drafting of patents being entrusted to lawyers (the drafting of a patent is a round trip between the inventor, often an engineer, and lawyers) is very sensitive to the developments of case law.

The proliferation of litigations also plays a role: a patent which has stood the test of the court acquires value as the risk of a dispute disappears.

Exogenous factors also contributed to patent's increased value. In the USA, companies that give patents to nonprofit organizations, universities, or hospitals can benefit from tax cuts. This practice is widespread. Companies that engage in this practice are naturally interested in getting the maximum value from their portfolio. When General Motors faced with serious financial difficulties envisaged to give its patent portfolio to nongovernmental organizations (NGO), its CEO did not hesitate to assign it a very high value ($3–5 million for each patent) to increase its tax exemptions (M-CAM 2003).

Other factors played a role like the purchases of patents to protect oneself from litigation or the creation of a market for high-tech companies. When a start-up is sold to a large company, most of its capital is intangible: skills, patents, and designs (Haeussler et al. 2009).

A lucrative market was created with companies whose interests are purely financial (Watanabe 2009). The case of Ampex is significant. This company that manufactured the first audiotape owns a patent portfolio that could generate significant revenues. In 2005, a hedge fund, Valuevest, wanted to buy it to exploit what its managers thought was fair value (The 271 Patent Blog, 08/09/2007).

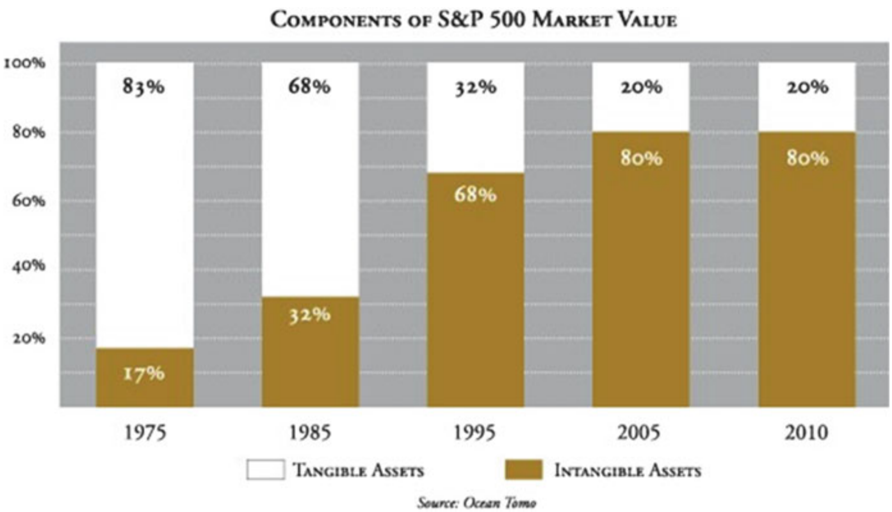
4 Portfolio Management or Predation

There is in this price inflation something of a speculative bubble. All components of a bubble are there: imitation, mimetic contagion, anticipation of future behaviors based on beliefs, and, of course, difficulty to properly value assets.

The techniques used to calculate the value of a patent or a portfolio pose almost insoluble problems. Several methods exist, but they do not necessarily give the same results. But there is more.

Behind this inflation lies a significant change in the behavior of tech companies, especially the big ones: they have chosen to manage their patent portfolios as a real asset. At all times, firms have filed patents to lure their competitors (Langinier 2005); General Electric was famous in the twenties for practicing "defensive patenting" (Nicholas 2005); DuPont used its patents to prevent the arrival of new entrants to its markets (Hounsell 1988), but firms that engage today in these practices want to value their intangible assets.

These portfolios represent a growing part of business assets. A research company, Ocean Tomo, has assessed the rise of these intangible assets as follows: "In 1975 more than 80% of corporate value reflected in the S&P 500 was tangible assets, while intangible assets comprised less than 20% of market capitalization. Today, the ratio of tangible to intangible assets has inverted—nearly 80% of corporate value resided in intangible assets (Ocean Tomo 2011)." By intangible assets, one must understand patents, brands, and reputation.



These results can be challenged, but they are corroborated by numerous studies (King 2003). The OECD explains that "in the United Kingdom investment in intangibles is estimated to have more than doubled as a share of market sector gross value added between 1970 and 2004." They are symptomatic of a new phenomenon: inflation of intangible assets. As explained by RPX, players on this market, "patent litigation used to be a form of legal redress. Today it is a business model."

5 Intellectual Property Rights: A Questionable Theory

It is, in fact, the whole governance of innovation that has changed. These changes were made on behalf of the theory that industrial protection is an incentive to innovate. A theory that can be summarized in a few lines: not enough inventions will be made unless incentives are provided; patents are the most effective means of providing these incentives.

This thesis is old. It is found in the texts of the first patent lawyers, but is it true?

We reported at the beginning of this article the explosion in the number of patents. This growth is generally seen as a sign of the acceleration of technical progress (Kirankabeş 2010), but these figures make their best sense when broken down by technology. More than 29,000 patents have been filed in the United States around USB (Universal Serial Bus), more than 27,000 on JPEG images, and more than 3,300 on 3G cellular modems. And this is not unique to computer science. The inhibition of angiogenesis, a recent strategy to fight cancer, has led to 28,000 patents, and sunitinib, a drug for the treatment of kidney cancer, to 3,000. Is not that in any case too much? Are these techniques so complex that they require so many inventions? This is unlikely. As we have seen, so many other factors contribute to the expansion of the number of patents that it has ceased to be a reliable indicator of technological progress.

The critique of industrial protection is not new. In an article published in 1950, Fritz Machlup and Edith Penrose showed that it has accompanied the beginnings of the patent law (Machup 1950). It is only when the protectionists have prevailed over the free traders in the aftermath of the crisis of 1873 that patent proponents won out after a vigorous propaganda campaign.[5] This shows that intellectual property protection was not obvious to most classical economists even if Adam Smith, John Stuart Mill, and Jeremy Bentham "viewed patents as a justifiable exception to free trade principles."

Contemporary criticism rarely mentions these ancient texts as it rather seeks to analyze the current situation. It has several origins. It comes, in part, from industrial

[5] Hostility to protectionism was particularly strong in Britain, where it gave birth to an abolitionist movement and in Germany. Defenders of patents saw it a protection of the industry similar to customs duties.

property specialists concerned about some of its deviations (USPTO 2003) and who highlight the various weaknesses of current arrangements.

It also comes from economists. The Austrian School (Murray Rothbard, among others) has long criticized intellectual property, accusing it, among other shortcomings, of diverting investment in basic research. If this risk has long seemed low, it has gained consistency since universities have the opportunity to apply for patents (1980 in the USA): a university like Yale, which had five patent applications filed in1981, had 246 in 2011 (97 United States and 149 abroad). How can one exclude that this has been done at the expense of basic research?

It was only recently that orthodox economists have questioned the link between patents and innovations. Josh Lerner showed that the smaller a company, the more it tends to favor trade secrets over patenting (Lerner 2000). Carl Shapiro expressed concern about the risk of holdup (Shapiro et al. 2007); others have developed models showing that a patent could reduce the potential for innovation (Tuomas and Kanniainen 2000) and highlighted the disappointing results of the extension of property law (Dey 2007). Based on an historical review, Bessen and Hunt have questioned the impact of patent systems on innovation: “In some industries such as pharmaceuticals, patents provide strong positive incentives to invest in innovation. But in many other industries, perhaps most, patents fail to perform like property and they may actually discourage innovation” (Bessen and Hunt 2007).

Historians of British industry have also shown that the sectors in which there was more innovations were not those in which more patents have been filed, which is reminiscent of the contemporary situation: IT is probably the sector in which innovations were in recent years the most numerous; it is also one of in which it was for long very difficult to file patents (MacLeod 1986).

These interrogations about the impact of patents on innovation finally come from practitioners. In its 2003 survey, USTPO cites a programmer who says: “The ease with which the US patent office has given patents in the last few years has already dampened my plans to write software as a primary business.” Patents are not or are no longer the engine of innovation that their advocates present. This is confirmed by the Berkeley patent survey of 700 US start-up in 2008 (Graham et al. 2009). It shows:

– That they do not consider patent as an incentive to innovate.
– That the use of patents by start-up varies by industry: low in the software world, and it is more important in companies involved in healthcare (biotechnology, medical devices). The main reason is probably related to the time to market.
– That the start-ups that file patents do it primarily at the request of shareholders.

Confirming these results, Bessen and Hunt indicate that large European companies do file patents for only 36% of their innovations (Bessen and Hunt 2009). Only the pharmaceutical industry proceeds otherwise. In most sectors, firms innovate without worrying about patents. The industrial sectors that could not until recently patent their inventions, such as IT, were no less inventive.

Does it mean that patents do not contribute to the development of innovation? Not necessarily. Some authors have suggested, like Pigou, that patents were not conducive to innovation, but oriented it: "By offering the prospect of reward for certain types of invention, they (the patent laws) do not indeed appreciably stimulate inventive activity, which is, for the most part, spontaneous, but they do direct it into channels of general usefulness" (Pigou 1920). In the same vein, Petra Moser has shown "that patent systems influenced the distribution of innovative activity across industries. Inventors in countries without patent laws concentrated in industries where secrecy was effective relative to patents, e.g., food processing and scientific instruments" (Moser 2003).

One can advance other arguments in their favor. To defend their institution, the rapporteur of the project of creating patents in France, Stanislas de Boufflers, advanced in 1790 an interesting argument: patents contribute to innovation because they promote the circulation of inventions and they give those who so wish the ability to access and possibly negotiate (Procès-verbal 1789–1791). They foster the dissemination of information which can be regarded as a positive externality.

Contemporary experience tends to confirm this thesis. It is a weak protection that favored the emergence of Silicon Valley as the center of IT innovation in the 1980s. Ronald Gilson showed that it was the impossibility to enforce "not to compete" contracts that explains the development of this cluster: an employee with an idea his company did not wish to develop could bring it to a competitor or create his own company (Gilson 1998).[6] Thus, ideas and inventions could move freely and be tested. The same argument could be applied to China. A poor protection of inventions, a high mobility of engineers willing to share the secrets of their employer did not hinder the development of its economy. On the contrary, it seems to have favored its expansion (Barboza 2011).

If patents are not an incentive to invention, the recent developments that attempt to manage patent portfolios as an asset like any other may stifle innovation and remove this positive externality. Several factors can contribute to the receding of innovation. The first, stressed by several authors, is the diversion of R&D funds toward legal expenses, whether to file patents and to defend them in litigation. Then come the high costs of litigation and the use of patents as a threat that creates a new uncertainty (Graham 2006).

This uncertainty is worsened by the proliferation of patents. The firm that would like to develop a new drug to inhibit angiogenesis in the fight against cancer should ensure that it does not infringe any of the 28,000 patents already filed on this very recent and promising technique. The risk that it could be the case is obviously very high. No doubt the laboratory can buy licenses, but as suggested by Carl Shapiro, if the firm has to give just 1% of its revenues to each holder of patents it infringed, it may soon give up (Heller and Eisenberg 1998).

All these developments may stifle innovation. They may also profoundly alter the direction of research. This is especially true in academia: universities that file patents may focus on applied research at the expense of basic research. Disciplines

[6] This thesis is supported by recent studies that establish a correlation between the productivity and mobility of researchers (Hoisl 2007).

that cannot be patented, mathematics, physics, and social sciences, could suffer. This is not the only danger: patenting imposes secrecy and therefore inhibits the flow of information which is at the heart of scientific activity. Patents make it more difficult for other researchers to use new ideas. They can create conflicts within the academic community: who is going to reap the most benefits? Who will get the most funding: those that do basic research or those that file patents? This trend is particularly worrisome in China as it encourages its academics to file patents (Ward 2011).

In the area of business, these developments could be no less significant. R&D could no longer be guided by the laboratories or marketing departments but by financiers whose main aim is to maximize the rent from the patent portfolio. They could try to get the best valuation of the portfolio, but they could also push defensive strategies at the expense of more interesting work.

In short, these recent developments are likely to hamper innovation. Unless, of course, governments decide otherwise. It's the legislature that created property rights, changes in regulations are responsible for the changes we documented. But all governments do not approve of these changes. Some might rebel, especially among the BRICS (India, Brazil, etc.), and want a more liberal regime (Bird and Cahoy 2007). We could see the emergence of a "digital divide" between overprotective countries and those that want to protect inventors from all over the world from excessive IP litigation.

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Monetization of Intellectual Property: An Open Innovation Perspective

P.M. Rao

1 Introduction

We start with the familiar proposition that innovation, out of which intellectual property (IP) is created, is costly to produce but relatively easy and inexpensive to imitate. As a result, innovative firms which invest heavily in R&D face what is known as the problem of appropriability. The difficulty such firms face in appropriating the fruits of their innovative effort—with or without legal protection in the form of patents, copyrights, trade secrets, and the like—has been well established (Arrow 1962; Williamson 1975, among others). In the language of economics, the social rate of return on innovation or the return to society in the form of new and better quality products at lower prices—and/or the production processes that reduce costs and improve the quality of end products and services—far exceeds the private risk-adjusted rate of return to the firm. The extent of divergence between the social rate of return (SRR) and the private rate of return (PRR) is evidence of the extent of the appropriability problem—a source of market failure in the production of innovation—which leads to underinvestment in R&D. This too has been well documented in the economics literature. According to Jones and Williams (1997), the social rate of return on R&D estimated by various scholars is about 30%, which is considered a lower bound, and about three times higher than the private rate of return. For a detailed discussion of estimated annual rates of return to R&D according to numerous studies, see Nadiri (1993). The greater (smaller) the divergence between SRR and PRR, the smaller (greater) the extent to which a firm is able to appropriate the fruits of its innovative effort. When innovative firms are able to achieve PRR above the risk-adjusted rates of return on their investments in R&D, they are said to be enjoying supernormal profits, which Nordhaus (2004) calls Schumpeterian profits. Put differently,

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realization of supernormal profits means firms are able to capture a piece of the SRR as well. In his pioneering empirical study of the extent of Schumpeterian profits in the US economy over the 1948–2001 period, Nordhaus provides a macroestimate and concludes that "only a miniscule fraction of the social returns from technological advances over the 1948–2001 period (*little over 2%*) was captured by producers, indicating that most of the benefits of technological change are passed on to consumers rather than captured by producers" (Italics added, p. 1). And Schumpeterian profits were only 2.8% of US corporate profits during the same period. To be sure, appropriability varies greatly across industries and firms within the patent life, and farming and farm-equipment sectors have a low rate of profit despite their rapid productivity growth. Apple apparently has been enjoying extranormal profits, at least for the time being, on its product line of iTunes, iPods, iPhones, and iPads. We now discuss many ways individual firms in a market economy monetize intellectual property (IP) and, in the process, attempt to privatize at least some of the benefits of innovation society enjoys for free. Although, the term IP can be defined to include a wide range of intangible assets, for purposes of this chapter, it refers to all technology-based intangible assets of a firm—an idea or a design for a new product or a process, a computer software package, and the like that may be protected as a property right under the legal framework that includes patents, copyrights, trademarks, or trade secrets.

2 Many Forms of Monetization

In modern economies, monetization of IP by firms takes several forms. Perhaps, the most common form of monetization involves incorporating the technology into a physical product—sometimes referred to as embodied technology—and markets it. This is typical of innovating firms producing and marketing goods. In short, monetization of IP occurs—in the product markets—through sale, lease, and rental of products in which the technologies are embodied. That the embodied technology remains the dominant means of monetization can be seen from the fact that innovative effort in the form of R&D input is still largely concentrated in manufacturing. In 2009, in the USA, about 76% of company-funded R&D by US MNEs was in manufacturing (Barefoot and Mataloni 2011). As might be expected, judging from data on top US patent holders, a similar concentration of R&D output in the form of patents appears to be present in the manufacturing sector (USPTO 2004). This is despite the fact that manufacturing in the developed world's economies accounts for increasingly smaller fraction of output and employment and nonmanufacturing sector—outside of telecommunications and electric utilities to a limited extent—which was once devoid of much innovation is now a rapidly growing center of innovation mainly in the form of software development. Note that monetization of IP—whether it is embodied into products or not—requires significant investments in complementary marketing assets in the form of building and sustaining difficult-to-imitate brand name and reputation of the firm,

Table 1 US receipts and payments of royalties and license fees, 1999 and 2009 ($ millions)

	1999	2009	CAGR (%)
Total, all sources	$50,044	$115,021	8.67
Receipts	39,670	89,791	8.59
Payments	10,374	25,230	9.49
Industrial processes and computer software	9,687	93,128	25.27
Receipts	7,602	71,660	24.04
Payments	2,085	21,468	26.12

Source: Bureau of Economic Analysis (2011)

Table 2 Licensing revenues of selected high-tech firms, 2010

Company name	Revenue sources	Revenue ($ millions)	Percentage of total revenue (%)
Rambus	Royalties from patent licenses	288.4	89.18
	Royalties from technology licenses	31.8	9.83
		320.2	**99.01**
	Total revenue	**323.4**	
Microsoft	Windows operating systems	19,494	31.20
	Microsoft Office and other software	19,076	30.53
	Servers	15,378	24.61
		53,948	**86.34**
	Total revenue	**62,484**	
Qualcomm	Licensing revenue	4,011	**36.52**
	Total revenue	**10,982**	
IBM	Software licensing	22,485	**22.68**
	Total revenue	**99,120**	

Source: Hoover's online database, 10-K annual reports

establishing relationships with customers and distributors alike, and various promotional efforts in order to maximize the return on R&D investments.

A second form of monetization of IP occurs when an innovating firm employs its new technology in the production process, which reduces the cost and/or improves the quality of the end products, and services it produces and markets. Note that process innovations—this is certainly true of industrial processes—are generally not patentable. However, processes are difficult to replicate. Legal protection of process innovations is mainly in the form trade secrets.

A third form of monetization of IP is through licensing of technologies. This has become a significant and growing means of monetizing IP. Cross-border technology licensing has grown dramatically in the recent period. Between 1999 and 2009, US receipts from licensing of industrial processes and computer software to other countries and payments to other countries have grown at an average annual rate of about 25% (see Table 1).

Moreover, as shown in Table 2, licensing revenues account for almost 100% of revenues of a technology firm like Rambus, which specializes in innovative computer memory design called RDRAM; a vast portion of the revenue stream of software firms like Microsoft (86%); and significant portion of a diversified firm like IBM (23%). Note that there are no physical products involved here. Technology is disembodied from the product. A variant of technology licensing is cross licensing, which involves companies exchanging technologies through the licensing process and netting out the difference in terms of valuation. Teece (2000) describes in detail various methods of valuation in the technology-licensing process.

A fourth form of IP monetization occurs when technologies are sold outright. This form of monetization is less common compared to licensing. A recent dramatic example of this form of monetization involved acquisition of Motorola Mobility, a subsidiary of Motorola, by Google for $12.5 billion (Richtel and Wortham 2011). The assets acquired by Google were simply the patents held by Motorola Mobility. Thus, Motorola, the parent, monetized IP held by its subsidiary, Motorola Mobility, in the form of patent portfolio, a rich trove of 17,000 patents. Another more recent example is Microsoft's deal involving $1 billion for 800 patents held by AOL. Note that licensing, cross licensing, and sale of technologies suggest the presence of a "market" for technologies. Indeed, Baumol (2002) and Arora and Gambardella (2001), among others, observed about the emergence of a growing market for technologies. An interesting twist on this occurs when the acquiring company's motive may have more to do with the value of human capital in the form of hard-to-get talented people employed by the firm to be acquired than the latter's patent portfolio. For example, Facebook has acquired some 16 companies, including Gowalla, in the last few years with the intention of buying talent rather than technology or user data as part of the deal. This is especially the case when the firm to be acquired is somewhat of a start-up with its financial feet not firmly on the ground.

A fifth form of monetization involves *securitization* of intellectual property. While IP-backed securitization remains a small fraction of total asset-backed securitizations, Hillery (2004) documents several deals involving patents, copyrights, and even trademarks. One such deal was the pharmaceutical patent royalty securitization (a $225 million deal involving a pool of patents on 13 drugs from 12 companies and Memorial Sloan-Kettering) of variable funding notes in 2003 by the Royalty Pharma Finance Trust. Note that the deal can be structured so that the owner of IP continues to have an equity component of the royalty stream, while the buyer participates on the debt side at rates far lower than the typical venture capital lenders. One way to view securitization is it makes the "market" for IP more efficient than it would be otherwise.

A sixth form of monetization involves firms that acquire patents from failed companies and independent inventors—often cheaply—and "monetize" them by bringing infringement law suits against companies whose products are related to such patents. Note that such firms are not in the business of creating any technologies or making any products themselves. They specialize in recovering damages and collecting royalties on unauthorized use of their patent rights. The suit brought by NTP, a small Virginia-based company, against Research in Motion (RIM) for violation of its wireless e-mail-related patents, which claimed over a billion dollars in damages, is a case in point. NTP is a patent-holding company that does not make or sell products. Ultimately, RIM settled the case with NTP for $612.5 million (Somaya et al. 2011). Such firms are inelegantly called patent trolls, meaning, they are in the business of gaming the system by taking advantage of the weaknesses inherent in the patent system. However, it is important to note that patent trolls do create market for inactive and/or marginal patents and provide some reward to the original owners, which might not exist in their absence.

All forms of IP monetization suffer—albeit to a different degree—from the appropriability problem due to reverse engineering and imitation around patents, competitors hiring away employees with trade secrets, and unpaid-for leakages to the licensees and unintended third parties because of the difficulty of writing technology-licensing contracts. On the other hand, rapid growth of technology licensing, monetization through sale of patent portfolios (e.g., Motorola Mobility), and securitization are indicators of the emerging, albeit highly imperfect, market for technologies.

3 The Role of Complementary Marketing Assets in IP Monetization

The most obvious but important point here is that investments in marketing assets—promotional effort to create and sustain difficult-to-imitate brand name and the reputation of the firm, establishment of an efficient distribution system, after-sales service, customer relationship management (CRM), and associated information systems, for example—complementary to innovation mitigate the problem of appropriability. Figure 1, adapted from Teece (2000) by Rao (2005), shows strong complementary marketing assets—along with hard replicability of innovation and tight intellectual property rights—result in a strong appropriability regime. A detailed discussion of the conceptual framework suggested by Fig. 1 is provided

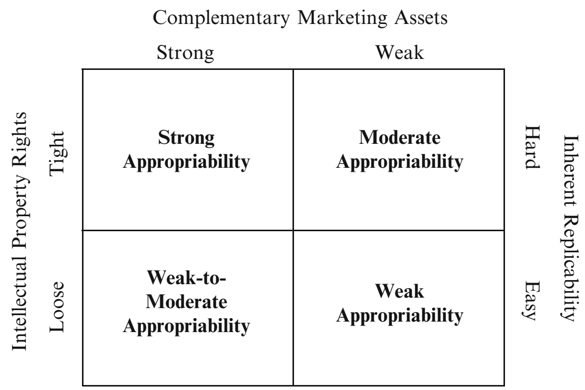

Fig. 1 Key determinants of appropriability regime (Source: Adapted from Teece 2000, p. 19; Rao 2005, p. 41)

in Rao (2005). Vinod and Rao (2000) have shown that, in the high-technology segment of the pharmaceutical sector, interfirm variation in promotional intensity (i.e., ratio of promotional expenditures to sales) is largely explained by variation in R&D intensity (i.e., ratio of R&D expenditures to sales). The authors also provided an econometric test of complementarity between R&D and promotion. Pharmaceutical firms specializing in the production and marketing of patented prescription drugs could be spending well above 40% of sales on promotion during the effective life of the patent in order to build the brand name which will enable them to compete—in the postpatent period—against cut-throat price competition from generics. The brand equity built during the life of the patent with the physicians and patients alike is so strong that firms are able to actually *raise* the prices in the relatively inelastic consumer segment in response to cut-throat price competition from the generics.

More recently, evidence, albeit indirect, of the importance of R&D and marketing to high-tech firms and their complementary relationship came from an important study by Hulten (2010). Hulten used familiar macrolevel growth-accounting techniques to explain sources of Microsoft's average annual rate of growth in real output of 30.0% over the 1988–2006 period and found that R&D and sales and marketing together explained—roughly in equal proportion—43% of Microsoft's growth. Microsoft's employment data reported by Hulten are consistent with the importance of R&D and marketing. In 2006, 28% of Microsoft's employees were in product research and development, 30% in sales and marketing, 17% in product support and consulting, and 10% in general administration. Note that only 3% of Microsoft's 71,000 employees were in manufacturing and distribution.

To cite another example of the role of marketing assets in mitigating the appropriability problem, few would argue about Apple's ability to produce Schumpeterian-like profits in recent years that has as much to do with the strength of its brand name, often personified in its CEO the late Steve Jobs and supported by huge investments in its own uniquely designed retail stores amply populated by *educated* and salaried sales people ready and willing to serve—as with its brilliant design and software. To elaborate on this point a bit, Apple offshored all manufacturing of iPhone 4 to low-cost high-quality Asian countries and still captured nearly 60% of the total value as a reward for its investments in design innovation and marketing assets (Kraemer et al. 2011).

4 Open Innovation and Monetization of IP

Open innovation as a means of monetizing IP has its roots in the notion of user innovation proposed by von Hippel (2005), among others. The trend toward open innovation has been discussed at length by Ghauri and Rao (2009), and this section draws heavily upon that discussion. Several recent trends—the growing importance of innovation networks, increasing trend toward alliances, and licensing coupled with private-public nonprofit linkages—may be viewed as indicators of the emerging open innovation (OI) paradigm that has received much attention in recent years (Chesbrough 2003). In contrast to the traditional vertically integrated (VI) closed innovation model, a company following the OI model commercializes internal as well as external ideas by utilizing outside as well as in-house pathways to the market. In the OI model, large companies are seen as becoming more and more as "market coordinators of increasingly distributed and vertically disintegrated value chains" (Christensen 2006: 46). As such, OI is the antithesis of the VI model; it challenges the core competency perspective of corporate innovation, and it emphasizes research and production via collaboration and networks. Firms adopting the OI model recognize the value of external IP as well as profits to be made from others' use of its IP through licensing, joint ventures, and the like. Among the pharmaceutical MNEs, Pfizer is such a firm. It uses external innovations in its product mix and markets internal as well as external innovations (West et al. 2006).

Open innovation is often compared, albeit loosely, with the "open-source" movement led by IBM and other companies in the software development (Although OI and "open source" have some elements in common, it is important to note that the open-source movement is unique to the software sector and is driven by network externalities and other factors that are not present in many sectors). In the open-source model, developers are free to access and build upon the efforts of others without paying royalties. Investment by firms in the "open-source" projects to gain competitive advantage through pooled R&D is consistent with open innovation.

Pisano (2006) provides an interesting story about Merck's Gene Index story in this context. It suggests that, contrary to the traditional view of IP strategy, a firm with strong downstream marketing assets may find the value of those assets higher in a regime of weak IPRs than in a strong one. This was the case of Merck's collaboration (in response to venture capital firms aggressively patenting genes associated with diseases in which Merck's research and marketing assets are strong) with Washington University to create a database of human gene sequence and make all findings public within 48 h. Merck viewed its interests as best served by preventing privatization of genes that could result in lockout in research areas central to its survival. Thus, the advocates of the OI model suggest that firms with strong R&D and downstream marketing assets may find that it is compatible with a high degree of appropriability even as it dilutes IPRs.

Still, open innovation (OI) presents a challenge to monetization of intellectual property to both biotech firms and firms operating under the open-source model. The (OI) model goes against the traditional approach of maximizing profits through innovation from strong IPRs (Christensen 2006; West and Gallagher 2006). Moreover, Chesbrough (2011) argues that product-driven companies are finding it harder to differentiate because of rapid commoditization made possible, in part, due to numerous software products. For example, Motorola's highly successful razor cell phone fell by the wayside within 3 years due to pressure from Apple and Google who are building platforms and services in collaboration with thousands of companies. The solution is to transform physical products into platforms with a variety of services that are created through open innovation. A different kind of transformation occurred at Amazon which started in 1994 as an online book seller and within a period of just over 10 years created and sustained one of the most successful online retail industry platforms in the world and leveraged its technology to move into providing web services to third-party retailers (Isckia and Lescop 2009).

Schwarz and Takhteyev (2009) argue that the intrinsic inefficiencies of proprietary software led to alternative mechanisms—such as the open-source software (OSS) movement—that provide software as a public good. One source of inefficiency has to do with holdup problem which occurs when users of software must make complementary investments to modify and/or customize it for their unique needs and when the success of such investments depends on the cooperation of software vendor. Another source of inefficiency has to do with production of software becoming more expensive when the source code is not open to the end users. The authors explain why open source dominates certain sectors of the software industry and not others. For example, the top ten programming languages all have an open-source implementation because they require substantial complementary investments and users have the need and the capacity to modify the source code. On the other hand, software for none of the top ten computer games is likely to need modifications and is offered to users with little or no programming skills to modify software even when the source code is offered to them. Therefore, it is virtually all proprietary.

Open-source operating systems and tools are being embraced not only by individuals, but they have become preferred systems and tools for Internet companies such as Amazon, Facebook, Google, and Yahoo! as well as IBM, Intel, and Oracle, among others. Corbet (2007) estimates that about a third of the changes to a recent release of Linux kernel were made by employees of only five companies (IBM, Novell, Intel, Oracle, and Red Hat). Schwartz and Takhteyev (2009) report that in 2001, IBM announced its plans to contribute \$1 billion to Linux open-source operating system and later reported that the investment was recovered in 1 year. This is not surprising because, given the need for complementary investments and frequent modifications in the software combined with their capacity to make modifications, these companies see the individual and collective benefits in making software a public good. Therefore, monetization of investments in OSS occurs through products and services enabled by the software rather than software itself. The holdup problem is largely mitigated.

While open innovation—of which OSS is one example—has the property of increasing SRR, it simultaneously reduces appropriability and hence innovator firm's incentive to innovate. This is especially the case when an innovator firm lacks the depth and breadth of downstream products and services (like, e.g., IBM) that benefit from OI. Put differently, a firm like IBM has more to gain by playing the OI as well as the proprietary game at the same time, whereas a firm like Rambus specializes in the production and licensing of proprietary technologies for its existence and survival.

5 Summary and Concluding Remarks

Monetization of IP presents a challenge with or without IPRs. This is because innovation possesses characteristics of a public good, and as a result, the problem of appropriability—the difficulty innovative firms face in monetizing IP—arises. Nordhaus (2004) estimated that over the 1948–2001 period, supernormal profits for innovation in the US economy—that is, profits over and above the risk-adjusted return—were very small, only 2.8% of corporate profits. However, this does not stop individual firms from continuing to innovate in search of supernormal profits, and some of them like Apple succeed, at least for some period.

Monetization of IP occurs in many forms. They include sale, lease, and rentals of technology embodied in products and services—which is the most common form; process technologies that reduce cost of production and/or improve the quality of end products and services; licensing and cross licensing of technologies, a rapidly growing means of monetization; sales of technologies such as those that occur through acquisition (e.g., Motorola selling Motorola Mobility to Google); securitization of IP; and infringement suits against firms whose patents are related to inactive and marginal patents acquired by patent trolls. The appropriability problem is present in all forms of monetization. The degree to which firms are able to appropriate the benefits of innovation depends not only on how tight IPRs are and how hard it is to copy but also on myriad complementary marketing assets in the form of difficult-to-imitate strong and sustainable brand name and reputation of the firm, promotion, distribution systems, and the like.

The traditional approach to mitigating the appropriability problem has been to internalize innovative activity within the firm through vertical integration (VI). The open innovation (OI) model, which has clearly taken hold in the software sector in the form of open-source software (OSS), turns the traditional VI model of innovation—and proprietary software—on its head. The rapid rise of OSS since the mid-1990s could be described as innovation without property rights. The essence of the OI model, in contrast to the traditional closed and VI model of innovation, is it enables firms to receive external ideas and produce competitively superior innovation and commercialization by opening their own innovation to outsiders. It also expands the innovation space. As such, it emphasizes research and productivity via collaboration and networks. Still, despite the doubling of projected revenues between 2009 and 2013, worldwide forecast of OSS revenues for 2013 ($8.1 billion) pales in comparison to $ 169.5 billion revenues from proprietary software applications (www.linux.com/news/enterprise, August 2009). Thus, it appears that despite the inefficiencies of proprietary software noted earlier, higher *excludability* keeps it dominant, at least for the foreseeable future. At the same time, Microsoft chose to team up with Novell, which like Red Hat, participates under the open-source license to share their respective patent portfolios on a bilateral basis. Moreover, Microsoft's Shared Source Initiative, which gives licensees the right to review and in some cases modify its source code for several of its platform products, represents an example of a trend on the part of firms producing proprietary software seeking to obtain the benefits of the open-source model. And Red Hat, which has consistently taken the position that patents generally impede innovation in software, now takes the view that they are needed as a defense against misuse by a small number of very large companies who amassed large numbers of software patents (www.RedHat.com/RedHat Patent Policy, 4/7/2008). Thus, as suggested by Rao et al. (2009), there appears to be a movement toward coexistence and convergence between OSS and proprietary software producers. On the other hand, the experience with OI in sectors outside of software is too limited to draw conclusions with any high level of confidence.

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Part 2.2
Human Resource Management

Role of Innovation in Practices of Human Resources for Organizational Competitiveness: An Empirical Investigation

Shivani Pandey and Debdeep De

1 Introduction

In an age of severe competition and increasing complexity, effectual human resource management (HRM) can no longer be at ease with simply implementing the traditional set of practices. There is a persistent need to develop and put into practice new and improved human resource (HR) practices subsequently to remain competitive.

The present study identifies innovation as a significant enabler for organizations, to create value and sustain competitive advantage in a rapidly changing environment. Organizations with advanced level of innovativeness will be more successful in offsetting the changing environments and in building new competencies that allow them to attain better performance. To facilitate innovation initiatives, an organization must depend significantly on HR practices which are the principal means by which organizations can influence the behavior of individuals and achieve organizational goals.

Regardless of the recognition of the existing relationship among HR practices, innovation, and organizational performance, very little has been examined from an empirical perspective. Preceding literatures (Wintermantel and Mattimore 1997) have paid emphasis to the link of HR practices and organizational upshot such as productivity, efficiency, flexibility, and financial performance, but the understanding requires to be extensive, to encompass innovation in organizational performance. The purpose of this chapter lies in filling this gap in literature, i.e., this study

The view expressed is of the authors and not of the institute they belong to. Usual disclaimer applies.

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empirically analyzes the relationship between practices of human resource and innovation and the effect of both on organization's performance.

In the consecutive sections, the literature on this topic is analyzed followed by the methodology for the study and finally, findings along with the managerial implications of the study, its limitations, and our suggestions for future research, are presented.

2 Review of Literature

2.1 Innovation and HR Practices

Organization's structure and management practices have undergone a radical change in the fast pace and competitive environment, each firm devising their own unique method to counter issues like fierce competition, globalization, technology change, etc. As the world is becoming more competitive and unbalanced than ever before, organizations are increasingly becoming more practical and rational in identifying HR issues and institutionalizing innovation in human resource practices (HRP). To survive in the age of cutthroat competition, industries like manufacturing, ITES, etc., are seeking to gain competitive advantage at all cost and are turning to more innovative sources through different HR practices to ensure the effective functioning and survival of the organization. HR practices in innovative organizations are treated as the organization's strategy to persuade team responsibilities, augment organizational culture, and build up customer relationships through involvement and empowerment.

The term innovation has been at variance in respect of whether "objective newness" is well thought-out as an important criterion of innovation or considers an innovation to be a system, product, or program which is new to the adopting organization. The adoption of innovation in HR practices can be considered effective within the social system of the organization as they are intended to improve organizational effectiveness and competitiveness by influencing employee attitudes and behavior. Organizations often take on HRM innovations in order to emerge as more legitimate. Nowadays, HR skills and knowledge are a means to success in research and development. Moreover, there is a general recognition about the significance of HRM as a determinant of innovation because it is considered that the innovative capacity of an organization dwells in the imagination, intelligence, and creativity of its employees and that their inference and support are needed for the development and implementation of innovation. Organizations can improve the success rate of their innovative HR programs by providing top-level support for HR innovations, ensuring that the HR department is not isolated from other departments, and that if HR does not meet the challenge of change, it risks being disbanded. Innovative HR practices build competencies and capabilities for better-quality performances today and simultaneously create long-term fertility for innovation of business ideas and strategies for future.

2.2 Functional Innovative HR Practices and Organization Growth

A budding body of pragmatic research has examined the effect of certain HRM practices on organization's performance. Although a long list of best HR practices can influence either autonomously or collectively the organizational performance, we chose to examine select HR practices that can be expected to influence the organization's performance. For instance, *recruitment* and *selection* (Olian and Rynes 1984) engrosses employing appropriate and competent candidates through internal/external sourcing (Sonnenfeld and Peiperl 1988) which offers greater significance to be attached to fit between person and organization culture. Thus, the elevated level of implementation of recruitment that attaches individual organizational fit is likely to result in high organizational innovation and that attracting and selecting the right employees increase the employee productivity, boost organizational performance, and contribute in reducing turnover, resulting in better growth and outcome. *Performance management* (Schuler and Jackson 1987) increases employee obligation and satisfaction since employees are given prospects to discuss about their work performance, which in turn, directs them to perform superiorly and increase involvement in bringing innovation in activities. In a similar stratum, *innovative learning (training) and development programs* (Chen and Huang 2009) may be related to organization's performance in many ways. Firstly, these programs amplify the organization specificity of employee skills, which, in turn, increases employee productivity and trims down job dissatisfaction that results in employee turnover. Secondly, training and developing internal human resources reduces the cost and risk of hiring, selecting, and internalizing people from external labor markets, which again increase employee organization's productivity and cost-effectiveness and reduces turnover (Miles and Snow 1984). *Organic compensation system* (Mabey and Salaman 1995) grants financial reward, promotion, and other recognition in order to motivate employees to take risk, develop successful new products, and generate different ideas, thereby leading to organization's productivity, cost-effectiveness, and increasing efficiency. As soon as the strategic value and the immense organizational transition that is involved in building a corporate-wide innovation capability are recognized, *leadership* automatically moves to center stage. HR leaders take an initiative by turning a company's strategic objective with regard to innovation into tangible everyday action; they make the necessary changes to executive roles and goals, political infrastructures, recruitment strategy, broad-based training, performance appraisals, awards and incentives, employee contribution and commitment, value systems, and so on. In short, HR leaders are the individuals who can build an organization where everyone, everywhere, is in charge/responsible for innovation every day—whether as a trendsetter, adviser, innovator, manager, mentor, or team member. It is truly considered that the pioneering capacity of a firm dwells in the intelligence, imagination, and creativity of its employees, assuming that *employee's knowledge* at a vast extent has a dominant role in influencing the organizational innovation because it is the individuals' proficiency and precious knowledge that allow them to obtain novel ideas and make the first move toward innovation. The explicit advancement, if an organization makes in its HR practices, may, thus, dole out the exclusive requirements of the organization and its employees. It can therefore be said that innovation plays a pivotal role in select HR practices by developing new insights and competence, thereby resulting in organizational competitiveness and performances.

2.3 Innovative HR Practices and Organizational Performance

HR being some of the most unique and complicated to imitate resources of any organization primarily because many of their most vital characteristics are tacit and highly complex. Therefore, HR is therefore a primary source of sustainable competitive advantage for the organization. The importance of executing internally consistent innovation in HR practices leads to higher organizational performance. The impact on organizational performance of sets or "bundles" of innovative HRM practices can be greater than the cumulative impacts of all the traditional HR practices comprising the bundle. That is because the use of innovative HR practices allows companies to get synergies from the complementarities among them. Furthermore, a greater emphasis on innovation that fosters HR practices seems to be an important illuminating factor for greater success or performance of an organization. Therefore, we can say that the organizations which encourage innovation in its HR practices would be positively coupled with its performance in terms of stakeholder's satisfaction, corporate decision making, customer satisfaction, and overall growth. Thus, it is clear that innovation is more contributing to HRM practices when adopted, not in isolation but as a scheme of jointly reinforcing practices (Jiménez-Jiménez and Sanz-Valle 2008).

3 Objectives

The objectives of this chapter are:

(a) To understand the linkage between human resource management and innovation and organizational competitiveness
(b) To analyze how innovative HRM practices contribute in successful functioning of an organization

4 Research Methodology

Literature reveals some obvious yet interesting facts. The design of this chapter has been empirical where a sample has been taken and validation of the facts stated through literature has been tried to achieve. In order to attain the objectives of the study, the Human Resource Department of IT and manufacturing companies are targeted to collect the data, where convenient sampling has been used. The present study takes up a questionnaire survey approach. The choice of the research design was based on the nature of the research objectives. Questionnaire has been used as a tool for conducting this study. The questionnaire is divided into four major parts. The first part includes bringing innovation into practice; the second part talks about functional performances of human resource practices that relate directly to the three main organizational performance indicators, i.e., productivity, cost-effectiveness, and efficiency. The third part comprises of organizational performances in terms of stakeholder's satisfaction, corporate strategic decision making, customer satisfaction, and organizational growth. The last fraction of the questionnaire concludes with the degree of innovation involved in select human resource practices.

Data collection is the significant part of the research. The data collected for this research is primary. This research has been conducted on 40 companies in Delhi and NCR region (Delhi NCR being one of the industrial hubs in India). Forty questionnaires were prepared and sent to the HR department of the respective companies, out of which 30 responses came back and were analyzed. Variables in the questionnaire include select human resource practices, degree of innovation involved, and organizational performance indicators. All independent and dependent variables required five-point Likert style responses ranging from "extremely low" to "extremely high." A five-item scale reflects the extent to which organizations are satisfied with the achievements in their development and implementation of innovation in select-HR-practice activities. The analysis has been carried out using descriptive statistics, and a correlation matrix has been designed. Further stepwise regression analysis has been carried out to see which particular innovative HR practices influence and/or explain organizational performance. Other than Microsoft Excel, SPSS has been used to carry out the results of the study.

5 Findings

Recruitment and selection, compensation system, and employees' knowledge are found to be significantly correlated with the three most important factors enhancing the competitiveness of the firm, namely, productivity, cost-effectiveness, and efficiency. The competitiveness of the firms may be best judged in terms of three basic parameters, namely, increased efficiency, reduced cost, and increased productivity. The correlation matrix as provided in the Table 1 suggests that recruitment and selection is a key factor in enhancing the firm's efficiency and

Table 1 Correlation matrix

	R&S			L&D			PMS			Lead			CS			EK		
	Effe.	Cost eff.	Prod.	Effe.	Cost eff.	Prod.	Effe.	Cost eff.	Prod.	Effe.	Cost eff.	Prod.	Effe.	Cost eff.	Prod.	Effe.	Cost eff.	Prod.
R&S	**0.617**	0.34	**0.59**	0.381	0.48	0.448	**0.73**	0.45	0.05	0.302	0.293	0.0246	0.423	0.28	0.45	0.458	0.405	0.352
L&D	−0.15	−0.46	−0.21	−0.159	−0.12	−0.13	0.032	−0.071	−0.01	−0.218	−0.174	−0.2	−0.2	−0.2	−0.2	−0.128	−0.28	−0.284
PMS	−0.12	0.1	0.05	0.035	0.33	0.309	0.302	0.271	0.234	0.298	0.323	0.389	0.19	0.22	0.24	0.056	0.132	0.128
Lead	0.143	0.44	0.32	0.036	0.48	0.497	0.245	0.363	0.288	0.497	0.454	0.55	0.382	0.47	0.292	0.463	0.48	0.494
CS	0.27	**0.56**	0.43	−0.027	**0.52**	0.485	0.298	0.485	0.366	0.483	0.488	**0.602**	0.511	**0.59**	0.426	0.486	0.481	**0.515**
EK	0.326	0.3	0.4	0.199	0.43	0.382	0.083	0.159	0.07	0.344	0.287	0.297	0.448	0.37	0.396	0.435	0.477	0.401

Abbreviations: *R&S* Recruitment and selection, *L&D* Learning and development, *CS* Compensation system, *PMS* Performance management system, *Lead*. Leadership, *EK* Employees' knowledge, *Cost eff*. Cost-effectiveness, *Prod*. Productivity, *Effe*. Efficiency

Table 2 Model summary

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
1	.391[a]	.153	.123	.66918

[a]Predictors: (constant), the HRM personnel's involvement in integrating innovation in HR practices

productivity. The values of the compensation system in the matrix suggest that it has a significant effect on cost-effectiveness and productivity of the firm. It is important to note that learning and development, on the other hand, has a negative impact particularly on the cost-effectiveness, as it increases the cost to the organizations. Thus, the result shows that the role of HR is by and large seen as critical in making sure that firms are able to attract, retain, inspire, and develop human assets or resources according to existing and future requirements to enhance competitiveness. The recruitment and selection of employees is therefore essential to the operating of an organization, and there are undeniable reasons for getting it right. Inappropriate selection decisions lessen organizational effectiveness, nullify reward and development strategy, and can be distressing for executives and managers who have to deal with employees lacking the attributes required for their skill set to be used as a desirable resource in any organization. Holding on to employees' knowledge in a deregulated, competitive environment has been found to be one of the most significant resources for competitive advantage for firms, which is only possible with practicing of innovative recruitment practices and implementing innovation in compensation and reward systems like using clear remuneration policies, flexible hours, and competency-based payment schemes which in turn can help in stimulating creativity throughout the organization (Amabile et al. 1996).

A stepwise multivariate linear regression analysis is carried out to predict the values of the dependent variables, i.e., organizational performance (Y) which is represented by stakeholder's satisfaction, corporate strategic decision making, customer satisfaction, and organizational growth for a given set of explanatory variables where x1, x2, x3, and x4 are degree of importance given to innovation, keenness of organization for investing in innovative practices, the HRM personnel's involvement in integrating innovation in HR practices, and the degree of acceptance of flexibility in innovative practices, respectively.

This multiple linear regression model for explanatory variable HRM personnel's involvement in integrating innovation in HR practices has *R*-squared value of 0.123. Thus, 12.3 % of the variation in organizational performances can be explained by this model (Table 2).

The ANOVA results clearly indicate that the HRM personnel's involvement in integrating innovation in HR practices within the organization affects the stakeholder's satisfaction in a significant way. The *F* value and the significance level are provided in the Table 3 for reference.

Table 3 ANOVA[a]

Model		Sum of squares	Df	Mean square	F	Sig.
1	Regression	2.262	1	2.262	5.050	.033[b]
	Residual	12.538	28	.448		
	Total	14.800	29			

[a]Dependent variable: stakeholder's satisfaction
[b]Predictors: (constant), the HRM personnel's involvement in integrating innovation in HR practices

Table 4 Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.379[a]	.143	.113	.79771

[a]Predictors: (constant), degree of acceptance of flexibility in innovative practices

Table 5 ANOVA[a]

Model		Sum of squares	Df	Mean square	F	Sig.
1	Regression	2.982	1	2.982	4.687	.039[b]
	Residual	17.818	28	.636		
	Total	20.800	29			

[a]Dependent variable: corporate strategic decision making
[b]Predictors: (constant), degree of acceptance of flexibility in innovative practices

Table 6 Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.505[a]	.255	.228	.54017

[a]Predictors: (constant), degree of importance given to innovation

Table 7 ANOVA[a]

Model		Sum of squares	Df	Mean square	F	Sig.
1	Regression	2.797	1	2.797	9.585	.004[b]
	Residual	8.170	28	.292		
	Total	10.967	29			

[a]Dependent variable: organizational growth
[b]Predictors: (constant), degree of importance given to innovation

The multiple linear regression model for explanatory variable degree of flexibility in innovative practices has an R-squared value of 0.113 (Table 4).

The degree of flexibility in innovative practices significantly affects the level of corporate decision making (significant level <5 %) (Table 5).

Similarly Table 6 shows the degree of importance given to innovation has an R-squared value of 0.228.

ANOVA results in Table 7 shows that degree of importance given to innovation significantly affects the growth of the organization (significant level <5 %).

Table 8 Innovative HR practices and organizational performance

S. No.	Degree of innovative HR practices explained by	Organizational performance indicators	Impact factor
1	The degree of focus/importance given on/to innovation	Organizational growth	Maximum
2	Keenness of organization for investing in innovative practices	Organizational growth, stakeholder's satisfaction, corporate strategic decision making, customer satisfaction	None
3	The HRM personnel's involvement in integrating innovation in HR practices within the organization	Stakeholder's satisfaction	Moderate
4	The degree of flexibility in innovative practices	Corporate strategic decision making	Least

6 Conclusion

The analysis suggests that an organization hoping to enhance performance through innovation should pay attention to its HR practices. It is important to note that innovation, like any organizational outcome, has multiple determinants in particular; it should emphasize the implementation of a set of practices which enhance innovation, e.g., recruitment and selection, learning and development, systematic performance management, leadership, organic compensation system, and employees' knowledge. The state of innovative HR practices is changing in India, and organizations are professionalizing their recruitment and compensation policies to face competition. Practical implications of this research are seen in some Indian firms like Infosys, Wipro, TISCO, State Bank of India, Ranbaxy, and many others which have understood that the differentiator for advanced performance is people and are thus setting an example for other companies for focusing on innovative recruitment and selection and compensation practices to improve their firm performance (Som 2006). However, this has achieved limited success as competitiveness is yet to be achieved through this route. The degree of focus/importance given on/to innovation came out to be the most important practice for enhancing firm performance, followed by the HRM personnel's involvement in integrating innovation in HR practices within the organization which influences moderately the stakeholder's satisfaction as revealed in the results (Table 8). It is clear that the organizational performance does not depend on the keenness of the organization which means that in today's globalized world the organizations do not have a choice whether or not to invest in innovative practices of HR in enhancing the firm performance and thereby competitiveness but are almost bound to do so to share a considerable size in the market.

This chapter in relation to the context presents a number of practical inferences. Firms today are required to change their business strategies and management practices in the dynamic and uncertain business environment. Technological innovations, in high-technology firms, turn out to be significant in adapting and resorting to fast changes. Even in this case, innovation depends intensely on attainment of new knowledge which could be obtained only when an organization fully utilizes its human resources in several innovative ways to sustain competitiveness. Innovative human resource practices can therefore play a vital role in sustaining and contributing to the conception, incorporation, and utilization of knowledge by preparing employees, meeting challenges, and responding to the dynamics of the work environment with high technological and critical skills. Organizations, where innovation and engagement in sustained efforts are more observable, become necessary to consider how best to draw upon the skills and knowledge of the whole workforce. This is where employee's knowledge has an imperative role to play in development of organizational innovation. Managers should therefore look forward in preventing individuals to be restricted into limited perceptual frameworks. In the end, innovation depends on the conception of skills and new ideas; therefore, managers must make an effort to build up ways intended to enhance new and diverse thinking among the employees. Organizations, at the same time, must implement means to develop existing skills, knowledge, and mindset of its people. This is where effective training, appraisal, and systematic contingent reward helps in ensuring that employees are comprehensible about their tasks and have the essential skills necessary to perform efficiently.

Thus, while we say that innovative practices are required or have become a mandatory part in any organization, it has to be understood that the organization has to adopt such measures not only by their choice but also in view of the available workforce aligning the same with the market requirement that would increase the competitiveness in the days to come. Moreover, the skill set has to be linked with the compensation of the employees, so that they can get sufficient motivation to aspire for undergoing such trainings that would lead them to remain competitive in their work environment. Hence, while we understand that for any organization to remain sustainably competitive in its business, the employees in the organization have to follow suit, the design of which should be taken in the spirit of the risk and reward practices that are percolating from the macrobusiness environment to the microlevel of the employees.

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Work Behaviors of Korean and Indian Engineers: A Study of Comparison

M.K. Sridhar and Paul Jeong

1 Introduction

Cultural understanding is a key issue in the development of international or cross border business. The greatest challenge to international business today is the management of business operations across cultural boundaries. In recent years, knowledge-based software business is facing very unusual problems of cross-cultural and work-related behavior issues. Such problems are found to be the major cause for software joint-development business failures between any two countries. This chapter explores the major differences in work-related behavior between South Korean and Indian engineers in knowledge-based software business.

Though a considerable number of works have been done on culture in international business, there is hardly any work done on the culture for business relationship between South Korea and India, particularly in the area of knowledge-based software business. One most important factor that can be attributed to absence of such work in the past is due to low level of economic relationship between the two nations. Though South Korea and India shared diplomatic ties since 1973, the bilateral trade and investments between the countries remained low till the last decade in spite of their structural complementarities.

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2 Need for the Study

One of the trends in ICT system software development is globalization. ICT software industry is becoming more and more globally interconnected. The software is getting developed in a diverse cultural organization and their subsidiaries. More and more companies are outsourcing their work across globe with diversified cultural backgrounds. This acceleration of global business development has generated a lot of interests in management research across cultures on international business

A number of scholars have argued that the existing local, sociocultural context is a critical factor in mediating the globalization process in a specific context and, in turn, will have an impact on the complexity of globalization. According to Greet Hofstede (1980, 1984), "The business of International Business is culture." Culture impacts each aspects of business in the international arena - the actors, the activities, the transformation of resources, as well as the environment in which this takes place and the interactions involved.

There are several models that theorize culture within the context of ICT. However, Hofstede's five cultural dimensions are the most widely used model for studies on cultural and cross-cultural issues in the IT field (Myers and Tan 2002). A study by Myers and Tan (2002), observed that 24 out of 36 studies from cross-cultural ICT literature used Hofstede's cultural dimension constructs.

A number of works are carried out on the cultural aspect, issues, and challenges with global ICT software development. Ifinedo (2004) and Herbsleb and Moitra (2001) examined the challenges and issues in global ICT system software development in multisite and multicultural environments. The challenges and issues associated are strategic, cultural, and inadequate communication; project and process management; trust; geographical distance; and strategic, political, and economical issues. One of the most significant obstacles in global software development is communication. Communication style and complexity of language barriers are key factors among developers and become barriers in most of the projects (Huang and Trauth 2007; Cho 2007). Abraham (2009) and Greg Borchers (2003) examined the cultural factors and differences in software development with the help of original Hofstede's dimension between the cultures to analyze the cultural impact on project management, configuration management, and software architecture to relate various attitudes and behaviors of the team members. Few researchers have examined the managing aspect of cross-cultural issues in global software development (Krishna and Walsham 2004; Gregory et al. 2008). Many researchers recommended ways to address and resolve problems and challenges in cross border software outsourcing relationships. Some of the suggested mechanisms to reduce the cultural impact, are, training on culture to understand different cultural norms and values, having a culturally aware liaison officer who could act as bridge between the teams, approaches to staffing etc.

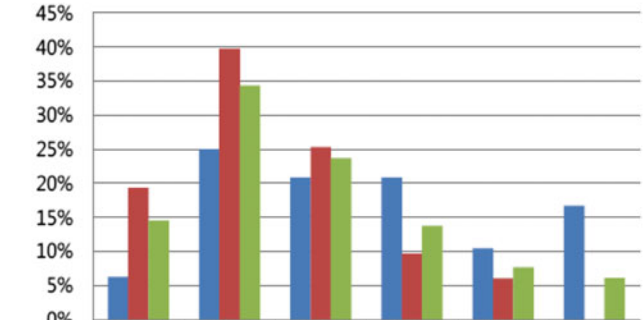
The issues connected with ICT industry are reasonably differing with other industries. The software development business is basically a knowledge-based business model, and the problems of managing both offshore and onsite workers in cross-cultural-related issues are complex. Knowledge-based work is highly interdependent. It is creative, individually styled, and many times cannot be fully planned, and the work consists of analytic and abstract processing of information and knowledge. Individuals working in such industry highly depend on each other for the exchange of information about their jobs (Perlow and Weeks 2002). One of the crucial challenges facing this industry is to overcome misunderstandings and conflict between engineers of different nationality and background due to lack of understanding of each other's culture and working behaviors of team members. In today's global business environment, not only the understanding of values and cross-cultural is necessary but also the understanding of the work behavioral differences between engineers of different countries is required for successful developmental work.

Thus, the problems, challenges, and issues associated with global software development are many. One of the most significant obstacles in global software development is the cultural differences and values which reflect in the work behavior among engineers from different countries working on the same project. Hence, there is a need for the present study. Though a sizable number of studies have been done on culture in international business, there is hardly any work done on the cultural for business relationship between South Korea and India, particularly in the ICT sector. Given the enormous rise in the number and nature of interfaces between South Korean and Indian business due to enhanced cooperation between the countries post-CEPA (a kind of FTA), it is essential that these two nations understand each other's cultural values and work behavioral differences for successful business ventures. Given the lack of any previous work on this topic, such work is completely a virgin territory. Through such research work and findings, meaningful business protocols can be made which can be used by both Indian and South Korean businesses to adapt and succeed in their business relationships.

Since the value system is an inner and intrinsic aspect of person, it is not easily recognized by others. The nature and the types of work values that people distinguish are all based on the theory of basic human values. The work-related behaviors are the expressions of general values in the work setting (Ros 1999). It is observed that the work behavioral dimensions or work goals usually studied are quite broad; they refer to what a person wants out of work in general rather than to the narrowly defined outcomes of particular jobs. Although some work is carried out based on Vunderink and Hofstede's list of work goals items by Routamaa et al. (2007), in this particular study, a behavioral dimensions model is developed to study the work behavioral difference between South Korean and Indian engineers.

3 Research Design

This study covered the exploration of cultural values and work behavioral issues in software development business in the context of Indian and Korean organizations; this chapter examines mainly the work behavioral differences. Several objectives were derived for this study; however, the key focus here is to address the differences of work behavior between Korean and Indian engineers.



	20-24	25-29	30-34	35-39	40-44	45>
Korean	6%	25%	21%	21%	10%	17%
Indian	19%	40%	25%	10%	6%	0%
Total	15%	34%	24%	14%	8%	6%

Fig. 1 Profile of respondent

Data were collected primarily from ICT companies in India and Korea. Basically, the companies who have experience of working with either Korean or Indian companies, or Korean companies having subsidiaries in India, were selected. The sample size of respondent organization was six software development organizations located in India and Korea out of the total population of 35 organizations. Thus, the sample forms 17% of the population. The respondents (primarily managers and engineers) who have experienced working with their counterparts (either Korean or Indians) were selected randomly by the HR managers from these companies. A survey was conducted among them, and a total of 135 respondents' data or samples were collected. Structured questionnaire was developed in English and was divided into sections such as demographic and work behavioral dimensions consisting of 30 behavioral statements/questions which were designed for this study, as explained subsequently. The response to each question was marked on a five-point Likert scale such as SA (strongly agreed), A (agreed), CS (can't say), D (disagree), and SD (strongly disagree). These scales were then converted to a value of 5,4,3,2, and 1, respectively.

Work behavior dimensions, work behavior factors, and work behavior domains of Korean and Indian engineers were analyzed by weighted mean values. *T*-test is used to test the significant difference of various work behavior factors. Chi-square test is used to test the significant difference of work behaviors with age for Korean and Indian engineers.

The profile of respondent (Fig. 1) software engineers of the study could be summarized as:

- Majority of them belonged to the age group of 25–34 years.
- Majority of them were male respondents.
- Most of the respondents were technical degree holders and postgraduates.

4 Operational Definition of Work Behavior

Work behaviors were measured by various statements which were developed through brainstorming and interviewing with project managers, project leaders, and senior engineers. Thirty "behavioral statements" were selected by correlation test. They are called "work behavioral dimensions." These 30 behavior dimensions were classified into 6 "work behavioral factors." They are process, task, time, individual, team, and emotion.

- Process factor consists of six behavior dimensions which are mainly related to documentation.
- Task factor has eight behavior dimensions which are related to achievement of the task.
- Time factor has five behavior dimensions which are related to importance given to time.
- Team factor has four behavior dimensions which are related to team working and collaboration.
- Emotion factor has three behavior dimensions which are related to person's emotions.
- Individual factor has four behavior dimensions which are related to individual life preferences.

Six "work behavior factors" are further classified into two "work behavioral domains." They are *work domain* and *people domain*.

- Work domain mainly refers to all those factors which are directly related to implementation of project. Hence, it includes process, task, and time factors.
- People domain refers to all those factors which are related to interpersonal interaction of work. Hence, it includes team, individual, and emotion factors.

5 Results Analysis

5.1 Work Behaviors of Korean Engineers

Weighted average mean values of work behavior factors and domains of Korean engineers are given in the Table 1 below.

In terms of working style, there are two factors, namely, task and emotion. They reveal whether the engineers are oriented toward task or emotion or both. Task factor has "high" orientation with 3.99, whereas emotion factor has "medium" orientation with 3.31.With regard to team working, orientation toward team or individual is ascertained. Team factor has "high" orientation with 3.68, whereas individual factor has "medium" orientation with 3.21.With respect to project management, there are two factors, namely, process and time. Both process factor and time factor have "medium" orientation with mean values of 3.60 and 3.51 respectively.

Table 1 Work behavior factors of Korean engineers

Behavior factors	Mean values	Orientation
Task	3.99	High
Team	3.68	
Process	3.60	Medium
Time	3.51	
Individual	3.21	
Emotion	3.13	

Basic human values such as "a sense of accomplishment" and "responsible" are related to task orientation. In comparing the study of values by Onesimo et al. (2008), terminal values such as "a sense of accomplishment," "responsible," and "capable" of Koreans among various age groups were found to be their topmost priority. This could explain the higher orientation for task behavior factor compared to other work behavioral factors.

The "work"-related behavior domain for Korean engineers has "high orientation" with mean 3.70, whereas people-related behavior domain has "medium orientation" with mean 3.28. The influences of Confucianism, Japanese, and Americans on Korean corporate culture are significant. Korea as a society evolved under highly competitive environment. South Korea is extremely work-oriented; the people are hard working and industrious. In the corporate culture, achieving task or result is more important than harmony with others. This could explain why the weighted mean value of "work"-related behavior domain is much higher than the people behavior domain.

With respect to age groups (younger, older), it is observed that younger Koreans have higher mean values compared to older ones in case of factors such as team (younger: 3.92, older: 3.58), process (younger: 3.80, older: 3.51), and individual factors (younger: 3.33, older: 3.15). In case of time and emotion factors, older Koreans marginally score more when compared to younger ones. The average means of both groups are more or less equal in case of task behavioral factor.

In the case of behavioral domains, the mean values of younger and older Korean engineers for "work" domain are more or less the same, both having higher orientation with a mean value difference of 0.06. With respect to "people" behavioral domain, younger Korean engineers score marginally higher than the older Koreans with a mean difference of 0.15.

Chi-square test has been used to test the significance of association between behavior domains and age. Chi-square test results reveal that the age of Korean engineers has an influence on people behavioral domain.

5.2 *Work Behaviors of Indian Engineers*

Weighted average mean values of work behavior factors and domains of Indian engineers are shown in the Table 2.

Among the behavioral factors, the team factor has the highest mean value compared to other factors. With regard to team working, team factor has high

Table 2 Work behavior factors of Indian engineers

Behavior factors	Mean values	Orientation
Team	4.10	High
Task	3.84	
Process	3.66	Medium
Individual	3.51	
Time	3.27	
Emotion	3.16	

orientation with mean 4.10, whereas individual factor has medium orientation with mean 3.51. With respect to project management, process and time factors have medium orientation with mean values 3.66 and 3.27, respectively. In terms of working style, task factor has higher orientation with mean 3.84, whereas emotion factor has medium orientation with a mean of 3.16.

With respect to behavioral domains, work and people domains of Indian engineers have medium orientation with almost similar mean values 3.59 and 3.53, respectively.

With respect to age groups (younger, older), it is observed that the means of younger Indians are higher compared to older ones in case of individual, emotion, and team factors; whereas, in case of time, process, and task factors, older Indian engineers marginally score more compared to younger ones. The maximum mean difference is observed in case of individual factor wherein the mean values for younger and older Indian engineers are 3.66 and 3.29, respectively. Younger Indian engineers appear to give more preference to individual factors such as “comforts in life,” “giving priority to personal issues,” etc.

In case of “people”-related behavioral domain, the mean value of younger Indian engineers is 3.70 compared to 3.43 for older Indian engineers. However, in the case of “work”-related behavioral domain, both younger and older engineers scored more or less similar with 3.56 and 3.64 mean values, respectively.

Chi-square test reveals that there exists statistically significant association between the people behavior domain of Indian engineers and their age, and also no statistically significant association was found between the “work” behavior domain of Indian engineers and their age.

5.3 Work Behaviors Between Korean and Indian Engineers

The following section analyzes the difference in mean values of work behavioral factors and domains of Korean and Indian engineers.

The highest difference in the mean values of various behavior factors between Korean and Indian engineers is observed in team factor (Korean, 3.68; Indian, 4.10; difference, 0.41) and the lowest difference of the same is observed in emotion factor (Korean, 3.13; Indian, 3.16; difference, 0.04). Process factor of Indian and Korean engineers is found to be similar with a mean difference of 0.06. With regard to team factor, Indian engineers have higher orientation than Koreans with a mean difference of 0.41. Individual factor of Indian engineers is higher than Koreans with a mean difference of 0.3. Time factor of Korean engineers has higher orientation than Indians with a mean difference of 0.23. For task factor, Korean engineers have higher orientation than Indians with a mean difference of 0.15. The mean values of both process and emotion behavioral factors of Korean and Indian engineers are found to be similar with a marginal difference.

Results of statistical mean values reveal that task and time factors of Korean engineers have higher orientation than Indian engineers, whereas team and individual factors of Indian engineers have higher orientation than Korean engineers. And the process and emotion factors of both Indians and Koreans have more or less similar orientation.

In the case of "people"-related behavioral domain, Indian engineers have higher orientation than Korean engineers with a mean difference of 0.19. And in the case of "work"-related behavioral domain, Korean engineers have higher orientation than Indian engineers with a mean difference of 0.11.

T-test is used to test the significant difference of various work behavior factors between Korean and Indian engineers. *T*-test results indicated that there are work behavioral differences between Indian and Korean engineers related to task orientation, team orientation, time orientation, and individual factors. However, no significant behavioral differences are found between Indian and Korean engineers relating to process- and emotion-related work behavioral factors.

T-test results also revealed that there are work behavioral differences in terms of both people and work behavioral domains between Indian and Korean engineers.

6 Findings and Discussion

Some of the key findings and analysis of this study with respect to work behavior differences between Korean and Indian engineers are discussed below.

With respect to "work"-related behavioral domain factors (task, time, and process), it is found that Korean engineers have higher orientation for both time and task factors than Indian engineers. In terms of task accomplishment, Korean engineers are found to be more responsible and accountable to achieve the work goals of the organization than their Indian counterpart. Korean engineers are also found to be more particular about schedule and timeline of the projects than Indian engineers by staying beyond working hours to finish the project as per the plan. This analysis reveals that Korean engineers are more task and time oriented in nature in the workplace than Indian engineers. In terms of process orientation, it is found that both Korean and Indian engineers almost equally agree in terms of process work behaviors such as documentation, minutes of meetings, etc., with a marginal mean difference.

With respect to "people"-related behavioral domain factors (team, individual, and emotion), it is observed that Indian engineers have higher orientation for team and individual work behavior factors than Korean engineers. Indian engineers exhibited more team-oriented work behavior such as “all team members are equally responsible,” “helping colleagues,” etc., in the work place than Korean engineers. Indian engineers also exhibited a higher “individual” work behavior pattern such as “job that provides time for comforts in life,” “self-learning,” etc., than Korean engineers. Indian engineers seem to have more preference to have a job that will provide work-life balance, personal time, comforts, and self-learning. In the case of “emotion” work behavior factor, both Korean and Indian engineers have similar work behavioral pattern with a marginal mean difference. Both Korean and Indian engineers regret for being harsh and abrasive in the work place. Koreans are more emotional than Indian engineers if harsh words are used in the work place.

This study reveals that there are significant work behavioral differences between Indian and Korean engineers in task-, team-, time-, and individual-orientation-related work behavioral factors. No significant behavioral differences are found between Indian and Korean engineers related to process orientation and emotion-related work behavioral factors. This study also revealed that there are work behavioral differences in terms of “people” and “work” behavioral domains between Indian and Korean engineers.

7 Conclusions

A major contribution of this study has been to understand and explore the work behavior of Indian and Korean engineers and their differences particularly in the context of ICT industry. Analysis and findings of this study bring out a set of business protocols for Korean and Indian companies to avoid any conflicts and make successful joint developmental work. Usually, business protocol means a set of guidelines between the companies for successful cross border business operation; however, this study suggested a set of project management protocols (for both Korean and Indian managers) considering work behavioral factors of Indian and Korean engineers and Korean and Indian managers who are managing offshore, onsite development projects; they should be made aware of work behavior of engineers to manage such projects to reduce the impact due to cultural differences.

The business relationship between Korea and India has been accelerated since CEPA (signed between Korea and India in 2010). This has uncovered more business opportunities for Indian and Korean companies for the global market because of their respective strength in ICT industry. In addition, merger of other industries with IT technology, enhancement of hardware capability, growing demand for software development, and shortage of engineers in Korea are some of the trends to be noted. Hence, the demand of collaboration between Koreans and Indians in software development industry becomes greater. This cannot happen without good and enduring relations between them. Understanding and appreciation of value system and work behavior of the other is essentially a prerequisite for successful business operation.

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Demographic and Personality Determinants of Entrepreneurial Tendencies of Aspirant Human Resources

Subhash C. Kundu and Sunita Rani

1 Introduction

For many years, scholars employed "trait research" in attempting to identify a set of personality characteristics that would distinguish entrepreneurs from others. A great deal was known about the personality characteristics, personal background, and family background (Louw et al. 2003) of entrepreneurs such as age, gender, birth order, family size, education levels, socioeconomic status, and religion that urged them to set up a business venture. Still very few studies had been carried out on the demographic variables and psychological characteristics as predictors of entrepreneurship in India despite the growing importance of entrepreneurship in the country.

In view of this, the present study intended to examine entrepreneurial vs. managerial personality characteristics in combination with various demographic factors and to predict the entrepreneurial tendencies of aspirants. This study included subjects at important life stages. High school was the stage when career aspirations were first taking form (Wilson et al. 2007). Adult career expectations and intentions began to be formed in the teen years, at least for college-bound students (Low et al. 2005). Further, the sample in the study also involved adults, in the age range of 31–40 years and above, who had already chosen a career as entrepreneurs or managers. This age range was considered to be the most active in terms of entrepreneurial activity (Reynolds et al. 2002), might be because they were likely to be a group that would act on their intentions in a relatively short time frame. Further sub-objectives of the study were:

- Do personality traits influence the entrepreneurial/managerial tendencies?
- Do demographic variables influence entrepreneurial/managerial tendencies?
- To predict aspirant human resources' entrepreneurial/managerial tendencies.

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2 Review of Literature and Hypotheses Formulation

The studies had shown that entrepreneurs usually started at early age falling between 25 and 40 years (Koh 1996), whereas the women entrepreneurs were late starters having the range of 40–44 years (Lee 1997). Women's participation rates in entrepreneurship were lower than men (Minniti 2006). Male and female entrepreneurs differed on personality characteristics and traits (Hisrich and Brush 1983) and education (Buttner and Rosen 1988). Further, female entrepreneurs were found confident and resourceful and enjoyed the challenge of entrepreneurial activity (Mordi et al. 2010). Kundu and Rani (2008) found differences between males and females on achievement and innovation and by gender and course categories (Kundu and Rani 2004). Personality traits differed between first and later born (Carlson and Kangun 1988), and in fact, first born were more entrepreneurial (Lee 1996). The entrepreneurs tended to be the oldest children (McClelland et al. 2005). Attaining a high level of education did not help the business start-up process (Stuart and Abetti 1990). Men often studied in technical or business areas, whereas most women in liberal arts (Hisrich 1990).

Entrepreneurship was a typical example of a planned and intentional behavior that in turn was determined by attitudes, personality traits, and situational variables (Krueger et al. 2000). Members of business family often played a critical role in the creation and survival of new ventures (Aldrich and Cliff 2003). Founders tended to have self-employed parents, those needed to be supportive and encourage independence, achievement, and responsibility (Hisrich and Brush 1986). Family played an important role (Shivani et al. 2006) in two ways, i.e., direct support and through the development of social, community, and economic networks (Stewart 2003). So, the following hypotheses:

H1 Entrepreneurs start their businesses comparatively at early age than managers.
H1a Age does have an impact on the prediction of entrepreneurial/managerial tendencies of aspirants.
H2 Gender does have an impact on entrepreneurial/managerial tendencies.
H2a Gender does have an impact on the prediction of entrepreneurial/managerial tendencies of aspirants.
H3 Birth order determines the entrepreneurial/managerial tendencies.
H3a Birth order does have an impact on the prediction of entrepreneurial/managerial tendencies of aspirants.
H4 Size of the family/number of siblings does have an impact on the entrepreneurial/managerial tendencies.
H4a Size of the family/number of siblings does have an impact on the prediction of entrepreneurial/managerial tendencies of aspirants.
H5 Educational qualifications do have an impact on entrepreneurial/managerial tendencies.
H5a Educational qualifications do have an impact on the prediction of entrepreneurial/managerial tendencies of aspirants.
H6 Subjects studied do have an impact on entrepreneurial/managerial tendencies.
H6a Subjects studied do have an impact on the prediction of entrepreneurial/managerial tendencies of aspirants.

H6b Choice of career (intentions) does have an impact on prediction of entrepreneurial/managerial tendencies among aspirants.
H7 Father's occupation influences the entrepreneurial/managerial tendencies.
H7a Father's occupation does have an impact on the prediction of entrepreneurial/managerial tendencies of aspirants.
H8 Family background does have an impact on entrepreneurial/managerial tendencies.
H8a Family background does have an impact on the prediction of entrepreneurial/managerial tendencies of aspirants.
H9 Socioeconomic status does have an impact on entrepreneurial/managerial tendencies.
H9a Socioeconomic status does have an impact on the prediction of entrepreneurial/managerial tendencies of aspirants.

Personality characteristics, as measured by personality tests and questionnaires, were effective predictors of the subsequent entrepreneurial activity of individuals (Stewart et al. 1999). There was a well-established body of research on the psychological characteristics associated with entrepreneurship (Littunen 2000). Need of achievement, affiliation, and power (McClelland 1965); tolerance for ambiguity and autonomy (Sexton and Bowman 1984); resistance to conformity (Sexton and Bowman 1983); risk taking (Palmer 1971); locus of control (Rotter 1966); and assertiveness, forward-looking, critical thinking, creativity, innovation, preparedness, responsibility, open-mindedness (Yonekura 1984) ready to change, dominance, endurance, self-esteem, low anxiety level, and self-reliance (Sexton and Bowman 1985) were analyzed with respect to entrepreneurship and were identified as correlates of being or desiring to be an entrepreneur (Bonnett and Furnham 1991). Psychological characteristics that were unique to entrepreneurs (vis-à-vis non-entrepreneurs) were a logical first step in studying entrepreneurship (Koh 1996). So, the study proposed following hypotheses:

H10 Entrepreneurs and managers do differ on sixteen personality factors (16 PF) (given in italics form in first column of Table 2).
H11 Entrepreneurs and managers do differ on second-order factors (see underline factors in first column of Table 2).
H12 Entrepreneurs and managers do differ on composite factors (given in bold form in first column of Table 2).
H13 Personality traits do have impact on prediction of entrepreneurial/managerial tendencies of aspirants.

3 Research Methodology

The Sixteen Personality Factors Questionnaire (16 PF) was used to measure the sixteen primary personality factors (16 PF), second-order factors, and composite factors (Cattell 1946). The 16 PF was one of the most influential and well-researched

Table 1 Description of sample

Categories	Target sample	Received	Rejected	Total	Response rate (%)	% to total
Matric	450	245	45	200	44.4	14.28
Senior secondary	450	236	36	200	44.4	14.28
Graduates	450	221	21	200	44.4	14.28
Postgraduates	450	232	32	200	44.4	14.28
MBAs	450	236	36	200	44.4	14.28
Managers	450	215	15	200	44.4	14.28
Entrepreneurs	450	210	10	200	44.4	14.28
Total	3,150	1,595	195	1,400	44.4	100

personality inventories (Dancer and Woods 2006). Manual scoring key and norms table were used for scoring and converting raw scores to sten (standard ten) scores for sixteen primary personality factors (16 PF).

The survey was conducted in two phases. In the first phase, the questionnaires were administered to respondent students of senior school to university level (including MBAs) in eighteen educational institutions in North India (including both males and females). In the second phase, the questionnaires were served to 450 managers and 450 entrepreneurs (including both males and females) in the same area. We stopped survey across categories after receiving 200 correctly completed questionnaires. Further, late-received and incomplete questionnaires were not considered. Out of 3,150 target sample, we could collect only 1,595 questionnaires, and finally, a total of 1,400 completed questionnaires were found in all respect that were used for analysis purpose. Table 1 showed the category-wise breakup, response rate, and percent to total of the sample.

Multinomial logistic regression (MLR) was used in the study to differentiate personality traits and demographic characteristics of entrepreneurs and managers and to predict the category and number of aspirants falling in entrepreneurial or managerial category. In the light of existing literature, the personality traits embodied in sixteen factors along with demographic variables (control variables) such as age, gender, birth order, etc., were considered as determinants of entrepreneurial or managerial tendencies for specifying the MLR model.

4 Results and Discussion

Table 2 showed the logistic regression coefficients, Wald statistic, and Exp (B) (odds ratios) of independent variables. Collectively, these factors could distinguish between entrepreneurs and managers at an overall accuracy rate of 92.5% for entrepreneurs and managers. Table 2 showed that age, birth order, educational qualifications, and socioeconomic status were significant in differentiating entrepreneurs from managers and in prediction of entrepreneurial tendencies of aspirants. The odds ratio showed that with one level increase in age, the chances

Table 2 Summary results of multinomial logistic regression (dependent variable: entrepreneur/manager)

Entrepreneur	B	Std. error	Wald	Sig.	Exp(B)/odds ratios	Model fitting information
Intercept	35.122	5.324	43.519	0.000		*Likelihood ratio tests*
Warmth (A)	0.736**	0.224	10.771	0.001	2.087	*−2 log likelihood*
Reasoning (B)	0.533**	0.182	8.539	0.003	1.704	Intercept only = 554.518
Emotional stability (C)	−0.115	0.336	0.117	0.732	0.891	Final = 185.106
Dominance (E)	−0.186	0.240	0.598	0.439	0.830	Chi-square = 369.412
Liveliness (F)	−0.742*	0.318	5.436	0.020	0.476	df = 34, Sig. = 0.000
Rule consciousness (G)	0.347	0.267	1.696	0.193	1.415	*Goodness of fit*
Social boldness (H)	0.346	0.287	1.456	0.228	1.413	Pearson = 611.305
Sensitivity (I)	−0.287	0.239	1.442	0.230	0.751	df = 265, Sig. = 0.000
Vigilance (L)	−0.752**	0.196	14.799	0.000	0.471	Deviance = 185.106
Abstractedness (M)	−0.699**	0.282	6.170	0.013	0.497	df = 265, Sig. = 1.000
Privateness (N)	−0.321*	0.148	4.724	0.030	0.725	*Pseudo R-square*
Apprehension (O)	−0.096	0.248	0.149	0.699	0.908	Cox and Snell = 0.603
Openness to change (Q1)	−0.576*	0.234	6.049	0.014	0.562	Nagelkerke = 0.804
Self-reliance (Q2)	0.149	0.253	0.347	0.556	1.161	McFadden = 0.666
Perfectionism (Q3)	1.065**	0.263	16.416	0.000	2.900	*Percent correct = 92.5%*
Tension (Q4)	0.600*	0.301	3.985	0.046	1.823	
Extraversion	−1.844*	0.824	5.007	0.025	0.158	
Anxiety	−0.061	0.985	0.004	0.951	0.941	
Tough poise	−2.759**	0.870	10.066	0.002	0.063	
Independence	1.297	1.020	1.618	0.203	3.660	
Superego control	−5.316**	1.291	16.942	0.000	0.005	
Adjustment	0.463	0.705	0.431	0.511	1.589	
Leadership	−0.017	0.947	0.000	0.986	0.983	
Creativity	0.923	0.921	1.004	0.316	2.516	
Age	−0.178**	0.045	15.828	0.000	0.837	
Gender	0.423	0.437	0.934	0.334	1.526	
Birth order	−1.504**	0.468	10.326	0.001	0.222	

(continued)

Table 2 (continued)

Entrepreneur	B	Std. error	Wald	Sig.	Exp(B)/odds ratios	Model fitting information
Siblings	−0.360	0.340	1.119	0.290	0.698	
Educational qualifications	−1.731**	0.531	10.633	0.001	0.177	
Subjects	−0.525	0.355	2.187	0.139	0.591	
Father occupation	−0.330	1.036	0.102	0.750	0.719	
Family background	0.050	1.042	0.002	0.962	1.051	
Socioeconomic status	−3.268**	0.814	16.133	0.000	0.038	

Note: 1. The reference category is manager. 2. $*p \leq .05$; $**p \leq .01$

of the respondents moving toward entrepreneurship decreased by about 17%. So, on the basis of these results, *H1* was accepted. Similarly, in case of birth order, with one degree change, i.e., with the subject going toward higher birth order, the chances of moving toward entrepreneurship decreased by 78%. It indicated that first born had more chances of becoming entrepreneurs as also found in various studies (Watkins and Watkins 1983). Thus, *H3* was accepted. With increase in educational qualifications, the chances of the subject moving toward entrepreneurship decreased by about 82%. It indicated that the higher the educational qualifications, the lesser the chances to become entrepreneurs. So, *H5* was accepted. In case of socioeconomic status, with the subject moving down from high to middle high, from middle high to middle, the chances of becoming entrepreneurs decreased. It indicated that the higher the socioeconomic status, comparatively the more would be the chances of moving toward entrepreneurship. As a result, *H9* was accepted. Further, gender, siblings, family background, father occupation, and subjects chosen for academics were not significant in prediction of entrepreneurship. Hence, *H2*, *H4, H6*, *H7*, and *H8* were rejected.

Among the personality traits, factor A, i.e., warmth; factor B, i.e., reasoning; factor F, i.e., liveliness; factor L, i.e., vigilance; factor M, i.e., abstractedness; factor N, i.e., privateness; factor Q_1, i.e., openness to change; factor Q_3, i.e., perfectionism; factor Q_4, i.e., tension; extraversion; tough poise; and superego control emerged as significant predictors of entrepreneurship and distinguished them from managers. Further, Table 2 revealed that factor C, factor E, factor G, factor H, factor I, factor O, factor Q_2, anxiety, independence, adjustment, leadership, and creativity were not found significant in prediction of the entrepreneurial/managerial category. So, *H10, H11*, and *H13* were partially accepted and *H12* was rejected.

The odds ratio for factor A indicated that for each one unit increase in the score there were more than double chances that the participant will move toward entrepreneur category. Similarly, for each one point increase on the factor B, there were 70% chances that the respondent would fall in entrepreneur category. Factor F's effect was in the opposite direction as with one point increase being associated with the decreased chances of the subject falling in entrepreneur category by about 52%. The same trend was noticed for factor L, factor M, factor N, factor Q_1, extraversion, tough poise, and superego control, where the chances of subjects falling into entrepreneur category decreased with increase in these factors. The odds ratio for factor Q_3 indicated that for each one point increase in the score there were more than double chances of the subject moving toward entrepreneur category. Similar impact was visible in case of factor Q_4 where the odds ratio indicated that with one point increase in the score there were 82% more chances of the subject falling in entrepreneurial category. These results indicated that higher sten scores of traits like warmth, reasoning, perfectionism, and tension and lower sten scores of traits like liveliness, vigilance, abstractedness, privateness, openness to change, extraversion, tough poise, and superego control were indicators of entrepreneurial tendencies if personality traits were studied along with demographic variables.

Being realistic was one of the 11 common characteristics identified in the entrepreneurs (Kao 1991). Entrepreneurs were trusting, accepting conditions, and easy to get along with (Hornaday 1982; IPAT Staff 1991). Extroverts were sociable, self-confident, and optimistic which were characteristics valued at senior levels of management (Moutafi et al. 2007). Entrepreneurs ventured into new and risky environment, set new trends which called for nonconformity, and were not guided by pre-learned set of rules. They were ready to take calculated risks (Kao 1991). Brandstatter (1997) found business founders to be more emotionally stable, less rational and therefore more intuitive, and more independent than those who had taken over the business from others. Envick and Langford (2000) found that entrepreneurs were significantly lower than managers in conscientiousness and agreeableness, but no significant differences were found with extraversion, neuroticism, or openness to experience.

Table 3 showed the predicted results of aspirants in terms of various demographic variables. The model predicted the entrepreneurial/managerial tendencies of aspirants based on the traits and demographics of entrepreneurs ($N = 200$) and managers ($N = 200$) using the results shown in Table 2. These results indicated that with increase in age, the entrepreneurial tendency decreased while the managerial tendency increased. Hence, *H1a* was accepted. Gender was not a significant factor in prediction of entrepreneurship. So, *H2a* was rejected. In case of birth order, the aspirants who were eldest children in the family were predicted more in the entrepreneurial category (62.3%). Similarly, in case of siblings, the aspirants with less number of siblings were predicted more in entrepreneurial category, whereas the aspirants with more number of siblings were predicted in managerial category. It also indicated toward positive impact of small family on entrepreneurship. Hence, *H3a* and *H4a* were accepted.

With increase in educational levels, the entrepreneurial tendencies decreased (matric students = 76.5%, senior secondary students = 77.5%, graduates = 39%, postgraduates = 34.5%, MBAs = 31.5%) and managerial tendencies increased. A large number of aspirants studying combination of subjects (76.5%) were predicted in entrepreneurial category followed by humanities (53.1%). Aspirants having commerce or management background were predicted more in managerial category (69.1%). So, *H5a* and *H6a* were accepted. Stuart and Abetti (1990) found that advanced education beyond the bachelor's degree did not help in entrepreneurship. Choice of career/intention showed that a significant number of aspirants with intention to choose entrepreneurship as a career was predicted in entrepreneurial category (56.8%) against predicted in managerial category (43.2%). Hence, *H6b* was accepted. Family background and father occupation did not show any significant difference in prediction of aspirants in entrepreneurial/managerial category, which resulted into rejection of *H7a* and *H8a*. In case of socioeconomic status, majority of aspirants predicted in entrepreneurial category were in high socioeconomic status (76.5%) followed by middle high socioeconomic status (68.1%), whereas more number of aspirants with middle socioeconomic status were predicted in managerial category (70.3%). Hence, *H9a* was accepted.

Table 3 Summary table of predicted response categories

Demographic variables		Predicted response category: Entrepreneurs	Managers
Age group	Up to 20	327(75.5)	106(24.5)
	21–30	189(33.5)	376(66.5)
	31–40	2(100)	–
Gender	Male	257(51.4)	243(48.6)
	Female	261(52.2)	239(47.8)
Birth order	First	261(62.3)	158(37.7)
	Second	246(53.6)	213(46.4)
	Third	11(12.1)	80(87.9)
	Fourth	–	22(100)
	Fifth	–	8(100)
	Sixth	–	1(100)
Sibling	One	109(68.6)	50(31.4)
	Two	276(56.8)	210(43.2)
	Three	126(46.7)	144(53.3)
	Four	5(8.1)	57(91.9)
	Five	2(10.5)	17(89.5)
	Six	–	3(100)
	Eight	–	1(100)
Educational qualifications	Matric	153(76.5)	47(23.5)
	10 + 2	155(77.5)	45(22.5)
	Graduation	78(39)	122(61)
	PG	69(34.5)	131(65.5)
	MBA	63(31.5)	137(68.5)
Subjects	Humanities	197(53.1)	174(46.9)
	Commerce/mgt	76(30.9)	170(69.1)
	Science	92(50.3)	91(49.7)
	Others	153(76.5)	47(23.5)
Father occupation	Business	205(54.5)	171(45.5)
	Service	313(50.2)	311(49.8)
Family background	Business	211(53)	187(47)
	Service	307(51)	295(49)
Socioeconomic status	High	13(76.5)	4(23.5)
	Middle high	378(68.1)	177(31.9)
	Middle	127(29.7)	301(70.3)
Choice of career	Executive/officer	318(49.1)	330(50.9)
	Business person	200(56.8)	152(43.2)

Note: Percentages are indicated in parentheses

5 Conclusions, Limitations, and Implications of the Study

The results derived showed that younger age group and first born had more chances of becoming entrepreneurs. Higher educational qualifications decreased the chances of moving toward entrepreneurship. Further, comparatively higher socioeconomic status increased the chances of the aspirants moving toward entrepreneurship. Among the personality traits, warmth, reasoning, liveliness, vigilance, abstractedness, privateness, openness to change, perfectionism, tension, extraversion, tough poise, and superego control showed significant impact in predicting entrepreneurial behavior. Further, the commonness in entrepreneurial and managerial traits in the study revealed that some managerial skills were also required to be a good entrepreneur and vice versa (Kuratko and Hodgetts 2004).

The study does have implications for younger population of students, professionals, organizations, and government. In particular, with knowledge personality traits along with demographic variables, programs can be initiated by governments to develop and enhance these traits in order to encourage entrepreneurship that will ultimately help in reducing the pressure of the problem of unemployment in developing economies like India. Further, organizations can cultivate corporate entrepreneurship to enhance corporate innovation and performance. These findings can be used as a career guidance tool for student aspirants who want to continue for higher studies or want to go for self-employment after a particular stage of education.

In particular, future research can investigate the relationship between psychological characteristics and entrepreneurial inclination in combination with other factors, such as financial, family, and environmental support, precipitating events, and economic conditions prevailing in a country or a particular region. Rather cross-cultural studies covering wide spectrum of respondents can be pursued by future researchers.

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Reducing Voluntary Turnover Through Improving Employee Self-Awareness, Creating Transparent Organizational Cultures, and Increasing Career Development

Jeffrey R. Moore and Douglas Goodwin

1 Introduction

Successful companies exist when employees and stakeholders interact in a constructive manner to focus on the accomplishment of critical tasks. This research examined the ways self-assessment and peer assessments can be used to reduce organizational dysfunction by increasing employee self-awareness as well as improving employee career progression. Employee management behaviors in a service company were assessed by their peers in order to determine positive organizational culture and level of stress. The study also explored two links: (a) between the consistency of self-evaluation versus peer evaluation of the employee and the level of stress in the organization and (b) between the consistency of peer evaluation versus the supervisor's performance expectation of the employee and the level of stress in the organization. The researchers hypothesized that lower levels of stress within the organization indicate a higher perception of skill among employees. This study also explored which management skills are most important for developing a healthy work culture in a service industry.

2 Review of the Literature

A company spends a significant part of its budget on recruiting, developing, and retaining its employees. According to a report entitled Retaining Talent, high turnover is very costly to organizations (Allen 2008). Voluntary turnover is expensive due to replacement costs which can be as high as 50–60% of the annual salary, new training costs of a replacement, paid benefits to the employee, as well as

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increased workload of the HR staff (Allen 2008). The total costs are estimated to represent on average of more than 12% of pretax income. With a high turnover rate, around 75%, the total costs are around 40% of pretax income. The report indicated that employee engagement and development are critical in retaining and improving an organization's human capital (Allen 2008).

Social scientists have long studied the dynamics of groups and their impact on the employee and the organization. Forsyth (1999) refers to a *group* as a collection of two or more employees who share a common goal, have a stable pattern of relationships, and perceive themselves as being a group. Benne and Sheats (1948) stated that the roles within the group tend to be differentiated between task-oriented roles and relations-oriented roles (socio-emotional). The two categories of task and culture (relations) roles in examining group dynamics within the organization informed the current research study.

In the mid-1970s, Hare (1976) examined the impact of cohesiveness and the lack of cohesiveness in groups. Groups, which lacked cohesiveness and where employees did not like each other, often worked against each other. Current research shows that highly cohesive groups are the ones where employees accept the group's goals, work toward meeting goals, have a sense of belonging to the group, and have higher performance (Beal et al. 2003). Data on group cohesiveness indicate that cohesiveness is a positive trait as employees in cohesive groups enjoy belonging to the group, accept and accomplish the group's goals, have fewer absences from their jobs, and show less voluntary turnover (Aronson and Mills 1959; Cartwright 1968; George and Bettenhausen 1990; Long 1984).

As relationships thrive in healthy partnerships, strategic alignment is improved and organizational goals are reached. Inversely, as relationships become toxic and survivalist, relationships deteriorate and organizational goals are lost to more immediate personal goals. When there is a sustained unhealthy toxic culture developed, silos are created (i.e., isolated work units do not communicate and are hostile one to another), and the organization loses its strategic focus and effectiveness (Moore et al. 2011).

2.1 Conceptual Models

Two conceptual models were used as the basis for this research. The Healthy versus Toxic Organization Model measures the stress in partnerships from a task as well as a culture dimension (Moore 2006). The Competing Values Framework (CVF) measures the management skill of employees in an organization (Quinn et al. 2007). CVF has been used extensively in research on organizational and leadership effectiveness and has become a tool for teaching management and leadership in universities. The framework is divided into four quadrants representing the Human Relations, Internal Process, Rational Goal, and Open Systems management models (Fig. 1). These models are associated with the action words collaborate, control,

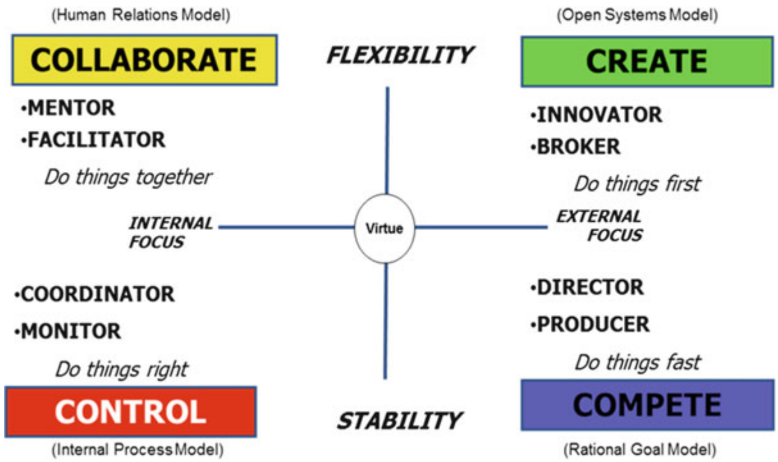

Fig 1 Competing values framework (Adapted from Quinn et al. 2007)

compete, and create, respectively. Within each of these quadrants, Quinn and colleagues (2007) noted two management roles, bringing the total management roles of the CVF to eight.

The Healthy versus Toxic Organization Model stems from research on virtue and survival behaviors in an organization (Moore 2006). Data show when virtue behaviors of truth, vision, and service existed in organizational partnerships, growth was present. Inversely, when survivalist behaviors of deception, use of fear, pride, or greed existed in organizational partnerships, toxicity was present. Stress in an organization, either internal or external, distorts a department's behavior to adapt and cope with the stress and interdepartmental dysfunction.

The Competing Values Framework provides a frame for examining specific feedback from peers and the supervisor's expectations and compares it to the self-assessment of each employee. Based on a scientific method for approaching these differences, a road map for employee career development and healthy cultural engagement and effectiveness can be established.

3 Methodology

Data for this research were collected in 2011 from a small medical service company in Atlanta, Georgia, with 21 employees. This company services national clinics and hospitals that cannot afford to hire full-time medical specialists. The service consists of reading and giving expert analyses for requested patient records. The company is comprised of the following five departments: executive, sales, operations, medical doctors (MDs), and finance/information technology (IT).

3.1 Survey Instruments

Three survey instruments were used in the data collection: (a) a self-assessment survey, (b) a peer assessment survey, and (c) a supervisor assessment survey. These surveys incorporated the CVF and Healthy versus Toxic Organization Models. All of the surveys administered were comprised of the same 20 questions which were scored on a scale of 1–7. A score of seven is high, indicating mastery or proficiency in a management behavior. The peer assessment score is computed by averaging four or five evaluations of employees who routinely work with that individual. The supervisor assessment was completed by the supervisor, not on the individual's performance but on his or her expectations of what the job performance standard should be for that position.

In order to represent graphically the results of the survey, a scale was developed to clarify the division between healthy and toxic organizational dynamics and was based on Lencioni's (2002) five dysfunctions of a team model. Based on the scores from the survey, employees could be evaluated as healthy or toxic, clarifying the realities of the departments in the company. An employee that receives a 5.0 and below was classified as being stressed (i.e., toxic). These scores were given by the peer assessment in either the accomplishment of tasks or the healthy culture dimensions of the Healthy Culture Model.

4 Findings

The data for this research are presented in five parts: (a) the differences between the employee's self-assessment and their peer evaluation of management skill, (b) the differences between the employee's peer evaluation and the gap with their supervisor's expectation of their management skill, (c) the correlations between the employee's self-assessment and their peer evaluation of management skill, (d) the correlations between the employee's peer evaluation and the gap with their supervisor's expectation of their management skill, and (e) the correlation for the employees in crisis and those who are not between their peer evaluation and the gap with their supervisor's expectation of their management skill.

Table 1 shows the difference between the self-assessment and peer assessment of eight management skills. The highest score possible is a 7. A negative difference indicates that the peer assessment was lower than the self-assessment. The individual scores of employees in the five departments were averaged together to provide an average score of peer perception and the difference between their self-assessments and their peers' perceptions. It is interesting to note that two departments show signs of stress and organizational dysfunction as measured by their peers with scores of 5.0 or lower. The MDs showed the greatest difference between their own perception of their management skill ability and what their peers thought. In particular, their producer (i.e., managing time and stress effectively) and monitor skills

Table 1 Differences between self-perception and peer perception of management skill

	Human relations model				Open systems model				Rational goal model				Internal process model				Healthy relational model			
	Facilitator		Mentor		Innovator		Broker		Producer		Director		Coordinator		Monitor		Task		Culture	
	Peer	Diff.	Peer	Diff.	Peer	Diff.	Peer	Diff.	Peer	Diff.	Peer	Diff.	Peer	Diff.	Peer	Diff.	Peer	Diff.	Peer	Diff.
Executive	7.0	1.0	6.8	0.3	6.5	0.0	6.9	−0.1	6.8	0.3	7.0	0.5	6.9	−0.1	6.8	0.3	6.8	0.1	6.9	0.2
Sales	6.2	−0.4	6.7	0.2	6.2	0.0	5.9	0.2	6.3	−0.5	5.9	−0.4	6.6	0.1	6.4	−0.4	6.4	−0.3	6.6	0.0
MD	5.2	−1.7	5.0	−1.2	5.3	−1.2	4.4[a]	−0.8	4.9[a]	−1.9	4.7[a]	−0.7	5.3	−1.1	4.7[a]	−2.4	5.0[a]	−1.7	5.4	−0.9
OPS	5.4	−0.5	5.7	−0.5	5.1	−0.3	4.7[a]	−0.2	5.3	−0.7	5.0[a]	0.0	5.5	−0.3	5.5	−0.4	5.0[a]	−0.9	5.7	−0.3
Finance IT	6.4	0.4	6.2	0.1	5.9	0.1	5.8	−0.4	6.2	0.2	6.0	0.5	6.4	0.5	6.1	0.5	6.1	0.0	6.5	0.5

[a]Scores in the organizational dysfunctional range

(i.e., doing things right) were the lowest. It was also interesting to note that the difference is rather large with −1.9 and −2.4 which equates to −25 and −34%, meaning they thought they were outstanding at these skills. This reveals a blind spot on the part of the MDs. The second department to show signs of stress was the operations (OPS) group in the areas of broker (presenting ideas) and task accomplishment.

It was noteworthy to find that the executive, sales, and finance/IT departments are perceived as very competent at what they do. Furthermore, perceptions of their skills were congruent with their peer's perceptions, and for the most part, their peers thought they had a higher skill level than they think of themselves.

The difference between the peer assessment and the supervisor standard can be observed in Table 2. The highest score possible was a 7. A negative gap score indicates that the peer assessment was lower than the supervisor standard. The individual gap scores of employees in the five departments were averaged together to give or provide an average score of peer perception and the gap with their supervisor's standard expectation.

The results point to the same two departments with important organizational dysfunctions. These results measure the perceived performance of the employees by their supervisor's expectations. This differs from Table 1 which compared their peer's perceived performance to their own perception. Worth noting was that the OPS department is underperforming in more skills than the MD department. The OPS department is underperforming their supervisor's standard by at least 12.5% (.9) in the producer, coordinator, monitor, and task accomplishment skills, and the MD department is underperforming in the area of the monitor (doing things right) by about 25%. The researchers confirmed the assessment of the executive, sales, and finance/IT departments as doing very well in the organization. These departments almost always overachieved their supervisor's standards.

Tables 1 and 2 confirm that two departments are stressed with particular attention needed for the OPS department. Due to the fact that the sample size for the doctors was small, the OPS department with 11 employees was isolated and statistical analyses were used to determine correlations between the eight management skills and the task and culture variables.

Table 3 shows the correlations between the peer perception of management skill of all the individuals in the group with the difference between their self-perception and their peers. Higher peer perception had a strong correlation with a positive difference in self-perception, whereas others had a greater perception of their performance. Lower peer scores were strongly correlated to a high negative difference, while others had lower perceptions of an individual's performance than the individual had of himself or herself.

The data in Table 2 show that in the OPS department, the producer, monitor, and task accomplishment skills are all strongly correlated. This means that the employees in the OPS department who received the lowest scores had greater levels of difference with their own perception of their work. This constitutes a blind spot in the OPS department thinking they are good producers and monitor well and perceiving that they are good at accomplishing team tasks. Without the 360-degree

Table 2 Differences between peer perception and supervisor expectation management skill

	Human relations model				Open systems model				Rational goal model				Internal process model				Healthy relational model			
	Facilitator		Mentor		Innovator		Broker		Producer		Director		Coordinator		Monitor		Task		Culture	
	Peer	Gap	Peer	Gap	Peer	Gap	Peer	Gap	Peer	Gap	Peer	Gap	Peer	Gap	Peer	Gap	Peer	Gap	Peer	Gap
Executive	7.0	0.5	6.8	0.3	6.5	0.0	6.9	0.4	6.8	0.3	7.0	0.5	6.9	0.4	6.8	0.3	6.8	0.3	6.9	0.3
Sales	6.2	−0.1	6.7	0.4	6.2	0.5	5.9	0.2	6.3	−0.2	5.9	0.4	6.6	0.6	6.4	−0.1	6.4	0.1	6.6	0.5
MD	5.2	−0.3	5.0	0.0	5.3	−0.7	4.4	−0.1	4.9	−0.6	4.7	0.7	5.3	−0.5	4.7	−1.8[a]	5.0	−0.3	5.4	0.1
OPS	5.4	−0.6	5.7	−0.5	5.1	−0.7	4.7	−0.5	5.3	−1.0[a]	5.0	−0.7	5.5	−0.9[a]	5.5	−0.9[a]	5.0	−1.2[a]	5.7	−0.5
Finance IT	6.4	0.7	6.2	0.1	5.9	0.3	5.8	0.8	6.2	−0.3	6.0	0.6	6.4	0.3	6.1	−0.1	6.1	0.0	6.5	0.6

[a]Scores lower than −0.9 show an important underperformance of supervisor standard

Table 3 Correlation coefficients for PEER management skill with DIFF self-assessment

	Human relations model		Open systems model		Rational goal model		Internal process model		Healthy relational model	
	Facilitator	Mentor	Innovator	Broker	Producer	Director	Coordinator	Monitor	Task	Culture
	Peer/Diff.	Peer/Diff.	Peer/Diff.	Peer/Diff.	Peer/Diff.	Peer/Diff.	Peer/Diff.	Peer/Diff.	Peer/Diff.	Peer/Diff.
All – OPS	0.94*	0.93*	0.63	0.68	0.87*	0.76	0.90*	0.92*	0.94*	0.93*
OPS	0.27	0.58	0.39	0.65	0.68*	0.61	0.68	0.76*	0.73*	0.14
All depts	0.67*	0.78*	0.39	0.60*	0.81*	0.63*	0.71*	0.83*	0.81*	0.49

Note: *Significant at $\alpha = 0.005$ in one-tailed test

Table 4 Correlation coefficients for PEER management skill with PEER assessment of Task accomplishment

	Human relations model		Open systems model		Rational goal model		Internal process model	
	Facilitator	Mentor	Innovator	Broker	Producer	Director	Coordinator	Monitor
	Peer/ Task	Peer/ Task	Peer/ Task	Peer/ Task	Peer/ Task	Peer/ Task	Peer/ Task	Peer/ Task
All – OPS	0.97*	0.95*	0.92*	0.96*	0.98*	0.96*	0.91*	0.98*
OPS	0.80*	0.63	0.79*	0.82*	0.75*	0.72*	0.74*	0.89*
All depts	0.88*	0.76*	0.87*	0.89*	0.87*	0.84*	0.84*	0.88*

Note: *Significant at $\alpha = 0.005$ in one-tailed test

Table 5 Correlation coefficients for PEER management skill with PEER assessment of Healthy Culture

	Human relations model		Open systems model		Rational goal model		Internal process model	
	Facilitator	Mentor	Innovator	Broker	Producer	Director	Coordinator	Monitor
	Peer/ Cult.	Peer/ Cult.	Peer/ Cult.	Peer/ Cult.	Peer/ Cult.	Peer/ Cult.	Peer/ Cult.	Peer/ Cult.
All – OPS	0.95*	0.98*	0.91*	0.95*	0.95*	0.90*	0.98*	0.92*
OPS	0.66	0.63	0.55	0.35	0.66	0.55	0.72*	0.3
All depts	0.86*	0.84*	0.74*	0.71*	0.85*	0.78*	0.89*	0.66*

Note: *Significant at $\alpha = 0.005$ in one-tailed test

organizational assessment intentionally revealing this blind spot, stress will likely continue to rise in the remainder of the organization and produce voluntary turnover when the employee finds another job or when the employee is terminated by their supervisor.

Table 4 demonstrates the correlations between the peer perception of management skill of the employees in different departments of the organization and the peer perception of their task accomplishments. A higher peer perception has a strong correlation with a higher task perception. This is a logical and an expected correlation to the extent that someone was perceived as accomplishing team tasks well to that same extent they were perceived as strong in management skills. A noteworthy observation is that management skills are correlated to the team task accomplishment.

For all of the departments with the exception of OPS, all of the management skills are positively correlated with the perception of team task accomplishment. However, in the OPS department, all of management skills except the *mentor* skill are correlated with the team task accomplishment. When looking at the entire company, all of the management skills are positively correlated with the perception of team task accomplishment.

Table 5 shows the correlations between the peer perceptions of management skill of the employees in different departments of the organization with the peer perception of their participation in developing a healthy culture. A higher peer

Table 6 Corr. coeff. for supervisor standard GAP in skill with supervisor standard GAP in Task accomplishment

	Human relations model		Open systems model		Rational goal model		Internal process model	
	Facilitator	Mentor	Innovator	Broker	Producer	Director	Coordinator	Monitor
	Gap/ Gap T	Gap/ Gap T	Gap/ Gap T	Gap/ Gap T	Gap/ Gap T	Gap/ Gap T	Gap/ Gap T	Gap/ Gap T
All – OPS	0.79*	0.80*	0.70	0.79*	0.93*	0.75*	0.77*	0.80*
OPS	0.72*	0.53	0.82*	0.75*	0.63	0.87*	0.68	0.81*
All depts	0.76*	0.69*	0.80*	0.78*	0.78*	0.81*	0.78*	0.67*

Note: *Significant at $\alpha = 0.005$ in one-tailed test

perception has a strong correlation with a higher healthy culture score. This is a logical and an expected correlation to the extent that someone who is perceived as being a healthy member of the team will be perceived, to the same extent, as strong in management skills. Particularly noteworthy is which management skills are correlated to the healthy culture score.

For all of the departments except OPS, all of the management skills are positively correlated with the healthy culture score. However, in the OPS department, none of management skills correlated with the healthy culture score, with the exception of the *coordinator* skill. When looking at the company as a whole, all of the management skills are positively correlated with the healthy culture score.

It is possible to conclude that the most important indicator for the OPS department is the task score which influences seven of the eight management skills. An employee in the OPS department can create stress for the other members of the company because of a lack of skill, which leads to not completing team tasks but having a good attitude and being a healthy team member. The organization should look at developing the OPS team task accomplishment skill since all of the employees' other competencies will be perceived as improving.

The correlations between the gap of management skill of the employees and their accomplishment of team tasks in regard to his/her supervisor expectation are illustrated in Table 6. A positive gap means the employee has exceeded their supervisor's standard, while a negative gap score indicates that they have underperformed. The correlation is that as a supervisor standard is exceeded in their management skill so will their score in the completion of team tasks be exceeded. Further, there is a correlation between management skills and task accomplishment gap score.

For all of the departments except OPS, all of the management skills are positively correlated with the team task accomplishment gap score, except for the *innovator*. However, in the OPS department, only the *innovator, broker, director,* and *monitor skills* are correlated. When looking at the company as a whole, all of the management skills are positively correlated with the team task accomplishment gap score.

Table 7 shows the correlations between the gap of management skill of the employees with regard to his/her supervisor expectation and the gap in their engagement in developing a healthy team also in regard to his/her supervisor expectation.

Table 7 Corr. coeff. for supervisor standard GAP in skill with supervisor standard GAP in Healthy Culture

	Human relations model		Open systems model		Rational goal model		Internal process model	
	Facilitator	Mentor	Innovator	Broker	Producer	Director	Coordinator	Monitor
	Gap/ Gap C	Gap/ Gap C	Gap/ Gap C	Gap/ Gap C	Gap/ Gap C	Gap/ Gap C	Gap/ Gap C	Gap/ Gap C
All – OPS	0.89*	0.89*	0.46	0.53	0.61	0.38	0.73*	0.62
OPS	0.46	0.43	0.13	0.27	0.58	−0.03	0.44	0.36
All depts	0.75*	0.77*	0.38	0.50	0.69*	0.41	0.69*	0.50

Note: *Significant at $\alpha = 0.005$ in one-tailed test

A positive gap means that the employee has exceeded their supervisor's standard, while a negative gap score means that they have underperformed the standard. The correlation is that as a supervisor standard is exceeded in their management skill so will their score in the developing a healthy team be exceeded. The interesting observation is to note which management skills are correlated to developing a healthy team gap score.

For all of the departments except OPS, the management skills which are positively correlated with developing a healthy team score are the *facilitator* (managing conflict in a healthy way), *mentor* (developing others), and *coordinator* (working across functions). However, in the OPS department, none of the management skills are correlated. These findings further confirm the results in Table 5 where an OPS employee may have a high healthy team score but be underperforming in all his/her management skills. When we look at the whole company, we find that the *facilitator, mentor, producer,* and *coordinator* are positively correlated with developing a healthy team gap score.

Table 8 focuses on two different groups of employees, the stressed employees and the non-stressed employees. Employees that received a 5.3 and below in task completion or healthy culture by peer perception were categorized as being stressed or causing stress. Eight out of the 21 employees were categorized as being stressed. The turnover risk is high due to the fact that seven of the eight are in the OPS department, representing 64% potential turnover in the department and 33% for the company. The two departments affected were the MD and OPS departments.

The correlations between the management skills of the employees perceived by their peers and the gap in their task accomplishment in regard to his/her supervisor expectation can also be found in Table 8. The *broker* skill (presenting ideas) and the *monitor* skill (doing things right), at 97%, are positively related. In looking at the second group of non-stressed employees, the key management skills that correlate with exceeding their supervisor's expectations are the *producer*, *coordinator*, and *monitor*.

The results clearly indicate that the key management skill to be developed in the stressed employee is the monitor and broker skill. The monitor skill is an essential skill in a medical service industry where the proper diagnosis might be the difference between life and death. The organizational culture of the company has very low

Table 8 Stressed employees group corr. coeff. for PEER perception of skill vs supervisor standard GAP of Task accomplishment

	Human relations model		Open systems model		Rational goal model		Internal process model		Healthy relational model	
	Facilitator	Mentor	Innovator	Broker	Producer	Director	Coordinator	Monitor	Task	Culture
	Peer/Gap T	Peer/Gap T	Peer/Gap T	Peer/Gap T	Peer/Gap T	Peer/Gap T	Peer/Gap T	Peer/Gap T	Peer/Gap T	Peer/Gap T
Stressed	0.59	0.73	0.7	0.85*	0.75	0.25	0.61	0.97*	0.75	0.81
Not Stresse	0.53	0.55	0.51	0.21	0.71*	0.46	0.76*	0.77*	0.56	0.58

Note: *Significant at $\alpha = 0.005$ in one-tailed test tolerance for an employee that is not focused on doing things right. A secondary area of improvement for a stressed employee is to improve their presentation skills internally. For the employee that is not stressed and wants to advance his/her career, the key management skills to develop are the *monitor*, *producer,* and *coordinator*.

4.1 Post-assessment

Approximately 1 year after the 360-degree organizational assessment was conducted, the company was asked to identify which employees had been voluntarily or involuntarily terminated. After this 1-year period, the company reported six employees no longer work at the company. Two of the employees voluntarily left the organization and the four other employees were terminated. All six of these employees were part of the *stressed* employee group that was identified. The remaining 13 employees are still employed and adding value in the company.

In the original assessment, there were eight *stressed* employees. We predicted that two of these eight employees were likely to voluntarily leave the company. When we returned a year later to conduct the post-assessment, we found that of those we predicted would voluntarily leave the company, one member was involuntarily terminated and the other changed his/her management behaviors to meet their supervisor's and team's expectations. The terminated employee demonstrated very high self-assessed stress in feeling part of the team culture. The reformed employee showed moderate self-assessed stress in team task completion. Undoubtedly, this organizational assessment process has revealed a gap in skills, and we hypothesized this was a driving force to correct their behavior.

There were two employees who voluntarily left the company. These employees did not previously display self-assessed team stress. However, the 360-degree tool helped them identify performance issues for which they were unaware. We believe that their reasons for leaving were that they did not (a) perceive that their contribution was adequately valued and (b) see themselves over the long term strategically fitting into the company, based on the perceived limitations of their current management skill sets.

The eight *stressed* employees had a reform rate of 25% since two of the eight changed their management behaviors to meet their supervisor and team expectations. The 360-degree assessment process provided these employees with an awareness of a blind spot concerning their weak performance, allowing the employees to intentionally change their behavior and improve their careers.

5 Conclusion

Successful companies are organizations that have leaders who develop the management skills of their employees while developing a healthy culture as well as being focused on accomplishing tasks. Using a management skills self-assessment, peer assessment, and supervisor standards, the leadership of the organization can determine the health of the culture, level of stress, and alignment of its work units. Skills strongly correlated to task accomplishment that leaders can help their employees develop are the *monitor* (doing things right), *producer* (managing time and stress), and *coordinator* (managing across functions). The mastery of these management behaviors will promote the accomplishment of tasks, decreasing stress in the organization and increasing a healthy workplace. Furthermore, employees who were perceived as creating dysfunction by not accomplishing team tasks had the highest correlation of failure, at 97 %, in the mastery of the *monitor* skill. Utilizing this framework, leaders can then help their direct reports make significant progress, based on quantifiable data, promoting employee engagement within their work and ultimately career growth.

This research study supports the need for self-assessment and peer assessment of management behavior to locate organization areas of dysfunction and stress. A barrier that potentially undermines this effort is among managers who avoid the performance evaluation process because they find it is unpleasant (Lawler et al. 1984). Research shows that some managers dislike giving feedback so much that they will not carry out appraisals unless there is administrative pressure behind them (Lawler et al. 1984).

The follow-up post-assessment validated the model presented with 100% predictability of the at-risk employees. Eight employees were originally identified in the *stressed* employee group. After a 1-year period, six of the eight were no longer employed in the organization. For all six employees, their peers did not perceive they met their supervisor's expectations. The two remaining employees from the at-risk group were able to successfully reform their management skills through intentional career development based on the 360-degree organizational assessment tool.

Through the use of training in monitor behaviors, directors can improve the effectiveness and alignments of their employees who potentially disrupt the work environment and are in danger of termination. This research demonstrates the benefits of self-assessment and peer assessment of management behavior to improve one's self-awareness in the organization, reducing blind spots, exposing a more accurate accomplishment of tasks, and creating a more transparent organizational culture where employee career development is encouraged.

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Impact of Technology on Leadership Style: Using "Least Preferred Coworker"

R. Srinivasan, B. Janakiram, and Rajendra Todalbagi

1 Introduction

The present day competitive scenario is witness to rapid changes in technology due to market pressure. This imposes a heavy challenge on organizational leadership to maintain acceptable performance levels.

The Least Preferred Coworker (LPC) scale is used in contingency theory (Ayman et al. 1995) to measure a person's leadership style. For example, it measures a person's style by how he/she describes a coworker with whom he/she had difficulty completing a job. This does not need to be a coworker he/she disliked a great deal, but rather someone with whom he/she least likes to work. After he/she has selected this individual, the LPC instrument asks him/her to describe his/her coworker on a metrics of 18 parameters.

Low LPCs are Task Motivated. They are individuals whose primary needs are to accomplish tasks and whose secondary needs are focused on getting along with people. In a work setting, they are concerned with achieving success on assigned tasks, even if at the cost of having poor interpersonal relationships with coworkers. Low LPCs gain self-esteem through achieving their goals. They attend to interpersonal relationships but only after they have directed themselves toward the tasks of the group.

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Middle LPCs are Socio-Independent Leaders. In the context of work, they are self-directed and not overly concerned with the task or with how others view them. They are more removed from the situation and act more independent than low or high LPCs.

High LPCs are Motivated by Relationships. These individuals derive their major satisfaction in an organization from getting along with people with interpersonal relationships. A high LPC sees positive qualities even in the coworker she or he least prefers, even though the high LPC does not work well with that person. In an organizational setting, the high LPC attends to tasks but only after she or he is certain that the relationships between people are in good shape.

This chapter extends the LPC to build linkage with demographic parameters. It examines the sample built on the hypothesis that there is a co-relationship between leadership style and various demographic parameters.

2 Objectives of the Study

To do the following in the changing technology scenario:

- Make use of survey instrument to classify the LPCs as low, medium, and high for a knowledge industry
- Analyze leadership style based on LPC
- Study the relationship of leadership with respect to demographic factors along with socioeconomic factors

3 Organization and Methodology

A product development organization in the space of media and entertainment is chosen as a sample organization for the study of leadership style using LPC metrics. This organization has been witnessing rapid technological changes. This impacts the market share of the company in a big way.

The organization is engaged in development of products in the space of digital content and content management tools, specifically addressing computer graphics and image processing solutions. The organization addresses the niche market segments such as broadcast animation covering international TV networks, print and publishing media, video professionals, and corporate presentation.

The organization employs computer software development engineers, graphic artists, and animators who form the core team of production activities carried out by the organization. Thus, the organization employs people with diverse educational and socioeconomic background to execute its product development activity. This diverse mix of population forms an interesting sample, for study and analysis of leadership style inventory, with respect to different demographic parameters. The organization was started around 8 years ago and has fully well established in its business space and is now working successfully. It employs close to 200 people across different product development activities with different skill sets and competencies to execute its projects. A sample of 100 employees was chosen for this leadership style survey across the organization forming a representative sample of the organization.

LPC instrument was administered on this set of employees, and the score was collected along with other demographic data for the sample.

The final LPC score is determined by adding up the numbers encircled on all of the 18 parameters. If the score is 57 or below, it is a low LPC, which suggests that the person is task motivated. If the score is within the range of 58–63, it is middle LPC, which means the person is independent. Individuals who score 64 or above are called high LPCs, and they are thought to be more relationship motivated.

As the LPC is a personality measure, the score one gets on the LPC scale is believed to be quite stable over time and not easily changed. Low LPCs tend to remain low, moderate LPCs tend to remain moderate, and high LPCs tend to remain high. Research findings show that the test-retest reliability of the LPC is very strong (Fiedler and Chemers 1984; Northhouse 2001; Robbins 2005).

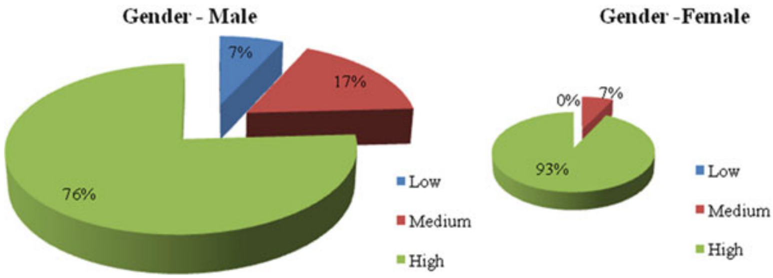
Thus, collected sample data was further analyzed on demographic parameters categorized under:

- Gender
- Age
- Origin or native (hailing from a city or a small town)
- Mother tongue
- Medium of instruction during schooling (regional language/English)
- Educational background
- Job function
- Impact of technology
- Work experience

4 Results of Demographic Analysis

4.1 Analysis by Gender

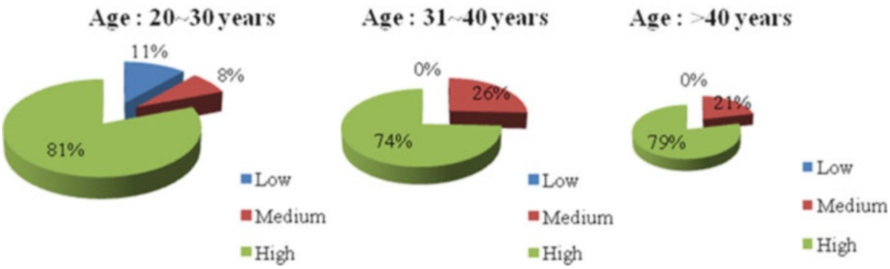
	LPC scale			
Gender	Low	Medium	High	Grand total
Distribution count:				
Male	6	15	66	**87**
Female		1	13	**14**
Grand total	**6**	**16**	**79**	**101**
Distribution %:				
Male	7%	17%	76%	100%
Female		7%	93%	100%
Grand total	6%	16%	78%	100%



Out of the total sample, 86% is male and 14% is female strength. With respect to LPC score, females are distributed more on high LPC with 93% compared to only 76% male. The low LPC counts are nil in case of female respondents. *One can infer from the above analysis that females tend to be more relationship-motivated leaders than their counter parts*. This has to be taken with caution as female distribution in the sample is low at 15% only.

4.2 Analysis by Age

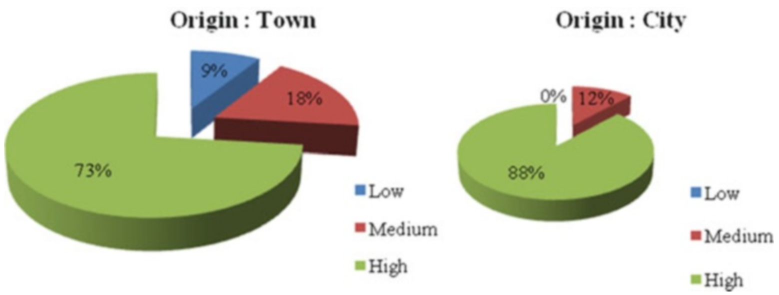
	LPC scale			
Age band	Low	Medium	High	Grand total
Distribution count:				
20–30	6	4	42	**52**
31–40		9	26	**35**
>40		3	11	**14**
Grand total	**6**	**16**	**79**	**101**
Distribution %:				
20–30 years	12%	8%	81%	100%
31–40 years		26%	74%	100%
>40 years		21%	79%	100%
Grand total	6%	16%	78%	100%



The sample is distributed with 52% in the age range up to 30 and balance 35% in the range of 30–40 and 13% in the age range >40. One important observation that can be inferred from the analysis is that people in the lower age group of up to 30 are more distributed on high LPC compared to people beyond the age of 30. *So younger people exhibit more relationship-motivated leadership style in comparison to older people*.

4.3 Analysis by Native/Origin

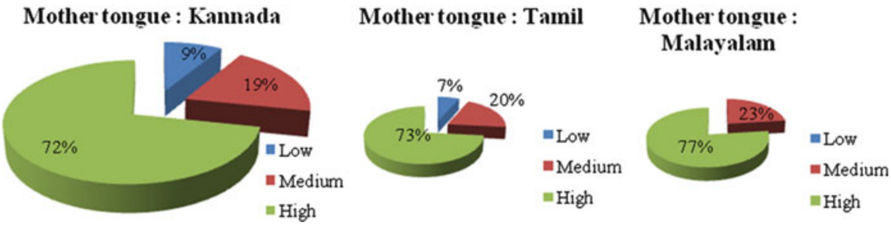
	LPC scale			
Origin (City/town)	Low	Medium	High	Grand total
Distribution count:				
City		4	30	**34**
Town	6	12	49	**67**
Grand total	**6**	**16**	**79**	**101**
Distribution %:				
City		12%	88%	100%
Town	9%	18%	73%	100%
Grand total	6%	16%	78%	100%



The sample has distribution of 66% people hailing from town, and balance 34% from city bringing-up. Interestingly, city group has no low LPC and has got higher concentration of high LPCs with 88%, whereas town group has got 73% high LPCs. *One may infer from the above analysis that city folks are more driven by relationship-motivated leadership style in comparison to people coming from town*.

4.4 Analysis by Mother Tongue

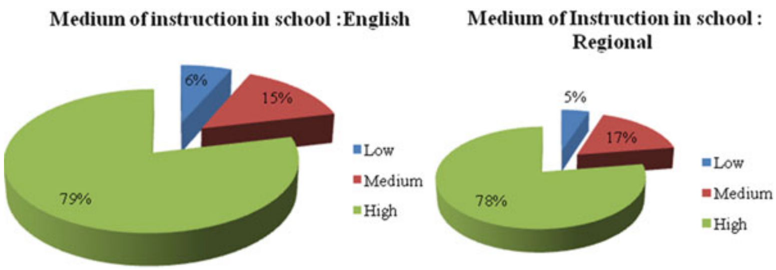
	LPC scale			
Mother tongue	Low	Medium	High	Grand total
Distribution count:				
Kannada	4	9	33	**46**
Tamil	1	3	11	**15**
Malayalam		3	10	**13**
Telugu		1	10	**11**
Hindi			6	**6**
Marathi	1		3	**4**
Oriya			3	**3**
English			2	**2**
Bengali			1	**1**
Grand total	**6**	**16**	**79**	**101**
Distribution %:				
Kannada	9%	20%	72%	100%
Tamil	7%	20%	73%	100%
Malayalam		23%	77%	100%
Telugu		9%	91%	100%
Hindi			100%	100%
Marathi	25%		75%	100%
Oriya			100%	100%
English			100%	100%
Bengali			100%	100%
Grand total	6%	16%	78%	100%



The sample has close to 50% Kannada speaking people, 40% other souther languages (Tamil, Telugu and Malayalam) distributed in the range of 10–15% each. However, interestingly, LPC scores are distributed almost same except Telugu which is skewed toward high LPC scores. *The inference that can be drawn from the above analysis is that all southern language speaking people seem to have similar leadership style distribution except Telugu speaking people*.

4.5 Analysis by Medium of Study During Schooling

	LPC scale			
Medium of study (R/E)	Low	Medium	High	Grand total
Distribution count:				
English	4	9	48	**61**
Regional	2	7	31	**40**
Grand total	**6**	**16**	**79**	**101**
Distribution %				
English	7%	15%	79%	100%
Regional	5%	18%	78%	100%
Grand total	6%	16%	78%	100%



Sixty percent of the sample have done their schooling in English medium, while balance 40% have done their schooling in their regional language medium. *It is clear from the above data analysis that medium of instruction had no bearing on the leadership style of people, since the distribution of LPC scores between low, medium, and high is almost identical between regional language and English medium schooling of the sample.*

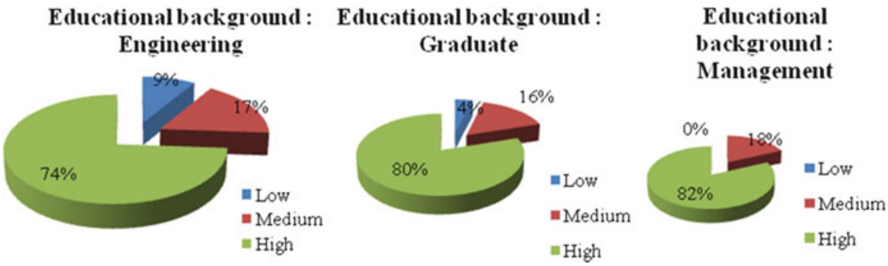
4.6 Analysis by Educational Background

	LPC scale			
Educational qualification	Low	Medium	High	Grand total
Distribution count:				
Diploma		1	11	**12**
Graduate	1	4	20	**25**
Postgraduate	1		5	**6**
Prof. degree-engg.	4	8	34	**46**
Prof. degree-mgmt.		2	9	**11**
Prof. degree-accts.		1		**1**
Grand total	**6**	**16**	**79**	**101**

(continued)

(continued)

Educational qualification	LPC scale Low	Medium	High	Grand total
Distribution %:				
Diploma	0%	8%	92%	100%
Graduate	4%	16%	80%	100%
Postgraduate	17%		83%	100%
Prof. degree-engg.	9%	17%	74%	100%
Prof. degree-mgmt.		18%	82%	100%
Prof. degree-accts.		100%		100%
Grand total	6%	16%	78%	100%



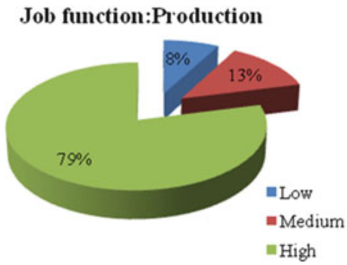
This sample has 46% engineering graduates, 25% graduates, 12% diplomas, and 11% management graduates. Diplomas have the highest high LPCs with 92%, engg. graduates have the least high LPCs with 74%. Others are having around 80% of high LPCs.

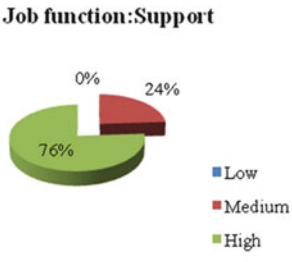
We can infer from the above analysis that there is a corelation between educational background and their leadership style.

Also we can infer that engineering graduates have higher percentage of task motivational leadership style, while diplomas have higher percentage of relationship motivational leadership.

4.7 Analysis by Job Function

Function	LPC scale Low	Medium	High	Grand total
Distribution count:				
Production	6	10	60	**76**
Support		6	19	**25**
Grand total	**6**	**16**	**79**	**101**
Distribution %:				
Production	8%	13%	79%	100%
Support		24%	76%	100%
Grand total	6%	16%	78%	100%

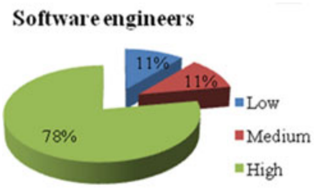


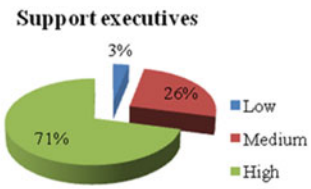


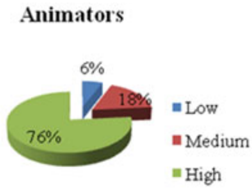
The sample has a distribution of 75% of production employees and 25% of support employees. *Distribution of LPC scores across production and support function is almost similar with high LPCs of 79 and 76%, respectively. Although the production has low LPCs of 8%, there are no low LPCs under support and middle LPCs are higher under support at 24%.*

4.8 Impact of Technology

	LPC scale			
Role	Low	Medium	High	Grand total
Distribution count:				
Animators	1	3	13	**17**
Graphic artists		1	16	**17**
Software engineers	4	4	28	**36**
Support executives	1	8	22	**31**
Grand total	**6**	**16**	**79**	**101**
Distribution %:				
Animators	6%	18%	76%	100%
Graphic artists		6%	94%	100%
Software engineers	11%	11%	78%	100%
Support executives	3%	26%	71%	100%
Grand total	6%	16%	78%	100%



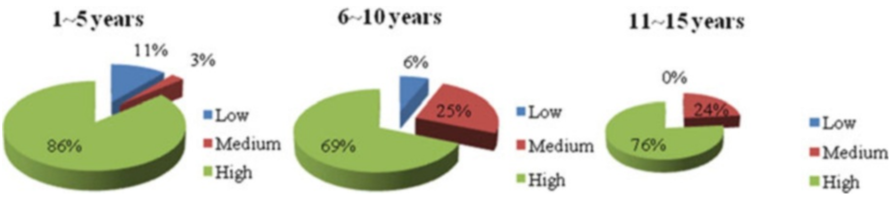




This sample has around 36% of software engineers, 31% of support personnel, 17% of graphic artists, and 17% of animators. The LPC score distribution among different roles is almost similar with an exception of graphic artists having higher % toward high LPCs with 94% and support executives having lowest high LPCs with 71%. The above analysis reveals that support personnel, software engineers, animators are having higher percentage of task-motivated leadership style, in comparison to Graphic artists who represent fully relationship-motivated leadership style. Animators and software engineers, who work with technology, are showing a higher percentage of task-driven leadership style in comparison to other roles, which shows influence of technology on leadership style. This might have also to do with individual contributor versus team contribution as a technical worker is more associated with machines and technology, and less with people, though the overall result depends on a good balance between the task and relationship even in a technological work environment, as the final outcome is a result of integration of various individual work products realized by many individual contributors to reach the final product or service delivery. *One can infer from the above that technological work environment gives rise to higher task-driven leadership style compared to nontechnical work environment.*

4.9 Analysis by Work Experience

	LPC scale			
Experience range	Low	Medium	High	Grand total
Distribution count:				
1–5 years	4	1	31	**36**
6–10 years	2	8	22	**32**
11–15 years		4	13	**17**
16–20 years			4	**4**
>21 years		3	9	**12**
Grand total	**6**	**16**	**79**	**101**
Distribution %:				
1–5 years	11%	3%	86%	100%
6–10 years	6%	25%	69%	100%
11–15 years		24%	76%	100%
16–20 years			100%	100%
>21 years		25%	75%	100%
Grand total	6%	16%	78%	100%



This sample has a distribution of 37% of up to 5 years of experience, 32% of 6–10 years experience, 17% of 11-15 years of experience, and 4% of 16–20 years of experience and 12% of >20 years of experience band.

The following observations can be made from the above analysis.

At lower experience bracket (1–5 years), highest relationship-motivated leadership style with 86% of high LPC distribution is observed. In the middle experience bracket (6–10 years), relationship-motivated leadership style is lowest with 69% of high LPCs. And then again at higher experience bracket (>11 years), relationship-motivated leadership style increases to around 75%.

One may infer from the above that, during the early part of the career, people exhibit relationship-motivated leadership style, while in the mid career, you see a higher task-motivated leadership style and again slightly higher percentage of relationship-motivated leadership at senior levels but less than what is seen in people in their early part of career (Srinivasan 2012a, b).

5 Summary Conclusions and Inferences

1. Changing work environment with increasing adoption of technology and continuously changing technology has an impact on leadership. Leadership styles can lead to effective organizational management and contribute to improved organizational performance. It is also observed that technical workers have higher task-driven leadership style compared to nontechnical workforce.
2. Female population exhibits higher percentage of relationship-motivated leadership style in comparison to their male counterparts.
3. Youngsters show more relationship-motivated leadership style compared to older people.
4. People coming from city show higher relationship-motivated leadership style in comparison to people coming from towns, who show higher task-motivated leadership style.
5. People from southern states of the country have an almost similar distribution of leadership style except Telugu region.
6. Medium of instruction in schooling has no bearing on the leadership style exhibited by an individual.
7. Also, we can infer that engineering graduates have higher percentage of task-motivated leadership style, while diplomas have higher percentage of relationship-motivated leadership.
8. Job function of an individual has low to moderate influence on one's leadership style.
9. Job roles have a definite impact on leadership style. Software engineers and animators showed a higher percentage of task motivational leadership, while graphic artists represented fully relationship-motivated leadership style.

10. People in their early career tend to exhibit more of a relationship-motivated leadership style, while during mid career show a higher task-motivated leadership style and again higher relationship-motivated leadership style at senior level but much lower than early career.

The above inferences and conclusions help as an extension to contingency theory of leadership, which can be further used for intervention of organizational development and optimization of leadership resources in an organization, thus helping boost the productivity of an organization.

6 Limitations

The sample size for the study being limited to 100 respondents, there is a strong possibility that findings may change with a large sample size. Also, the composition of the sample has to be kept in mind while extending the applicability of findings.

The study done on knowledge industry needs to be examined further, as to whether it holds good for other industry segments and sections as well.

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Part 2.3
Learning and Knowledge Management

An Empirical Model to Foster Innovation and Learning Through Knowledge Sharing Culture

Vijila Kennedy and M. Kirupa Priyadarsini

1 Introduction

In today's knowledge-based economy, knowledge is the most important resource for an organization to gain competitive advantage (Stewart 1996). Knowledge creation, sharing, and dissemination are the main activities in knowledge management. Being part of knowledge management (KM) process (Kim and King 2004), knowledge sharing is the exchange of experience, events, thoughts, or understanding of anything. Knowledge sharing culture is viewed as an important process because it results in shared intellectual capital (Liao et al. 2007). Knowledge sharing culture is defined in many ways: Culture with a positive orientation to knowledge is the one that highly values learning on and off the job (Davenport et al. 1998); positive attitudes of leaders and colleagues toward knowledge processes (Dobrai and Farkas 2008); people would share ideas and insights because they see it as natural rather than something they are forced to do (McDermott and O'Dell 2001); and a way of organizational life that enables and motivates people to create, share, and utilize knowledge (Oliver and Kandadi 2006). Knowledge sharing culture impacts the organization in many ways – at individual, group, and organizational level.

The aims of this chapter are to explore and measure the impact of knowledge sharing culture on foster of learning and innovation in organizations in IT sector. To assess the knowledge sharing culture, Theory of Planned Behavior (TPB) (Ajzen 1991) framework was adapted. This chapter examines the application of TPB model which proposes that behavioral attitude, subjective norms, and perceived behavioral control are predictors of behavioral intentions and actual behavior among IT professional's perception of knowledge sharing culture. The study also analyzes the influence of knowledge sharing culture on innovation and learning culture of the organization.

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2 Review of Literature

Knowledge is regarded as a fluid mix of framed experiences, values, contextual information, and expert insights that provide a framework for evaluating and incorporating new experiences and information (Davenport 1997). Knowledge has been classified as explicit and tacit knowledge (Nonaka 1994). While it is easy to transmit explicit knowledge through formal language, it is much difficult, on the other hand, to convey tacit knowledge (Nonaka and Takeuchi 1995). Though knowledge itself is essential for an organization, knowledge sharing is a very significant process which will enhance the permeation of knowledge across the employees. The importance of knowledge sharing to organizations has been widely acknowledged. Knowledge sharing culture contributes to knowledge application, innovation, and ultimately the competitive advantage of the organization (Jackson et al. 2006). Knowledge sharing between employees and within and across teams allows organizations to exploit and capitalize on knowledge-based resources (Cabrera and Cabrera 2002; Damodaran and Olphert 2000; Davenport and Prusak 1998). Research has shown that knowledge sharing is positively related to reductions in production costs, faster completion of new product development projects, team performance, innovation capabilities, and firm's performance (Arthur and Huntley 2005; Collins and Smith 2006; Cummings 2004; Hansen 2002).

Sharing of knowledge at the individual level is the most critical to an organization, even though it may exist at other levels of an organization that include team and organizational levels (Lukas et al. 1996). A firm can successfully achieve promotion of knowledge sharing culture not only by directly incorporating knowledge in its business strategy but also by changing employee attitudes and behaviors to promote willingness and consistent knowledge sharing (Lin 2007).

The positive impacts of knowledge sharing are productivity, task completion time, organizational learning (Argote 1999; Argote and Paul 2000; Cummings 2004), enhanced innovation, and reducing redundant learning efforts (Scarbrough 2003).

Growth and sharing of knowledge are recognized as the most important elements in becoming a learning organization (Easterby-Smith and Araujo 1999; Marsick and Watkins 1994; Senge 1990). Johnston and Hawke (2002) define learning culture as the existence of a set of attitudes, values, and practices within an organization which support and encourage a continuing process of learning for the organization and/or its members. A learning culture is said to exist in an environment where teamwork, collaboration, creativity, and knowledge processes exist that have a collective meaning and value (Joo 2007). For an organization to improve its performance, it requires a learning culture (Kumar 2005). Hence, organizations take deliberate effort to develop learning culture (Walsham 2002). Mixed results have been found in studies examining the relationship between learning culture and knowledge sharing. Taylor and Wright (2004) found that a climate that encouraged innovation and focused on learning from failure was positively related to effective knowledge sharing. Hsu (2006), in the case studies of companies in Taiwan, highlighted the significance of continuous learning through knowledge sharing. Lee et al. (2006), however, did not find a significant relationship between knowledge sharing and learning orientation.

Innovation is about "a process of developing and implementing a new idea" (Van de Ven and Angle 1989). Kanter (1988) states that innovation is most likely to occur in organizations that (a) have integrative structures, (b) emphasize diversity, (c) have multiple structural linkages inside and outside the organization, (d) have intersecting territories, (e) have collective pride and faith in people's talents, and (f) emphasize collaboration and teamwork.

Literature search revealed that hardly any research has been conducted on the role knowledge sharing culture based on TPB model and its influence on innovation and learning. Thus, the result of this study may be relevant to various stakeholders in IT sector. For the management of IT organizations, findings of this study will be of great significance. It will shed light on how the knowledge sharing behavior can be encouraged among its employees. From an academic perspective, this study's insights will add to the existing literature on the impact of knowledge sharing culture on innovation and learning.

3 Research Hypotheses and Model

This research study aims at assessing the extent to which IT companies promote knowledge sharing environment and its effect on innovativeness and learning and development. The Theory of Planned Behavior (TPB; Ajzen 1988, 1991) proposes a model about how human action is guided. It predicts the occurrence of a specific behavior provided that the behavior is intentional. The model is depicted in Fig. 1 and represents the three variables which the theory suggests will predict the intention to perform behavior. Intentions are the precursors of behavior. Innovativeness and learning and development are the critical factors for success for any organization, more so for IT industries. Therefore, the TPB model had been extended by adding these two constructs.

The variable names in this model reflect psychological constructs, and so they have a special meaning within the theory. In the context of this study knowledge sharing intention can be used as a proximal measure of knowledge sharing behavior. Attitude towards knowledge sharing refers to a person's overall evaluation of knowledge sharing. Subjective norms are a person's own estimate of the social pressure whether to/not to share knowledge. Perceived behavioral control refers to the extent to which a person is able to enact knowledge sharing.

Studies have shown that attitude has a positive influence on intention to behave (Chang 1998). In this study, attitude toward knowledge sharing refers to the IT professional's positive or negative view about knowledge sharing. But since

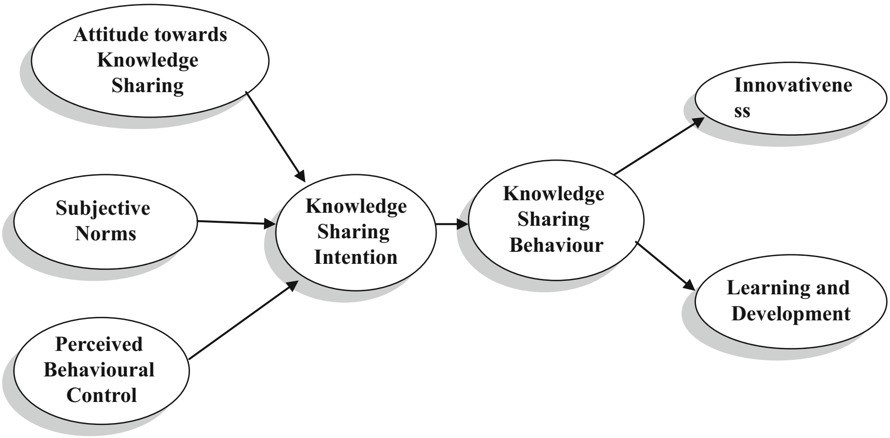

Fig. 1 Conceptual framework

knowledge sharing has many positive influences in the organization, IT professionals will have a positive view about it. Hence, the following hypothesis was formulated:

H1: IT professionals' attitude toward knowledge sharing will positively affect the intensions to share knowledge.

Subjective norms are the social pressures a person faces which influence them to have intentions of certain behavior. In this study, subject norms about knowledge sharing refer to the pressures that IT professionals face from the system or people in their organization encouraging knowledge sharing behavior. Therefore, the following hypothesis was formulated:

H2: IT professionals' subjective norms regarding knowledge sharing will positively affect the intensions to share knowledge.

Perceived behavioral control is the disposition and skills, knowledge, abilities, and information an individual has concerning a particular behavior. In this study, this refers to the IT professionals' perceived behavioral control toward knowledge sharing intention. Hence, the following hypothesis was formulated:

H3: IT professionals' perceived behavioral control regarding knowledge sharing will positively affect the intensions to share knowledge.

According to TPB, higher behavioral intention exhibits stronger behavior (Chang 1998). In this study, IT professionals' intentions to share knowledge will enhance behavior. This led to formulating the following hypothesis:

H4: IT professionals' intention to share knowledge will positively influence the knowledge sharing behavior.

Studies have shown that knowledge sharing culture fosters learning at individual, group, and organizational levels (Argote 1999). Therefore, the following hypothesis was formulated:

H5: Knowledge sharing culture will positively influence organizational learning and development.

Creativity and Innovation thrives in organizations where knowledge is shared. Innovation is looked at from two perspectives: Innovativeness – the degree to which an organization welcomes new ideas and capacity to innovate – is the degree to which the organization has the capacity to adopt or implement new ideas. Hence, the following hypothesis was formulated for this study:

H6: Knowledge sharing culture will positively influence organizational innovation.

4 Methodology

The population of the study consisted of the IT professionals in Coimbatore. Online survey questionnaire was sent to 550 IT professionals. Usable 295 questionnaires were returned which were used for the study.

The standardized questionnaire (Ajzen 1991) with five constructs included in the TPB framework comprises of (1) attitudes toward knowledge sharing, the degree to which the IT professionals believe that their organization thinks favorably about knowledge sharing; (2) subjective norms about knowledge sharing, the degree to which IT professionals social pressure to share knowledge; (3) perceived behavioral control to knowledge sharing, the degree to which the IT professionals feel the ease of sharing knowledge; (4) intentions to knowledge sharing, the degree to which IT professionals believe that their organizations promote knowledge sharing; and (5) knowledge sharing behavior, the degree to which company actually shares knowledge with others. All constructs had multiple items.

To measure on innovativeness and learning, the instrument developed by Hurley and Hult (1998) was used. The capacity to innovate was operationalized as the number of new ideas that had been adopted by the organization and recognized in formal award program. The learning construct measures the degree to which support is provided for formal and informal learning in the organization.

All the constructs of the study were measured from items adapted from previous studies, with some alterations to account for the peculiarity and setting of the study. To improve the reliability and validity, multiple-item measures were used for all of the variables. Responses were recorded along a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) for all the items in the questionnaire.

The data collected was analyzed by developing suitable hypothesis. Structural equation modeling was used to test the goodness of the framework developed through the VPLS software.

Table 1 Reliability and validity of constructs

Constructs	Composite reliability	AVE	Cronbach alpha
Attitude toward knowledge sharing	0.92	0.75	0.89
Subjective norms about knowledge sharing	0.93	0.76	0.89
Perceived behavioral control	0.83	0.56	0.74
Knowledge sharing intentions	0.94	0.84	0.90
Knowledge sharing behavior	0.81	0.52	0.83
Innovativeness	0.82	0.75	0.82
Learning and development	0.81	0.73	0.77

5 Results and Discussions

5.1 Reliability and Validity

Reliability and validity tests were conducted for all the constructs in the conceptual model. The reliability of the seven constructs used in the study was carried out using VPLS software. The reliability of the constructs refers to the accuracy with which the constructs repeatedly measure the same phenomenon within permissible variation. The composite reliability for internal consistency of the constructs was tested and was above 0.7. The Cronbach alpha scores were found to be greater than 0.7 which is good reliability for social science research (Nunnally 1978). The AVE scores for all the constructs are greater than 0.5 indicating sufficient convergent validity (Table 1).

5.2 Correlation of the Model Constructs

The correlation values were generated using the VPLS software for the constructs in the model. The results of the correlation analysis are shown in Table 2. It can be seen that all the correlation values are greater than 0.6. Innovativeness showed the lowest correlation for attitude toward knowledge sharing and knowledge sharing intentions. All the correlation values were also found to be significant at 0.05 level.

5.3 Testing the Conceptual Model

The result of VPLS structural equation model is given below in Fig. 2. Tests of significance for all paths were conducted using bootstrap resampling procedure. The test of each link is mapped to each path in the model. The estimated path coefficient along with their *t*-statistic is shown in the model. All the paths are found to be significant and important in magnitude (Table 3).

Table 2 Correlation of the model constructs

Constructs	Attitude	Subjective norm	Perceived behavioral control	Knowledge sharing intentions	Knowledge sharing behavior	Innovativeness
Attitude	1					
Subjective norm	0.749	1				
Perceived behavioral control	0.777	0.804	1			
Knowledge sharing intention	0.802	0.759	0.774	1		
Knowledge sharing behavior	0.795	0.788	0.822	0.82	1	
Innovativeness	0.633	0.77	0.76	0.644	0.77	1
Learning and development	0.79	0.808	0.811	0.79	0.81	0.758

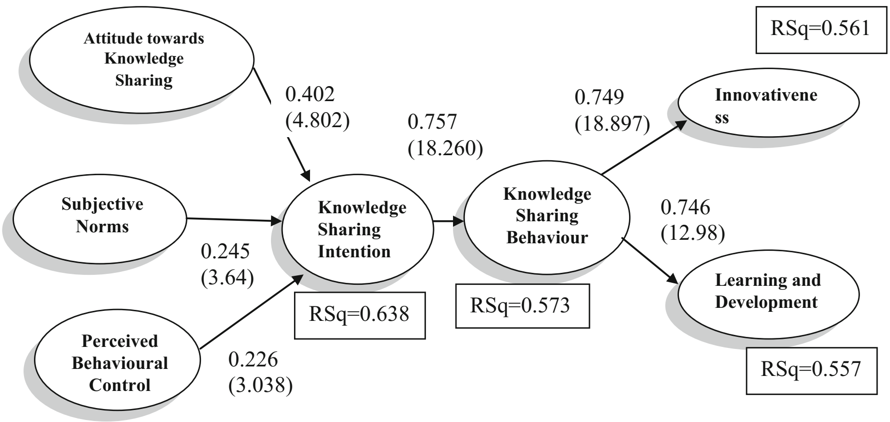

Fig. 2 Model of knowledge sharing's impact on innovativeness and learning and development

Table 3 Structural model: bootstrap

Hypothesis	Standardized path coefficient	*t*-Statistic
Attitude toward KS → knowledge sharing intentions	0.402	4.802
Perceived behavioral control → knowledge sharing intentions	0.245	3.640
Subjective norm → knowledge sharing intentions	0.226	3.038
Knowledge sharing intentions → knowledge sharing behavior	0.757	18.260
Knowledge sharing behavior → innovativeness	0.749	18.897
Knowledge sharing behavior → learning and development	0.746	12.980

From the figure and the R-squared of knowledge sharing intention, it can be concluded that 63 % of the overall variation in knowledge sharing intention is of the sample as explained by the three constructs, namely, attitude, behavioral control, and subjective norms. Among the three, knowledge sharing intention is influenced positively to a greater extent by knowledge sharing attitude with a path coefficient of 0.40. Perceived behavioral control and subjective norms contribute to 22 and 24 % of the variations in knowledge sharing intention. Therefore, the hypothesis that above three constructs affect knowledge sharing intentions is accepted and evident. The next hypothesis to be tested is that of the impact of intentions on behavior. The model results depict that knowledge sharing intention is able to explain 57 % of the variation in the knowledge sharing behavior.

The main objective of the study is to assess the extent to which innovativeness and learning and development can be fostered in the techno savvy IT industry through knowledge sharing culture. The path coefficient for knowledge sharing behavior to innovativeness was found to be 0.74, and this amounts to explaining 56 % of variation in innovativeness, while the remaining 44 % is being explained by other factors which do not form a part of this study. Similarly, knowledge sharing explains 55 % of variation in organizational learning and development. Therefore, the hypothesis that knowledge sharing affects organizational learning and development is accepted.

The empirical results of the model show that all the six hypotheses H1, H2, H3, H4, H5, and H6 are verified. It can be seen that the first three hypotheses that the knowledge sharing intention is influenced by attitudes, subjective norms, and perceived behavioral control are positive and significant. Innovativeness (path coefficient 0.749 and t-statistic $= 18.87$) and organizational learning and development (path coefficient $= 0.746$ and t-statistic $= 12.98$) are influenced by knowledge sharing behavior. This empirical investigation supports the Theory of Planned Behavior and also supports the fact that innovativeness and organizational learning and development are influenced by knowledge sharing behavior.

6 Conclusion

Knowledge sharing culture is an initiative of knowledge management. However, the success of this depends not only on the organizational initiatives but more from the change at the individual level. This study was an attempt in that direction to see how an individual's intentions are influenced and, in continuum, how his behavior is influenced by his intentions. The study also throws light on how the knowledge sharing behavior can have a great effect on the innovativeness and organizational learning and development. Having realized this, organizations should start taking steps to strengthen the individual's faith and belief in knowledge sharing so that he starts inculcation of a knowledge sharing culture.

To make knowledge management imperatives, successful individuals must understand that the creation and application of new knowledge is essential to the survival of almost all businesses. Expertise learned and applied at one part of the organization is not leveraged at another part. Only if employees can realize the magnitude of the efforts that go into creating and sustaining a knowledge sharing culture, and the benefits that accrue to them as individuals in terms of learning, they shall remain supportive. Therefore, organizations need to bring in processes that shall be able to absorb the knowledge sharing among its employees. Some suggestions by David Gurteen (2000) in creating a knowledge sharing culture like overcoming objections to create a knowledge sharing culture, rewarding knowledge sharing culture, and motivating knowledge sharing can go a long way in improving an organization's learning and fostering innovation. Another area that may be a great value addition in this is to put in place the knowledge sharing technology and train and educate people in its effective use. The two together – people with the appropriate knowledge sharing mindset and the appropriate knowledge sharing technology to support them – will rapidly bring about a knowledge sharing culture that can give any organization a competitive edge over their competitors.

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Collaborative Learning and Knowledge Management: A Case Study

Giulia Monetta, Francesco Orciuoli, and Gabriella Santoro

1 Introduction

The aim of this chapter is to present an Italian firm, MOMA, the main actor of the network 'Pole of Excellence on Knowledge'. This chapter illustrates in detail the company's vision, evolution, profile and business strategy emphasising how these aspects differentiate MOMA from its competitors. In particular, the specific objectives of the research paper are:

– To identify resources (organisational, human, technological, physical and financial) exploited for commitment to research and innovation
– To highlight individual competences with a focus on the enhancement of human resources to constantly improve the value proposition
– To develop a process to classify and place relevant information as a shared resource (often referred to as a 'knowledge repository') that can be assessed by all relevant stakeholders.

The first part of this chapter presents a brief description of the methodology used for data collection and data analysis. After, a case study of an Italian firm is presented to help illustrate how MOMA gives access to knowledge management facilities and practises and meets the need for collaboration and communication in a working environment. The data-gathering sources were both secondary and

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primary in nature, and the second part of this chapter provides a detailed analysis of the phenomenon investigated. Finally, we present our conclusions, underlining the research implications for academicians, industry leaders, technology managers and innovators.

2 Methodology

Our research was developed according to a qualitative approach and a methodology based on a field case study (Eisenhardt 1989; Yin 1994; Ryan et al. 2002).

A combination of case analysis, observation and interviewing approach was used. Attributes such as evolution of the company, corporate philosophy, human resource management, products, customers and competitors, technology strategy, technological strengths and weaknesses, the integration of technology strategy with corporate strategy, technology management practices and business performance were studied in depth. Opting for a choice of 'revelatory case' (Bryman and Bell 2007) – the presence of particular elements and content information (Saunders et al. 2003) – the analysis of the firm MOMA was put in place.

2.1 Data Collection

Following Eisenhardt's suggestions (1989), we combined different methods of data collection. The analysis is based on the collection of qualitative and quantitative information obtained in the course of two successive interviews with the entrepreneurial team (scientific coordinator and general manager) of the 'Pole of Excellence on Knowledge' conducted on the basis of semi-structured questionnaires and an analysis of printed documentary sources.

In more detail, to analyse MOMA, the sources of empirical evidence can be divided into the following:

Semi-structured interviews: the primary method of data collection involved a total of six semi-structured interviews with the following organisational members: sales and communication director, strategic business manager, production manager, R&D manager, quality, safety and control manager, human resources manager. The questions asked during the interviews were non-standardised, the dual aim being to ensure involvement on the part of the respondents and, at the same time, to give them a certain degree of freedom in their responses (Kvale 1996). Interviewing time ranged from half an hour to two hours, and most of the interviews were recorded. Whenever this was not possible, detailed field notes were taken. Interviews were based on a list of open-ended questions developed on the basis of the main research questions, such as specific initiatives and relationships with business partners.

Annual reports and other external communication tools: Annual reports regarding the economic and financial situation, the Corporate Code of Conduct and Ethics Code were analysed, as were the corporate website, press releases and other documents for institutional and market communication.

Field observation: the company was visited between September and December 2011 in order to experience directly day-to-day company life.

Corporate histories and other archival material: an archival search helped us track the evolution of MOMA over time and at different levels of analysis.

2.2 Data Analysis

As first-order codes became consolidated across interviews, we started aggregating them and moving from open to axial coding. As a general consideration, and given the selected strategy of inquiry, theory was created iteratively from observation and data, and emerging ideas were compared with archival data and the literature in order to validate the findings and inform interpretation. The systematisation and codification of the answers of the questionnaires were carried out separately by two researchers (Silverman 2001). The analyses were then compared to discuss and resolve differences. Where these differences could not be resolved easily, clarification was sought from the support of the sales and communication director for MOMA's 'Business Development' area, Gabriella Santoro, involved in drafting the paper.

As explained in the data collection section, data were gathered from different sources in order to validate findings through both documentation and triangulation and to build a coherent justification for assumptions. Finally, conclusions were evaluated by company representatives.

3 Case Study

3.1 Company Profile

MOMA, created as a non-profit spin-off of CRMPA (Centre for Research in Pure and Applied Mathematics), was established in 1993 as a limited liability consortium that distinguished itself for its innovative approach in the areas of knowledge and learning. In 2000, the original consortium was changed to a limited liability company whose corporate structure included a minor participation of Italian IT companies, made up mainly of experts from both local universities and international companies. Over the years, MOMA encouraged employee-based participation in the company. Since 2010 furthermore, MOMA has changed to a joint-stock company.

MOMA performs activities in industrialisation and marketing of products and advanced services in the ICT industry with a particular focus on the knowledge and learning as well as that of the collaboration sector. More precisely, with reference to the NACE code used for European industry classification (EUROSTAT), MOMA ranks 72.19 for other research and experimental development on natural sciences and engineering and 62.0 for computer programming, consultancy and related activities. MOMA leverages the combination of 'strength of technological know-how and absolute focus on offering personalised services'. Its approach is based on knowledge orientation with the objective of utilising information and communication technology to create knowledge as opposed to the simple acquisition of information. MOMA also sustains specific learning models to improve effectiveness and efficiency in learning processes and knowledge management (Aziz and Poorsartep 2010; Vequist 2008).

The search for excellence and the awareness of competition based on ideas, know-how and expertise are summed up in the company's corporate vision: 'Models, techniques and system environments based on semantics and knowledge represent the decisive competitive factor for production systems and are the keystones for modern companies to respond to complex challenges'. Through technology, MOMA facilitates organisational and production renewal processes that allow businesses to differentiate themselves and become leaders in their markets. Starting from the definition of e-learning solutions, in the educational field (schools and universities) based on explicit knowledge representation, MOMA has expanded its vision by developing learning and knowledge solutions in the corporate field through innovative technologies (Schmidt and Kunzmann 2007) in order to represent and manage the whole knowledge cycle as well as the business process, with reference to both knowledge repository and management and human resource management for activities and projects. Consequently, the company is committed to the development of information technology systems capable of responding to the growing needs of collaboration, communication and economic factors in knowledge.

3.2 The 'Pole of Excellence on Knowledge'

MOMA is the main actor of the 'Pole of Excellence on Knowledge'. In this network, university departments, research centres and firms are focused on providing innovation through collaborative and knowledge-sharing processes based on a suitable division of roles along the value chain.

More precisely, the experience stems from the Department of Information Engineering and Applied Mathematics (DIIMA) at the University of Salerno, thanks to a team of young graduates, technicians and researchers, interested in the ICT innovation technologies, and headed by Professor Saverio Salerno, the group's acknowledged leader. After a preliminary but encouraging phase for R&D activities, not fully exploited due to complex university bureaucracy in the 1990s, the team and its leader created the Centre of Research on Pure and Applied

Mathematics (CRMPA) as a non-profit research centre. It conducts activities in the ICT sector and sets up various collaborations with industrial R&D groups – including those at an international level – contaminating the process with industrial and market visions Gaeta and Piscopo (2011). Currently, CRMPA has a structure based on a network of young professionals, also expert in fields other than ICT. Intense participation in European community-funded projects entails exchange of experiences and work with European companies. Key persons with sensitive and systematic awareness of external relationship dynamics coordinate the project teams and the professionals.

In 2000, a CRMPA spin-off created Mo.M.A. (Mathematical Models and Applications), now known as MOMA, a firm which is dedicated to the industrialisation, production and marketing of innovative solutions for e-learning and knowledge platform. Three years later, from a project developed by DIIMA (now DIEII – Department of Electronic Engineering and Information Engineering), in collaboration with CRMPA and MOMA and financed by the Italian Ministry of University and Research, the Centre of Excellence on Methods and Systems for Competitive Enterprises (CEMSAC) was set up. Through ICT application, it defines processes and products, electronic systems, methods and technologies for knowledge and learning. As a consortium non-profit organisation, it manages R&D programmes and technological innovation in order to promote collaboration between the scientific world and the economic context. In addition, CEMSAC promotes entrepreneurial initiatives to increase corporate competitiveness, growth and development in the local territory. The latest addition to the Pole is MIA (Methodologies Investment Applications). Started in 2007 as a limited liability company, it focuses on methodological and operational aspects for the social Web. The company's overall offer is enriched by business issues regarding Enterprise 2.0 for the management of informal knowledge and on personal productivity PWLE (Personal Learning Environments Working). The MIA business strategy is based on the creation of 'ad hoc' solutions and the use of techniques of data mining and knowledge discovery, guaranteed by the active collaboration of experts with a high scientific and technological level of expertise.

Both MIA and MOMA are responsible for production and marketing of the products created and designed by the Pole. Depending on the type of output, either one or both firms (alternately or jointly) deal with the production and marketing of products developed. In short, through the integration of different actors (university departments, research centres, consortia and firms), the 'Pole of Excellence on Knowledge' covers the entire chain of innovation from basic research to industrial research and from pre-competitive development at the industrial level to commercialisation of products. Each actor provides specific contributions of skill and expertise along the value system (Porter 1985) of knowledge production (Fig. 1).

The Pole's value system is enhanced by Italian and international partnerships with other scientific organisations, research centres and university departments, as well as large Italian firms. In a relational vision (Normann and Ramirez 1995), the Pole promotes, transfers and shares knowledge and technology that are transferred in processes and products (Hakansson and Snehota 1989). Thus, partners

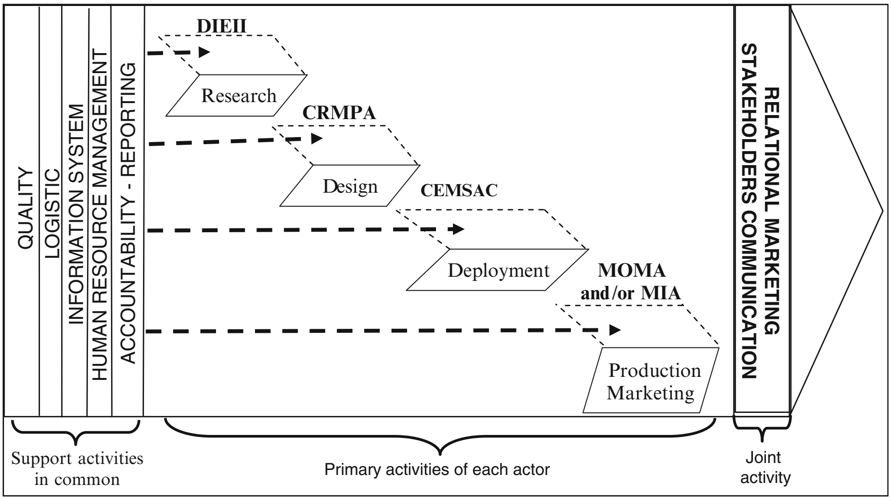

Fig. 1 The Pole value system

with common goals and converging interests share skills and competencies on the basis of a learning network logic (Thorelli 1986; Jarillo 1988). In particular, the network's main areas of ICT-based expertise are learning and knowledge technologies, networks, future Internet and security.

With respect to the 'Learning and Knowledge Technology', the focus is mainly on exploiting state-of-the-art knowledge technologies (e.g. natural language processing, computational intelligence, machine learning, ontologies) in order to support technology-enhanced learning scenarios including personalised learning, collaborative learning, competency-driven learning, workplace learning, simulation-based learning, talent management, organisational learning, knowledge management, human resource management and so on. In the last year, new specific competences have been developed in the Pole, regarding knowledge extraction, knowledge alignment and ontology matching/merging.

According to the 'network' area, the focus is mainly on studying and defining solutions based on fluid dynamic models to optimise speed and travel time, supply-chain strategic design, flows optimisation, production planning and optimisation of package routing policy, the optimisation of traffic coefficients and service quality studies.

In the 'future Internet' area, the focus is mainly on studying the semantic Web, social Web, cloud computing and Internet services technologies in order to define new smart applications for virtual organisations and extended enterprise management, enterprise-class social networks, service annotation, discovery and interoperability, etc.

In the 'security' competence area, the focus is on image analysis methods, tools and technologies to optimise common security processes (area supervision, profiling, automatic identification and recognition), methods and models for data

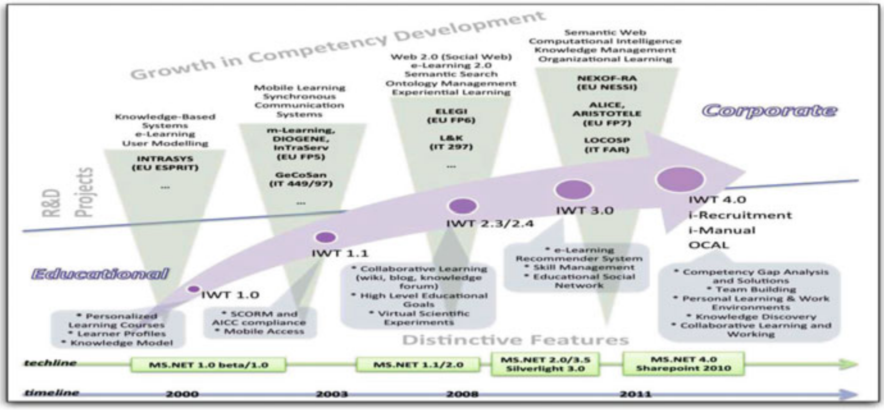

Fig. 2 The evolution of MOMA technology experience

information fusion of heterogeneous information in multimodal biometry contexts, techniques and tools finalised to intelligence agencies and scientific investigations, mathematical and technological methods and methodologies for digital fingerprint recognition.

3.3 *Technological Resources and Human Capital*

From the technological point of view, the specific competences claimed by MOMA can be divided into two groups. The first, mainly focused on Learning and Knowledge Technology and future Internet, has been gradually acquired by exploiting the collaboration within the Pole in the context of R&D projects. The second is mainly represented by software engineering, software architecture and software development platform competences. It has been acquired in several years by means of blended learning and training activities.

Figure 2 shows the main software technologies (see in particular the *techline*) that MOMA exploits in order to build IWT (Intelligent Web Teacher), its main software product, and other prototypes and applications. IWT is a software platform that meets the needs of information, training and knowledge in various areas of education, business and professional use. It is used to improve the creation and sharing of knowledge through collaborative environments, social networking, communities, integration of computational tools, the simulation of a virtual reality environment and competency management. It includes several suites (learning, competency/resource management, enterprise knowledge management and collaboration/cooperation management) built on a modular and scalable software architecture. Its innovative and distinctive elements can be applied in different advanced technological scenarios.

Currently, MOMA is defining new software solutions: I-recruitment, for analysing curricula vitae; I-press, generating personalised press releases; and I-manual, providing personalised and adaptive manuals. All are complementary to IWT suites. In the course of its activities, MOMA has developed the following: CWT (collaboration Web tool), a modular system aimed at services for the management of cooperative work and distributed processes; MoMAM@th, an interactive online maths workbook; RIPArTI, software for the management of company costs based on the principles of ABC; 'TourismOnLine', a Web portal for the promotion of tourism; 'Formamentis', an interactive forum that allows the daily emulation of educational activities performed in classrooms by students and teachers; and 'Banca Dati Lavoro', a software application where all job opportunities can be archived and accessed via the Web.

In addition, Fig. 2 shows the importance of the R&D projects for the growth of competences. In particular, the objective of ARISTOTELE project (VII Framework Programme of the European Union) is mainly on improving the learning ability and work training of human resources within firms through the design and development of models, methodologies, technologies and tools that support the management of those skills. Already, the LOCOSP project (FAR) has defined a software platform to support dynamic collaboration among enterprises. Also within the KEEN project (FAR, a II level masters programme entitled Chief Knowledge Officer) has been developed to train on the use of information technology that enables sharing and management of corporate knowledge.

The evolution of technology in MOMA is closely linked to the development of knowledge and skills in human resources. MOMA learning and training activities for its employees are embedded in the knowledge and learning management activities of the Pole (Grieco et al. 2010). Firstly, the formal training courses are delivered in blended mode by using IWT and internal or external teachers. Moreover, informal learning is enabled by means of a knowledge management solution realised on the Microsoft Sharepoint 2010 platform, used to manage and share documents; to sustain an internal enterprise social network, corporate blogs, and enterprise wikis; and mainly to provide a PWLE. All these informal tools allow skilled employees to practise coaching, mentoring and so on. The entire vision of learning and knowledge management within the Pole relays on the exploitation of ontologies (Schmidt and Kunzmann 2006; Gruber 1993).

MOMA is characterised by a lean and efficient organisation that is rapidly expanding and evolving in the market, consisting of approximately 30 employees and additional collaborators that vary according to specific initiatives. As already emphasised, the company is supported by key individuals as well as by a system of external scientific and industrial partnerships. In order to cover the industrialisation and exploitation phases along the value system (see Fig. 1), MOMA has designed its organisational structure in four activity areas: marketing and market research, production, sales and assistance. Corporate governance promotes participation in company ownership and involvement in decision-making processes of the most talented employees. In other words, the strong commitment to research and innovation and the focus on the individual for the valorisation of human resources allow a constant improvement of the value proposition.

3.4 Market Orientation and Competition

MOMA provides innovative software solutions for the management of advanced training and knowledge, for critical business processes and for skills management in the market segments not already provided for by competitors.

MOMA's strategic business units (Hofer and Schendel 1978; Hax and Majluf 1991) are the following:

Consultancy and service: this unit supports businesses and governments in specialised and systematic consulting for identification of bids for tender and funding channels, development of industrial and scientific partnerships, management of proposal development and dissemination and enhancement of results. In addition, it offers turnkey solutions for content technologies and services, higher education services for courses, master and Ph.D.

Research projects and orders: this unit deals with participation in European, national and regional projects, especially in the areas of learning and knowledge technologies. It is also responsible for customised software solutions developed on work orders.

IWT solutions: this unit deals with personalised knowledge-based systems, solutions for learning, competency management, enterprise KM and collaboration tools.

Prototypes and applications: in this unit, activities based on collaboration and defined solutions oriented at e-Science are carried out.

MOMA addresses a variety of broad and different targets, from complex organisations to individual operators. More precisely, MOMA's customer portfolio is divided into the following segments:

– Education (25%): government school (national and local), higher education (universities, business schools, etc.), high schools and students (as end users)
– Corporate (60%): system integrators, companies and SMEs
– Government (15%): articulated in European, national and local geographical levels

From a competitive analysis, the market is characterised by the presence of big ICT players that are established in the most common business segments of management software production (such as ERP, CRM, etc.) and by specialised players in the niche segment for knowledge management systems (content and document management) and data mining. The solutions offered by the latter are more or less sophisticated but are not based on mathematical models for complex systems. The comparative analysis carried out by MOMA, in the application of knowledge and management systems, learning systems, social Web in the workplace systems, human capital management and in innovation factory systems shows a relevant competitive advantage based on the use of a semantic approach as well as computational intelligence and user profiling techniques. Other distinctive elements are a modular and flexible offer, based on high customisation; rapid product development, thanks to participation in the Pole; competitive prices and high investments in R&D; and anticipation of market needs.

3.5 Value Proposition

The success of MOMA's outputs is a market-oriented development process and the company's resources (technological and human). MOMA combines service innovation synergies with existing resources (human capital, technological resources, relational vision). MOMA makes extensive use of 'soft' organisational mechanisms and proficiency in the development process between the requirements of the new service and sufficiency of knowledge and marketing resources. Furthermore, the synergy is the result of established partnership with its clients and other stakeholders (employees, suppliers, research entities, industrial and commercial partners).

The value proposition of MOMA is enhanced by the following:

– Integrated behaviour: the firm guides clients and partners towards coordinated and dynamic management that involves all actors in the Pole.
– Sharing of information: the firm has developed flexible tools for collaborative knowledge management that responds quickly to unexpected variations in business situations; by exploiting the quality and speed of the information exchange, they can achieve optimum results thanks to their use of modern technology.
– Integration of processes: from basic research to industrial development of products along the value system of knowledge, this integration is achieved by process teams. The transition to a process management logic has underlined how there needs to be stronger links between management and the creation of value for clients.
– Partnership: strong alliances with system integrators and IT companies (Italdata, Fastweb, etc.) are based on a win-win logic. In this way, activities can be carried out in a coordinated fashion, creating business relationships that can produce higher earnings than if activities were all carried out separately.
– Cooperation: by establishing relationships with clients for the management of specific and high additional value activities. In order to promote flexible responses, MOMA implements integrating mechanisms to approve clients' special requests, define focus teams dedicated to particular clients and tackle unexpected events and changes in demand.

3.6 Business Performance

In recent years, MOMA's business offerings in products and services in the ICT sector recorded a growth rate of 20–25% per year, which reached objectives in 2010 for an overall production value of approximately 2,227,077 € (Fig. 3).

In terms of economic success, the attractiveness of the marketplace and the company's ability to launch services that meet customer needs are important determinants. Paradoxically, these positive economic results were achieved despite the extremely negative economic conditions both at national and international level and confirmed the strength and positive trend recorded by MOMA in recent years.

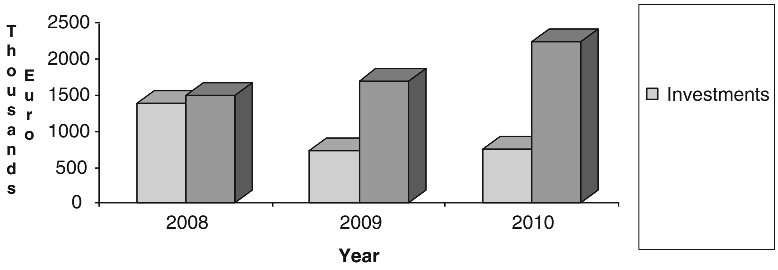

Fig. 3 Business growth

Table 1 Relational turnover

	2008 (%)	2009 (%)	2010 (%)
Employees	+20	0	+12
Suppliers	−0.07	100	−0.03
Clients	−30	+35	−30
Partnerships	+33	+100	+130

Also the main economic and financial indicators in the 2010 (ROI: 1.41%; ROE: 53.74%; ROS: 5.1%) remain positive.

Positive results are recorded not only from an economic and financial point of view but also at a relational level. Over the last 3 years, MOMA has doubled its relationships with its various stakeholders (Table 1).

Table 1 highlights both a positive or negative trend in strictly quantitative terms. From a qualitative point of view, the trend is positive overall for all stakeholder categories (Freeman 1984). Despite the reduced number of clients, relationships with some of them have been consolidated. This is confirmed by the significant increase of production value in the last year (see Fig. 3). Furthermore, in qualitative terms, partnerships have also developed if we consider the opportunities arising from the collaboration in R&D projects and commercial activities. A case in point concerns the synergistic and virtuous collaboration with Publicis Healthware Ltd., for e-training of medical staff in European countries; Poste Italiane group, to develop components and tools for team building management; FIAT group, for sharing tacit and explicit knowledge within the company and its clients; FORMEZ and other local governments, to improve the learning ability and training of their employees.

4 Conclusions

This chapter presents a case study of an original innovative business model where high tech meets research centre. A formula to guarantee innovation and the evolution of products and services offered with respect to any competitor, MOMA offers reliable, useful, up-to-date technology solutions through which timely knowledge not only can be created and shared internally, but also externally (e.g. among business partners). It develops models, methods and innovative technologies to support the acquisition, elaboration and information and knowledge sharing by the use of emergent social software platforms within companies or between companies and their customers or partners. MOMA possesses specialised and highly distinctive competences in the fields of mathematical models and knowledge-based applications and for the creation of new business and organisation models. These competences, united and opportunely integrated with those of the other actors of the ‘Pole of Excellence on Knowledge’, are of prime importance, differentiating MOMA from its competitors.

This chapter demonstrates how the vision of MOMA has evolved over time. Starting from the definition of e-learning solutions, in the educational field (schools and universities), based on explicit knowledge representation, MOMA has expanded its vision by developing learning and knowledge solutions in the corporate field through paradigms such as Enterprise 2.0 and innovative technologies such as semantic Web and computational intelligence.

5 Managerial and Research Implications

The following research and managerial implications from the case study analysed can be drawn. The case study could be used as an example of successful management of knowledge innovation. As such, more than a point of arrival, these findings represent a starting point, that is, the basis for further investigation modalities and perspectives. However, the field research suffers from the limit of having considered only one case study, and should be replicated to verify the findings.

In addition, the study might be useful to enable knowledge management to identify factors that will drive collaborations, alliances and networks; online social networks and Enterprise 2.0. Managers can identify key processes and consider the possible contributions, with reference to both human resource management and knowledge repository.

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A Descriptive Analysis of Intellectual Capital Concept Implementation Within Slovak Companies

Ján Papula and Jana Volná

1 Intellectual Capital Model as a Measurement System for Knowledge Management

In the 1950s, Maslow and Herzberg argued in their management theories that the single individual's personal motivation plays a crucial role in realizing their activity. Human capital of a company was thus understood as a place, where the value was created through knowledge. Because knowledge was in human individuals and it could not be created without people, the aim of the company was to develop and manage those people. Human capital became the center of knowledge management while the distribution of knowledge among organization's employees was considered as its main activity (Mouritsen and Larsen 2005).

The evolution of knowledge management has later completed the human capital representing the knowledge source of the company as the object of knowledge management with other components of intellectual capital, namely, with organizational and relational capital (relational capital including the customer relationship). The idea is that in reality, it is not possible to separate employees from the company's internal and external relations. Individual items of knowledge are always oriented toward something outside the person, and therefore, the object of knowledge management has been broadened to all parts of intellectual capital (Mouritsen and Larsen 2005).

At these times, intellectual capital of a company can be understood as the value-adding element of knowledge management of that company. It is value adding in a sense that it brings a numerical value to knowledge management activities through usage of so called intellectual capital indicators that can be measured. It is important to note that measurable objects are easier to evaluate and manage. Both knowledge management and intellectual capital tend to manage knowledge assets toward creating

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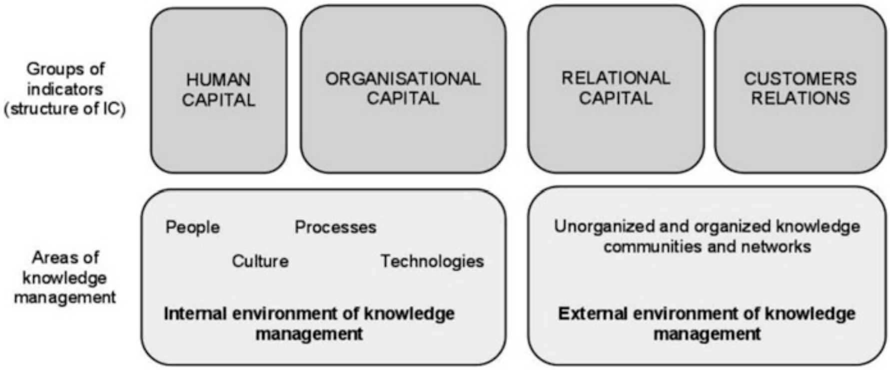

Fig. 1 Intellectual capital as a measurement system for knowledge management

values for better achieving of strategic goals of organization. While knowledge management brings theoretical and practical framework of setting and realizing knowledge initiatives throughout all of defined areas of internal and external environment, intellectual capital on the other hand gives the structure needed for proper evaluation and visualization of indicators which will be used for measurement of knowledge management initiatives and gained results (Fig. 1).

In the complex assessment of knowledge management, there is appropriate to use the model of intellectual capital, which evaluates the structure of knowledge assets from the point of view of value creation. The essence of intellectual capital is the value creation that can be understood as a complex of intangible property, knowledge, skills, processes, and applied experience and technologies used in organizations to ensure a competitive advantage on the market. Intellectual capital measures knowledge intensity and knowledge performance through clearly defined structured indicators.

There are several views at the breakdown structure of intellectual capital model presented in literature, usually consisting of three main components: human capital, internal (structural or organizational) capital, and external (relationship) capital including customer relationship component. As human and organizational capital both contain knowledge oriented toward something inside the organization, the relational capital contains knowledge items oriented outside the company. To define every component of intellectual capital independently, human capital can be described as combinations of knowledge, skills, innovativeness, and ability of the company's individual employees (Edvinsson and Malone 1997). The human capital cannot be owned, it can only be rented (Edvinsson 1997). The structural capital consists of internal structure, which includes patents, concepts, models, computer, and administrative systems. Popular is defining the structural capital as knowledge that does not go home at night (Stewart 1998) or what's left behind when the staff went home (Edvinsson 1997). The third category of intellectual capital resources comprises external structure, customer capital, and market assets, which are basically about relations with customers (Bukh et al. 2001).

2 Research Methodology

The aim of our research is to discover the usage of the intellectual capital concept within Slovak companies. For the research, we have used the breakdown structure of intellectual capital as used in majority of literature independently with the customer capital (not as a part of relational capital); also four different intellectual capital dimensions were defined: the human capital, the organizational capital, the relational capital except customer relationship element, and independently the customer capital.

The sample consists of 29 randomly selected Slovak companies, which were interviewed face-to-face regarding their opinion about the importance of different areas of knowledge management and their usage of individual intellectual capital indicators. Interviews were conducted during April and May 2011 with company owners, company directors, financial directors, or financial controllers. As already outlined, our interview consists of two different parts. In the first part, companies have been interviewed about their opinion about importance of different areas of knowledge management, what is shown in Table 1. It was possible to allocate one of four different answers to individual questioned areas:

1. The specific area has for the company almost no importance.
2. Weak to medium importance.
3. Medium till strong importance.
4. Very strong importance.

Second part of interview contains questions regarding the usage of different intellectual capital indicators by interviewed companies. Indicators were grouped to four different areas, according to used breakdown structure of intellectual capital. Table 2 shows questions of the second part of interview. The extent of involvement in evaluating of intellectual capital indicators by interviewed companies was measured by giving the interviewees four different possibilities to answer:

1. We do not measure/evaluate the specific area/indicator.
2. We evaluate on minimal basis.
3. We partially evaluate.
4. We definitely evaluate.

We have also asked interviewees if they understood and evaluated the term intellectual capital, but we have decided not to report this question in our paper. We have understood that the term and the concept of intellectual capital as we described earlier in this paper is almost absolutely unknown within managers in Slovakia, and even if they answered that they knew the term of intellectual capital, they did not mean the concept as described in our paper. We therefore do not consider this research question and its results as unbiased and applicable for our research. Evaluating given conditions, we think our research, thanks to given questions about usage of specific

Table 1 Questions 1–8 of the interview

From the vision and strategy point of view of your company, what importance do you accredit to the following areas?
1. Brand and company image building
2. Relationships to external subjects
3. Quality of human resources
4. Knowledge (knowledge management)
5. Process of continual improvement
6. Optimization of processes
7. Innovations
8. Informatization and technologies

Table 2 Questions 9–33 of the interview

To what extent does your company evaluate the following indicators from customer dimension?	To what extent does your company evaluate the following indicators from organizational dimension?
9. Market share 10. Customer satisfaction 11. The perception company's image by customers 12. Penetration index 13. Profitability of customers 14. Loyalty of customers 15. Expenditures on marketing and external communication	22. Innovation activity (on product, resp. organization as a complex level) 23. Process changes (optimizational, innovational) 24. % of sales invested into research and development 25. Whole productivity 26. Company image perceived by employees
To what extent does your company evaluate following indicators from relational dimension?	**To what extent does your company evaluate following indicators from human resources dimension?**
16. Partnerships building 17. Number and fruitfulness of cooperation (common projects) with partners 18. Care of business partners 19. Cooperation with schools and universities 20. Value of goodwill 21. Knowledge chain extensiveness	27. Employee satisfaction with management (management style) 28. Average age of management and employees 29. Educational degree of employees 30. Total no. of hired people during the year 31. Employee abilities development 32. % of sales invested into training and development 33. Employee satisfaction with job description

intellectual capital indicators, reviews conscious and as well unconscious usage of intellectual capital concept within Slovak companies because companies may not understand the correct meaning of the term intellectual capital, but they can use specific intellectual capital indicators to evaluate different parts of their business without knowing that they manage the intellectual capital of company.

To allocate percentage values for given answers, we have used following methodology:

1. 1% for answers "with almost no importance" in first part of interview and "we do not measure/evaluate the specific area/indicators" in second part of interview

2. 35% for answers “weak to medium importance” in first part of interview and “we evaluate on minimal basis” in second part of interview
3. 65% for answers “medium till strong importance” in first part of interview and “we partially evaluate” in second part of interview
4. 99% for answers “very strong importance” in first part of interview and “we definitely evaluate” in second part of interview

3 Results

As a result of our research, we have acquired an electronic database consisting of information about answers in the form of following types: 1, 35, 65, and 99% for every area of importance of individual parts of knowledge management as shown in Table 1 and for every intellectual capital indicator involvement as in Table 2. Data collected are presented in this chapter through descriptive statistics and analyzed based on histograms, bar charts, and statistics summaries such as average, median, and standard deviation. Figure 2 shows the bar chart reporting average values for questions 1–8. From the picture, the importance of individual parts of knowledge management for companies in Slovakia can be analyzed. As can be seen, Slovak companies pointed “brand and company building” as the most important area. Other areas with importance are “quality of human resources,” “process of continual improvement,” and “relationship to external subjects.” “Informatization and technologies” on the other hand was evaluated as the area of knowledge management with lowest importance for managers in Slovakia.

Figures 3 and 4 present histograms for questions 9 till 33 divided into defined intellectual capital dimensions: customer and relational dimension (Fig. 3) and organizational and human resources dimension (Fig. 4). Histograms, together

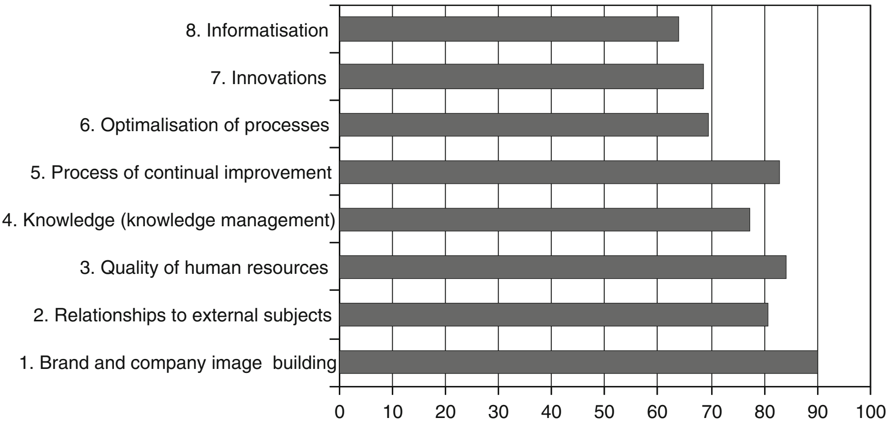

Fig. 2 Bar chart of average values for answers of questions 1–8

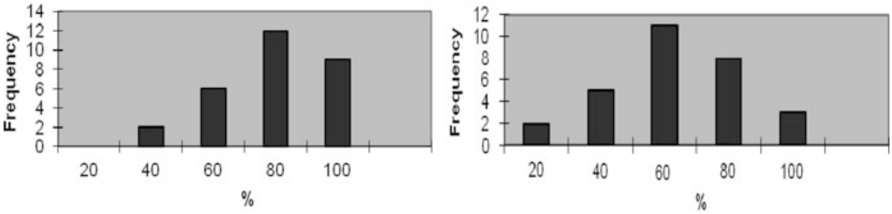

Fig. 3 Histograms for customer dimension of intellectual capital evaluation by companies: answers of questions 9–15 (*left*) and for relational dimension of intellectual capital evaluation: questions 16–21 (*right*)

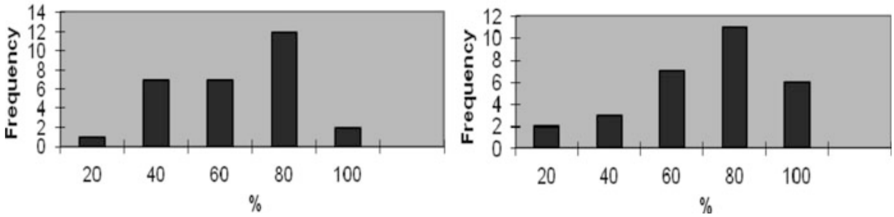

Fig. 4 Histograms for organizational dimension of intellectual capital evaluation by companies: answers of questions 22–26 (*left*) and human resources dimension of intellectual capital evaluation: questions 27–33 (*right*)

Table 3 Statistical summaries for interviewed indicators of customer dimension of intellectual capital

Intellectual capital indicator	Average	Median	Standard deviation
9–15. Customer dimension	70.2	65	28.1
9. Market share	77.4	99	27.9
10. Customer satisfaction	86.2	99	18.7
11. The perception of company's image by customers	79.5	99	25.6
12. Penetration index	39.2	35	33.5
13. Profitability of customers	63.8	65	33.5
14. Loyalty of customers	71.7	65	27.5
15. Expenditures on marketing and external communication	73.9	65	29.7

with statistical summaries such as average, median, and standard deviation presented in Tables 3, 4, 5, and 6, give adequate base for evaluating the results. Absolutely most monitored area of intellectual capital by managers in Slovak companies is the customer relation's area with average value 70.2% and median 65%. From the customer relation's area, it is important to underline the specific indicator of customer satisfaction evaluation (labelled in text as 10. Customer satisfaction), which has attained the highest average value of 86.2% and the lowest standard deviation value of 18.7%. This fact can be interpreted as that the companies in Slovakia primarily focus on and evaluate the indicator of customer satisfaction (the highest achieved average) and that this specific indicator can be

Table 4 Statistical summaries for interviewed indicators of relational dimension of intellectual capital without the customer relation's component

Intellectual capital indicator	Average	Median	Standard deviation
16–21. Relational dimension	51.1	50	31.1
16. Partnerships building	67.1	65	34.2
17. Number and fruitfulness of cooperation with partners	57.0	65	33.4
18. Care of business partners	74.8	65	24.6
19. Cooperation with schools and universities	26.9	1	32.8
20. Value of goodwill	40.2	35	33.8
21. Knowledge chain extensiveness	40.4	35	27.5

Table 5 Statistical summaries for interviewed indicators of organizational resources dimension of intellectual capital

Intellectual capital indicator	Average	Median	Standard deviation
22–26. Organizational dimension	56.4	65	32.3
22. Innovation activity	61.4	65	32.1
23. Process changes	49.1	65	33.0
24. % of sales invested into research and development	35.8	35	34.5
25. Whole productivity	79.6	99	32.3
26. Company image perceived by employees	55.8	65	30.0

Table 6 Statistical summaries for interviewed indicators of human resources dimension of intellectual capital

Intellectual capital indicator	Average	Median	Standard deviation
27–33. Human resources dimension	59.0	65	32.3
27. Employee satisfaction with management	66.9	65	26.8
28. Average age of management and employees	43.6	35	36.8
29. Educational degree of employees	66.0	65	33.7
30. Total no. of hired people during year	55.2	65	40.0
31. Employee abilities development	74.9	65	28.9
32. % of sales invested into training and development	43.9	35	36.9
33. Employee satisfaction with job description	62.2	65	23.4

considered as well as the most stable from all indicators monitored (the lowest standard deviation). Human resources area and organizational area have resulted with average value between 56 and 59% and median 65%. The least controlled dimension by Slovak managers with average value of 51.1% and median 50% is the relational dimension.

4 Discussion and Conclusion

Although the topic of knowledge management and management of intellectual capital is among Slovak enterprises still new and not established, conducted survey has pointed out some facts regarding existing situation.

First of all, managers of enterprises do perceive the role and the importance of resources for fulfilling the strategy of their company and at the same time they are aware of the benefits of long-term targeted investments in areas falling within intellectual capital. In terms of competitiveness, they correctly identify the importance of *human resources*, *processes,* and *corporate image*. But further investigation has revealed that while organizations are aware of the importance and benefits of resources related to intellectual capital, the proper indicators which testify these resources are not measured or evaluated by them. Taking into consideration the fact that it is difficult to manage objects without the possibility to measure them, or in other words, managers cannot manage what they do not measure, the question is how the organization can fulfill its strategy through intellectual capital resources if they are not measured properly.

In the meaning of the performance management systems, to achieve the objectives of various dimensions of intellectual capital, it is necessary to clearly define all parameters that determine the performance of a given dimension. Through these indicators, it is possible to assess the company's success in increasing the intellectual capital as a source for the development of sustainable competitive advantage and to provide feedback that is crucial for progress and continuous improvement of a company.

The results of our research show that there is a discrepancy between what Slovak companies consider as important for the implementation of the strategy and what is actually measured and evaluated by them. More than 80% of companies consider the area of *continual improvement* and about 70% consider the area of *optimalization processes* as important. At the same time, only 49% of companies evaluate the indicators of *process changes*, and only 61% of companies evaluate the indicators of *innovation activities*. Just over 80% of companies consider the area of *external relationships* as an important area, but the indicators which *assess the building partnerships* are evaluated by only 67% of them, and indicators evaluating the *number and fruitfulness of cooperation with partners* is evaluated by only 57% of companies, and *the indicators of knowledge chain extensiveness* are evaluated by only 40% of companies. The median of all evaluated indicators in *relational dimension* is only at 50% level. Finally, the area of *quality of human resources* is considered as important by about 85% of companies, but only 43.9% of these companies evaluate the *percentage of sales invested into training and development*.

The second finding from our research is the fact that companies are more focused on indicators presenting outcomes of activities already executed, let us call them outcome indicators, and that companies less track the indicators that measure today's activities with outcomes coming in the future, let us call them predictive indicators. According to this research, Slovak companies most evaluate the following indicators: *customer satisfaction, the perception of company's image to customers*, *whole market share*, *and productivity*. These all are outcome indicators which present outcomes of already realized activities. On the other hand, the least evaluated indicators by Slovak companies are *percentage of sales invested into research and development, cooperation with schools and universities, knowledge chain extensiveness, and percentage of sales invested into training and development*, all predictive indicators.

As a conclusion we recommend to Slovak organizations to ensure that their intellectual capital performance management model meets following criteria:

(a) The model includes assessment of both outcome indicators and predictive indicators. Outcome indicators tell the company about the results and allow the measurement of final effects. Predictive indicators tell companies about the bases, respectively about causes to the results.
(b) The model should respect the cause and effects principle.
(c) The model contains the indicators form all four dimensions of intellectual capital (human capital, organizational capital, relational capital, customer's relations capital).

We understand that the limitation of this research is that it examines a relatively small number of companies. This analysis is therefore a preliminary step toward a much more detailed research on intellectual capital management among Slovak companies. We also suggest accomplishing a correlation analysis between matching areas of first part and second part of interview, also between the importance of individual areas of knowledge management and matching indicators followed up by companies to receive answers important for understanding the situation more precisely.

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Two Perspectives on Intellectual Capital and Innovation in Teams: Collective Intelligence and Cognitive Diversity

Ishani Aggarwal and Anita Woolley

1 Introduction

Creativity and innovation are becoming increasingly important for organizational effectiveness (Woodman et al. 1993; Kaplan et al. 2009). The importance of organizational teams for enhancing and maintaining an organization's creative potential and innovative performance is widely recognized (Rietzschel et al. 2009). Teams have creative potential because they draw together individuals with diverse backgrounds and perspectives toward a shared creative purpose (e.g., Bantel and Jackson 1989).

Unlike tasks with a single correct answer, developing creative ideas often means addressing ambiguous problems that necessitate the divergent perspectives and cross-fertilization of ideas that teams are expected to provide (Kaplan et al. 2009). However, if innovation implicated generation of ideas alone, then teams would have much more creative potential than individuals given the increased availability of resources provided by diverse perspectives. But because it is a multifaceted, multi-stage phenomenon (Rietzschel et al. 2009), and involves both divergent and convergent processes (Levine and Moreland 2004), it is important to understand the implications of using teams through the cycle of the creative process.

In the following sections, we will discuss two properties of the team related to the teams' intellectual capital, i.e., collective intelligence and cognitive style diversity, which can contribute toward our understanding of the teams' potential to innovate. Borrowing from these two perspectives, we will generate propositions that will help us predict the conditions under which teams will have the greatest potential to innovate.

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2 Innovation in Teams

Innovation encompasses two stages: the generation of new ideas and their implementation (Hülsheger et al. 2009; Amabile 1996; West and Farr 1990; Woodman et al. 1993). It involves generating a set of novel ideas, i.e., divergent thinking, and also narrowing this set to one alternative, i.e., convergent thinking (Levine and Moreland 2004). Farr et al.'s (2003) framework, conceptualizes innovation in four stages: problem identification, idea generation, idea evaluation, and idea implementation. This model, like past models (Amabile 1988; Kanter 1988; West 2002) conceptualizes the innovative process as entailing a series of temporally ordered stages (Kaplan et al. 2009). In this chapter, we will focus on the idea generation and idea implementation phases of innovation since the former encapsulates divergent processes and the latter convergent processes. Studying these two phases will help us understand the contrasting demands on teams incurred by the two opposing creative forces.

Both the idea generation and idea implementation phases are important parts of the creative process. The need for divergent thinking can be seen in terms of the need to take different perspectives and to generate alternative solutions when faced with problem-solving or decision-making tasks, whereas the need for convergent thinking can be seen in a group's need to evaluate alternatives and choose one to use or recommend (Milliken et al. 2003). One can imagine an organizational team generating a brilliant idea that is original and has the potential to give an organization extraordinary competitive advantage in the market, but failing to implement it either because of the idea's complexity or lack of thoroughness, or team level factors such as lack of skill, lack of coordination, or inability to forge consensus about the means to achieve the selected idea (Aggarwal and Woolley 2010). Similarly, a team can have all processes needed to implement the idea in place but lack a highly creative or breakthrough idea. Whereas divergent thinking promotes generation and sharing of as many different ideas as possible, convergent thinking allows groups to select among the available options and to put these ideas into practice (West 2000; Milliken et al. 2003).

In the following sections, we will consider the relationship between the teams' potential to innovate, here conceptualized as their projected ability to generate and implement ideas, and two distinct team properties: collective intelligence and cognitive style diversity.

3 Collective Intelligence

The first perspective exploring the relationship between the team's intellectual capital and its potential to innovate draws on recent work on collective intelligence in teams (Woolley et al. 2010). Collective intelligence refers to a patterned regularity in group interaction that allows us to measure and predict a group's performance across a wide array of tasks. It is distinct from characteristics of individual members in teams. Collective intelligence is theorized as resulting from the availability of different resources required for different tasks, combined with a collective's ability to both utilize the different resources available and integrate them to generate solutions to novel problems.

Teams that are highly collectively intelligent demonstrate an ability to generate solutions to multiple problems, which involves processes such as breaking perceptual sets, breaking cognitive sets, and trying new problem-solving strategies (Taggar 2002). Also, teams that have the ability to perform well over time across different task domains demonstrate the ability to utilize their member resources well. This includes bringing forth the multitude of perspectives, ideas, and opinions that members may hold (Milliken et al. 2003). Because of this demonstrated ability, collective intelligence should be positively associated with idea generation which relies on divergent processes.

A lot of dysfunction in groups occurs because they tend to quickly settle into habitual modes of interaction (Bettenhausen and Murnighan 1991; Gersick 1988; McGrath and Rotchford 1983); however, it is possible for them to identify and change dysfunctional patterns of behavior (Gersick and Hackman 1990; Milliken et al. 2003). Recent research on collective intelligence in human groups demonstrates that it is an important component in group learning of coordination (Aggarwal et al. 2011). We expect the enhanced ability of highly collectively intelligent groups to coordinate over time will also promote idea implementation as it relies heavily on the convergent processes required by coordination.

Proposition 1: A team's collective intelligence will have a positive relationship with the team's potential to both generate creative ideas and to implement them.

4 Cognitive Style Diversity

Cognitive diversity in the group relates to differences in nonobservable (Milliken and Martins 1996) or deep-level (Harrison et al. 1998) characteristics of members. Organizational researchers have suggested that cognitive diversity in the composition of a group may enhance task-related or cognitive performance, especially on tasks requiring creativity (Austin 1997; Bantel and Jackson 1989; McLeod et al. 1996).

We conceptualize cognitive diversity in terms of cognitive styles, which are psychological dimensions that represent consistency in information acquisition and processing in individuals (Bartlett 1932; Paivio 1971; Richardson 1977; Ausburn and Ausburn 1978; Messick 1984). Three cognitive styles that are of particular interest to us because of their direct relation to functional specialties common in organizations are *verbalizers, spatial visualizers,* and *object visualizers* (Kozhevnikov 2007). Verbalizers process information in words, spatial visualizers process information in terms of spatial relations among objects, and object visualizers process information in terms of the global size, shape, and color of objects. People with different cognitive styles are represented in different professions. For example, scientists are stronger than visual artists in spatial visualization, whereas visual artists are stronger than scientists in object visualization (Blajenkova et al. 2006; Kozhevnikov et al. 2005).

4.1 Cognitive Resources

A high level of cognitive diversity is generally associated with a wide range of perspectives and opinions members bring to the task (Strasser 1992). For creativity and innovation to occur, teams must first have a variety of resources to draw from and second, must combine those resources in novel ways (Nijstad and Stroebe 2006). Cognitive styles provide teams with such cognitive resources. High group creative potential results from the availability of a broad array of skills, expertise, and knowledge in the group. The greater the representation of the three different cognitive styles in the team, the more potential the team has to generate creative ideas and solutions. Past research has also demonstrated that cognitive resources have a positive influence on performance in implementation and execution tasks (Aggarwal and Woolley 2010). Therefore, we expect that increased cognitive resources will give the team access to different modes of thinking and processing information and higher potential for the idea generation as well as idea implementation.

4.2 Cognitive Divergence

Most cognitive resources reside within different individuals in a team. And, while added resources, in terms of a variety of perspectives, skills, and knowledge may be beneficial to innovation, the differences in members' perspectives can have different implications for convergent and divergent processes. For example, these differences might facilitate the tabling of different perspectives and encourage discussion and debate that are fruitful for idea generation. However, the positive effects of divergence in behaviors and opinions during the idea generation phase may backfire when teams turn to the task of implementing ideas (Kaplan et al. 2009). For example, they may lead to communication and coordination difficulties (Klimoski and Mohammed 1994; Cannon-Bowers et al. 1993; Mathieu et al. 2000; Mathieu et al. 2005; Rentsch and Klimoski 2001), errors in performance and inability to form consensus about the best means to execute the solution (Aggarwal and Woolley 2010).

Proposition 2: Cognitive resources in the team will be positively associated with the team's potential to generate ideas, especially when coupled with higher cognitive divergence.

Proposition 3: Cognitive resources in the team will be positively associated with the team's potential to implement ideas, especially when coupled with lower cognitive divergence.

Cognitive diversity should also be related to collective intelligence. With added cognitive resources, team decisions and actions are more likely to encompass the full range of perspectives. Since collective intelligence captures the patterned regularity in group interaction and predicts group performance across a wide array of tasks, we would expect that the team's cognitive resources will increase the team's ability to tackle tasks with multiple demands well and be positively associated with collective intelligence. Also, based on our previous propositions, while some amount of cognitive divergence might facilitate idea generation, too much of it is likely to hurt idea implementation. Given this trade-off, we propose a nonmonotonic—inverted U shape—relationship between cognitive style diversity and collective intelligence, such that increase in cognitive divergence will be positively related with collective intelligence until a certain point, after which the relationship will become negative.

Proposition 4: Collective intelligence will have a positive relationship with cognitive resources.

Proposition 5: Collective intelligence will have an inverted U-shaped relationship with cognitive divergence.

5 Discussion

Teams are the locus of creativity and innovation in organizational settings. The increasing use of teams to generate and implement creative ideas and solutions calls for a deeper understanding of the team properties that affect different phases of a team's creative process. We explore collective intelligence and cognitive diversity as contributors to intellectual capital in teams, and generate propositions relating both to the divergent (idea generation) and convergent (idea implementation) phases of innovation.

Collective intelligence, which refers to a patterned regularity in group interaction that measures a group's performance across a wide array of tasks, demonstrates the team's ability to constantly update its strategy in the face of new challenges and uncertainty to perform on tasks requiring different knowledge, skills, and processes for effective outcomes. We expect that this property of the team will be positively related to the team's potential for both divergent and convergent processes (Fig. 1).

It has been demonstrated that diversity, the second perspective, is a double-edged sword (Milliken et al. 2003; Moreland et al. 1996). Although it can increase the range of knowledge and skills available to the group and stimulate divergent thinking, it can also inhibit effective communication and decrease interaction. For these, and related reasons, diversity has the potential to both facilitate and inhibit innovation in groups (Nijstad et al. 2003; O'Reilly et al. 1998). In order to

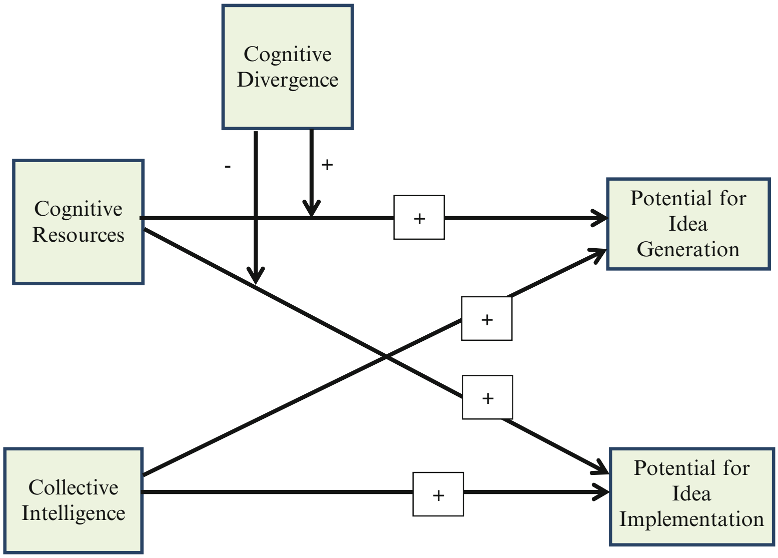

Fig. 1 The proposed relationship between collective intelligence, cognitive diversity, and potential for idea generation and implementation

resolve this paradox, we dissect the different aspects of diversity, i.e., cognitive resources and cognitive divergence, and generate propositions about their relationship with the two critical phases of innovation (Fig. 1).

Both collective intelligence and cognitive diversity are ways of indexing intellectual capital in teams. We also generate propositions to understand the relationship between the two. Overall, investigating how these team properties affect the team's potential to generate and implement ideas will lead to a more comprehensive understanding of how to use teams effectively to maximize their potential for innovation in organizations, while minimizing any associated costs.

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Effective Utilization of Tacit Knowledge in Technology Management

Indumathi Anandarajan and K.B. Akhilesh

1 Introduction

Technology is the most visible competence of individuals as it represents the tools that human beings use to do activities. In the present day, there is increasing competition in all aspects of life; there is continuous change in customer expectations leading to greater demand for new technologies and innovations. Technology can be defined as know-how. Know-how encompasses patents and ancillaries to the working of product and process technologies (Kotabe et al. 1996). Technology is a combination of physical capital and organizational capital resources (Barney 1991), which firms use to gain sustained competitive advantage.

Technology represents the means while knowledge represents the end of a process. Technology has both forms of knowledge, i.e., tacit and explicit knowledge. For technology to be successfully transferred to others, there has to be sufficient learning that organization has to obtain by managing both types of knowledge. Knowledge management systems need to address both tacit and explicit knowledge systems of intervention and practice to achieve the desired results. This chapter attempts to understand the issues of technology management from knowledge management perspective in technology intensive companies. We in this chapter argue that organization need to be creative in supporting multiple initiatives to capture and use tacit knowledge, for the growth and building technology capabilities of the organization. We have proposed a model for effectively capturing the tacit knowledge, as well as suggested appropriate techniques that would help in increasing the acquisition of tacit knowledge.

Polanyi identified the significance of the concept of tacit knowledge. Polanyi (1966) encapsulates the essence of tacit knowledge in the phrase "we know more than we can tell." Nonaka (1991, p 98) explores the term further: "tacit

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knowledge is highly personal and hard to formalize and, therefore, difficult to communicate to others." Tacit knowledge is experiential knowledge. It is linked to personal perspectives, intuition, emotions, beliefs, know-how, experiences, and values. It is intangible and not easy to articulate, making it difficult to share with others (Polanyi 1966; Nonaka and Takeuchi 1995; von Krogh et al. 2000). In comparison, explicit knowledge has a tangible dimension that can be more easily captured, codified, and communicated.

Nonaka and Takeuchi (1995) further articulate the distinction between explicit and tacit knowledge and state that when tacit and explicit knowledge interact, "knowledge conversion" occurs. They describe the process of creating knowledge as a spiral and believe that the interaction of tacit and explicit knowledge produces four modes of knowledge conversion that are interconnected. Nonaka et al. (2000) have identified the four modes of knowledge conversion; they are socialization (from tacit to tacit), externalization (from tacit to explicit), combination (from explicit to explicit), and internalization (from explicit to tacit). These four modes of knowledge conversion form a spiral, the SECI process. Knowledge created through this spiral process can trigger a new spiral of knowledge creation, expanding horizontally and vertically across organizations. This interactive spiral process takes place both intra- and interorganizationally. Tacit knowledge is further considered to comprise two dimensions; the first is the technical dimension which encompasses the "know-how," and the second is the cognitive dimension which consists of beliefs, ideas, and values which we often take for granted (Nonaka and Konno 1998).

Michael Polanyi (1966) argues that knowledge cannot be completely codified. "While tacit knowledge can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied. Hence all knowledge is *either tacit* or *rooted in tacit knowledge*. A *wholly* explicit knowledge is unthinkable." Technological knowledge is not as well codified as scientific knowledge. Kuhn's (1970) analysis of scientific revolutions shows the importance of tacit knowledge in shaping the trajectory of scientific knowledge, and tacit knowledge shapes technological development even more powerfully (Nonaka and Takeuchi 1995). Tacit knowledge is a main resource for new knowledge creation and continuous innovation.

The key characteristic that defines the technology is the fact that it focuses on the know-how of the organization. One of the major concerns of technology management is to transfer the technology, licensing of the technology, and revenues obtained from them. Today, there are several other aspects of modern technology development described below.

1.1 Modern Technological Developments

Modern technological development includes technology transfer, open innovation, technological forecasting, technological licensing, collaboration, risk taking, etc., and each of these evolved into a very specialized activity of technology management. Following, we give a few lines on each of this, so tacit knowledge could be integrated taking into consideration of all of the above-mentioned practices.

1.1.1 Technology Transfer

Technology transfer has been defined by Charles and Howells (1992) as "the diffusion of the complex bundle of knowledge which surrounds a level and type of technology." Such a wide-ranging definition of technology transfer includes transfers of information and knowledge at a micro- and macro-level between individuals, organization, and economies. Ounjian and Carne (1987) state that the most important dimension in relation to technology transfer is the role of people in initiating and facilitating transfers of knowledge and technology between organizations and places through person-to-person communication.

1.1.2 Open Innovation

Chesbrough (2003) coined the notion "open innovation" to signify a new model for organizing technological innovation in large R&D-intensive companies. According to this model, "firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology." Open innovation is effective and possible with the increasing availability and mobility of knowledge workers. Dosi (1982, 1988) argues that tacit knowledge is a key element of the innovative process.

1.1.3 Collaboration

Collaboration today focuses on the knowledge perspectives such as sharing, exchanging, and integrating knowledge to overcome barriers to achieve the research goals (Carayannis et al. 2000). Owing to knowledge is not restricted to be created only inside an organization; it can be obtained from outside the organization (McAdam 2000). Sharing of experiences of different partners based on their tacit knowledge tends to play a crucial role in effective development and implementation of technology. Collaboration is a process of knowledge transfer. It might take the form of specific, identifiable skills and technologies (Hamel 1991). It can lead to a number of tangible and intangible benefits, including the acquisition of specific skills and competencies, the achievement of interfirm cooperation, or the simple acquisition of knowledge generally, such as learning how to learn from collaboration itself (Simonin and Helleloid 1993). Technological knowledge is an intangible asset that can serve as a source of competitive advantage when it is valuable, not imitable, and not substitutable (Barney 1991).

1.1.4 Technological Forecasting

Technological forecasting is an exploration of developments in the technology domain in which the possible applicability is assessed over a longer term (Coates et al. 2001). Technological forecasting is used in many cases, ranging from vision development on the future to investment decisions with regard to emerging technologies. Technological forecasting offers a comprehensive view of the technologies already available of emerging technologies and the way these technologies influence or substitute each other (Porter et al. 1991). Technology management helps to understand the future, and so forecasting comes handy to develop road maps for the future growth and development in the technological aspects.

1.1.5 Technology Licensing

Technology licensing has been historically referred to the transfer of technology for a fee from a technologically dominant firm to technologically deficient firms (Kotabe et al. 1996). Traditional literature (Buckley and Casson 1976) posits that the net profits extracted by the licensor from a licensing transaction are lower for licensing than for keeping the technology in-house or licensing it to the firm's own subsidiaries because transfer and opportunity costs are higher for transferring technology to other firms. As a result, licensing was expected to be employed mostly when extracting the remaining value from a mature technology (Telesio 1979). A firm licenses its technology to others for increasing consumer acceptance of its technology (Dunning 1981).

1.1.6 Risk Taking

Every human endeavor involves risk (Wider and Davis 1998). Risk can be defined as the chance of an event occurring that is likely to have a negative impact on project objectives and is measured in terms of likelihood and consequence (Wideman 1992; Carter et al. 1993; Chapman 1998). Risk taking is an important element of innovation. Risk can be better assessed through past insights, experiences, and expertise.

The scope of technology management mentioned above is only an illustration, but it is an evolving and expanding space playing the strategic role in creating new opportunities for the organization on the one hand and achieving the growth on the other. Through this chapter, we would like to put forth a model depicting the existence of tacit knowledge at all spheres and its importance. We also argue in this chapter that organizations should create multiple initiatives for acquiring tacit knowledge; there are several techniques that could be adopted by the organization for increasing and effective utilization of tacit knowledge. Here, we highlight some of the techniques in relation to our proposed model.

2 Model

Our proposed model is depicted in the Fig. 1 below, where core technology, explicit knowledge, and people all have their own "tacit" knowledge; we suggest from this model to bring all of them together to have better technology management. This tacit knowledge which is present at all levels as shown in the figure needs

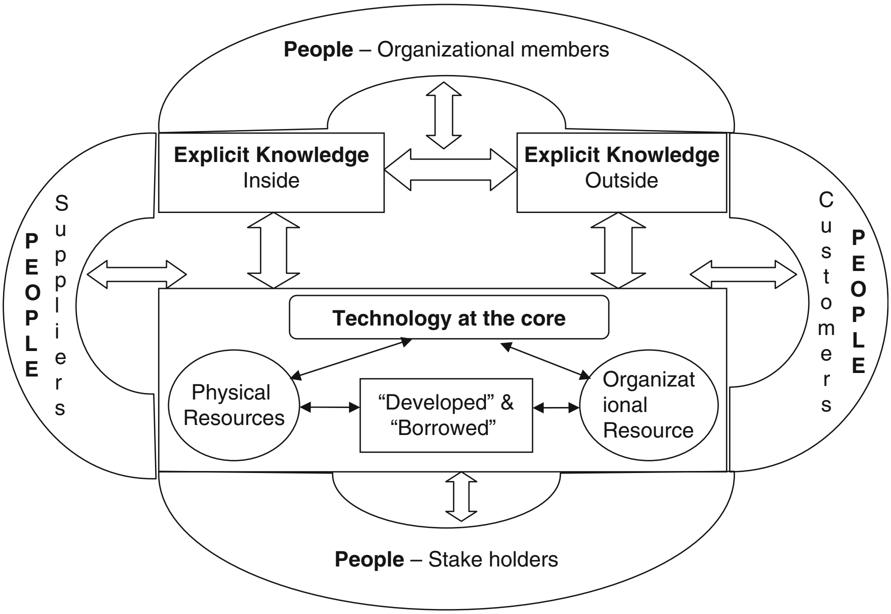

Fig. 1 Knowledge transfer model from tacit knowledge to technology at the core. © Akhilesh K. B. & Indumathi Anandarajan, 2012

to be transferred from people to explicit knowledge to core technology and vice versa, which is illustrated below.

The proposed model comprises of *technology* at the core, with technology developed by the organization as well as technology borrowed from other R&D's. Core technology also comprises both physical and organizational resources.

Explicit knowledge is codified knowledge; it is in the form of procedures, guidelines, techniques, standards, testing, instruction, software, etc. This comprises of both explicit knowledge inside the organization which is standards and procedures, testing, etc., developed "inside" the organization, while explicit knowledge obtained from "outside" is from outside the organization, i.e., R&D units, partners, etc., i.e., who developed a product and stored their instructions, the procedures to operate in the form of manuals.

People comprises of organizational members working within the organization and stakeholders as well as the suppliers for the raw materials, the new R&D developed, and the consumers of the finished technology.

Transferring knowledge from the core technology comprising of "Developed" and "Borrowed" tacit knowledge in terms of the do's and don'ts in handling technology, knowledge required to operate the technology etc. is captured as explicit knowledge and transferred to people comprising of stake holders, suppliers, organizational members and customers, and vice versa. The core technology comprises of both physical and organizational resources, these resources are used in the making of technology which is again tacit knowledge. Technology is the most efficient way to capture the tacit knowledge and stored in explicit mode of knowledge.

Explicit knowledge is captured, recorded, and stored in appropriate fashion, in terms of standards, procedure's guidelines, techniques, standards, testing, instruction, software, etc. The explicit knowledge inside the organization which is standards and procedures, testing, etc., developed from the tacit knowledge of people who are working within/"inside" the organization. Explicit knowledge outside is obtained tacit knowledge from people outside the organization, i.e., R&D units, partners, etc., who are experts in the respective field. The explicit knowledge is then transferred to the people who would in turn come with their own knowledge in the field which is acquired through experience; all the individuals are encouraged to read and understand the stored knowledge about the core technology.

People comprise organizational experts who have acquired the knowledge through trial and error and hence possess lot of experiential tacit knowledge. People also comprise customers who demand the product on the basis of their needs and requirements which is formed from their tacit knowledge; it could be the suppliers who provide the requirements for a particular technology while placing the order, and it could be the stakeholders as they influence the top management, all these different people tend to have their respective tacit knowledge in the field which needs to be effectively managed.

While on the other hand there could also be capture of tacit knowledge and its transfer the other way around wherein knowledge from people comes first, their experiences, their knowledge about usage of tools, learnings and experiences obtained while developing and innovating new technology, etc., can be acquired and transferred on face-to-face interaction, from people to people and stored in a manner where this knowledge can be made portable. The portable knowledge is moved to the next level and is made explicit for all the other individuals to acquire and utilize it in the future with the help of intranets, groupware, search engines, and databases. This explicit knowledge is made available to people who are within the organization as well as to people who are outside the organization and require such expert tacit knowledge. This explicit knowledge will help to move to the crux of tacit knowledge to core technology and will help in understanding the core technology as well as in developing new technology in the future.

This kind of model of understanding tacit knowledge at different levels and trying to analyze it at a deeper and intense level is a necessity now as previously organizations were working in silos, where they believed that succession planning happens within each group and pace of technology development is slow and systematic. Now we are in opposite scenario where there are shortened technology life cycles, extremely competitive technology, demand for new technology, usage and acceptance of different methodologies which are faster and easier, as well as increased effective use of communication which is becoming cheaper. There is pull factor from people for acquiring knowledge with the usage of Facebook, Linked in, and Twitter, so for organization there is a need to see how they can leverage and use them effectively for capturing tacit knowledge. People use all these tools extensively but do not meet organizational goals; hence, using it effectively and capturing tacit knowledge which is experiential are important. Hence, we suggest organizations should get creative and support as well as adopt the newer techniques for acquiring and increasing tacit knowledge.

3 Techniques for Increasing Tacit Knowledge

The techniques suggested for increasing the tacit knowledge are superimposed on the suggested model and are hence grouped into the same three broad divisions as per the model. They are technology centric, explicit centric, and people centric. We strongly believe that understanding techniques and applying the same will help the organization to grow.

3.1 Technology Centric

3.1.1 Virtual Platform

Virtual platform is the working environment where people work remotely across time and/or place and/or organizational boundaries (Townsend et al. 1998). Advances in information technology have made it possible for people to communicate and coordinate remotely (Saunders 2000). Major advantage of virtual platforms is that they help exploit the knowledge of distributed employees with diverse backgrounds and experiences (Malhotra and Majchrzak 2004). Research has shown that people with different backgrounds are able to contribute to integrated knowledge repositories to support a firm's knowledge management activities (Alavi and Tiwana 2002). Thus, tacit knowledge can be effectively captured within virtual platform.

3.1.2 Hyperlinking

Hyperlinking uses reference to that data which the professional can directly follow; it helps in enabling a shared context on a particular subject, capturing all the innate tacit knowledge and converting to explicit knowledge, thereby possessing a special significance in knowledge management activities for capturing tacit knowledge. Fahey and Prusak (1998) suggest that a shared context is important since in its absence, "individuals' differing perspectives, beliefs, assumptions, and views of the future are most likely to collide and thus immobilize decision-making." There are both explicit and implicit links. Explicit links are set by the creator as well as the other users. Implicit links are the links that exist between the knowledge content, the tags, categories, information about authors and their other writings, etc.; this way the innate/tacit knowledge can be captured and further put to use.

3.1.3 Hypermedia

Hypermedia is a computer-based information retrieval system that enables a user to gain or provide access to texts, audio and video recordings, photographs, and computer graphics related to a particular subject, e.g., e-mail correspondence and graphical representations. According to Shum (1998), "hypermedia is an ideal technology for capturing informal knowledge types with relationships that are hard to formalise." Hypermedia helps in collaborating and shared understanding to capture the tacit knowledge. This form of knowledge helps in storage by the organization and eventually becomes organizational knowledge once it is integrated and can be retrieved and utilized for the benefit and growth of the organization.

3.2 Explicit Knowledge Centric

3.2.1 Joint Conferences

Joint conferences are participatory meeting designed for discussion, fact finding, problem solving, etc., designed to capture tacit knowledge of all the experts present and facilitate knowledge transfer among one and all. The advantage of using these activities for capturing tacit knowledge is the high commonality of interests that usually exists among participants, allowing the interaction and two-way flow of knowledge to easily happen. Conferences often focus on particular areas of knowledge. The main purpose of a conference is to transfer new knowledge (Rollof and Sefcik 2010).

3.2.2 Communities of Practice

Community of practice was developed by Jean Lave and Etienne Wenger. A community of practice is a collection of people who engage on an ongoing basis in some common endeavor (Eckert and McConnell-Ginet 1992). Communities of practice steward the knowledge assets of organizations and society. It is learning systems wherein peers tend to informally connect with one another to solve problems, share ideas, build tools, and transfer knowledge based on all of their innate learnings or experiences, i.e., tacit knowledge.

3.2.3 Collaborative Knowledge Management

Collaborative knowledge management is where there are articles or written material on topics and the interested members can connect between all the readers, individuals who have read and commented. This kind of platform brings together individuals with similar interest and hence leads to stimulating their past experiences and perspectives on the field, thereby exchange of their tacit knowledge. This is a useful method of capturing the tacit knowledge of individuals in the same specialization.

3.3 People Centric

3.3.1 Human-Centered Systems

The "human-centered systems" approach recognizes that technology can only be as effective as the humans who must use it. The success of "human-centered technology" comes from putting people first and recognizing that the human contribution is a critical part of technology development, system implementation, and operation (US DoT 1999). Individuals are the creators of technology, and hence, it is necessary to obtain their experiences, learnings, and ideologies which comprise of the core tacit knowledge about the technology.

3.3.2 Exchange of Personnel

Exchange of personnel involves bringing together professionals working on related topics and to promote knowledge exchange and generation through union and diversity. Professionals who possess knowledge on the same field are brought together for exchanging ideas, information, and discussion on the matter of concern, and thereby, their innate knowledge on the field is obtained and transferred to the other individuals as well.

3.3.3 Mentoring

Mentoring is a process where in the experienced, knowledgeable person tends to share his/her knowledge to the individual who is less experienced and knowledgeable. This can be both a formal and an informal process. Informal process is when two individuals come together and one seeks knowledge from the other, while in the formal process, organization brings in the expert to share his knowledge with the inexperienced. This is the most effective way of capturing tacit knowledge as the individual who possesses the knowledge, tends to share their learnings, understanding obtained from their success and failure, expertise they possess in the field etc., are transferred to the person who does not possess such knowledge.

In conclusion, it can be said that the above-mentioned techniques and the proposed model help in capturing the innate knowledge which the individual/organization possesses through their past experience. When knowledge is obtained in this fashion, it becomes clear, is accurate, becomes very important, and is of value to the receiver. The difference between a good and a star performer is huge especially in knowledge-intensive business. Tacit knowledge has the potential for making a star performer. Organizations are realizing that it is no use having good technology and not being able to transfer. When implementing technology management, we need to check the proven experience of adopting the interventions and current pressures of organization. Exposure of people through multicultural work context defines the specific scope and success of the alternatives proposed. This chapter is not overclaiming about the possible interventions; however, we want each of the organization to recognize problems which are complex and develop some appropriate actions to rely on monitoring each of these interventions and constitutions of the team to be implemented. Some of the suggested methods will bring out enhanced understanding and better performance. Several researchers also have verified that the capturing of tacit knowledge by third parties is almost next to impossible. Once we recognize the limitations of some of the practices, organization may work hard to make the intervention more successful through better collaboration and exchange of experiences in a systematic way.

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Part 2.4
Technology and Innovation

Semantic Web as an Innovation Enabler

Ranjith Nayar, K. Venugopalan, Rajeshwari Narendran, and Smitha Nayar

1 Introduction

The Flemish Government says, "With the advent of the Web, companies and research institutions. . .realize that they can no longer rely on their own research to innovate." The Internet has evolved into the primary vehicle for communication, information, and commerce. This chapter examines why Web 3.0 is an enabler for innovation and its management. Existing literature defines Semantic Web in different ways; a concise definition is "Highly specialized information silos, moderated by a cult of personality, validated by the community, and put into context with the inclusion of meta-data through widgets" (Spalding 2007). While information silos are Web 1.0, community validation is a characteristic of Web 2.0, and contextuality (or "semantic") via metadata is a feature of the interoperability characteristic and user-centric "cult of personality."

This chapter examines the role of evolving Web as innovation enablers, with examples of financial and nonfinancial enterprises like investment bank DrKW, Wells Fargo, and Dell. By an informal definition, in Web 1.0, we "read" from the Web as hierarchies distributed information to us. In Web 2.0, we "write" to the Web and learned the possibilities of peer-to-peer networks by participating in social networks. In Web 3.0, we "execute" on the Web and collaborate to deliver community outcomes. Web 3.0 will connect and focus effort with the same

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commercial and community outcomes in open, transparent, and accessible networks. They harness the wisdom of crowds for superior decision making and focus collective effort (Cake 2011). The Web 3.0 consortium, W3C, defines Semantic Web as a web of data. "There is lots of data we all use every day, and it is not part of the web. I can see my bank statements on the web, and my photographs, and I can see my appointments in a calendar.... Can I see bank statement lines in a calendar? Why not? Because we don't have a web of data. Because data is controlled by applications, and each application keeps it to itself. The Semantic Web is about two things. It is about common formats for integration and combination of data drawn from diverse sources, where on the original Web mainly concentrated on the interchange of documents. It is also about language for recording how the data relates to real world objects. That allows a person, or a machine, to start off in one database, and then move through an unending set of databases which are connected not by wires but by being about the same thing" (Web3 Consortium 2011).

2 Driving Innovation

Experts say, "Web3.0 will deliver a new generation of business applications that will see business computing converge on the same fundamental on-demand architecture as consumer applications. This is not something that's of merely passing interest to those who work in enterprise IT. It will radically change the organizations" (Wainewright 2005).

We conducted two surveys: mid to senior professionals across industries and four countries—the UK, India, Singapore, and Taiwan—(with average age of 37.5, 15-year work experience, and 1:1 distribution of IT versus non-IT profiles) showed the two primary drivers for driving innovation in any organization are prevalence of a "culture of innovation" and an organization to sustain this culture (Narendran and Nayar 2011). Our second survey in a controlled sample in India (22 MBA students, 55% engineers, with 2.5-year work experience) shows 82% IT usage in organizations and 50% prevalence of Web search for new information at work. Eighty-two percent agreed innovative organizations show higher energy in their people and functions. Taken together, the high trend of IT usage will help deployment of enterprise social networks or "e-SocNets." While difficult to quantify gains from innovation, literature does show evidences of 5% increased productivity due to organizational transformation, coexisting with internal IT (Brynjolfsson and Hitt 2000). Consequently, transforming the organization via e-SocNets and Semantic Web will help increase productivity. Matteo Rizzi, innovation manager at SWIFT, examines Web 2.0 in the financial community as a business enabler, bringing collaboration to the next level using KM, utilizing social context and reputation as part of the new business paradigm and how Web 2.0 maximizes innovation, knowledge management, and social data.

2.1 Web 2.0

The shortfall of Web 1.0 (document exchange; lacking participation) led to Web 2.0 which boosted collaborative innovation. In turn, its shortfall of interoperability will be overcome in Web 3.0 which brings a contextual paradigm. Web 2.0 covers a range of technologies, most commonly, blogs, wikis, podcasts, information tagging, prediction markets, and social networks. Making innovation work using Web 2.0 within a business needs sufficient technology integration of the Web 2.0 tools with the legacy IT systems, managers who are comfortable in peer-credibility-based leadership, and employees "agreeing" to a socialization of business (Domínguez 2011).

Web 2.0 tools do not necessarily simplify innovation management. However, they bring together the expertise into one network and enhance communication in line with the cryptic, informal, short, (and, more important) public twitter-like platform, unlike email communication where most information sharing is personal and hence locked in intray silos. Survey data confirmed market research group Gartner's anticipated trend: "By 2014, social networking services will replace e-mail as the primary vehicle for interpersonal communications for 20% of business users" (McAfee 2010).

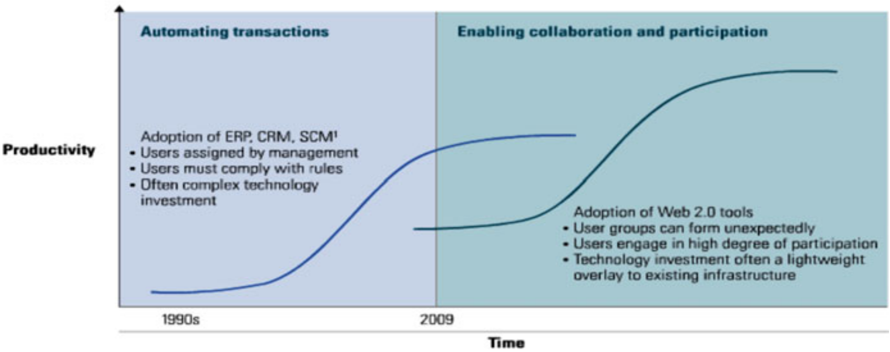


Exhibit: 1 The New Tools (Chui et al 2009)

2.2 Web 3.0

Web 3.0., on the other hand, enables interoperability across platforms, enhancing KM capability and communication. Its "guided search" will be a staging point, where search engines do not provide relevance. Hence, technology enablers enable innovation not only by idea sharing but also by providing better insights and contexts. They also become new branding and market research tools and low-cost advertisement, bringing not just enabling but redundancy.

Experts (like J. P. Rangaswami, CIO at investment bank DrKW) expect today's core enterprise applications will be superseded by four new types of applications in Web 3.0 era where "powerful forces are in motion that are going to fundamentally shake up our current view of enterprise applications, replacing the current demarcations—ERP, CRM, BI, collaboration, and so on—with something new." And that all requirements will coalesce around four core application families of requirements—which are already shaping DrKW's internal architecture:

> **Publishing**: Any application that generates data will act as though it's a content publisher, using RSS or similar to publish its data. The significance of this is that it reduces all of these applications to the level of raw feed generators: "You can't differentiate, it's just content." **Discovery**: Single, homogenous database where everything is stored and discoverable, with access and authorization controls added only as necessary for specific items or classes of information. **Fulfillment**: This is the application that makes things happen, most notably for customers. Identity management plays a crucial role here, controlling the catalog choices that are shown to each user and their rights to approve shipment. **Conversation**: All the channels of collaboration between people, either inside the organization or beyond its walls.

These will enhance innovation, e.g., application-independent raw feed enables interoperability.

2.3 Asian Innovation

The Web as an innovation tool as well as a marketing tool (via semantic clustering) is invaluable in an Asian context where cost sensitivity is very high. Over the past 2 years, the Asia New Business Creation project, conducted by the Danish Universe Foundation, has done extensive research in Asian companies and produced case studies and workshops to exchange methods among five large Danish companies and three Asian companies (Haier from China, Singapore's STe, and Woonjin/Coway from Korea). The study concluded that Asian companies are different from Western companies in their approach to innovation. It identified four generic elements of the Asian approach (Hesseldahl 2011):

1. Suitability of products (as opposed to generic).
2. Ability to let go of style or details in order to chase the market.
3. Fluidity, i.e., support change and uncertainty.
4. Companies are young, have fluid organization structures, and are in a hurry to grow up.

These are especially true for financial services and banking industry where product differentiation is narrow and customer spectrum is wide. Asian companies tend to work on existing products, adapting these to local community needs, driven by diversity of Asian marketplace, price sensitivity, and features their target customers need. Banks, traditionally, have not been threatened by innovations introduced by other organizations trying to enter their sector because of the barriers imposed by security requirements and regulation.

An innovation for the currency remittance industry in Singapore was done by one of the authors for Asinnova LLP and proposed for implementation to Singapore Telecom to enter the financial sector as a strategy to derive competitive advantage using developments in telephony as the technology enabler. Lessons drawn from that include the reservations by SingTel to invest in a technology that is easy to penetrate by competition. However, the Internet is opening opportunities for firms keen to enter the sector, e.g., PayPal, CheckFree, and Amazon, which are offering new payment models that are becoming popular with customers.

Many on-line start-ups are providing tools to enable customers manage personal finance. Some larger banks, e.g., BBVA in Spain, responded to these evolutions in the market and are rethinking their on-line banking models, experimenting with how to combine Web 2.0 capabilities, such as personalization and information aggregation, with financial services that make the customer experience simpler and more relevant (Domínguez). This implies a stronger need for community and contextual information, and input from grassroots—areas where Web 3.0 can play a significant differentiating role. Web 2.0 impacts both knowledge diffusion within and outside a company, and product commercialization with its smaller "path-of-innovation." Forrester Research found 25% of enterprises set Web 2.0 priorities in 2008, and predicts a $4.6 billion enterprise spending on Web 2.0 by 2013. But, enterprises need clear Web 2.0 policy to maximize benefits, as done at Wells Fargo and Dell. P&G targets half its innovations to come via its open innovation community. However, McKinsey survey shows that among companies that have tried and implemented Web 2.0, 22% were dissatisfied with results. McAfee (2010) survey shows 49% primary concerns about Web 2.0 security (virus, malware), productivity 27%, legal risks 15%, and reputation 9%. Success depends on having a clear Web 2.0 strategy, as well as managing it through each of these three levers: "technology, managers, and employees" (Domínguez 2010). Yet, Web 2.0 adoption rate is high (60% in Canada to Brazil 100%) (McAfee 2010).

2.4 *Web 2.0 and 3.0 and Innovation*

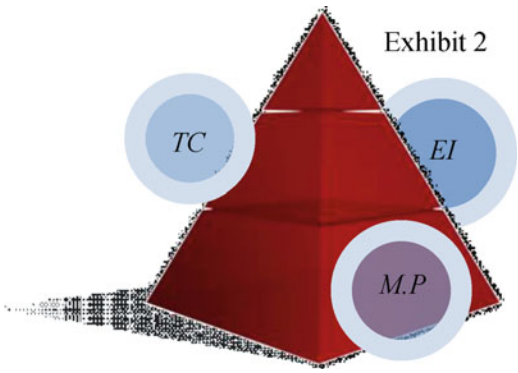
Ning and O'Sullivan (2006) have developed a framework for Semantic Innovation Management System (SIMS) based on metadata harvesting and RDF access technologies and developed a practical case study using RDF Gateway. Their work "demonstrates the feasibility and potential to adopt Semantic Web technologies to improve innovation management across extended enterprises." Any enterprise that is large and spread across multiple areas of operation or geographies can be considered an extended enterprise.

Extended enterprises face a problem in managing internal innovation that while innovation does grow with collaboration, it is largely a collection of local process. Collaboration across boundaries helps seed new ideas and germinates local ideas—and, indeed, helps carry developing concepts further. Yet, innovation is essentially local in nature (much as imported seeds will probably flower in the local soil, but the nature of growth is a localized process dependent on the contextual parameters). This implies the need and existence of local IM infrastructure for innovation climate nurturing and managing. Extended enterprises use central coordination among local IM organizations to share and cross-fertilize ideas and innovations across the enterprise. This is largely through process-oriented management techniques like periodic meetings, workshops, as well as Web 1.0 style of electronic sharing such as emails, Webpages, etc., which are push techniques for targeted audiences and emphasis on information delivery and not on insight development.

As an extension of Ning and O'Sullivan's proposal for semantic innovation management, we examined the steps required to collate, and potentially aggregate, the innovations and the innovation potential/climate available across a particular extended enterprise. This high-technology enterprise is headquartered in Europe and has high levels of innovation capabilities and patents from several of its R&D centers spread across Europe, Asia, and North America, as well manufacturing centers in Europe and Asia. Large cultural variance within this enterprise has led to variances in innovation culture and climate—but there exists easy sharing of know-how's and know-who's so essential in Web 1.0 or IT-driven environment.

2.4.1 Classical Innovation Management

Innovation is managed in this enterprise in the classical method most prevalent in the Web 1.0 era. Organizational/process innovation is encouraged, even if innovation is largely seen as an R&D function with new products and product designs being the expected outcome, and while there is no specific reward scheme in place, failure is not discouraged—a fundamental prerequisite for innovation incubation. In late 2010, an innovation management organization was set up in the company's IT department, globally centered but with local representation.



Implementing innovation in an organization boils down to implementing a good system of innovation management (IM)—a multilayered pyramid of three sides (exhibit 2)—managing team competencies, external influences, and management platform. The components are as follows (Table 1):

Table 1 Components of three sides of innovation management pyramid

Team competency (TC)	External influences (EI)	Management platform (MP)
Idea management	Internal to company	Culture
User management	Industry level	Strategy
Project portfolio management	Socio-technical level	Tools and processes
Platform management		Metrics
Project management		

This method, while effective, tends to be limited largely to the geographies (even virtual geographies which too are limited), yet does extend the geographies of the facilitator. Improvements in communication technologies have, of course, moved some of the geographical boundaries, but the new virtual geographies are perhaps best described as the inclusion of either some specific remote expertise or some remote less-engaged participants who are more validators than part of the team and hence may be described as more cooperative innovation than collaborative innovation.

2.4.2 Web-Driven Innovation Management

The benefits of introducing collaborative communication technologies into enterprises are obvious, even if the results are not guaranteed. Current knowledge and information repositories tend to exist in application silos and interoperability—the ability to access information residing in different operating systems/applications/databases—that ranges from limited to nil. Introducing collaborative tools fashioned on Web 2.0 technologies—equivalents of Facebook and Twitter—will not address this problem but will enable people (experts, researchers, and engineers) to share communication and information within their communities at the speed of modern communication, cutting across geographical or functional barriers. This turns enterprises into fast moving/reacting enterprises (or Enterprise 2.0, a term being popularized by Andrew McAfee of MIT (McAfee 2010)) where hierarchies and silos have lesser significance. These enterprises are also fundamentally more democratic, less encumbered by processes and protocol, one where hierarchies are established more by the peer recognition than by organization charts.

Web 3.0's interoperability across application is important since it helps bridge knowledge fractured into silos. We also make use of interoperability to aggregate geographically distributed activities that have interest confluence.

The first author is working on building a semantic tool that will be able to aggregate talent (of experts) in a network (intranet/extranet/the Internet/social networks), with a focus on leveraging employee networks to increase individual and organizational performance with an enterprise. This is envisaged as the first step to move the enterprise to McAfee's (2009) Enterprise 2.0.

Social networks exist throughout this organization in various forms. The more formal ones include ITIL tools like Remedy. Organizational network analysis (ONA) helps analyze network to identify nodes where strong collaboration helps increase innovation (Garud et al. 2010), or effectiveness where some experts are not collaborating to the level expected. We could compare this with an individual's performance appraisal data available to identify nodes or experts in terms of their broader collaborative contributions. This second dimension helps executives identify which employees are extensively leveraged and which employees have potential to contribute more to the network. Examining talent along both dimensions would reveal four levels of talent utilization: high-performing, marginalized, hidden, or underutilized talent.

By identifying specific network-centric practices and conducting a set of in-depth case studies using ONA to expand our knowledge of how networks impact performance and to understand the behavior of top performers, we attempt to establish a road map for leaders interested in building collaboration through talent management. We target this network to become the predominant social network in the enterprise under study and to enhance semantic innovation within this enterprise.

Innovation has many facets, or components—business model innovation, business function innovation, product innovation, operations innovation, etc. Each of these facets has several layers: execution strategy, business strategy, technology enablers, and innovation enablers. Technology enablers are primarily Web tools, like micro-blogs instead of market research, social networks that boost the potential to collaborate on the innovation of value, and wikis. Mostly, these are Web 2.0 technology-based tools:

> Innovation is "the process of making changes in something established by introducing something new", which can be viewed as a cyclic loop consisting of four distinct phases, i.e., recognition, initiation, implementation, and stabilization. Within a typical organisation, there are various degrees of innovation from simply suggesting ideas or managing a single project to managing an entire programme of change comprising various performance indicators and portfolios of projects. To support the lifecycle of innovation, different innovation management tools or tool families have been developed. Conceptually, they can be classified as five layers, i.e., individual innovation, project innovation, collaborative innovation, distributed innovation, and semantic innovation.
>
> Current research focuses on the development of structured collaboration environments, and the entire system is designed to be used collaboratively by every user of the system to gather information and update their own contributions to their community. Distributed innovation is innovation across a particular intranet within an organization's supply chain and even a specific virtual team. This level of innovation is defined by all of the "collaborative", "project" and "individual" innovations, taking place lower in the innovation hierarchy. The tools required for distributed innovation, which build mostly on portal servers (e.g., Sharepoint, Lotus Notes, and Plumtree), are in their infancy. Principal design features include enterprise wide search and navigation, user personalisation, integration and content management, notifications (push technologies), workflow, and application integration to other information sources. Since current state of the art is manual browsing, a well-designed collaboration/management structure is necessary to allow any individual easy access to the information that they are looking for. The generation of semantic innovation is derived by the emerging semantic web technology. (Li and O'Sullivan 2004)

Web 3.0 will enable innovation more by virtue of the contextuality of search, such as semantic clustering which enables one to search for concepts and ideas and their interrelations rather than Web 1.0's search of static strings. This ability to search for concepts expands the informational horizon that the innovator is seeking information of and from, as well as shrinks the time horizon that is consumed in executing that search effectively. The efficacy of idea development is clearly a function of both.

How will Web 3.0 be an enabler for innovation management? In two ways: first, like innovation itself, Semantic Web will enable innovation managers seek contextually valid IM techniques from a more focused information horizon; second, and more important, IM practitioners will be able to aggregate innovations happening within a defined boundary (such as intra-enterprise) within the contextual space they seek to working in.

We will examine these in some length here:

1. Studies show that the two primary drivers of innovation in an organization are the prevalence of a culture of innovation and the prevalence of an organization to drive innovation. McKinsey consulting says, "Organizing the innovation process from beginning to end is a critical element of IM. Lack of formal organization is a common problem. Execution is the biggest challenge. Fundamentally, the biggest challenge is organisation." Deployment of Web 2.0 in an enterprise has two major effects on establishing the culture: first, it is a major change, a new one at that, and this change passes down a clear commitment toward innovation from the top management to the middle managers and to the prospective innovators, both product innovators and those concerned with process improvements; second, the availability of SocNet applications like Twitter (or its enterprise-level equivalents like Yammer) encourages better communication which is especially useful across an extended enterprise. Further down the second point, the availability of a network of experts/expertise has a snowball effect as professionals come out of silos and build on incremental ideas that are discussed freely in a way that is difficult to sustain in, say, email communication. Web 2.0 deployment within the enterprise also streamlines the work of an innovation management organization as the gathering of innovation information becomes easier (so too the dissemination) due to the prevalence of experts' networks which will also help in specific innovation examples by bringing together even those who are not directly involved, but interested in the topic, to contribute incrementally.
2. Most extended enterprises have innovations happening in different areas and geographies. The more formalized projects are usually visible across the enterprise, even while the routine or day-to-day are not. Yet, via the FOAF (from "friend of a friend") which is an RDF-based schema to describe persons and their social network in a semantic way, we can parse user pages or describe articles about people. Since Semantic Web promises a vision to make information and knowledge machine accessible in the Web rather than displaying them for interpretation by humans, semantic innovation which exploits the potential of Semantic Web technologies will improve effectiveness and efficiency of innovation management in a large networked organization. This is true for each individual aspect of the innovation pyramid described in p. 5. Within

each of these "sides," we have the different component layers. RDF, OWL, and FOAF technologies provide the ability to aggregate each of these layers present in the different areas of the extended enterprise.

We take one layer to illustrate the point: According to the fact that different organization or project contexts can make statements about the same innovation process using different language, semantic mediation which can make use of concepts and relations defined elsewhere and facilitate the interaction between shared ontologies and different local ontologies is another technical pillar for semantic innovation (Ning and O'Sullivan). Semantic Web can be envisioned as an extension of the current Web, which makes the Web more understandable to computer programs, and then allows data to be shared and reused across application, enterprise, and community boundaries easily (Berners-Lee et al. 2001). The original proposition of semantic innovation is to exploit the potential of Semantic Web technology to improve the effectiveness and efficiency of innovation management in the large networked organization. One of these is semantic clustering, a technique that groups related concepts—by enabling computers to understand sentence meaning and group similar text across a large number of documents, statistically profiling the co-occurrence of all the themes—but unable to judge importance of the concept. It explains the idea flow created by the Internet to help understand how people are ideating across the Web by analyzing their opinions (Shaughnessy 2010). This points to Web 2.0 conversations becoming a market research tool. Therefore, enterprises need to start experimenting with digitally active population (within the enterprise and in the marketplace) by using Web 2.0 tools and SocNets, say with company-controlled community, "perhaps through a blog, that gives your customers a place to offer feedback about your products and services—a basic move many companies still ignore" (Hoffman 2009).

We are engaged in an experiment to extend this principle in this enterprise to design a model to augment the engagement of vast pool of knowledge workers and technical experts present in the European extended enterprise under study. Studies have indicated that the enterprise was losing advantage of its technical expertise since the level of engagement of its expertise was insufficient. The experiment is ongoing, and this author has drawn up a model named Interactive Semantic Energy Calibration Tool (InterSECT) with seven axes for classification of engagement energy. Each axis measures (via a set of 7–12 questions) the time-variant energy of a participant, the time-invariant energy as well as semantic factors that contribute to engagement. This model is currently in validation stage and will be implemented after that. The semantic factors involve the level of integration of the Web 2.0+ tools with legacy information system tools available to the experts to enumerate their technical innovations, as well as the two other key factors, namely, acceptance of SocNet as a way of professional working and hierarchies based on peer credibility. The validation of these factors will conclusively point to acceptability of Web 2.0/3.0 in conventional but forward-looking extended enterprises.

The bottom line is that by focusing on the fundamental aspects of the consumers' online behavior—not just current best practices—companies will be better prepared when Web 2.0+ morphs into Web 3.0 and beyond (Hoffman 2009).

3 Conclusion

Web 3.0 overcomes the limitations of Web 1.0. It helps link people within communities of common interest, and this collaboration will help deliver a higher quality of community outcomes. The development of Web 2.0 technologies is leading to change in enterprises, or what is increasingly being defined as Enterprise 2.0, which brings social networks inside firewalls. With the IT evolution—or revolution—bringing in newer technology of Web 3.0, semantics will also come inside enterprises and lead to Enterprise 3.0 with major implications on how organizations work. While it is early to predict what these impacts will be, the most obvious implication will be a boost in their innovation capability because of increased participation or deeper engagement of quasi-hidden talent pools (Kumar and Puranam 2011) within the community and by integrating separate groups and geographies. They aggregate the "wisdom of crowds" for superior decision making and focus collective effort on prioritized outcomes (Cake 2011). We have attempted to define the implications on the way these enterprises will innovate and drive their innovation. Semantic Web will enable innovation by being an aggregator of innovations practiced across the extended organization via SIMS, or Semantic Innovation Management Systems. In parallel, techniques like semantic clustering, semantic mediation, and its characteristic of breakdown of information silos through interoperability across applications and easing knowledge management will give a significant boost to innovation itself with enterprises and in the open innovation community.

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How to Charge Electric Vehicles: A Comparison of Charging Infrastructure Concepts and Technologies

Benedikt Römer, Tobias Schneiderbauer, and Arnold Picot

1 Introduction

The transportation sector accounts globally for over 50 % of the world's oil consumption and is responsible for 23 % of the world's CO_2 emissions (IEA 2011). Additionally, motorized transport is responsible for several local emissions such as noise, particulate matters, smell, hydrocarbons, and nitro oxides, which matter especially in densely populated areas (U.S. Environmental Protection Agency 1994). Charged with electricity from renewable energy sources, electric vehicles (EV) can avoid these negative influences. EVs are in development by nearly all original equipment manufacturers (OEM) with first models already in the market. By 2020, global EV (incl. plug-in hybrids) sales are expected to reach 6.9 million vehicles per year (Tanaka 2011). However, one of the main restraints for the EV market and the consumer acceptance of EV is a lack of charging stations. As the setup of charging infrastructure is still in the very beginning, it is important to develop, implement, and support the right technologies. In particular, it is unclear which technologies are most suitable for certain charging locations. Our combined qualitative and quantitative research makes the following contributions: first, we provide an overview of technology selection methods, charging technologies, and categories of charging locations. Second, we provide key criteria for assessing charging technologies. Third, we propose a decision framework for selecting suitable charging technologies. Last, we test the framework on the European market

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and recommend a selection of charging technologies depending on the planned location. This chapter addresses researchers in the field of technology management and assessment as well as practitioners from the automotive and energy industry.

2 Comparing Infrastructure Setups

2.1 Decision Tools

To answer our research question, we considered quantitative as well as qualitative criteria. For solving complex decision problems, we found a variety of multicriteria decision analysis tools in literature (Ananda and Herath 2009; Kiker et al. 2005; Linkov et al. 2006). Developed by Saaty (1977, 1980), the analytical hierarchy process (AHP) is widely used and has been applied to diverse decision problems. Vaidya and Kumar (2006) analyzed 150 application papers and give an overview of AHP applications. Chou et al. (2004) used the AHP to compare technology alternatives for e-payment systems using technological, social, and economic factors. We could not find an AHP application for an evaluation in the area of charging infrastructures. However, it was used for an analysis of alternative-fuel buses for public transportation (Tzeng et al. 2005).

2.2 Charging Infrastructure Technologies and Charging Location Types

EVs can be charged using a cable, via battery swapping or wireless through inductive charging (excluded from our study due to immaturity of technology). Our study examines four different technologies: normal, semifast, and fast charging (all wired) as well as battery swapping.

Normal charging (United States (USA): level 1 charging) refers to the power level, which standard power outlets provide in domestic installations. The rating of power outlets differs around the world (1.8 kilowatts (kW) to 3.7 kW). *Semifast charging* (USA: level 2 charging) has a higher power level (7.2–22.2 kW). It uses mainly three-phase power connections. *Fast charging* (USA: level 3 charging) provides the highest power levels (50–250 kW). Fast charging stations are mainly direct current (DC) systems and need specific expensive fixed infrastructure. The power level determines the speed of charging ranging from 16.5 h to charge a 30 kWh battery (typical size of a car battery) at 1.8 kW to only around 10 min at 250 kW (Van den Bossche 2010). *Battery swapping* is an automated process to replace an empty battery of an EV with a fully charged one. It allows quick charging (replacement) with switch times of around one minute but requires a high degree of standardization and compatibility for various vehicles and high investments for swapping stations (Lombardi et al. 2010).

Charging systems differ also in communication capabilities between the EV, the charging station, and the further entities such as grid operators. Supported functions (use-cases) exceeding mere charging like safety control, billing, or grid stabilization (e.g., power renegotiations and charge rescheduling) lead to additional communication requirements. Relevant use-cases and communication capability levels will be described in the upcoming standard IEC/ISO 15118 (Schmutzler and Wietfeld 2010).

Drivers of EV can charge their vehicles in different locations. Depending on the location, charging behavior, economics of charging, and, as a consequence, investments for charging infrastructures vary. In accordance with Framel et al. (2010), in this chapter, locations are categorized into four types:

- *Home* charging is used for charging at private places (e.g., garages), where the EV is typically parked for a long time.
- *Work/business* charging relates to locations where EVs usually stay for several hours, e.g., place of work.
- *Public* charging applies to places the EV is parked for a few hours (e.g., restaurants or shopping malls).
- *Highway* charging is used for locations, where the short stop's main purpose is charging.

3 Method and Procedure

In our study, we combine qualitative and quantitative methodologies. In a first step, we conduct expert interviews in order to find and verify relevant evaluation criteria for the comparison of charging infrastructure technologies. In a second step, we apply the AHP, adapting the approach of Chou et al. (2004) and combining it with the methodology of direct point allocation (Saunders 1994). Key inputs for the second step are the evaluation criteria we determined in the first step.

3.1 Expert Interviews

Expert interviews are specific semi-structured interviews. The main interest lies on the experts' knowledge (Meuser and Nagel 1997). As the application of charging infrastructure technologies for EV is a relatively new research field, only limited information is publicly available in reports or papers. Therefore, we use a systematizing expert interview to treat experts as guides, who help to gain specialized knowledge (Bogner et al. 2009).

We identified relevant stakeholders for the research question: charging station manufacturers, charging infrastructure providers, utilities, original equipment manufacturers (OEMs), and other industry experts like consultants. To identify possible interviewees, we used an analysis of the EV market by Frost and Sullivan (2009) and analyzed conferences for EV infrastructure. As a conceptional preparation for the interviews, we developed an interview guideline and sent it to identified experts. Through these activities, we built up knowledge upfront, increased the probability of interviewees' acceptance to participate, and structured the interviews themselves (Liebold and Trinczek 2009; Trinczek 1995). From 50 approached interview candidates, 20 experts participated. Interviewees were high- and mid-level managers of eight charging station manufacturers, four utilities, two OEMs, two charging station providers, and four other industry experts. The interviewees were located in the USA, Europe, and Japan. Each interview was conducted separately (one-to-one) via telephone in May and June 2011. The interviews lasted between 30 and 90 min and have been recorded. We paraphrased all interviews and selectively transcribed specific points of special importance (Liebold and Trinczek 2009). Views, opinions, and attitudes of interviewees were analyzed and compared using thematic coding (Flick 2009). As the last step, interview evaluations were confirmed by respective interview participants. As a result, 11 relevant criteria for an assessment of charging infrastructure technologies have been identified and verified. These are described in the results section.

3.2 Adapted Analytical Hierarchy Process

We used an adapted AHP to evaluate and compare the application of four charging infrastructure technologies in four different location types. First, we used previously identified evaluation criteria and the described technologies to construct the hierarchical structure of alternatives, factors, and subfactors (Bhushan and Rai 2004). We broke down the three main criteria of technological, economic, and social factors into 11 subfactors. Second, we calculated priority weights between subfactors. The industry experts were involved in this evaluation and we conducted this step four times to calculate priority weights for all location types. We adapted the AHP using the direct point allocation to keep the effort for participants low and thus increase the participation rate. Third, we evaluated the performance of the four technology alternatives in each of the criteria through pairwise comparison. Fourth, we calculated the total value for each technology alternative based on data from an expert poll multiplied with the priority weights (Chou et al. 2004). This procedure again was performed for each of the charging locations, hence four times with varying goals. The general procedure is illustrated in Fig. 1.

The *data collection* was conducted by an expert survey as this is considered to be the best source of sample data to the AHP (Chou et al. 2004). Characteristics of the criteria vary for different regions of the world. Eleven European experts participated in the survey: employees of four charging station manufacturers, three utilities, two OEMs, and two consultancies. Thus, the sample is covering the views of the major players of the charging infrastructure industry and is balanced between different industry groups. As charging infrastructure technologies are

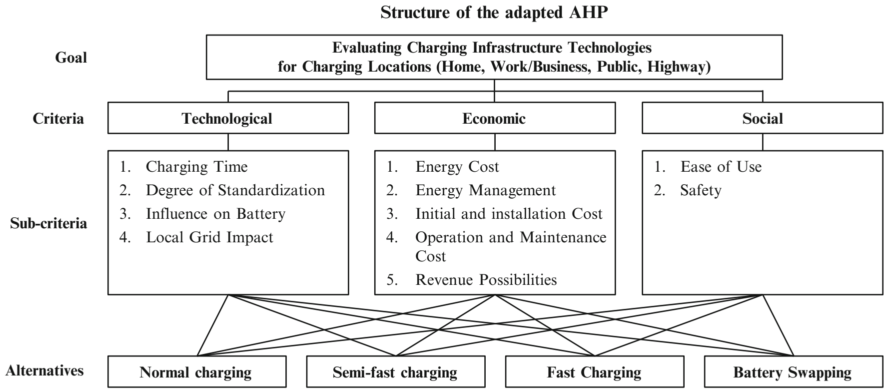

Fig. 1 Structure of the adapted AHP

not yet widely brought to the market, we did not ask consumers as they might lack necessary experience and knowledge.

For the *direct point allocation*, experts were asked to allocate a fixed number of points to the 11 evaluation criteria to determine their relative importance (Schoemaker and Waid 1982). The questioned participants had to allocate four times 100 points for each of the four charging locations. To aggregate the subjective allocations of participating experts, the arithmetic mean was used.

For the *pairwise comparison*, all alternatives are paired against all others regarding each of the sub-criteria. We chose this technique to ease decision making as it requires survey participants to make only relative judgements instead of absolute ones (Kiker et al. 2005). The questioned experts had to compare alternative technologies in the context of each criterion (e.g., charging time). Adapting the scale recommended by Saaty (1977), we used a nine-level scale (ranging from "alternatives are equal" (1) to "one alternative is extremely better than the other" (9)). Saaty (1990) gives a detailed description of the pairwise comparison methodology and of the related calculation algorithm. For the calculation of local ratings and testing for consistency, we used the software MakeItRational.

The final step of the adapted AHP is the *aggregation of the relative weights* of the decision elements. Hence, the local rating of each of the alternatives for each subfactor is multiplied by the priority weight of the respective subfactor to receive the global ratings. The sums of all global ratings for each technology are used to select an alternative (Bhushan and Rai 2004). This step was performed for each of the locations. The results are described in the second part of the findings section.

4 Findings

Our findings are structured in two parts. In the first section, we explain the identified evaluation criteria. In the second section, we present the results of the adapted AHP survey for Europe.

4.1 Choosing the Right Criteria Is Key for Taking Good Decisions

The evaluation criteria provide the most important input factors for the adapted AHP for comparing charging infrastructure technologies. In this section, we present and explain the evaluation criteria, which are results of an analysis of expert interviews and accompanying literature review. We structure the criteria into three categories: technological factors, economic factors, and social factors with respective subfactors.

4.1.1 Technological Factors

Technological factors consist of the subfactors charging time, local grid impact, degree of standardization, and influence on battery, which we explain in detail:

Charging time: Charging time can be differentiated into theoretical charging time and charging speed. The theoretical charging time measures the time needed to charge the battery of an electric vehicle from 0 to 100 % and in the case of fast charging from 0 to 80 %, whereas charging speed is defined as the number of kilometers, which can be driven by charging the electric vehicle for 1 h. The charging speed of normal charging is 18.5 km/h, the one of semifast charging up to 111 km/h, and fast charging goes up to 250 km/h (Van den Bossche 2010). In comparison, a battery swapping station takes on average less than one minute to switch the battery, which enables the vehicle to drive a distance of typically about 150 km (Yudan 2010).

Local grid impact: Although the adoption of electric vehicles is expected to be gradual, experts predict that the distribution of electric vehicles will be concentrated throughout certain neighborhoods. In these areas, early adopters of electric vehicles are clustered due to demographics such as educational level and income. This might result in local strain on transformers and even transformer failures (Boulanger et al. 2011). Therefore, the most demanding issues for utility companies are the distribution of transformers and substations, which have to be upgraded with respect to the anticipated charging load of EVs in these cluster areas (Laufenberg and Moorhouse 2010). Due to distinct power levels, the grid impact varies for different charging technologies.

Degree of standardization: In general, standardization can be seen as one of the key enablers for the adoption of the electric vehicle. The standardization of plugs, communication, interfaces, and power is of major importance to make the interoperability of chargers and vehicles feasible (Brown et al. 2010). The level of standardization is different for the studied technologies. In Europe, the standardization of the plug for normal charging and semifast charging is already on a high level. However, Germany, Austria, the Netherlands, and other European countries prefer one specific standard, called type 2, while France and Italy are in favor of the type 1 plug (Society of Motor Manufacturers and Traders 2010). In the United States and Japan, a plug for level 1 and level 2 is defined in a joint standard (Chambers 2011). For DC fast charging, there are two charging standards on the way. On the one hand, there is the CHAdeMO standards, which is already deployed in several charging stations in the world. On the other hand, European and American automakers are working on an AC/DC combo connector (European Committee for Standardization 2011). Battery swapping requires big efforts for standardization on the side of the electric vehicle, as it needs the capability to remove and release the battery very fast by having the battery pack at a certain position under the vehicle. Currently, the EASYBAT consortium, consisting mainly of Better Place, Renault SA, and Continental, is working on building a standard for a battery switch platform (Gabay 2011).

Influence on battery: As batteries are very expensive and present such an important part for electric vehicles, it is crucial that a battery is not damaged during charging. OEMs design the battery of an electric vehicle for a lifetime of about 10 years, which equals about 3,000 charging cycles. In order to avoid battery deterioration, the battery should neither be overcharged nor be overheated during the charging process.

4.1.2 Economic Factors

Economic factors include the subfactors energy management, energy costs, initial and installation costs, operation and maintenance costs, as well as revenue possibilities:

Energy management: The possibilities for energy management depend on the way the electric vehicle is integrated with the grid. Thereby, five different ways of charging (not to be confused with the four examined technologies) can be differentiated depending on the complexity of connectivity (Brylawsk et al. 2008). Convenience charging means that the electric vehicle starts charging as soon as it is plugged in, similar to typical appliances. Timed charging is more advanced and allows delaying the charging process for a given time until an installed program or the utility company gives a signal to start. Smart charging enables real time communication between an electric vehicle and the grid and is thereby able to adjust the charging directly to the needs of the grid. In addition, the electric vehicle can provide unidirectional ancillary services such as frequency regulation. Vehicle-to-building/home is similar to vehicle-to-grid (V2G), but the electric vehicle communicates only locally with the energy management system of the building and not with the grid. The batteries of the electric vehicles can be used via a bidirectional power transfer as a back-up power for certain periods of time in order to increase flexibility and reliability of the electrical power distribution system. Vehicle-to-grid is the most complex form of connectivity as an electric vehicle is directly connected to the grid and enables a bidirectional energy flow. V2G offers all the functionalities and benefits of the other options and also makes bidirectional ancillary services possible like spinning reserve (Boulanger et al. 2011; Brylawsk et al. 2008). The studied technologies differ in suitability for the usage of energy management services as they are operated with different power levels and over different time spans.

Energy costs: The energy costs for a driver of an electric vehicle will differ mainly depending on the charging infrastructure technology. The reasoning behind this is that the running costs for a connection to the power supply increase with the level of charging power provided, which results in higher energy costs. In addition, experts anticipate that in future when more and more electric vehicles are on the road and replace conventional internal combustion engine vehicles, governments will introduce some kind of mobility tax on the distributed electricity. Imposed taxes may differ across distinct charging infrastructure technologies in order to support technology-specific properties.

Initial and installation costs: The total costs for a charging station consist of hardware and one-time installation costs. The installation costs consist of labor, construction, and permitting costs. These costs vary widely depending on the type of charging station and on the location they are installed (Wiederer and Philip 2010). The total cost of a charging station for normal charging is 500–3,000 €, while a charging station for semifast charging costs 5,000–11,000 €. A fast charging station accounts for total costs of 40,000–60,000 € and the costs for a battery swapping station vary between 400,000 and 1,100,000 €.

Operation and maintenance costs: The operation costs of the charging station are related, among others, to the management of the process topology including billing, customer management, and other features. However, these costs occur only for smart chargers with integrated communication functionality. Other operating costs can occur in public places when parking space in front of charging stations needs to be rented. In addition, for fast charging, a certain provision fee has to be paid to the utility company for making such high amounts of power available. The maintenance costs for charging stations consist of carrying out necessary maintenance, cleaning tasks, and inspections of the functionality of the charging station and vary for the different technologies (Wiederer and Philip 2010).

Revenue possibilities: There are two basic models to generate revenues from a charging station, the pay-per-use model and the subscription model. In a pay-per-use model, revenues are determined by the degree of utilization of the charging station, the throughput in kWh, and the price per kWh. In a subscription model, the consumer has to pay a subscription fee for using the charging station either monthly or annually (Frost and Sullivan 2011). Both models can also be combined. Further revenues may be generated depending on technologies. These could be a combination of charging and parking, charging and shopping (free charging gives an incentive to go shopping/eating in nearby shops/restaurants), and advertisement as well as the gas station concept (secondary services).

4.1.3 Social Factors

Social factors are composed of the subfactors, ease of use and safety:

Ease of use: The ease of use to charge an electric vehicle is decisive to increase market penetration of electric vehicles by showing their convenience and decreasing the barriers of technology acceptance. Therefore, the whole charging

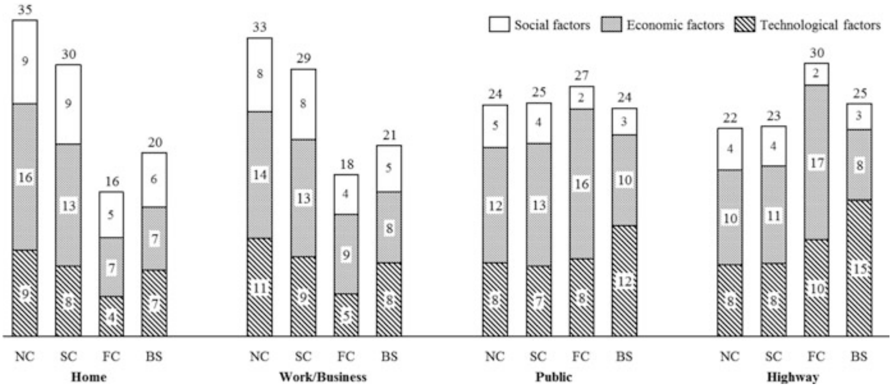

Fig. 2 Alternative utility scores for the different charging locations (rounded values)

process should be designed as convenient as possible from a consumer perspective. The charging process at a charging station involves the use of the charger and connector as well as handling the control elements (authentication/identification, billing, etc.). Control elements as well as necessary process steps differ with the studied technologies.

Safety: The different types of charging stations have to be protected from overcharging, technical shocks, vandalism, as well as accidents with the electric vehicles' battery. The intelligence and the protection mechanism, which are integrated into a charging station, are increasing with power levels in order to provide sufficient safety features. In the standard IEC 61851-1, the different charging modes are defined, and certain safety standards are determined. In addition, it is important to educate consumers on the charging process of an electric vehicle with different voltage levels in order to reduce their anxieties, especially for fast charging.

4.2 Not "One Ring to Rule Them All": Different Technologies for Different Locations

Figure 2 shows the alternative utility scores of the different charging infrastructure technologies for the respective charging location. These scores illustrate the preferences toward a charging infrastructure technology for the different locations. In the following, the results for each location are explained in detail:

Home: As shown in Fig. 2, normal charging scores 34.61 %, semifast charging 29.71 %, fast charging 15.69 %, and battery swapping 19.99 %. The three subfactors with highest priority weights are ease of use (17 %), initial and installation costs (13 %), and safety (12 %). Thus, normal charging is the superior charging infrastructure technology for home charging, followed by semifast charging. Battery swapping and fast charging are not recommendable. Normal charging is ranked best in all three aspects: technological, economic, and social.

Work/business: Normal charging scores 32.55 %, semifast charging 29.04 %, fast charging 17.62 %, and battery swapping 20.78 %. The three subfactors with highest priority weights are in this case as follows: ease of use (15 %), safety (11 %), and the degree of standardization (11 %). Hence, we recommend normal charging for the charging location work/business followed by semifast charging. Battery swapping and fast charging are not considered to be a viable option for this location. Once more, normal charging outperforms the other alternatives in all three factors technological, economic, and social, while semifast charging is always ranked second.

Public: Normal charging scores 24.80 %, semifast charging 24.88 %, fast charging 26.22 %, and battery swapping 24.10 %. Most important subfactors are revenue possibilities (20 %), charging time (16 %), and ease of use (9 %). Fast charging is ranked best in regard to economic factors as the revenue possibilities are considered to be very high and account for 20 % in this case. It can be concluded that fast charging is the most preferred option for the charging location public. However, as utility scores of other alternatives for this location are very close, we cannot give a general recommendation. Individual cases should be analyzed.

Highway: Normal charging scores 22.84 %, semifast charging 22.88 %, fast charging 29.25 %, and battery swapping 25.03 %. Most important subfactors are revenue possibilities (23 %), charging time (22 %), as well as initial and installation costs (9 %). We recommend fast charging for highway locations.

5 Conclusion and Implications

Finding the right infrastructure setup is key to leverage the huge potential of EVs. We provide a catalogue of 11 criteria to assess the technologies of normal, semifast, and fast charging as well as battery swapping. Furthermore, we developed and tested a decision framework for the selection of the most suitable technology in specific use-cases. For Europe, we found that, on the one hand, at home and workplaces, normal charging is the most suitable technology. Hence, for these locations, more expensive technologies should not be promoted by governments and advertised by manufacturers. On the other hand, in public places and for highway stations, fast charging is the most suitable technology. Thus, publicly accessible stations should offer fast charging. For all studied use-cases, our recommendation is that battery swapping stations should not be implemented.

6 Limitations and Further Research

Our study provides a decision framework for the selection of charging technologies and recommends a selection of technologies for certain use-cases in Europe. However, there are still some limitations providing avenues for further research.

First, the defined location types are still an aggregation of use-cases, which could be differentiated more precisely, e.g., depending on the income-level in home locations or depending on the branch in work/business context. Especially for public locations, further differentiation could lead to more stable recommendations. Second, we only applied the decision framework on Europe. As conditions and preferences differ around the world (e.g., varying power levels), future research could focus on other regions, followed by a comparison of technology selections. Third, our research compared the technologies of normal, semifast, and fast charging as well as battery swapping. Further research could be extended on inductive charging technologies. Fourth, we interviewed and surveyed experts as up to now market penetration of charging technologies is on a low level. Future research could directly question end users.

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Innovations in an Emerging Software Cluster

M. Arun

1 Introduction

India is home to a thriving software industry with an estimated total production of Rs. 3,012 billion (2009–2010). The industry, with its strong export orientation, has done wonders for India's foreign exchange, earning a gross export revenue of 50.1 billion USD. It has put India in the fifth place among countries that export information and communication technology (ICT) services and in the first place among non-OCED countries (UNCTAD 2009). India is also the most dynamic country in terms of software services export, going by the data on export growth between 2000 and 2007 (UNCTAD 2009).

These impressive figures notwithstanding the Indian software industry have also come in for some criticism for not being innovative and offering only low-value services (D'Costa 2002; Joseph and Harilal 2001; Heeks 1996). Researchers attribute the industry's growth to India's low wage rates, an advantage which India could soon lose in the face of stiff competition from other Asian and East European countries. Most authors, therefore, believe that for the industry to sustain its growth, it should move up the value chain with an increase in wage rate or grow quantitatively with increased labour supply which could, on the other hand, lower wages. Anything short of these strategies is expected to stunt the growth of the Indian software industry.

India's low share of software products[1] in total software and related services exports (Heeks 1996; Joseph and Harilal 2001) has been oft-cited as a sign of lack

[1] Software products are those pieces of software which provide generic functionality so that it can be useful to more than one user. Software products are made once and sold many times.

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of innovation in the industry. The export orientation of the industry and the lack of a domestic market for software are held responsible for this turnaround (D'Costa 2002; Heeks 1996). However, there are others who argue that the Indian software industry is moving up the value chain (Arora et al. 2001; Balakrishnan 2006). Their argument is based on anecdotal evidence of software products coming up in India and the enhanced capability of Indian software industry in the form of adoption of new technology and upgradation of software development processes. The emergence of embedded software development is also considered as an indication of Indian firms delivering higher value services.

Innovation in software sector need not be only in the form of new technology or products. Recently, new business models have become an important source of innovation. From software as a value add to hardware, software production has evolved into an independent specialised activity. With the evolution of technology, the business model has continued to change. This interaction between business model and technology has been a continuous source of innovation in software sector. Recently, with the emergence of free and open source software (FOSS), a range of new business strategies and licensing software has come up (Lippoldt and Stryszowski 2009), fuelling more innovation in the sector.

This chapter is structured into five sections. Section 2 summarises the research question and methodology. In Sect. 3, I briefly discuss the analytical framework used for this study and clarify some of the concepts used. Section 4 provides a background picture of the software industry in Trivandrum and an analysis of the case studies. In the concluding section, I reflect on the findings of case study and their implication for the Indian software industry.

2 Research Question and Methodology

Existing literature throws little light on innovation in the Indian software industry. Developing a micro level picture can help comprehend innovation as it manifests itself in whole of Indian software industry. Hence, I raise the following questions in the context of the emerging software cluster in Trivandrum:

- Are the software firms in the cluster innovative?
- If yes, how do they innovate?

To answer the research questions, I adopted multiple case study methods (Yin 2009) covering six firms from Trivandrum cluster. While Trivandrum has only a small share in India's overall software production, it is one of the oldest and fast growing clusters. It is a microcosm of the Indian software industry in that both are dominated by software service firms with a few large firms and several small firms. But there is a limit to this comparability. This study does not capture innovation in large firms which contribute to a bulk of India's software production. The study also leaves out multinational firms in India.

The most important challenge was in accessing information. Firms, in general, are not open about their internal operations. This study required someone at the senior management level to provide necessary information.

3 Analytical Framework

The word innovation comes from the Latin word, 'innovatus', which means 'to renew or change'. According to Joseph Schumpeter, innovation is what drives economy through a qualitative change at a historical time (Fagerberg 2005). Change brings the newness that is often associated with innovation. Schumpeter identifies five different types of innovation—(1) introduction of new products, (2) new methods of production, (3) identification of new sources of supply, (4) exploitation of new market and (5) new ways to organise business. Despite the recognition of five types of innovation, in economics literature, there is an overemphasis on the first two. For example, in OECD's Oslo Manual (OECD 2005), innovation refers to 'implemented technologically-new products and processes and significant technological improvements in products and processes'. A broad perspective of innovation as outlined by Schumpeter has been adopted for this study. The study looks at whether firms are able to bring in change within themselves and in the world around.

Innovation is nowadays considered a complex interactive process involving several actors. These actors include firms like suppliers and organisations like governments, academic institutions, users, etc. They influence and are influenced by each other. The system of innovation approach helps to understand innovation in its complexity. It is considered as a holistic and multidisciplinary approach to innovation (Edquist 2005). Lundvall who made pioneering contributions to the development of the system of innovation approach argues that, even if the approach is not sufficiently 'theoretical', it does offer itself as an analytical tool to build general and valid knowledge of causality relating to innovation (Lundvall 2010). He refers to the system of innovation as an analytical framework (see Lundvall (2007) for general process involved using this analytical framework). Along with this broad framework, I also use ideas developed in the sectoral system of innovation.

The idea of sectoral system of innovation comes out of the question, why different sectors of industry like chemical, software, machine tools, etc., differ in terms of innovation. Apart from the difference in terms of actors, institutions and interconnections, Malerba, the pioneer of this approach, brings in characteristics of knowledge and technological domain as the key differentiator for innovation in different industrial sectors (Malerba 2002). The boundary of sectoral system is determined by knowledge and technological domain, which can have national, regional and global dimensions.

3.1 Learning

Learning is the most important process in innovation. Two different modes of learning are discussed in the context of innovation—STI and DUI mode of learning (Lundvall 2010). STI learning is the learning associated with scientific and technological knowledge creation. R&D and other activities that relate to utilisation and access to knowledge are emphasised here. It is associated with exchange of explicit codified knowledge. DUI learning, on the other hand, is about learning by doing, using and interacting. It involves organisational learning, employee participation and competency building, participation in industrial networks, etc. (Jensen et al. 2007). I try to look at the role of these different learning modes in software firms in Trivandrum.

4 Software Cluster in Trivandrum

The growth of software industry was closely tied up with the growth of electronics industry in Kerala in the 1970s. Trivandrum, the capital city of Kerala, was one of the nine locations selected by the Government of India to setup software technology parks. Until 2004–2005, the software industry of Kerala was almost exclusively based in Trivandrum. Although new locations like Kochi have emerged, Trivandrum continues to be the most important hub for software industry in Kerala.

Most software firms in Trivandrum are situated in Technopark, a technology park under the government. As of November 2010, it is a host to 164 fully operational firms, which account for nearly 30,000 employees. Out of these firms, 110 are software firms and 52 are ITeS firms (2 are unknown). Two software firms, UST Global and IBS Software Services, together account for nearly 40% of the total employment (6,000 numbers each). Both firms were started by entrepreneurs from Kerala who were working abroad.

In terms of size, the industry is positively skewed. Twenty-six percent of software firms and 31% of ITeS firms are in the incubation stage with 10 or less number of employees. Four firms in software sector and two firms in ITeS sector have more than 500 employees.

More than 60% of firms were started and are owned by Indian entrepreneurs. Except for the two Indian IT majors, Infosys and Tata Elxsi, all other firms were started in Technopark by entrepreneurs from Kerala. Thirty-one percent of the firms have foreign equity. There are no important multinational firms in Kerala.

5 Case Study Analysis (Table 1)

5.1 Nature of Innovation

Table 2 summarises the case studies. Adoption of new processes and acquiring new technological capabilities are two important forms of innovation in the cluster.

Table 1 Summary of firms selected for case study

Firm	No. of employees	Year of establishment	Type of firm
NeST	1,000	1991	Embedded systems
SunTec	400	1990	Software product
QBurst	300	2004	Software service
PIT Solutions	128	2000	Software service
InApp	100	1996	Software service
Ospyn	25	2008	Software service

Source: Technopark, Trivandrum, India

Nature of innovation is also found to be linked with the challenges the firms face. Lack of skilled human resource and need for addressing attrition have forced firms to come up with innovative organisational strategies.

Economic recession has been another challenge, which forced firms to look at new markets like Japan and India itself. Some firms try to turn recession into an opportunity for itself. They recognise that by providing FOSS-based solutions over proprietary solutions, they can create new business opportunities during recession.

5.2 Systemic View of Innovation

Firms are at the core of any innovation. Figure 1 illustrates how firms linkup with other actors to create system of innovation. Based on the linkages, firms can be classified into two types. This classification interestingly correlates with the nature of work done and learning mode.

General software service companies, which represent a majority of firms, come under the first group (type 1 firm). They concentrate on DUI mode of learning and innovation. Firms like NeST, on the other hand, focus on development of new technologies either based on client needs or based on anticipated user needs (type 2 firm).

This classification also matches with the nature of knowledge these firms use. The first group deals with knowledge of business. It combines business knowledge with software technology to create software that addresses some business needs. The other group deals with scientific and technological knowledge, where it produces new scientific and technological knowledge in the form of software.

5.3 Important Actors

For all the firms, the user or the client is the most important source of innovation. Linkage with the lead user is identified to be particularly useful (Hippel 1986).

Table 2 Innovation in firms under study

Firm	Firm type	Type of innovation	Source of innovation opportunity	Knowledge source	Significance of NDA	Learning mode	Presence of formal R&D
NeST	Embedded	New technology development, HR process	Development in hardware technology	Hardware manufacturers (client), FOSS community, research organisations	Strong	STI Mode	Yes
SunTec	Software product	New features in product, HR process	New platform software technology, new business requirement	Suppliers of platform software, user community	Nil	Combination of STI and DUI	Yes
InApp	Software services	New market, new technological capabilities, new quality practices	Learning new software technology	Suppliers of platform software, FOSS community	Moderate	DUI mode	No
PIT Solutions	Software services	New technological capabilities, new quality practices	Learning new software technology	Suppliers of platform software, FOSS community	NA	DUI mode	No
QBurst	Software services	New technological capabilities, new organisational practice	Learning new software technology	Suppliers of platform software, FOSS community	Nil	DUI mode	No
Ospyn	Software services	New technological capabilities	Learning new software technology	FOSS community	Nil	DUI mode	No

Source: Own compilation

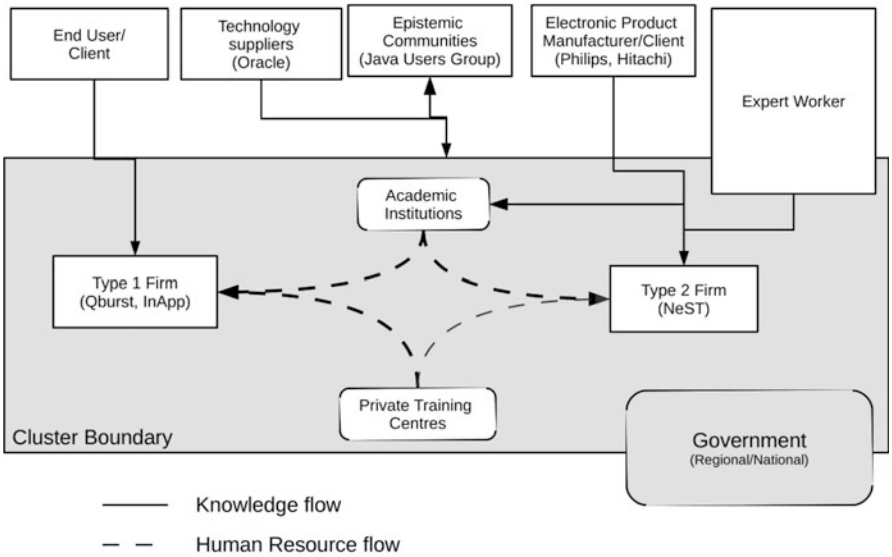

Fig. 1 Innovation system in Trivandrum software cluster

Product firms like SunTec have created user communities on the Internet which help them identify new requirements and faults in existing software. The client has been the source of technological- and process-related knowledge, particularly when the client is an intermediate user with technological capabilities of its own.

Academic institutions enter innovation process in two ways. They build human resource through educational activities and develop knowledge through research activities. For all the firms in the cluster, academic institutions like universities are a source of skilled human resource. This has been identified as the most important role of academic institutions in the innovation system.

Type 2 firms use academic institutions as sources of knowledge. Firms specialising in embedded systems like NeST have linkages with institutions like Sree Chitra Tirunal Institute for Medical Sciences & Technology (SCTIMST), College of Engineering, Trivandrum, and Centre for Development in Advanced Computing for research. They build technological and scientific knowledge collaboratively (STI learning).

Demand for human resource has spawned a large number of private training institutions. They focus on training people in specific technological skills that firms need. They fill the gap between a university level education and the industry's needs.

Expert professionals are the next set of actors who contribute independently to the innovation process of a firm. While there is a lot of discussion around reverse migration and knowledge coming back, none of the firms studied here were able to give an example of an expert coming back to the cluster with new knowledge and enhancing the innovation potential of the firm. However, many of the entrepreneurs are expert professionals who have worked outside the cluster. Interpersonal relation is another channel through which an expert professional contributes to innovation process. This has been exploited in the case of type 2 firms, where knowledge access is restricted.

Epistemic communities form a very important source of knowledge for firms in a cluster. Virtual communities in the form of mailing lists act as an important knowledge base for firms. There are communities centred around various technologies and products. Some of them are supported by supplier firms like a community of developers using a microprocessor, or they are independent like free software users group. Unlike codified and explicated knowledge that is available through knowledge bases like scientific articles, books or patents, these communities are source of what is usually considered as tacit, contextual knowledge. The firms find it easier and efficient to use these community forums to raise questions about technical challenges they face. According to a manager of a research division, these community forums are a more efficient source of knowledge than even a known peer in the cluster, as chances of getting contextually relevant knowledge is higher in forums in which professionals from different parts of the world participate. Often, they receive a response from someone who has experienced a similar challenge. In the process, a lot of contextual knowledge which is tacit gets explicated.

5.4 Open Technology and Innovation

Open technologies like web-related technologies and free and open source software have contributed significantly to innovations by firms. Open nature of knowledge and fewer cost barriers such as licensing give firms easier access to knowledge. All the firms reported to be heavy users of free software. More than 50% of NeST's projects now depend on GNU/Linux operating system, the most popular free software operating system. Firms become part of an epistemic community built around these technologies and access knowledge from it.

There is a significant concentration of firms working on web technologies in the cluster. All the generic software solution providers in the cluster work with web technologies. Most of them claim expertise in free software tools for web development. These tools vary from a simple tool to publish content on the web to software development framework to develop complex software for business needs. Availability of free software for all these needs helps firms to provide various solutions, from websites to high-value e-commerce and social networking solutions, easily and quickly. Free availability of tools helps firms to move up the value ladder. It is observed that firms start off as a simple website design company. Then, they make use of tools like content management system to provide more complex websites and slowly move to higher value solutions such as cloud-based software. From supply side, heavy concentration of firms in web technologies has to be understood from the point of view of low entry barrier with very low skill requirement, low cost of access to knowledge (open, non-proprietary knowledge base) and advanced development tools (free software) and high level of scalability from simple website to complex software (innovation potential). On the demand side, the industry has been moving more towards web-based solutions for custom software needs. Demand for services also varies considerably in its quality, from a simple website to complex software. Web has turned out to be the most important platform for software innovation in the last several years.

5.5 Learning and Related Institutions

Accessing and accumulating knowledge is one of the most important processes that go on in firms. Two important institutions that have come up in this context are non-disclosure agreements (NDAs) and FOSS licence. NDAs play a significant role in knowledge access for all firms. While the objective of NDA is to limit a firm's ability to exploit knowledge transferred to it, the case studies show that it does not achieve its objective.

Similarly, the FOSS model of open and collaborative development provides access to a wealth of knowledge which firms leverage on. Stock of knowledge openly available for appropriation enables new firms to leapfrog older firms which have accumulated knowledge.

As a source of knowledge, virtual epistemic communities have a prominent role. A lot of contextual and tacit knowledge flows through these communities. Considering the importance of tacit knowledge in production, it is important that the working of these communities is investigated more. SunTec has been able to create a community around its software, which provides inputs for innovation. It is an innovative approach to ensure continued flow of knowledge relevant for innovation from users to firms.

5.6 Global Linkages over Local

One interesting aspect that comes out in the case study is that important knowledge-related linkages of innovation are global. These include the linkage between firms and the user/market and between firms and suppliers of technology. Only a few firms have connections with other agents regionally or nationally. Hence, clusters like Technopark appear as nodes in a global system of innovation. Their linkage with national or regional actors is primarily for skilled human resource.

6 Conclusion

6.1 Innovation

The growth record of Indian software industry has proved all pessimistic observers wrong. The study of software firms in Trivandrum suggests that the industry is indeed innovative. The industry has been improving its capabilities through improvement in process, absorption of new technological capabilities and entry into new markets.

Discussions on the innovativeness of Indian software industry are often based on the assumption that creation of software products and new technological knowledge signals superior innovation. Such an assumption comes out of a narrow perspective of innovation which emphasises on technological knowledge and STI mode of learning. The micro level investigation shows that software service firms are also quite innovative and dynamic.

Literature on the Indian software industry so far has not looked into the characteristics of the knowledge base that the firms in the industry deal with. This chapter argues that there are at least two sub-sectoral systems of innovation that depend on two different knowledge base-business knowledge and technological knowledge. These sub-sectoral systems emphasise on different modes of learning and adopt different models. Further research in this direction will help to better explain the service orientation of the Indian software industry and its evolution.

6.2 Changing Pattern of Innovation

The innovation strategy of software firms has been predominantly based on learning the latest technologies, combining them with business knowledge and building solutions for specific needs of customers. It follows Schumpeter Mark II model characterised by ‘creative accumulation’. The industry is dominated by a stable core of large firms which present a significant barrier for new firms from entering. This configuration is changing with the availability of technological knowledge through FOSS and spillovers. The industry may move to Schumpeter Mark I model characterised by ‘creative destruction’ (See Malerba 2002 for discussion on this). Rather than follow technologies developed outside, the industry may build new technologies at home. The industry may come up with new products and services that address as well as create new demand. The current stable organisation of industry could be replaced by a more turbulent one, with new firms emerging with new technologies or addressing new demands.

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Innovation Management Strategy: Empirical Evidence from Indian Manufacturing Firms

Jyoti S.A. Bhat

1 Background

The importance of having a well-focused innovation management strategy to achieve a competitive edge needs no underscoring. Firms are well aware that innovation performance has a significant impact on overall firm performance. Several researchers have analysed the underlying factors that contribute towards successful management of innovation. Two sets of opposing concerns dominate, one focusing on strengthening of core capabilities for retention of business stability and the second on acquisition of new capabilities to meet change requirements (Kim and Mauborgne 2005). Despite an increased interest in reconciling continuity and change in this context, few studies have examined how to balance the two. This chapter analyses the impact of innovation management processes covering both continuity and discontinuous change-related dimensions, on innovation performance and on overall firm performance in an emerging country situation. Analysis of the Indian manufacturing industry in this context offers some interesting perspectives.

The broad rationale used in this chapter and an introduction to the basic concepts are presented in the next section. The following section delineates the approach used in the study, followed by a report on the major findings and important implications emerging from these. The final section concludes by presenting the study contributions and limitations.

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2 Innovation and Its Management

Although acknowledged widely that innovation is critically important, there is no academic consensus yet about its definition, scope, characteristics or operationalization. The definition for innovation adopted for use in this chapter is the mechanism by which firms produce new and improved products, processes and systems required for adapting to changing markets, technologies and modes of competition (National Knowledge Commission 2007).

Innovation management literature dwells on the innovation process itself: the development of new products, processes or services; and on innovation competence: the ability to develop and carry out innovative activities. Innovation management in a firm, referred to in this paper as its innovation capabilities, is a set of firm processes that influence the outcome of innovation, including the development of new products, processes or services, and improvements thereof. The outcome of innovation, referred to as innovation performance in this paper, influences the overall firm performance.

A firm needs to have ambidextrous capabilities enabling it to adapt to shifting environments to ensure continued survival and competitiveness (Birkinshaw and Gibson 2004). March's (1991) exploration-exploitation framework has explicitly brought out the importance of inculcating organizational preparedness and simultaneously implementing measures for creation of innovation capabilities. However, pursuing change and continuity simultaneously creates tensions that are fairly significant, as the goals and time horizons of these two approaches are undeniably most often quite divergent and dissimilar (Mintzberg 1994). Yet, firms that balance and reconcile these tensions effectively appear to achieve greater innovation performance and, in addition, higher firm performance (Bhat et al. 2011a).

Literature indicates that five broad categories of firm processes encompass the innovation capabilities of a firm. Each category has a number of continuity processes as well as change processes that are distinct in terms of purpose and implementation. *Technology* processes play a central role in acquiring innovation development capabilities for sustaining organization-level competitive advantage (Tushman and Anderson 1986). Technology processes are as important for the success of planned new product development as for enabling the firm to improve its response to sudden changes in the environment prompted by external technology developments (Bhat 2011). The firm's *organizational* processes are vital to promote a facilitating culture for encouraging continuous innovation and at the same time enable smooth and creative transition of skill sets in times of unanticipated change (Barney 1995). The *learning* processes are concerned with knowledge accumulation within the firm and influence its continuous improvement capabilities and its ability to create new and useful knowledge (Nonaka and Takeuchi 1995). The firm's *managerial* processes generate and strengthen the skills, knowledge and resources to implement an innovation (Teece 2007). Trott (1998) describes how interactions of the functions with the external environment, or the firm's *networking* processes, are equally as important as the interactions of the internal functions such as research and manufacturing within the organization for successful innovation management. These processes enable the firm forge effective alliances for planned activities and at the same time fall back on partnerships in times of unanticipated change. Invariably, each of these five sets of processes has both continuity and change dimensions. This surmises that innovation management in a firm largely comprises managing different *continuity* and *change* dimensions of its *technology, organization, learning, managerial and networking processes*. A firm's innovation capability is thus multifaceted, involving all these dimensions meshed in an integrated manner. Prior research offers interesting insights into the characteristics of each of these innovation management dimensions (Bhat 2010; Bhat et al. 2011a). The continuity dimensions in the case of each set of processes follow a trajectory that is quite different from that of the change dimensions, and yet, both are necessary for growth and survival of the firm. Harmonizing these tensions is a challenge but necessary to enhance innovation performance (Bhat et al. 2011a), as mentioned below:

H1: Capability of a firm to manage both continuity and change aspects of innovation will be positively related to its innovation performance.

2.1 Continuity and Change Dimensions of Technology Processes

Considering technology continuity processes related to innovation, new product development projects conceived with long-term business targets in view and implemented through accumulation of knowledge from a variety of different inputs, such as marketing, R&D and manufacturing, allow technology skills to build up gradually over time, with better understanding of customer needs (e.g. Nonaka and Takeuchi 1995). A company-wide integrated approach in this regard is especially significant. Unforeseen change prompts the need for technology processes that allow experimentation and exploration because it is impossible to tell which options are appropriate (Bhat 2005). Partnerships, even unlikely alliances, for generation of technology solutions are resorted to when change occurs. Dynamic technological capabilities enable firms to achieve superior long-term business performance (Teece 2007).

2.2 Continuity and Change Dimensions of Organization Processes

Literature on organizational continuity aspects of innovation has identified appropriate resources, and several elements of the work environment, such as organizational systems, practices and processes; use of teams and organization orientation;

champion holding a senior position and with proven leadership capability; and shared corporate platforms and functions, as drivers of innovation (e.g. Collins and Porras 1997; Bhat 2005). Mintzberg (1994) has observed that flexibility and its entrepreneurial mode are both important for innovation. This organizational strategy-making mode can provide a clear and complete vision or direction, a degree of deliberateness, and provide for integration of strategies with each other and with the environment and yet allow the flexibility to elaborate and rework the vision. Hence, both continuity and change-related organization processes matter to innovation performance (Bhat 2010; Bhat et al. 2011a).

2.3 Continuity and Change Dimensions of Learning Processes

Learning capabilities comprising communication, specialized domain knowledge, adaptability, collaboration, teamwork, planning and organizing have inter alia been identified as crucial for honing of innovation capabilities. Change-capable organizations have processes for organizational learning, benchmarking, best practices and leveraging the knowledge of customers, competitors, suppliers and partners (e.g. Leonard-Barton 1995). When dramatic changes occur that radically alter an organization's equilibrium, adequate steps to overcome organizational inertia can make the outcome favourable (Beer and Nohria 2000). Doubtless, learning processes have both continuity and change dimensions, that both cooperate and act in conflict, and yet both of which matter to innovation performance (Bhat et al. 2011c).

2.4 Continuity and Change Dimensions of Managerial Processes

Amongst managerial continuity aspects, the importance of linking technology strategy to business goals for a company to thrive has been emphasized (Barney 1995). Other critical factors include building and embedding an enduring and innovation-supportive culture, appropriate organizational mechanisms for orchestrating managerial skills and the vibrant and emphatic support by senior management (Collins and Porras 1997). Managing change comprises myriad interconnected and interdependent areas, calling for a 'proactive/intended strategy' that merges with a 'reactive/adaptive strategy' (Mintzberg 1994). Different managerial processes including use of a strategic framework, resource planning, tactics to handle varied risk situations and use of a 'shared language' for effective communication have been advocated to handle change (e.g. Tushman and Anderson 1986). There is no gainsaying that both continuity and change managerial processes are vital for innovation performance (Bhat et al. 2011b, c).

2.5 Continuity and Change Dimensions of Networking Processes

Mechanisms and technologies to support different types of knowledge discovery, capture, sharing and application systems from external sources are important. The process enables the fusion of knowledge flows between people, facilitating the knowledge transfer from person to person or from information to person (Bhat et al. 2008). Lead users, partners and even competitors can be valuable sources of innovation in an environment that supports sustained learning (von Hippel 2005). In his innovation management framework, Trott (1998) draws attention to the utmost need for interactions of the various organizational functions with the external environment, particularly the customer (Nonaka and Takeuchi 1995). External suppliers and lead users can be important conduits of knowledge, and interaction with them can be particularly beneficial (von Hippel 2005). Hence, it is difficult to deny that change and continuity aspects of networking are both necessary for innovation performance (Bhat et al. 2011a, b).

There have been many empirical studies firmly establishing that innovation performance, in itself, also markedly influences firm performance (Bhat et al. 2011b). Thus, the above continuity and change innovation management processes also positively influence firm performance, as mentioned below:

H2: Capability of a firm to manage both continuity and change aspects of innovation will be positively related to firm performance.

3 Data and Measures

This chapter uses evidence from empirical analysis based on an opinion survey of manufacturing firms in India. Data collected for the research uses cross-sectional survey methodology, involving collection of information from different manufacturing firms at a single point in time. Purposive sampling, targeting the top management (managing directors/chief executive officers or executives designated by them) of 150 Indian manufacturing firms fulfilling specific financial performance criteria, has been used. Firms covered are those with highest financial performance (basis: highest average return on total assets during 2006–2007 and 2007–2008) selected from amongst top performing Indian firms during 2008 (basis for top performance: market perception measured by highest average market capitalization in 2007–2008). The sectors covered are (1) auto/auto-components (private sector), (2) chemicals/drugs/pharmaceuticals (private sector), (3) general engineering (private sector) and (4) general engineering (public sector).

Traditionally, measures for innovation performance rely on input-related factors such as amount of R&D expenditure, R&D intensity, and number/kind of scientific/technical personnel, patents and publications. In India, these measures have not only been particularly unflattering in terms of assessing innovation capabilities of firms, but not very effective either. Patenting and publishing activity by Indian firms is nominal and does not signify the extent of innovative activities carried out by them. In fact, Indian firms have acquired the reputation of being innovative with very less resources, giving rise to the term 'frugal innovation' (The Economist 2010). Under the circumstances, we measure innovation performance of Indian firms on innovativeness (being novel), success in introduction of new products/processes/services and improvements in managerial and production processes leading to improved product/service quality and features (Bhat et al. 2010).

Financial measures such as net profit, returns on assets and operating profit margin popularly assess firm performance. However, several studies have drawn attention to the need for balancing between financial and nonfinancial measures with regard to overall firm performance (e.g. Kaplan and Norton 1996). Clear definition of innovation goals, aligning them towards organizational goals, customer satisfaction, resource availability and process quality improvements are aspects that measure firm performance (e.g. Griffin and Page 1996). Thus, we link firm performance to stakeholder (shareholder, government, employee, management, local community, government supplier and collaborator) satisfaction, resource (financial and human resource) generation capabilities, reliability (quality and timeliness) of internal processes and the extent of linkage between the innovation goals and the business goals of the firm (specificity, relevance and measurability).

The input variables are measured by drawing on the discussion presented earlier in Sect. 2 and on research undertaken in this regard (Bhat 2010; Bhat et al. 2011a). There have been directed efforts to develop a valid and reliable instrument to measure the variables under consideration effectively. The questionnaire covered 130 items. Suggestions from seven seasoned experts, comprising three academicians and four from industry, established *face validity*. Carrying out of *criterion validity* using the same set of experts ensured the questionnaire's predictive or external validity.

The questionnaire has been pilot tested on four select firms, which are a subset of the 150 sample firms. Based on the suggestions received, we carry out modifications in the language, sequencing and formatting of the questionnaire to improve its clarity before administering it to the sample firms. The questionnaires, with a request to generate a consolidated firm-level response, were directly addressed to the chief executive officers/managing directors of each of the firms and in turn been directed internally to a core team. Sixty-nine usable responses received out of the one hundred and fifty firms targeted in the survey indicate a firm response rate of 46%, which is quite satisfactory, as each firm response is in effect a distilled effort of a core team in each firm.

4 Results and Discussion

Data collected from each firm covered its strategy relating to management of innovation, as well perceptions about its innovation performance and overall firm performance, using a 7-point Likert scale (1: strongly disagree to 7: strongly agree). The *respondent firms profile* is as indicated in Table 1.

Table 1 Profile of respondent firms

Sector	Number of firms	% of total respondents
Auto and auto-components	17	24.64
Chemicals, drugs and pharmaceuticals	18	26.09
Miscellaneous	23	33.33
Public sector	11	15.94

Table 2 Summary of principal component factor analysis and reliability test results

Sr No	Variables	Cumulative % of loadings	Cronbach's alpha
	Firm performance		
1	Innovation goals	87.026	.9145
2	Innovation resources	83.954	.8054
3	Internal processes	89.829	.8822
4	Stakeholder satisfaction	78.797	.9603
	Innovation performance		
5	Innovativeness	Only one item	Only one item
6	New product/service	77.917	.8733
7	Managerial process improvements	Only one item	Only one item
8	Production process improvements	75.891	.8381
	Continuity and change capabilities		
9	Technology continuity	67.971	.8312
10	Organization continuity	81.548	.9233
11	Learning continuity	82.764	.9237
12	Managerial continuity	75.487	.8884
13	Networking continuity	63.491	.7911
14	Technology change	81.251	.9201
15	Organization change	71.076	.8611
16	Learning change	81.013	.9218
17	Managerial change	86.186	.9439
18	Networking change	75.143	.8827

Construct validation and empirical inquiry being closely aligned, principal component factor analysis was done to validate the constructs. The summary results are as presented in Table 2.

A measure possesses *construct validity* if the factor loading is greater than 50%. The cumulative percentage values of the factor loadings range between 63.491 and 89.829%; both are well above the recommended cut-off of 50%, thus justifying inclusion of all the constructs.

The summary results of Cronbach's alpha values computed to assess the reliability of the questionnaire are as reproduced in Table 2. The Cronbach's alpha values range from 0.7911 to 0.9603. Both these values being well above the accepted criterion for internal consistence of 0.701, the reliability of the constructs was established.

From the univariate analysis conducted to identify major trends, the mean values across the industry sectors are as summarized in Table 3.

Table 3 Summary results of one-way ANOVA and univariate analysis

Variables	*F*	Sig.	Industry sector means: Auto and auto-comp	Chem, drugs and pharma	General engg. – private	General engg. – public
Innovation performance						
1. *Innovativeness*	.563	.642	5.8235	6.0000	6.0435	5.6364
2. *New product/service*	1.746	.166	6.1471	6.1667	6.2174	5.5455
3. *Managerial process improvements*	.282	.838	5.9412	5.9444	6.1739	5.9091
4. *Production process improvements*	2.178	.099	5.8039	6.2407	6.2319	5.6061
Firm performance						
5. *Innovation goals*	1.555	.209	6.0000	6.0000	6.1449	5.4545
6. *Resource generation*	1.637	.189	5.8824	6.0556	6.1522	5.3636
7. *Process capabilities*	2.329	.083	5.5882	6.1389	6.0435	5.3636
8. *Stakeholder satisfaction*	.884	.454	5.7794	6.1806	6.0870	5.8409
Continuity and change capabilities						
9. *Technology continuity*	2.248	.091	5.4338	5.9144	5.8406	5.4280
10. *Organization continuity*	2.976	.038	5.5539	6.0556	6.1105	5.5189
11. *Learning continuity*	1.322	.275	5.1868	5.7444	5.6130	5.2409
12. *Managerial continuity*	1.805	.155	5.3848	5.9537	5.8967	5.4621
13. *Networking continuity*	2.153	.102	5.0809	5.7515	5.4529	5.2008
14. *Technology change*	2.928	.040	4.6667	5.6343	5.5290	5.2955
15. *Organization change*	3.044	.035	5.1299	5.7037	5.6431	4.9697
16. *Learning change*	1.830	.150	5.1544	5.7292	5.5489	5.0795
17. *Managerial change*	1.496	.224	5.2230	5.6574	5.7183	5.2045
18. *Networking change*	3.058	.034	5.1544	5.6991	5.7971	5.0227

There is no significant difference between the mean values of the variables across the industry sector groups. In order to examine the scope for using a unified approach across the entire sample, we conduct one-way analysis of variance (ANOVA) tests to identify significant differences between the sectors of industry. The significance level of all the variables is observed to be greater than 0.01 (99% significance), and the F values (observed) are lower than the F value (critical) for all the variables studied, thus establishing that there is no significant difference between the various sectors in respect of the variables being studied.

After establishing the homogenous nature of the sample, we examine the relationships between the independent and dependent variables. Firstly, we identify definitive criteria for discrimination amongst the respondent firms. For this purpose, we classify the data into two clusters using the K-means (quick cluster) test using innovation performance. This statistical analysis procedure attempts to identify relatively homogeneous groups of cases based on selected characteristics, using an algorithm that iteratively estimates the cluster means and assigns each case to the cluster for which its distance to the cluster mean is the smallest. This is necessary

Table 4 Cluster analysis results: final cluster centres ($N = 69$)

Ser.	Factors	Cluster 1	Cluster 2
	Innovation performance	5.03	6.36
1	Innovativeness	4.94	6.25
2	Innovation new product/service	5.14	6.41
3	Innovation managerial process improvement	4.89	6.41
4	Innovation production process improvement	5.13	6.35
	Firm performance	4.88	6.31
5	Firm innovation goals	5.07	6.27
6	Firm resource generation	4.69	6.37
7	Firm process capabilities	4.72	6.25
8	Firm stakeholder satisfaction	5.04	6.33
	Continuity and change capabilities		
9	Technology continuity	4.88	5.98
10	Organization continuity	5.02	6.16
11	Learning continuity	4.36	5.88
12	Managerial continuity	4.63	6.10
13	Networking continuity	4.47	5.73
14	Technology change	3.93	5.79
15	Organization change	4.41	5.78
16	Learning change	4.26	5.83
17	Managerial change	4.37	5.90
18	Networking change	4.47	5.85

to identify the innovation performance mean value that divides the data into two clusters. In the results brought out in Table 4, cluster 1 is the moderate innovation performance cluster, and cluster 2 is the high innovation performance cluster. The innovation performance mean for the moderate innovation performance cluster is 5.03 and that for the high innovation performance cluster is 6.36. Further, the means of all the continuity and change factors are lower for the moderate innovation performance cluster suggesting that all these factors under consideration are important for innovation performance. Dividing the cases into two categories after converting innovation performance into a categorical variable, we employ stepwise discriminant analysis using the new categorical variable as the grouping variable, in order to determine the factors that discriminate between these two groups.

This analysis technique is useful to build a predictive model of group membership by generating a discriminant function, based on linear combinations of the predictors that provide the best discrimination between the groups. The procedure firstly generates functions from the above sample of firms for which group membership is known and then applies these functions to the data with measurements for the predictors but unknown group membership. The predictors are selected in steps by entering those with acceptable values meeting entry and removal selection criteria. Table 5 indicates the success rate for prediction of membership of the grouping variable's categories using the discriminant function developed from the analysis.

Overall, 92.8% of the original cases are correctly classified, with 100% of moderate innovation performance firms being accurately classified and only 91.4%

Table 5 Discriminant analysis classification results

Grouping variable		Predicted group membership A	B	Total
Count	Moderate innovation performance (A)	11	0	11
	High innovation performance (B)	5	53	58
%	Moderate innovation performance (A)	100	0	100.0
	High innovation performance (B)	8.6	91.4	100.0

[a]92.8% of original grouped cases correctly classified

Table 6 Eigenvalues and Wilks' lambda values of canonical discriminant function analysis

Function	*Eigenvalue*	*% of variance*	*Cumulative %*	*Canonical correlation*
1	1.157	100.0	100.0	.732
Test of function(s)	*Wilks' lambda*	*Chi-square*	*Df*	*Sig.*
1	.464	50.726	2	.000

Table 7 Standardized canonical discriminant function coefficients

Significant predictors	Function
Managerial continuity	.539
Technology change	.576

of the high performance firms being correctly classified. The Wilks' lambda**,** used as the statistical criteria to identify the significant factors, is .464, and the eigenvalue is 1.157, revealing a fair discriminating power, as brought out in Table 6. The chi-square value and p-value (sig.) indicate that discrimination between the two groups is highly significant.

Out of the ten independent factors, technology change and managerial continuity are the significant predictors of innovation performance, as evident from the standardized canonical discriminant function coefficients presented in Table 7. Thus, aspects such as provision of alternative mechanisms for innovation implementation, multiple sources for idea generation, experimentation, strategic partnerships and effective mechanisms for new technology alerts, technology acquisition, technology transfer and spin-offs encompassing technology change and the firm's business-technology strategy link, external technology and consumer environment trend tracking efforts, top management commitment and use of effective procedures encompassing managerial continuity appear to be vital for innovation performance. Hence, both continuity and change processes matter vitally to innovation performance.

Table 8 lists the pooled within-groups correlations between the factors and standardized canonical discriminant functions ordered by absolute size of correlation within the function. The table reveals the inter se importance of the remaining factors. Managerial change, learning change, learning continuity, networking change, organization continuity, organization change, technology continuity and networking continuity in descending order of importance influence innovation performance. Further, it is observed that the correlations amongst the factors are not very divergent (highest .904 and lowest .681), signifying that both continuity and change factors

Table 8 Structure matrix

Variable	Function
Technology change	.904
Managerial continuity	.889
Managerial change	.792
Learning change	.778
Learning continuity	.774
Networking change	.726
Organization continuity	.714
Organization change	.707
Technology continuity	.689
Networking continuity	.681

influence innovation performance. Evidently, focus on only one set of factors would lead to diminished innovation performance, thus confirming the hypothesis H1 set out to be tested.

Next, the predictors for overall firm performance have been determined by repeating the above cluster analysis and discriminant analysis procedures after including the innovation performance factors amongst the input variables tested. Innovation performance and technology continuity (standardized canonical discriminant function coefficients of .574 and .571, respectively) have been identified as the significant predictors. Once again, the correlations (maximum .925, minimum .687) amongst the input factors (continuity, change and innovation performance-related) were not divergent. Thus, it emerges that a holistic focus by a firm on managing both continuity and change dimensions of innovation matters to its overall performance captured in the dimensions studied, confirming hypothesis H2. Besides, keeping in view that technology change and managerial continuity influence innovation performance significantly, it is established that technology change, managerial continuity and technology continuity have preeminent roles of in respect of firm performance.

These results may be viewed in the context of the environment prevalent in most emerging countries. Firms in such countries, in general, do not spend exorbitantly on R&D, exceptions apart. Systems for technology appropriation have also evolved very differently in these countries in keeping with their culture, ethos and prevailing requirements. Yet, the pressure to compete, and not merely survive, but also grow in the face of strong domestic and global competition, has made innovation an imperative. The focus on both technology change and technology continuity by firms that have been successful in using innovation to improve performance brings out the importance accorded by them to technology-related processes. The significance of managerial continuity implies that top management commitment, setting specific innovation targets and implementation of effective management systems are vital to perpetuate growth. Whilst the inter se priority amongst the continuity and change-related innovation management processes derived pertain only to Indian manufacturing companies in specific areas of activity, these are likely to be the same across all sectors, as validated by the ANOVA results. These findings have important implications for all emerging countries with similar high innovation potential and with similar environments.

5 Conclusions

The major contribution of this chapter is the analysis of innovation performance in an emerging country situation, where the measures for innovation performance are different from other more established economies. The analysis has revealed that Indian manufacturing industry has been giving due importance to innovation. Focus of innovation is more on new product development as well as on product and process improvements and less in terms of conventionally referred indicators such as patents or publications. Homogeneity of the Indian manufacturing industry has been established in respect of innovation management strategy. Discriminant analysis has yielded the key predictors of a firm's innovation performance to be related to *technology change* processes in terms of providing for options, strategic partnerships, technology alert mechanisms and well-aligned technology acquisition and transfer mechanisms and *managerial continuity processes relating to* business-technology strategy link, external environment trend tracking, top management commitment and effective routines and procedures. These processes, together with *technology continuity* processes encompassing those concerned with customer-oriented new product development, company-wide innovation, efficient idea sourcing and flexible operations, are significant predictors of overall firm performance. Thus, convergence of continuity and change dimensions of managing innovation leads to higher innovation performance and enhanced overall firm performance has been established, and an innovation strategy direction that firms may adopt whilst prioritizing performance concerns is suggested.

One limitation needs to be mentioned. The research has focused on select sectors of the Indian manufacturing industry with particular financial performance yardsticks, and the conclusions are universalized based on statistical tests at 99% confidence level. These results may hence need verification across other sectors and in other emerging country situations.

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Rethinking the Management of Technological Innovations, Product Complexity and Modularity: The Effects of Low-Probability, High-Impact Events on Automotive Supply Chains

Adrian E. Coronado Mondragon and Christian E. Coronado Mondragon

1 Introduction

Modularity has delivered multiple benefits such as the introduction of postponement and the effective management of complexity to various industry sectors. In the automotive sector, the management of technological innovations using modularity to provide customized products can be seen in the use of complex electronic components such as microcontroller units (MCUs) to support a large number of vehicle applications. In this case, specialized suppliers and not original equipment manufacturers (OEMs) are behind the development of MCUs and other complex automotive components. This shift represents a well-known value migration from the final product manufacturer to component suppliers, the result of the former's outsourcing decisions and the pursuit of platforms by the latter (Sako 2011). Furthermore, OEMs in the auto sector have deployed lean principles to run the supply chains of complex automotive components such as MCUs.

The increasing use of modules that depend on complex automotive components such as MCUs has its roots in the use of a modular architecture, the controller area network (CAN) which was originally designed to enable MCUs to communicate with each other (Wright 2011), hence making possible to connect additional devices as further technological developments take place. In modern vehicles anywhere from 30 to over 100, MCUs are used to control everything from electronic parking brakes, pre-crash seat belts and engine control units to onboard entertainment systems, stability control and power steering (*Automotive News*, April 8 2011c).

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Extreme situations such as Black Swans which are low-probability, high-impact events like the earthquake/tsunami disaster that hit Japan in March 2011 or the floods that took place in Thailand during the summer of 2011 can seriously disrupt the operation of automotive supply chains, as the sources of innovation for modular architectures located within the firms supplying highly engineered components like MCUs prove to be irreplaceable or very difficult to copy/imitate. Black Swans, as defined by Taleb (2007, xxiii), are events with 'rarity, extreme impact and retrospective (though not prospective) predictability'. The Japan earthquake and subsequent tidal wave or tsunami of March 2011 have been labelled as a Black Swan for the global auto industry (*Automotive News*, March 30 2011a; *Yahoo News*, March 30 2011) as it has affected not only the Japanese industry and economy, but its ramifications are felt everywhere in today's integrated global supply chains. Few months later, disaster struck again as supply chain disruptions resulted from the floods that hit Thailand in 2011.

In the aftermath of Japan's earthquake/tsunami and the Thai floods, numerous voices have indicated the need for the global auto industry to rethink how it sets up its supply lines, as there might be some cracks, some inefficiencies and some unplanned-for problems in the global supply system (*Automotive News*, March 30 2011a). Furthermore, practitioners recognize that the industry may have consolidated its suppliers too much; it may have exceeded sharing parts across too many models and may have built regional models with global parts, which means lines going down for cars that do not sell anywhere else (*Automotive News*, March 30 2011a). However, there have been practitioners asking manufacturers not to move away from lean inventory and just-in-time delivery and production processes, even in the wake of a number of well-documented disasters this year that have hit the automotive supply chain (*Automotive Logistics Magazine*, November 2011).

Given the evolution of events in 2011, this chapter makes an argument for the need to rethink the management of technological innovations, product complexity and modularity in order to mitigate the negative effects caused by Black Swans in automotive supply chains. Following on Sako's (2011) suggestion that a product manufacturer can regain control of its supply chain by reshaping its industry and developing an ecosystem of providers engaged in complementary innovation, this chapter revisits the principles of 'supplier parks' addressed in Coronado Mondragon and Lyons (2008). This chapter presents the case of the supply chain of an MCU-based module used in powertrain applications. A network of semiconductor fabrication facilities or 'fabs' in combination with the principles of the supplier park model is presented as an alternate configuration that can be used to mitigate the effects of the Black Swan in automotive supply chains.

2 Modularity, Technological Innovations and Product Complexity

Modularity has delivered multiple benefits to several sectors, and the automotive is no exception. The adoption of modularization gives the opportunity to handle mass customization and impact customer satisfaction, especially for products with high

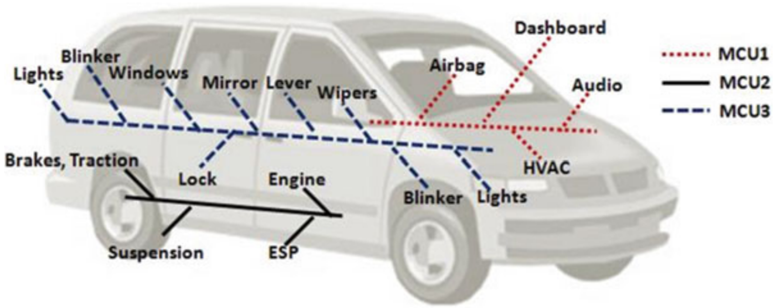

Fig. 1 Simple illustration of the applications of automotive *MCU*s in modern passenger vehicles

innovation content like today's passenger vehicles. Under a modular product architecture, platform products normally have a fixed number of modules with customization being achieved through variant modules to choose among a set of given module options (Huang et al. 2007).

A simple representation of the use of MCUs to control various applications in modern passenger vehicles is shown in Fig. 1. In this illustrative example, three MCUs are used to control some key vehicle systems. MCU_1 is used to control the audio systems, the dashboard and panel of instruments, heating/air conditioning and the airbags; MCU_2 is used for the purpose of controlling the engine module, electronic stability programme (ESP), traction, suspension and brakes, and MCU_3 is used to control the lights, blinker, wipers, lever, electric mirrors, windows and locking/entry system. Modern passenger cars from basic compact models to luxury high-performance models have electronic control units (ECUs).

MCUs are specialized parts with a high content of proprietary technology. The degree of complexity of key components such as MCUs represents a formidable challenge in case of disruptions from a Black Swan. *Automotive News* (April 4 2011b) reported that for raw materials and some components, automakers can make the switch fairly swiftly. Replacing electronics and other highly engineered parts – already in short supply before the March quake-tsunami – takes substantially more time. The next section presents the disruption to the supply chain of MCUs and discusses relevant work that has been undertaken related to addressing supply chain risk.

3 Review of Research on Supply Chain Disruptions

In the automotive sector, OEMs and their suppliers have fully embraced the principles of lean thinking in their operations, from vehicle assembly to the supply chain of the most critical modules and components used to build a vehicle. The trend towards lean supply chains might result in low inventories achieved by close collaboration with customers and suppliers, but this leads to high vulnerability

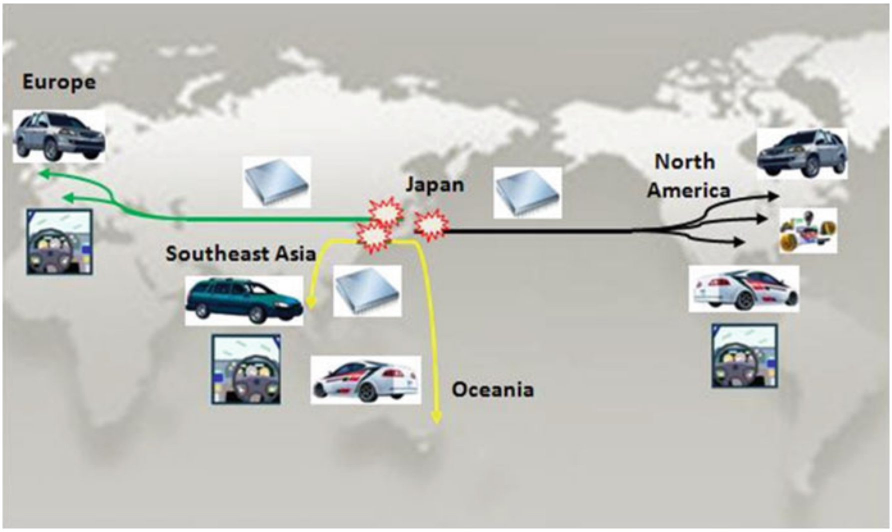

Fig. 2 Disruptions to the global supply chain of *MCU*s made in Japan

since turbulences in the supply chain can barely be compensated without safety stocks (Thun and Hoenig 2011).

The Black Swans represented by the earthquake/tsunami and floods of the year 2011 confirm that one of the major shortcomings of the lean thinking philosophy is the lack of recovery plans in case of disruptions to the supply of components, especially when these components are complex and difficult to replace. For this reason, numerous academics and practitioners have indicated the importance of successfully handling disruptions from natural catastrophes. Altay and Ramirez (2010) highlight that it has become imperative to better understand how catastrophes affect global supply chains. The researchers state that reasons to support this include the compelling evidence that the frequency and intensity of natural disasters are increasing (Altay 2008). Indeed, the earthquake/tsunami of Japan and the floods in Thailand show how severe this situation has become, especially when looking at the disruptions to the supply of specialized components with proprietary technology such as MCUs. Figure 2 depicts the disruptions to the global supply chain of MCUs made in Japan and more particularly to the situation experienced by Renesas and the first-tier suppliers and OEMs that use its line of products. Renesas, the largest manufacturer of MCUs with a global market share of 41%, concentrates about 90% of its global capacity in Japan (*Automotive News*, April 13 2011d), which means that production of MCUs at its Japanese sites was severely disrupted, and as a direct consequence, Japanese vehicle assembly plants and numerous facilities around the world have to idle production.

The extent of the scale of the problem has been truly colossal. Ohnsmann et al. (2011) report that Japanese automaker's such as Toyota Motor Corp and Honda Motor Co. plans to operate their factories overtime to recover production lost to parts shortages caused by Japan's earthquake may be delayed until early 2012 because of the floods experienced in Thailand. Ohnsmann et al. (2011) state that Toyota, Asia's biggest carmaker, had to scale back output in Japan for a third week and suspended overtime in North America for a second week as disruptions from the floods spread. Also affected, Honda had to temporarily eliminate overtime and run North American plants at half capacity until Japan's third-largest automaker finished assessing its inventory. In early November 2011, Toyota's plants in the USA and Canada were forced to suspend overtime and Saturday output, with reduced production affecting facilities in South Africa, Indonesia, Philippines, Vietnam, Pakistan and Malaysia.

The disruption to the supply chain of MCUs has raised questions on the long-term viability of lean policies in a global scale. Wagner and Bode (2006) highlight that a number of scholars have recognized that modern supply chain management initiatives have great potential to make operations leaner and/or more agile in a stable environment but simultaneously amplify the fragility of supply chains. Fragility becomes evident in the aftermath of the Black Swan. The researchers suggest the assumption that the more complex the interactions and the tighter coupled the supply chain, the more prone the supply chain is to unexpected, untoward events. In fact, academics in the literature have recognized that significant negative impact on organizations can result from failure to manage supply chain risks effectively. Khan and Burnes (2007) state that negative impacts include financial losses, reduction in product quality, damage to assets and loss of reputation. Identified consequences of disruptions to the supply chain might include financial losses, a negative corporate image or a bad reputation eventually accompanied by a loss in demand as well as damages in security and health (Juttner et al. 2003). Thun and Hoenig (2011) highlight that lean management approaches prove to be very efficient and seem to be indispensible in order to be competitive in the automotive industry, but they bear the risk of making supply chains vulnerable.

4 Supply Chain Configurations to Mitigate the Impact of Black Swans

Slowly, auto OEMs have started to recover from the disruptions to their supply chain operations. However, some of the immediate solutions considered by affected OEMs like Toyota (to prevent a repeat of what happened after the disaster) include a request for suppliers of complex electronic components like MCUs to hold additional months of inventory (*Automotive News*, September 6, 2011e). Toyota's demands contradict lean manufacturing principles that have been widely promoted and adopted in the auto industry, not to mention the high cost that such move might represent. *Automotive Logistics Magazine* (November 2011) reports that Toyota is establishing a system to track bottlenecks down to the second tier, especially for complex components, by instilling a need for disaster prevention and response methods throughout the tier levels and by creating safety stock. However, according to the same publication, carmakers' efforts were not enough to keep a sufficient level of inventory during the Thai floods.

Richter (2011) reports that Renesas whose operations were hampered by earthquake damage in Japan sees industry moving away from the obsession with lean inventories and low cost and more towards a policy that recognizes the alternate costs that they would incur if they had to stop producing. The way to recovery by Renesas, as discussed by Murray (2011), highlights that throughout the recovery period, the company communicated with customers around the world, calling many of them on a daily basis and giving them real-time updates on the rebuilding of the 'fab'. The author reports that the company pulled parts from inventory wherever possible and provided similar 'superset' microcontrollers when direct replacements were not available. In some cases, they also shifted manufacturing from one of their most damaged production sites to so-called dual fabs in Singapore and Taiwan. It is important to highlight that the manufacturing process for MCUs has a long lead time; this means that it can take up to 2 months to manufacture a batch of MCUs (*Automotive News*, April 8 2011c).

In the aftermath of the earthquake/tsunami, Renesas created a continuity plan (Murray 2011; Renesas 2011) comprising of three key strategies:

(a) Keeping inventory ready, which is about maintaining a healthy inventory to recover from a natural disaster, as the tendency is to let inventory drop.
(b) Partner with customers, this involves adopting a 'multi-fab' strategy that would make possible to shift manufacturing to another factory. When dealing with customers who want application-specific integrated circuits, the strategy for Renesas is to work with them to build masks for these types of circuits at an alternative 'fab', hence becoming 'fab-ready'.
(c) Establish a risk strategy, the company tells its customers where their devices fit within a three-level risk strategy. The first levels involve having 'multi-fabs' to supply devices in 3 months, the second level is about having the 'fab-ready' strategy and in case customers are employing an older fabrication process which is the third level, Renesas will make inventory available in advance.

After reviewing the strategy adopted by Renesas, the leading manufacturer of MCUs for automotive use, it becomes evident the fact that the strategy adopted does not contemplate the relocation of production facilities/'fabs' outside Japan, which at present concentrates 90% of the company's global capacity. The argument here is that it would make sense to spread the risk of impact of the next Black Swan by relocating MCU 'fabs' near first-tier production facilities which sometimes happen to be in close geographic proximity to OEM vehicle assembly plants. The supplier park is a concept which has been around for a while, and it has been widely adopted in European vehicle manufacturing sites. The VW group, Ford Europe, GM Europe and PSA Peugeot-Citroën have developed supplier parks around their European vehicle assembly plants. Therefore, the above facts might support the definition of the research objective, which is to compare the convenience of adopting the

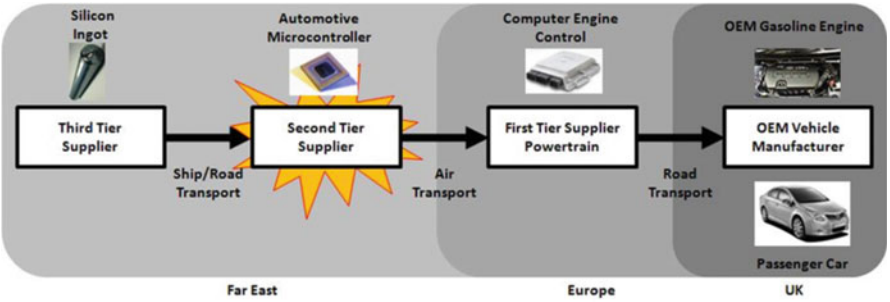

Fig. 3 Disruption to the supply chain of *MCU*s for powertrain applications with second-tier supplier located in the Far East

characteristics of the supplier park model into a 'multi-fab' strategy to spread the impact of Black Swans. The research question might read like this:

– How would it compare a 'multi-fab' strategy that still concentrates most of its global capacity in one country against a 'multi-fab' strategy that incorporates elements of the supplier park model?

The next section discusses the characteristics of the supplier park model and presents the illustrative case of the supply chain of MCUs used for powertrain applications for an Asian vehicle manufacturer with production in Europe.

5 'Multi-Fab' Strategy for MCUs and Supplier Parks

Coronado Mondragon and Lyons (2008) highlight that organizations have acknowledged the importance of synchronizing the flow of material in the supply chain which relies heavily on the reliable delivery of components. In the automotive industry, synchronized sequenced production has its origins in just-in-time (JIT) deliveries. Furthermore, the geographic proximity of suppliers to the OEM can be seen as a structural mechanism for integrating supply chains. This concept is not new as Tetu (1998) postulated that companies have to see themselves as part of the whole chain and accept the need to achieve a global optimum. Figure 3 depicts the illustrative case for a commonly found supply chain arrangement for powertrain modules involving the manufacturing and shipping of MCUs components from the Far East to first-tier suppliers located in Europe. Those first-tier suppliers supply modules using the MCUs shipped from the Far East in this case Japan to OEM vehicle assembly plants located in various countries within Europe, in this case the UK. Figure 3 highlights the effect of the Black Swan represented by the earthquake/tsunami that hit Japan on the second-tier supplier which is the manufacturer of MCUs.

In the illustrative case depicted in Fig. 3, the UK-based OEM passenger vehicle assembly plant manufactures 137,054 vehicles out of a total capacity of 170,000.

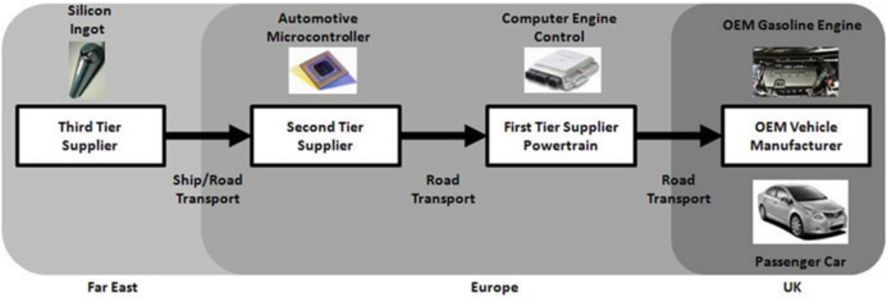

Fig. 4 Supply chain of *MCU*s for powertrain applications with second-tier supplier relocated to Europe

The car with the greatest volume accounts for an annual volume of 72,740 units, a daily output of 285 cars. The first-tier manufacturer of powertrain modules is based in Spain. The MCU-based powertrain modules are used in three vehicle configurations that include a 1.8-l gasoline engine manufactured in the UK and two diesel engines, 2.0 and 2.2 l manufactured in Eastern Europe. A key element that has been successfully managed by most vehicle manufacturers is schedule stability through better information sharing. Indeed, greater stability in the vehicle manufacturer schedule is critical for reliable schedule and deliveries by upstream suppliers. For years, first-tier suppliers serving several OEMs have acknowledged that Japanese vehicle manufacturers are efficient at producing stable schedules. Figure 4 illustrates a suggested reconfiguration of the supply chain of MCUs for powertrain applications where the schedule stability from the OEM facilitates making decisions such as relocating the MCU 'fab' outside Japan/Far East to Europe and hence closer to customers.

Relocating a 'fab' is expensive, added to the fact that production lead time of MCUs is long; the production process requires clean conditions and a source of power that is long and uninterrupted. However, 'fab' relocation meets the new conditions set by the industry who is calling for a more diverse sourcing strategy (*Automotive Logistics Magazine*, November 2011). Relocation meets sourcing strategy requirements for both OEMs and first-tier suppliers as a 'fab' gets closer to their production sites but also for the manufacturer of MCUs, as the diversification of production locations mitigates the impact of future Black Swans. There are also implications in terms of costs reduction as air freight (both reduction of energy consumption and emission of greenhouse gases) is replaced by road transport.

Figure 5 illustrates the supply network that may result from the combination of the 'multi-fab' strategy with the inherent characteristics of the supplier park arrangement. In its current form, the 'multi-fab' strategy means that it would make possible to shift manufacturing to another factory. That works fine within a country where it is possible to link wafer manufacturing with assembly and tests sites and shift manufacturing based on demand needs. But rather than confining the entire network to the geography of a country and region, in this case Japan and the Far East, the network must be able to relocate one or more of its nodes outside its

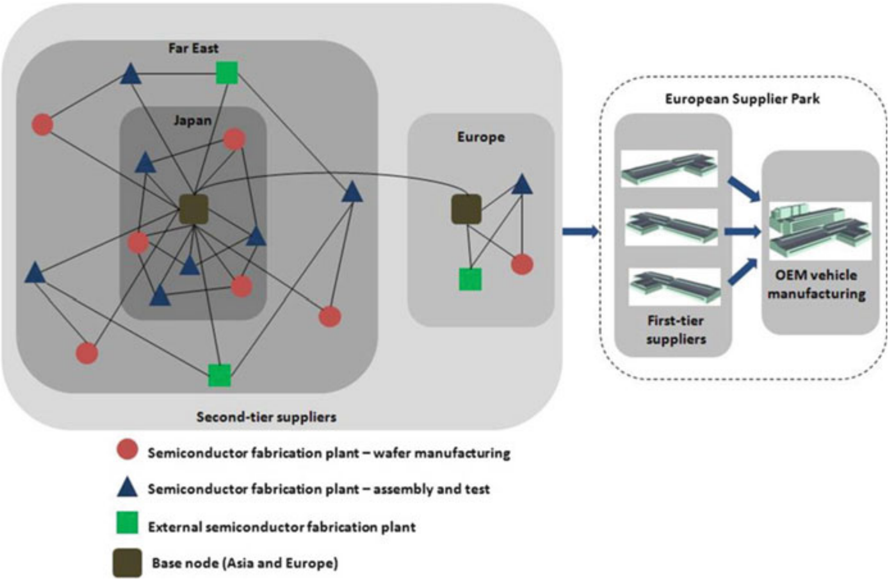

Fig. 5 Proposed network configuration for the second-tier supplier manufacturer of *MCU*s serving a European supplier park location

original geography, hence creating a base node that is still 'fab-ready' with wafer manufacturing, assembly and test capabilities. The relocation move depicted in Fig. 5 might represent benefits in terms of diversification for the MCU manufacturer itself. The European node facilities of the second-tier supplier (MCU manufacturer) should be close enough to support deliveries to a supplier park configuration and still benefit from OEM and first-tier supplier's schedule stability. By having diversified production sites with 'multi-fab' capabilities, the MCU manufacturer may be in a better condition to mitigate disruptions of the next Black Swan.

6 Conclusions and Future Research

The Black Swans represented by the natural disasters of 2011 have pushed organizations to rethink the management of technological innovations, product complexity and modularity based on the capacity of the Black Swan to disrupt supply chains. In the automotive industry, the disruption to the supply chains of complex components that are difficult to replace has forced companies to review their supply chain strategies without disclosing any details to the public. The truth is that well-known production models such as supplier parks and its underlying principles based on information sharing, schedule stability, geographic proximity, time windows for delivery and offset times control are fundamental to mitigate the disruptions caused by the Black Swan. Process flexibility, high levels of responsiveness and reliable vehicle manufacturing plans resulting in schedule stability are nothing new but also important to overcome future Black Swans.

In the supplier park model, several first-tier suppliers of critical modules that make use of MCUs such as computer engine controls, instrument panels and dashboards, infotainment and HVAC, among others, have dedicated substantial resources to build facilities that are in close distance from the OEM vehicle assembly plant. Hence, it may seem as a logical step for the second-tier/MCU manufacturer to have a site that is close to the supplier park. The 'multi-fab' strategy based on a network linking wafer manufacturing with assembly and tests sites capable of shifting manufacturing faces severe limitations against the Black Swan as long as the network is confined to a country or region. In order to mitigate the effects of the Black Swan, the 'multi-fab' strategy needs to consider relocating one or more of its nodes outside its original geography, hence creating a base node that is still 'fab-ready' (comprising of wafer manufacturing, assembly and test capabilities) and relatively close to first-tier suppliers and OEMs which may be operating using the supplier park model.

The supply chain of MCU-based modules used in the automotive industry is a truly multi-tier supply chain. Hence, supply chain strategic plans designed to mitigate the disruptions by the Black Swans will have to consider trust between suppliers and customers which is an area that could be explored in the light of Black Swans affecting global supply chains.

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Part 2.5
Technology Nurturing

Enhancing and Leveraging Potential for Innovation

V. Kovaichelvan

1 Background

India is an emerging economy that offers abundant business opportunities in a highly competitive environment. Indian companies are required to compete with global players who have sound business models, matured business processes, core competences and strong brand equity. Indian organizations have to build scale and sustainable competitive advantage in order to effectively compete and grow not only India but also in the global markets. Profitable business growth can be achieved only through innovative products and services. This is even more important in the automotive industry, where the author is working in. The Indian automotive industry is highly competitive and dynamic with innovation being driven by customers, competition and legislation. Hence, automotive organizations always strive to enhance their capacity for innovation by aligning their talent management process to this goal. Talent management process starts with hiring the right engineers at entry level, then developing their competencies and creating the right environment for innovation.

2 Capacity for Innovation

Krishnan (2010) emphasizes the need for innovation in India as the needs of Indian customers are different from that of customers in other parts of the world. Indian organizations have to close large gaps in their performance with reference to their counterparts from developed nations. Cost advantages tend to erode with time and hence Indian companies have to innovate to build sustainable competitive advantage.

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Krishnan (2010) points out that the countries such as Japan and South Korea have become major industrial powers in the world by innovation.

Krishnan and Prahalad (2008) in their book *The New Age of Innovation* explains two principles for innovation. The first one is $N = 1$ which means that the individual is at the heart of the experience. With the locus of value shifting from products and services to experience, value creation must focus on individual consumers. This approach requires focus on flexibility, quality, cost, customer interface and scalability. The second principle is $R = G$ which refers to the approach of understanding the nature of the response base of large firms and learning how to access high-quality resources at low cost. This principle covers access to resources, speed, scalability and innovation arbitrage. This would require a different set of capabilities.

As per Krishnan (2010), some of the requirements to build capacity for innovation include transformation of large private companies and creating an incentive system for institutions of higher learning that is more consistent with the strengthening of industrial innovation capabilities. The Indian automotive industry is dominated by multinational companies from Japan, Korea, the USA and Europe. These companies have built capacity for innovation in their respective countries with experienced people and excellent infrastructure. Only a few Indian companies focus on innovation, and even they face several constraints both internal and external. The emergence of IT and ITES sector has led to proliferation of engineering education institutions in the country. Unfortunately, the quality of engineering education has been steadily deteriorating. This sector not only hires engineers from computer science and IT branches but also from core branches such as mechanical, electrical and electronics.

Design, development and manufacture of automotive products require a strong foundation in domain knowledge and continuous learning to keep pace with rapid technological developments. As the most students are assured of placement in the IT and ITES sector, they focus more on clearing examinations and securing a placement without acquiring in-depth domain knowledge and skills. Given this scenario, most companies are required to offer foundation courses and on-the-job training to acquaint the engineers with fundamental knowledge and skills and make them fit for contributing to the innovation process. It takes 2–3 years to get the engineers fully functional in their roles especially in design and development. Engineers depend only on in-company training programmes and experience to acquire competence. They do not invest adequate time for continuous learning required to enhance their potential for higher responsibilities and challenges and hence capacity for innovation.

3 Defining Potential

Research shows that organizations that successfully identify and develop high-potential talent will enjoy short- and long-term advantages over their competitors. The reality is that it is difficult to identify high-potential talent and ensure that they live

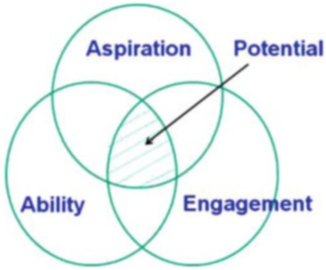


Fig. 1 Potential of employees

up to expectations. The Corporate Leadership Council has been doing pioneering work on strategies that build employee potential. Of the more than 300 strategies, programmes and interventions examined in this study, fewer than 80 truly build employee potential.

Based on the quantitative research, Corporate Leadership Council (2005) recommends a framework to identify high-potential employees and develop them to realize their full potential. They define a high-potential employee as someone with the ability, engagement, and aspiration to rise to and succeed in more senior and critical positions (shown in Fig. 1). Ability of an employee is determined by innate ability which is part of their core personality and learned skills are acquired through formal and informal learning. Engagement is about how an employee is governed by four factors such as rational commitment, emotional commitment, discretionary efforts and intent to stay on with the job/organization. Aspiration is advancement, recognition, financial rewards and overall enjoyment one seeks to achieve in their life or career.

4 Challenges in Aligning Careers with Potential

As discussed earlier, the reality in India is that a large proportion of students who join engineering courses are driven by parental aspirations or peer group influences rather than their own aspirations based on their innate abilities. Hence, the discipline of the courses they choose, the interests they pursue and the organizations and roles they opt for do not lead to enhancing or leveraging their potential. Many of them are not fully engaged during their studies, career and life, and in the process, they do not learn the skills that are required to excel in their studies, current and future roles.

There are not enough scientific methods to determine innate abilities and career counselling to choose the right courses and careers. Parents and students go by the opportunities available for immediate placement rather than a long-term career. Those who have a better alignment of their jobs with their innate ability and have clear aspirations do excel in their studies and career. Others take the jobs that come on their way, and they neither make adequate progress in their career nor contribute their best to their organizations.

The author is engaged in an experiment with a polytechnic and an engineering college where students are assessed for their innate abilities, oriented to set right aspirations aligned with their innate abilities, created opportunities to engage and learn the knowledge and skills towards not only their current role but enhance their potential for future roles.

5 Assessing Innate Abilities

One of the most popular and widely referred reference works on competency is Spencer and Spencer (1993). According to the authors, "Competency is an underlying characteristic of an individual that is causally related to criterion—referenced, effective and/or superior performance in a job or situation". They list the following five types of competency characteristics in their work as shown in Fig. 2.

Motives: The thing a person consistently thinks about or wants that cause action
Traits: Physical characteristics and consistent responses to situations or information
Self-concept: A person's attitude values or self-image
Knowledge: Information a person has in specific content areas
Skill: Ability to perform a certain physical or mental task

Surface level knowledge and skill competencies are relatively easy to assess and develop through education and training. Motive and trait competencies are more difficult to assess and to develop which is equivalent to the innate ability mentioned in the CLC research. Spencer and Spencer (1993) recommend that organizations should assess motives and trait competencies as the basis for selection and teach the knowledge and skills required to do specific jobs.

The author along with a team of an applied psychologist and line managers identified the motives and trait competencies for three benchmarked roles in his organization. The ideas have been sourced from the above-mentioned trait theory and adapted to the requirement and relevance of the author's organization. A few examples of trait include rigour, sociability and idea orientation; abstract reasoning and examples of motives include achievement and affiliation.

The identified traits and motives were defined for better understanding and assessment. For example, sociability includes five factors such as inclusion, belongingness, intimacy, collaboration and empathy: inclusion—paying attention to a person and treating him as important; belongingness—willingness to join others on tasks particularly in challenging situations; intimacy—interpersonal openness, being close and affectionate; collaboration—supporting and complimenting, adding value; empathy—sensing the difficulties of others, concern for others' difficulties and being in the shoes of others. Abstract reasoning includes four factors such as synthesizing, correlating, and theorizing and recognizing patterns and generalizing for application. Each of these factors is defined in terms of behaviours which can be observed and measured.

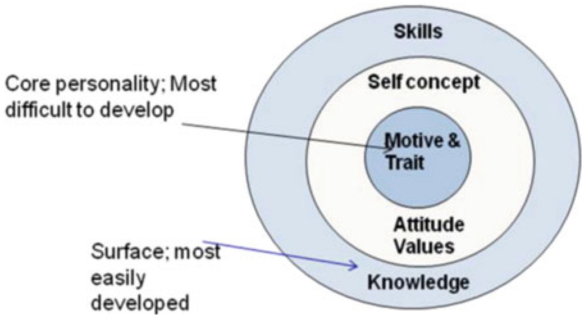


Fig. 2 Characteristics of competency

Traits and motives and their levels required for a few key roles in research and development (R&D), production engineering (PED) and manufacturing operations (operations) are established. Three levels for trait and motive include high (H), medium (M) and low (L). For example, for CAD/design engineers in R&D, the identified traits and motives are rigour(H), sociability(M), idea orientation(H), abstract reasoning(H), flexibility(M) and achievement(H), and for team/group leader, the identified traits and motives were rigour(H), sociability(H), influencing(H), urgency(H) and achievement(H) and affiliation(H).

Assessment of motives and traits is a very challenging task. Traits and motives are tracked from the behavioural manifestations or cognitive responses to hypothetical situations framed in a questionnaire, individual tasks, group tasks and behavioural event interviews (BEI). Behaviourally anchored rating scales (BARS) are used to measure each of the trait or motive. One or more tools measure each of the selected traits and motives. Many of the assessment activities are performed by the candidates individually, while a few activities are performed in a group. Assessors are trained on how to observe the candidates during the activities and to assign scores as per guidelines. The duration for each activity was fixed based on the target group. While all the individual and group activities are conducted over a day, a separate day is dedicated for conducting BEI.

This framework was initially applied for selection of students in the polytechnic and engineering college based on their innate abilities and later utilized for deciding their roles. (Table 1: Selection and role fitment using traits and motive) shows the final output of trait and motive scores and the roles the candidates are most suited for. It can be seen that some candidates are found to have fitment for more than one role.

6 Engaging to Learn the Skills

The author has benchmarked several universities in the USA and UK who follow competency-based education framework. In these universities, engineering programmes have clearly articulated programme objectives. Further, the content of the courses and pedagogies are aligned to deliver the programme objectives.

Table 1 Selection and role fitment using traits and motive

S. NO	Name	RIGOUR	SOCIABILITY	ABSTACT REASONING	IDEA ORIENTATION	FLEXIBILITY	URENTLY	INFLUENCIN	ACHIVEMENT	AFFILIATION	CAD Engineer	Proving engineer	Team Leader
1	AAAA	1.00	0.79	1.00	0.65	0.89	0.91	0.74	1.00	1.00		PED	
2	BBBB	0.90	1.00	1.00	0.82	1.00	0.81	0.80	0.89	1.00	CAD	PED	TL
3	DDDD	0.96	0.78	1.00	0.62	0.89	0.82	0.79	1.00	1.00		PED	TL
4	EEEE	0.96	0.90	1.00	0.75	1.00	1.00	0.85	1.00	1.00	CAD	PED	TL
5	FFFF	0.94	0.74	0.95	0.82	0.89	0.94	0.68	0.78	0.88	CAD	PED	
6	GGGG	0.81	0.78	0.85	0.96	0.89	0.92	0.78	0.89	0.88		PED	
7	HHH	0.86	0.81	0.95	0.68	0.78	0.81	0.91	0.89	1.00			TL

There is a good balance between lectures for knowledge and understanding and tutorials for acquiring the skills. In addition, hands-on live projects involving design, manufacturing and testing have become integral part of the engineering programme right from first year and not just in final year. There is also an emphasis on multidisciplinary awareness both in terms of the choice of courses and projects. The programmes not only prepare the students for the immediate roles but provide perspectives, learnability and professional development required for future roles.

While a great deal of the school education in India is oriented to rote learning, engineering is all about understanding and application in order to design, manufacture and service products. Towards this, the author studied the Bloom's taxonomy framework described in *A Taxonomy for Learning, Teaching, and Assessment* by (Anderson et al. 2001) based on research carried out on cognitive and knowledge dimensions of learning. Anderson et al. (2001) explains that there are six dimensions of cognitive learning such as remember, understand, apply, analyse, evaluate and create. These six dimensions represent cognitive complexity; that is, "understand" is believed to be more cognitively complex than "remember". "Apply" is believed to be more cognitively complex than "understand" and so on. The knowledge dimension contains four categories: factual, conceptual, procedural and metacognitive. These categories are assumed to lie along a continuum from concrete (factual) to abstract (metacognitive).

In addition to Bloom taxonomy, another methodology that is useful for developing competency-based education is instructional design methodology. Learning objectives can be delivered through a structured design of instructions, activities and projects. In this regard, Gagné et al. (2005) have presented a detailed approach to instructional design.

According to Gagné et al. (2005), instruction facilitates learning when it supports the internal events of information processing. Instructions are external events that must align with internal events to support internal learning processes. Gagné et al. (2005) list five domains of capabilities. They include *intellectual skills* which are to do with symbols, like putting things into categories, applying rules and principles and solving problems; *cognitive strategies* that govern the individual's own learning, remembering and thinking behaviour which are developed with experience; *verbal information* that are the facts organized stored in the learner's memory which provide learners with structure or foundation upon which to build other skills; *attitudes* that amplify an individual's positive or negative reaction to some person, thing or situation; and lastly *motor skills* that underlie performances whose outcomes are reflected in the rapidity, accuracy, force or smoothness of body movements.

An effective learning process must address most of the above capabilities. It is not enough to concentrate the instruction on any one or two of these capabilities. Based on the benchmarking of engineering education, Bloom taxonomy, instructional design methodology and the author's experience in developing competency-based education programmes in-house, detailed process steps were established for competency-based engineering education programme.

First, programme objectives relating to functional competencies for the undergraduate programme in mechanical engineering were defined as follows: At the end of the programme, students will:

1. Apply scientific principles and concepts relating to development of products and processes
2. Design and develop products and processes that deliver requirements of the target customer group and related quality functions
3. Use modelling and simulation to analyse systems' behaviour and optimize for results
4. Demonstrate working level understanding and appreciation of interdisciplinary domains that are required for design of products and processes
5. Check the design for DFX—assembly, manufacture, cost, quality and reliability, serviceability, recyclability, environment, ergonomics, etc.
6. Choose appropriate quality tools and techniques for problem solving
7. Understand industrial and business environment in which the enterprise operates

Similarly behavioural objectives are defined for the programme.

After the programme objectives were identified, objectives for each of the courses were articulated by a team of faculty from the institution and subject matter experts from the author's organization. Next, the content for teaching was mapped to the course objectives using instructional design methodology. Appropriate teaching/learning methodologies were selected based on the knowledge and cognitive dimension of the course objectives. Some sample methodologies used are indicated in Table 2: Teaching/learning methodologies. The review of the content was conducted by team of experts. Once the content development stage was completed, trainers or teachers who would handle the class were oriented with the content and methodology. Then a pilot is conducted and review is carried out to make necessary improvements prior to regular delivery of the programme.

Evaluation of learning was carried out using assignments, continuous assessment tests and examinations with weightages for each Bloom categories. Based on the weightages, the types of questions and number of questions are decided. A comprehensive question paper is prepared using these guidelines. After each test and examination, an analysis is made to understand how the whole class had performed and how each individual student has performed. Then assignable causes—such as content not adequate, teaching methodology not appropriate etc.—and appropriate actions are initiated.

Two streams of specialization are planned, namely, design and manufacturing with electives appropriate to the streams. Internships are organized in the industry during every vacation, aligned to the competencies of the specific roles for which they are being groomed. During the last semester, projects are designed to learn and demonstrate their competencies and to confirm their role readiness.

The first batch of engineers from the polytechnic has been assigned to three functions, namely, R&D, PED and operations under managers handpicked to mentor and coach them. Periodic reviews are conducted by the author with the managers and students. At the end of the projects, formal reviews are conducted to

Table 2 Teaching/learning methodologies

Knowledge dimension	Cognitive process dimension					
	Retention	Transfer				
	Remember Recall State Define	Understand Explain Describe Interpret	Apply Solve Apply Practice	Analyze Compare Contrast Deduce	Evaluate Choose Justify Appraise	Create Design Compose Formulate
Factual (basics of a subject, unquestioning facts)	Repeat in the class, use PPT and photos	Describe using video and use QBD	Exercises, solving problems	Individual and group exercises/activities in class and in the workplace	Individual and group exercises/activities in class involving comparison of result and against standards	Multi disciplinary projects
Conceptual (classification models, concepts)	Lecture—verbal representation, pictorial representation (PPT, photos, video), write on black/white board	Explanation with good and bad examples, use of photos and videos, case study discussion, derive on black/white board	Participant solving problems/exercises, individual and group exercises	Individual and group exercise/activities in class and in gemba	Individual and group exercises in class and in gemba involving comparison against a standard	Multi-disciplinary projects
Procedural (specific techniques, general techniques, how to choose which technique)	Flow chart bullet points, 1, 2, 3, steps, demonstration of steps	Flow chart, bullet points with explanation, demonstration of steps by faculty with cause and effect explanation, if, then chart, solve problem on white/black board	Participant solving problem/exercises, demonstration, activity or post learning project by participant, role play, individual/group exercise	Individual and group exercise/activities in class and in gemba, case study	Individual and group exercise/activities in class and in gemba against a standard, choice, case study	Multi-disciplinary projects, Producing a design/object against a goal

verify if the students have learnt the competencies and are able to execute the projects effectively following the standard operating procedures (SOP) and achieving the outcome. A formal viva was conducted by a panel of head of the department of the polytechnic, senior managers from corporate. It was found that most of them were able to accomplish more than 70% ready for the target roles. Along with their managers, a review is carried out with the managers and faculty to identify actions for improvement in the next cycle.

7 Aspiration

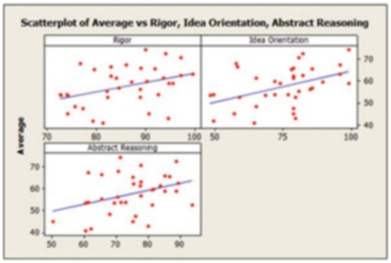
As mentioned earlier, most students opt for engineering are driven by parental aspirations or peer group influence. It is important that the students have their own aspiration or a goal for themselves. CLC defines aspiration as advancement, recognition, financial rewards and overall enjoyment one seeks to achieve in their life or career. Towards this, Frankl (2006) in his book *Man's Search for Meaning* emphasizes the necessity of finding meaning in life even in adverse situations. Ulrich and Ulrich (2010) say that "The Why of Work refers to the human search for meaning that finds its way into our offices and factories, a search that motivates, inspires, and defines us. Humans are meaning-making machines who find inherent value in making sense out of life. The meaning we create can make life feel rich and full regardless of our external circumstances or give us the courage to change our external circumstances. Employees who find meaning at work are more competent, committed and contributing". All these references clearly emphasizes the need for meaning, purpose and goals which can drive people to engage, learn the competencies and realize what they aspire.

Workshops were conducted for first batch of students in the engineering college and entry level engineers to create awareness about himself/herself on realities of self and life-path, develop perspectives on own professional self and set personal goals and align his/her career with it. This workshop used interactive activity-based learning experiences which helps the engineers to make their own choices without regrets. It is planned to share the output of the workshop with the managers, the first batch of engineers. A mentoring and coaching workshop is planned for the managers to help them acquire the skills for formal mentoring and coaching.

8 Validation of Innate Ability to Students' Performance

The author has carried out a hypothesis test to validate the alignment of diploma students' trait level to their academic performance. For example, engineers identified for design role are required to possess traits such as abstract reasoning, idea orientation and rigour at a higher level compared to roles in other functions. Trait scores and academic performance of two batches of 35 diploma students are

Table 3 Relationship Plot - Trait score vs Average marks



Test score	
Rigor	0.386 0.022
Idea orientation	0.439 0.008
Abstract reasoning	0.360 0.034

used for this testing. The outcome of the test shows that "with 95% confidence, the students with better trait score, obtained 10 marks higher compared with other students with t-value of 2.07".

This approach of selecting engineers based on the innate ability is applied for campus recruitment of graduate engineers. On their joining the company, a foundation test is carried out covering students selected from several institutes across the country. An analysis was carried out to check the relationship between trait scores and scores in the foundation test. It is found that P value <0.05 and hence the data is significant and there is a positive correlation with scores for three traits (Table 3).

The author is planning to refine this model further to improve the correlation by two-pronged approach. First is to improve the accuracy of assessment of trait through a qualification of observers and interview panel members through a formal workshop and assessment. Second is to evaluate students identified for design using their performance on higher Bloom level questions in the design-related courses and in the project work. Eventually, the author is planning to carry out this validation by assessing the potential of engineers in their entry level and next role.

9 Conclusion and Way Forward

This approach comprising both focused selection and development of engineers has shown significant difference in the way the students are motivated, actively engaged, taking ownership for learning and ready to take on challenges. Most of the students for this programme come from rural backgrounds and are the first-generation students getting into vocational or professional education. They lack language skills as they have done their schooling through Tamil medium, and most of their parents are not educated and cannot guide them through their education and career. Despite these constraints, the programme was able to provide competence for entry level role.

For realizing full potential of the programme, it is necessary to raise the bar for performance continuously. The author is planning to monitor and review each batch of engineers for 2 years along with their managers. In addition, they have to engage in continuous learning to enhance their potential further to prepare themselves for future roles. Towards this, competency-based education and training framework are introduced in the organization to enable the engineers to continuously learn the new skills for future roles. Towards equipping the managers, programmes are planned to provide skills to coach and mentor the engineers. This is likely to be a long and exciting journey for human excellence.

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A Soft Technology for Effective Enactive Management

Osvaldo García de la Cerda and Alejandro Salazar Salazar

1 Introduction

The task of every administrator can be understood as taking care of the human activity system for which he is responsible. This task is made complex when we see the accelerated rate of change in industry, markets, product lifetime, international competition, quality, costs, and the sophistication of the products and services that they require (Bullinger et al. 1995; Nudurupati et al. 2011).

Historically, the tools and methodologies created for administration have faced a reductionism problem associated with the human beings that constitute the organization. Therefore, these tools have deficiencies when considering that it is possible to establish an objective representation that is adequate to the problem situations, without including considerations of the human beings that operate the developed models. In this sense, it can be seen that there is dissatisfaction of the administrators because at the time of applying them, they do not see the real advantages of their use, and this idea is reinforced by the research of Tangen (2004), who finds strong criticism by the users and researchers of the many platforms and mechanisms developed for management control.

These human beings, acting in their role as administrators, arise as observers in the experience of being aware of themselves, of what they do, and of the possible consequences of what they do (Maturana 2008), accounting for their different emotional states through self-observation, generating structural interactions and couplings in the language (Maturana and Varela 1987), and forming conversational networks that become complex systems whose participants have the ability of operating individually as autonomous agents and influencing others (Garcia and Saavedra 2011).

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In that sense, the CLEHES ontological tool has been created, which allows the configuration of an observer capable of distinguishing and characterizing the mode of being of human beings, of their interactions, and of the networks that they constitute, from six constitutive and interlinked dimensions: Body (*C*uerpo in Spanish)–*L*anguage–*E*motions–*H*istory–*E*ros–*S*ilence (García and Saavedra 2006; García 2009). Each dimension of CLEHES is a domain from which human beings observe and operate in the interactions moving around in the social scenario, opening and closing conversations, triggering or resolving conflict situations, building networks, and participating or inhibiting their participation according to their way of interpreting the world. These dimensions configure micro- and multi-identities as they are observed in human beings moment by moment, in their community or organization.

This tool is considered as a technology because it brings repertoires of distinction to the body and creates practices. This is supported by the observation of human beings that constitute organizations as a unit and as a complex activity system, that belong to relations networks, that reflect on themselves, that know and learn in action, that also have a designing ability in the conversations in which they participate, and that can change, if desired, their way of operating, taking charge of the consequences that it implies.

Aware of this complexity, an enactive approach to administration has been prepared aimed at providing distinctions and practice to those in charge of management so that they can attenuate the complexity that is configured from human activity systems. Enactive management arises to offer a particular view of management as the explicative undertones of what is human and their implications in the way in which not only the administrators, but all persons, see themselves and others.

2 Enactive Management

A particular approach of management organizations is based on the proposal that the science of enaction gives to the cognition phenomenon (Varela et al. 1992; Masciotra et al. 2007; Stewart et al. 2010), which among its main ideas states that a living organism "enacts" its effective action and embodies it in the world, in that way constituting its perception and therefore its cognition, so that the basic ability of human cognitive systems is not only the manipulation of symbols or the processing of information but being in the world (Shanon 2010), thereby creating the world in which it exists (Maturana 1987).

Different observers express that enaction in its conception delivers an alternative view of what is stated by the classical theories of cognition, as is the case with the representationalist line, which state the existence of objective entities in the real world, independent of the observer, and where cognition is understood in terms of perceiving, processing, and acting on information (McGee 2005) and it is also understood as a computation over mental representations at the same time that the cognizing subject is not committed with the world but is conceived as a distant neutral observer (Engel 2010). Varela expresses that enaction is not the representation of a pregiven world by a pregiven mind but is rather the enactment of a world and a mind on the basis of a history of actions that a being in the world performs (Varela et al. 1992). Therefore, the world arises from how we move, touch, breathe, feel, and respond to others, i.e., from our living experience.

What is particular about enaction is the embodiment of the world, where the body that we have influences how we think, placing cognition in the interaction of the body and the world (Hutchins 2010). Enaction is then the idea that an organism creates its own experience through action, so it is not a passive receiver of inputs from the surroundings, but it is action in itself, and just as experience is formed will be how they act.

Enactive management states that the administrator takes the place of the observer and choreographer of viability. In this sense, he is continually generating meanings in the interaction with other human beings, in combination with the histories, experiences, expectations, thoughts, and humor with which he embodies those interactions (Di Paolo et al. 2010), bringing out a spectrum of concepts not seen under the previous paradigm, which are those involved with the human factor, i.e., we no longer have a set of tasks to direct, but human beings and their interactions, emotions, and expectations appear (García and Mendoza 2011).

CLEHES is the main tool of enactive management. As an ontological tool, it allows human beings to be characterized in those dimensions that make up their identity, where by means of self-observation, observation of the interactions and of the networks that we constitute allows self-learning and learning from others, attenuating organizational complexity (García 2009). In this sense, an organization can be characterized as a network of CLEHES coupled by means of language interactions, in turn forming conversational networks. These networks make it possible to evaluate the coherence with respect to the actions of the human beings in the organization, constructing the realities perceived by the observer responsible for its care in the different organizational domains and contexts. Therefore, managing these networks requires conversational and communicational distinctions that trigger and support them, from their primary activities and from each of the organizational subsystems.

Enactive management is concerned with those performance elements that arise from human beings, moment by moment, from their interactions, and from the networks that constitute them, using tools that allow or facilitate the design of the strategic conversations oriented to action and performance. In this sense, administrators must be capable of abandoning the linear view of the organizations in their operation in the day-by-day urgency, to take position in a platform of reflexive observation in terms of the pursuits of the human activity system and its operation.

3 The Technology

What will be proposed here is a soft technology that makes it possible to configure distinctions that can be used to trigger strategic organizational conversations in a learning system of the actors oriented at survival and viability, giving rise to that we call effectiveness. A particular strategy consists of four nonlinear steps that will be explained below.

3.1 Configuration of the Attention Focus

Configuring the attention focus is to have clarity about the situation with which the administrator is faced. This is a conversational process that is carried out by the actors of the process, consisting in the observation and self-observation of their own current operation, as well as looking at the organization's context and current situation. In this process, the administrators/observers should be capable of knowing and understanding how the CLEHES that constitute the organization, system, or subsystem are related.

The observed situation provides a combination of circumstances in which the administrator will be at some point in time, and he must generate effective actions that allow him to keep the organizational viability. In this sense, it is possible to observe the inseparable relation between the person and its acts by means of which the administrator places himself and the situation that "acts" on the person (Masciotra et al. 2007), the situation being an emergency that results from the relation between the administrator's personal conditions, his ability for observation, the distinctions that he has in his CLEHES, and the conditions of the surroundings.

The intervention of the actors to allow the configuration of an attention focus with an organizational sense takes place at this stage of the methodology, allowing the characterization of the actors involved, as well as generating the maps of the conversational networks that they constitute. However, the importance of configuring the *focus* is not only to characterize the relevant actors for the organizational performance but also to map the conversations, existing and missing, that affect the performance of the system and the people.

3.2 Critical Enactive Factors

We state that a critical enactive factor (CEF) is a contextual determinant attributed by an observer or a system of observers that allows the design of conversations for the conservation or transformation of the human activity system and from there triggers both the required structural transformations and adjustments in behavior, generating embodied learning in persons. This configuration allows constituting and observing the system as a dynamic learning metasystem.

CEFs emerge from the self-observation that administrators carried out on the components of their CLEHES and from observation, in terms of CLEHES, of both the interactions in which administrators participate and the organizational networks to which they belong. These CEFs must be considered as a design space that allows opening or closing of some organizational conversations starting at the focus configured by the administrator. To identify them, a set of enactive technologies supported on CLEHES are used in order to facilitate self-observation and the observation of the organization in different contexts and domains (García and Saavedra 2006, 2011; García 2009; García and Laulié 2010; García and Orellana 2008).

The CEFs are configured as states, elements, relationships, conversations, or measurements oriented at achievement which appear relevant moment by moment, and they are seen as constructors of observation, self-observation, and enaction spaces for human beings. In particular, the CEFs are related with reflection and awareness spaces with respect to the performance of the system under care and with the operational deficiencies that affect viability in the future.

The set of CEFs generated could include measurable elements and nonquantifiable elements that result from the multiple interactions of human beings that have great incidence in organizations. Thus, what is essential in critical enactive factors is that they allow the design of the missing conversations and their constituent actors oriented at the action to improve the organizational performance and their learning.

3.3 Cognitive References

When the critical enactive factors have been declared, it is necessary to be able to evaluate whether the observer's expectations are being met or it is necessary to generate structural adjustments. With respect to the cognitive references within the enactive context, they arise as a consequence of enacting the situations; they are supported by common sense and are stored in the form of experience, helping the observer or administrator to have the possibility of knowing the system under care.

The design of cognitive references, measurements, and indicators through data treatment for the generation of information allows coupling the systems to the CLEHES. This brings about an observer that learns from distinctions, which enacts according to its practices, constituting the learning system.

Every time an expectation is or is not fulfilled, different emotionalities are generated that affect the CLEHES of the administrators, establishing their action space possibilities and configuring design spaces that allow making the decision of generating changes in the system because every decision making comes from a human being that is ontologically erotic emotional (García and Mendoza 2011). In this sense, organizational achievement arises when group individual achievements in the language are coordinated (García and Laulié 2010), creating action insofar as the participation of others is promoted and holding them responsible for the actions they perform (García and Mendoza 2011).

3.4 Support on Soft–Hard Technologies

The use of technologies in a human sense can be conceived as the ability to constitute different psychic and emotional states in the body; in this approach, we can say that technology should be conceived from the perspective of touching and altering the perceptions, generating distinctions which, expressed in language and associated with the experience (history) of human beings, allow people to act in a particular domain. In enactive management, the emphasis lies in the effectiveness of the action.

Communicational and conversational technologies of observation and self-observation allow conflictive situations in organizations to be attenuated or dissolved, as well as to make changes and adjustments in the observers, to configure freedom and autonomy spaces in operational, strategic, and political aspects.

The use of hard–soft technologies can be understood as a way of facilitating the incorporation of distinctions and practices as part of the learning process of human beings and their ability to trigger different emotional states. When the practices become transparent to the persons, they become part of their embodiment (Espejo and Reyes 2011), allowing them to be used effectively in the search for organizational solutions.

4 Enactive Experiences

Two of the more significant experiences with top executives in charge all the way from small companies to large corporations will be discussed in what follows.

4.1 Enactive Experience A

This process was enacted by the executives of a software company in an insolvency situation. In the focus stage, laboratory sessions took place in which the executives brought up from their *H*istory the organizational pains that were affecting them. Starting from there and after various self-observation exercises on organizational actions, the following conversation was observed, triggered by the CEO's expression: "We are not doing the correct things." This sentence, together with data on drops in sales and profits, led the sales manager to express her resentment against the CEO due to unrecognized previous commitments and the programming manager to express his doubts and fears on the deadlines and costs that they would not be able to fulfill.

Observing the interaction of the executives, a characterization was made of their CLEHES, showing that they not only spoke a different language, but in view of their previous learning history, they were also responding in a different way to commitments, were not paying the same attention to their efficiency and effectiveness numbers, and were not assuming emotionally the necessary authority, and loyalties played a fundamental role in personal covering up, neglecting organizational meaning. Different perceptions with respect to the motives had triggered the problem situation, responsibilities were avoided, and the lack of communication and coordination among the executives of the sales and implementation areas in situations that required joint work was made clear. Credibility, broken trust, and professional ego problems had caused this breakage that inhibited conversations on organizational performance, setting off a list of organizational pains that affected all the workers.

Work sessions and workshops with observation protocols on the interactions of the executives allowed changing the observer in terms of judgments, complaints, resentments, and denials, focusing on their conversational breakages, changes, and conservation. The enactive silence in states of reflection and positioning their body consciously in the various organizational problem situations opened up new conversations between the group of executives. A list of organizational pains that could be seen as important design spaces were related to organizational structure, efficiency, missing conversations, and lack of leadership skills, which were then dealt with through educational activities and soft methodologies such as automatic writing, creating poems, songs, and storytelling, among others.

Structural adjustments of the CLEHES of the actors involved in the various organizational conversations allowed the configuration of new CEFs such as the mood of the personnel and the executives themselves when facing high uncertainty situations, as well as the enactive silence spaces when reflecting on the right things. The missing conversations and coordination between the executives were enacted, trust among the different actors of the process was repaired, and, something very important, in view of the lack of leadership skills of the CEO himself to allow him to direct the organizational transformation process, an educational program to support the management in soft technologies was designed. These transformations have allowed those executives to remain in their positions, grow, and develop.

4.2 Enactive Experience B

The second enactive experience that will be shared corresponds to a large mining corporation, its human groups in charge of production and sales, and its CEO. The intervention focused on the tension seen by the CEO between the sales executives and those in charge of production. The former, seeing themselves as a strategic group of a corporation that is a leader in the world's copper market, had a very high self-esteem because they belonged to a group with a higher organizational status, and they were mainly concerned with the fulfillment of the production plans and the production schedules to ensure that the clients would receive the product on the agreed dates.

The above triggered negative effects in the emotional state of the persons because they saw the arrogance with which the group of executives was acting, as well as in their ability to understand production: only from the perspective of the amount produced, without including costs. The silence areas were therefore characterized with respect to the inhibited production conversations, and it was discovered that cost was not considered to be a relevant CEF. There were different mines, with different production and transport costs, and different product quality, i.e., each mine had its own map of cognitive references, while the executives only recognized the aspects related to product quality.

When the executives were confronted in self-observation workshops with these areas of silence with respect to their work, they stated that it was not important to set costs as a reference because the whole production would be sold anyway. This denial indicated that the executives were assuming that there was no organizational learning related with knowing the costs, and at the same time, it constituted an excuse for not incorporating new conversations to reflection on the strategy of sales and relation with the clients in terms of differentiation between products that until then had been treated homogeneously.

The design, using soft technologies in CLEHES, became apparent in the following way: at first, it was centered on three stages. First, self-observation of the *H*istory that characterized the human group and allowed knowing its *L*anguages, its competencies acquired enactively, and its *E*motions and moods with respect to their role in the organization; second, observation of the interactions and causes of their arrogance by pretending to know what they did not know specifically with respect to production, which was verified by their conversational absence; and third, observation of the networks, confrontation with a *S*ilence area means establishing the organizational damage to performance, its costs, and its justification. Mitigation of the damage required establishing a new organizational distribution of the *B*odies (*C*uerpos) and renewing the conversations in which the persons participate, giving rise to an enactive organizational transformation.

With respect to the new CEFs and their cognitive references, information on costs was structured to produce a reflection on the relation between the sales strategy and the organization's performance. This reflection put in evidence the cognitive shortsightedness of the sales group, generating conditions to modify the relations between sales and production. This process was generated by means of the creation of management indicators in an "enactive map" format that changed the conversational dynamics of those who make up the organization. The conversations were focused on the performance of people at all levels, who started interacting from an enactive observer, embodying the CEFs and their cognitive references, and making them part of their new daily practices, their bodily arrangements, and the desires of each of the constituents in managing this learning process.

5 Learnings and Final Remarks

Current experience and evidence show increasing dissatisfaction among administrators in terms of the results generated by the present tools to administer the complexity of organizations. It is stated that such dissatisfaction has been the consequence of limited attention and education of the actors in their structural coupling with the human system, and this situation is the main source of all organizational pains.

In this sense, enactive management emerges as a complementary view in management, placing at the center of its study the human being and its ontology in its role as an administrator. CLEHES allows the administrator to generate action and enaction in multiple domains, configuring an important strategic design space to attenuate the pains, ruptures, and breakages characteristic of human activity systems, particularly in top management.

Critical enactive factors are configured as strategic elements for performance in different organizational domains and contexts that allow, first, to become aware of the organizational inhibitions of performance, and second, to design the missing conversations oriented at action to improve performance and incentivizing an embodied organizational learning. In this sense, self-awareness emerges as the central element of the critical enactive factors in personal terms because from observation and self-observation, they lead to taking responsibility for the organizational aspects of daily practice. The above results in making adjustments in the structure and the conversational networks within the organization.

The organizational intervention processes allowed making a number of important changes within the organizations that were studied. On the one hand, important adjustments were generated in their structure and in their reference performance systems, and on the other hand, successful changes were achieved in the types of conversations and in the relational dynamics of the constituents by generating changes in the observers that configured the managers, executives, and CEOs. This is the main factor that makes it possible to evaluate the success or failure of the applications.

The application of soft technologies and the delivery of distinctions in enactive management and its CLEHES tool allowed the administrators to configure qualified observers with greater autonomy when facing organizational situations problem, in addition to a greater capacity for solving conflicts. This movement of the observer, from a linear view in terms of input–output to a correction of his own mistakes and questioning the actions of his operation, has constituted the learning system in the administrators, which is an important process in the care of the human activity system.

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The Evolution of the Production Function: Transition to the "Value Creation Cube"

Moira Scerri and Renu Agarwal

1 Introduction

Natural resources (e.g. land, labour and capital) all contribute to production in varying proportions. Changes in the proportions, and the way in which they contribute, have occurred over many decades. A number of scholars and government reports concur that reliance on physical resources have declined, replaced by intangible factors such as knowledge and information (Australian Government 2007; Stam 2007). Toffler (1981) views the shift as occurring in three waves with the first being the domestication of mankind and the move from hunter and nomad to farmer and land owner. The second wave refers to the industrial revolution with the third focusing on the technetronic age, knowledge work, demassification, and diversity as the preferred operational methods (Toffler 1981). Therefore, we accept the role of historical time in relation to industrial dynamics and organisational theory and endeavour to understand the impacts and measures of value creation in today's organisations.

This chapter is theoretical in nature, follows the evolution of production in the context of developed nations and is developed in four stages. We begin with the industrial economy, then incorporating the service- and knowledge-based economy, followed by the creative economy before concluding with the rationale for the development of the Value Creation Cube (VCC) framework. At each stage, we examine the work of scholars whose contributions aid in clarifying the transitions to a more productive- and knowledge-dependent economy.

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2 Industrial Economy

The characteristics of the industrial economy introduced and described by Frederick Taylor (1911) through his time and motion studies are standardisation, specialisation, synchronisation, concentration, maximisation and centralisation. These were later extended by the introduction of the scientific management of production theory (Stam 2007). Taylor worked on the premise that there was one best method to perform any task and established a set of principles to illustrate this phenomenon (Stam 2007). Underpinning these principles was the division of labour (Fischer and Sirianni 1994; Stam 2007) where managers were seen as intellectually superior to employees and, therefore, having responsibility to supervise and organise their own work. This included the responsibility for selecting, training and developing employee skills. Furthering Taylor's viewpoint, Stam (2007) saw the employee contribution as primarily physical in nature and an extension of machines where tasks are performed in unison, routinely, and in a set sequence. Henceforth, efficiency experts popularised Taylor's viewpoint on the importance of management (Fischer and Sirianni 1994).

Over time, scientific study of the workplace continued and moved away from the mechanical aspects of work towards the inclusion of behavioural and motivational factors (Campion and Thayer 1987). In this context, Hackman and Oldfield's Job Design Theory and Job Characteristic Model make a significant contribution. The three classic variables are the employees psychological state and effects on motivation, job characteristics that affect the psychological state of the individual and employee attributes which show the effects and responses to complex and challenging jobs. In this context, Hackman and Oldham provide five components relating to the core job dimensions which affect employee motivation – namely, skill variety, task identity, task significance, autonomy and lastly feedback. Using a five-point Likert scale, a motivational potential score (MPS) matrix is determined, wherein a near-zero score in skills variety, task identity or task significance will not affect the overall score, whereas a near-zero score in autonomy or feedback will affect the overall MPS. Next, we examine the operations and marketing literature to show how contributions from this field shaped the transition to the service- and knowledge-based economy.

3 Service- and Knowledge-Based Economy

In this section, we provide details on both the overlay of manufacturing models to the service domain and where the service domain takes on its own area of study devoid of a manufacturing.

Whilst the definition of services has been cumulative and variable, it was not until Vargo and Lusch (2004) rejected the goods dominant (GD) logic that a breakthrough occurred in the understanding of services. Vargo and Lush defined services as *the application of competencies, knowledge and skills for the benefit of* *another party* (Vargo and Lusch 2004, 2008). Sampson and Frohle's (2006) Unified Service Theory (UST) extends this on the foundation that customer input is *a necessary and sufficient condition to define a production process as a service process* (Sampson and Froehle 2006, p. 331). More recently, Spoher and Maglio (2008) provide a more holistic and systemic view, after which Agarwal and Selen (2011, p. 1169) define services system as *the application of competencies (knowledge, skills and experience) of the stakeholders, whereby customers provide themselves, or provide significant inputs into the service production process and in the best case are transformed by the simultaneous consumption – the experience* which integrates key service characteristics and symptoms of services, along with partnerships, knowledge, skills and experience. After accepting the service system views, we look at the contributions arising from service marketing and operations literature.

Schmenner (1986) derived the Service Process Matrix (SPM) from the Product Process Matrix which described factor operations in relation to production with the horizontal axis (*X*-axis) representing the *degree of customer interaction and customisation* and the vertical axis (*Y*-axis) as the *degree of labour intensity*, being the ratio of labour costs to plant and equipment (Schmenner 1986). Subsequently, Schmenner (1994) overlayed a manufacturing framework to services and applied the Theory of Swift Even Flow to operations of service businesses which states that *productivity increases as the speed of materials (or information) increases and variability decreases* (Schmenner 1994, p. 102). Schmenner's (1986) framework shows four operating models: Service Factory (SF), Mass Services (MS), Service Shop (SS) and Professional Services (PS). In response to criticism of Schmenner's (1986) SPM, dimensions of the axis were amended with the *Y*-axis renamed as the degree of relative throughput which relates to the speed of operations and the *X*-axis represents the degree of variability, whilst still referring to the interface between the customer and the organisation (Schmenner 2004) added with the notion of the productivity diagonal as shown in Fig. 1 (Schmenner 1994).

A number of limitations existed with this model, namely, the axes, were designated as low and high and there was no accurate way of mapping coordinates and, therefore, plotting the organisations' operation on the matrix. Secondly, the assumption that organisations have a single mode of operation is an incorrect assumption as many organisations choose multiple operating models to cater for different customer segments. Finally, the notion of throughput is flawed: production in manufacturing is linear in nature, whereas the creation of services is based on the dynamic interactions between customers, employees and suppliers. Henceforth throughput as it was defined by Schmenner (2004) cannot be applied in the context of services and that these limitations prevented Schmenner's SPM from being operationalised (Scerri and Agarwal 2011). In this context, Agarwal and Selen (2005) recognised the importance of technology as an enabler in the SPM, especially in the context of emerging service value networks. This contribution is discussed next.

Whilst Schmenner's (2004) model incorporated the characteristics of variability and throughput, it failed to acknowledge or provide causal relationships between

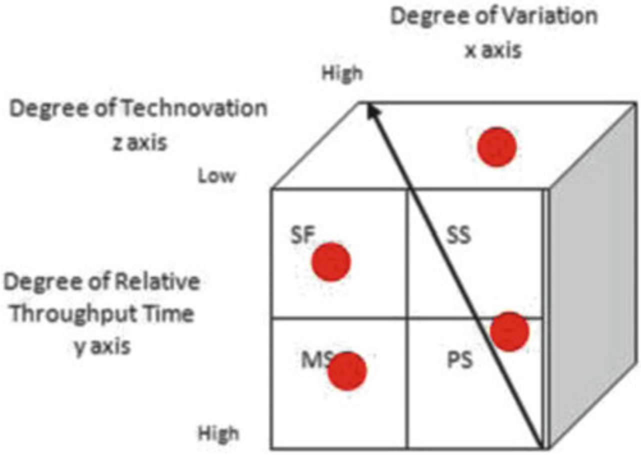

Fig. 1 Service cubicle (Source: Agarwal and Selen 2005)

the two. Agarwal and Selen (2005) do this with the introduction of a third dimension – the degree of technovation. The introduction of the *Z*-axis, along with the two existing dimensions of Schmenner's (2004) framework – the degree of variability and the degree of relative throughput resulted in the creation of the *Service Cubicle* (Agarwal and Selen 2005). In this Service Cubicle as shown in Fig. 1, the productivity diagonal now moves from the bottom right-hand corner to the top left-hand corner of the *Service Cubicle*.

Agarwal and Selen (2005) attributed the improvements in throughput and the ability to reduce variation (especially in the back office functions) across the service value network to technology and innovation. The significance of this achievement was twofold. Firstly, the use of technology introduced a new operating space and an ability to extend the provision of services across time and space. Secondly, it provided mechanisms that resulted in increased productivity through automating the back office functions where technology could perform functions previously processed manually. This reinforced the notion that the means of increasing productivity (or achieving increased business value) is achieved by minimising the use of labour and maximising the use of technology, machinery or both. Whilst Agarwal and Selen (2005) make a significant contribution, they inherited the limitations of the SPM. After having outlined the various concepts centred on the service processes, we next examine various emerging service theories and concentrate discussion around service dominant (SD) logic, UST, networks and social capital.

Vargo and Lusch contend that a GD-logic treats services the same way as a good, whereas a SD-logic considers services as *a process of doing something for another party* in its own right (2008). This can be interpreted as part of the evolutionary process whereby the role of knowledge is elevated and that human resources should no longer be viewed merely as physical labour or an extension of machines. Rather, it is the ability to apply competencies, knowledge and skills that becomes *the* means of creating economic value (Ng 2008). These competencies may also be embedded in products, and the consumer purchases the product for the embedded service rather than for the features of the physical product. Managers, on the other hand, still require skills to manage employees' work but these now involve the need for personal and emotional intelligence in the form of dynamic capabilities for the successful performance of their changing roles (Agarwal and Selen 2009; Pfeffer and I 2000; Pfeffer and Sutton 2000).Whilst there has been a shift in the nature of production from physical to intangible realms, the measure of productivity remains unchanged. This is the topic of our research endeavours, and we discuss the contribution of UST next.

Sampson and Frohle (2006) make a significant contribution to our understanding of services which is underpinned by three main concepts. The first notes that the customer is a provider of input into the production process, and their input is a necessary and sufficient condition for the service process to begin. In this way, customers are co-creators and co-producers in the service process. The second concept involves the definition of a customer and the differentiation between the entity that purchases the service and the entity to which the service is delivered. Goldratt (1992) viewed throughput as the rate at which the system generated money through sales; the implication being that if something was not produced and sold, then it would be not treated as throughput. This definition does not take into account other supplementary or support services required for an organisation to operate (Goldratt 1992; Sampson and Froehle 2006). These services are often referred to as knowledge-intensive business services. Additionally, the bidirectional nature of services means service supply chains become hubs, rather than functioning as linear chains (Fitzsimmons and Fitzsimmons 2006). In these inter-organisational operations, service providers perform the function of an intermediary, acting on behalf of customers, when dealing with outside suppliers (Fitzsimmons and Fitzsimmons 2006; Sampson and Froehle 2006). This further complicates the involvement of downstream customers in the service process as networks are created connecting customers and suppliers through direct and indirect ties (Ter Wal and Boschma 2009) giving rise to new network formations. This is an area identified for future research.

Given the importance of inter-firm operations in service delivery, human interactions play a significant role in connecting organisations and creating value through social interactions and by supporting technical integration (Onyx et al. 2007; Ter Wal and Boschma 2009). At this point, it is pertinent to introduce the contribution of Bruno Latour's (2005) Actor Network Theory (ANT). ANT is a distinctive approach that combines the study of sociology with technology to provide a socio-technical view of social construction of individuals into groups and networks, which Latour terms *appropriate social aggregates* (2005, p. 5). Latour claims that the causes of group formation and reformation determines the dynamic nature of groups and that this aspect is worthy of further study (Latour 2005). Latour also suggests that value is created in the invisible associations and interactions between agents, and this concurs with scholars such as Putman (1993), Baker et al. (2011) and Onyx et al. (2007) in their contention that social networks create social capital.

Putman (1993, p. 167) defines social capital as *those features of social organisation, such as trust and networks that improve the efficiency of society by facilitating co-ordinated actions*. Therefore, social interactions and social networks are often used to create and maintain a competitive advantage by protecting privileges and excluding wider access to resources and knowledge (Baker et al. 2011; Onyx and Bullen 2000; Onyx et al. 2007; Ter Wal and Boschma 2009) and are available regardless of wealth or status. Social connections exist in three structural forms: bridging, bonding and linking. It is the interconnectedness of these networks that form the basic ingredient of social capital, the dimensions of which are trust, reciprocity, tolerance of diversity and social agency (Baker et al. 2011; Onyx and Bullen 2000; Onyx et al. 2007).

Next we move from service- and knowledge-based economy to the time-related phenomenon in the creative economy.

4 Creative Economy

Creative industries are defined as the *cycle of creation, production and distribution of goods and services that use creativity and intellectual capital as their primary input* (*Creative Economy Report* 2008).Whilst other scholars define creativity with an outcome focus and as producing something novel, useful ideas or products, Dewett (2004) and Potts (2009) view it in process terms stating: *the adoption and diffusion of new technologies that drive economic growth and evolution are significantly affected by the creative industries through their role in handling and processing social information about new things*. Given the importance of creativity and intellectual capital, we adopt the Csikszentmihalyi (2008) theory of flow as the means for examining value creation in the creative space.

Csikszentmihalyi (2008) claims that the human nervous system is able to process up to 110 bps data, and during the creative process, this capacity is totally consumed. No human attention is left to monitor the self; the state of mind cannot determine feelings, and there is no realisation of identity through consciousness, in effect, existence is temporarily suspended. Csikszentmihalyi (2008) designates this mental position as state of flow and describes it as the state in which the mind is in dynamic equilibrium with the task at hand. The individual's attention is most productive when operating at full capacity and exists in this state (Csikszentmihaly 1996).Csikszentmihalyi identified the phenomenological landscape mapped into eight graduated levels which are: arousal, anxiety, worry, apathy, boredom, relaxation, control and flow (Fig. 2) (Nakamura and Csikszentmihaly 2002). It can take at least 10 years to achieve the balance between challenge and skill which results in the state of flow(Csikszentmihalyi 2008), highlighting that experience as well as skill is a contributor to productivity.

A number of contradictions surface when comparing Csikszentmihaly (2002) theory of flow model with that of Schmenner's (2004) Service Process Matrix. The first is the role of time. Schmenner advocates reducing the time for production, whereas creativity requires time and space in which employees become lost in time

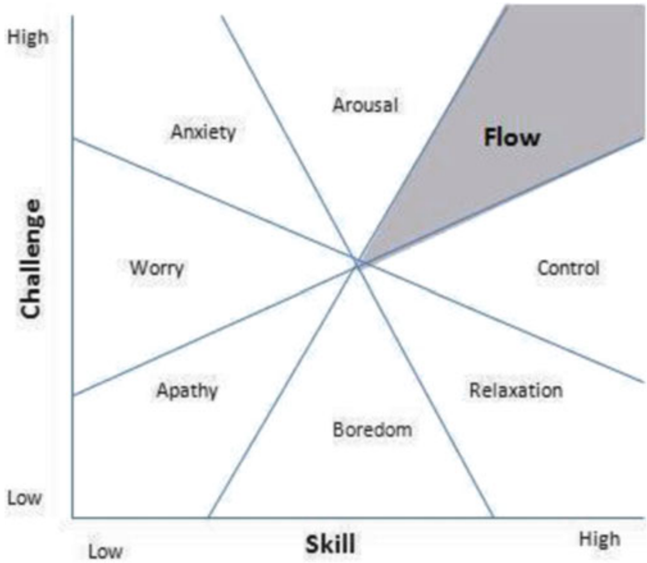

Fig. 2 Current model of the flow state (Source: Nakamura and Csikszentmihaly 2002)

to produce. The second contradiction is over the point of maximum productivity wherein both the SPM and the Service Cubicle maximum productivity are represented by a single point, whereas the creative economies maximum productivity exists in a zone. The third contradiction arises from the differences in economic outcome. Schmenner’s point of productivity moves to reducing cycle time (improved throughput times) and lowering variability whereas Csikszentmihalyi’s theory of flow supports the ability to create value through customers engaging in the service delivery process for as long as possible.

Two other interesting points worth emerge – the first is description of the flow experience as being independent of organisational culture and is the same regardless of activity, culture, gender, age, social status or sex (Csikszentmihaly 1996), and the second is with creativity each output must have utility and be deemed relevant and useful to managers, customers or other peers requiring employees being willing to take risks (Dewett 2004). This risk-taking characteristic is also attributed to entrepreneurs and is discussed next.

Schumpeter (1942) is known for his contribution on innovation and entrepreneurship (Muller 2011). He claims that the dynamism of capitalism is not brought about by owners of capital but by entrepreneurs who bring innovation in the form of new products, new markets and new forms of distribution (Greve 2003; Muller 2011; Schumpeter 1942; Smith 2006). Entrepreneurs do this in one of six ways: by creating or bringing new products to market, by producing better versions of existing products, by creating new markets, by creating new methods of production, by creating new sources of production for existing commodities or by creating new forms of economic organisation (Schumpeter 1942). The change brought about by entrepreneurs is described by Schumpeter (1942, p. 81) as *creative disruption*, where the innovations have such dynamic effects that it is possible for incumbents to be displaced. From a psychological viewpoint, entrepreneurs need to achieve a high internal locus of control, a willingness to take risks and a need for autonomy and independence (Muller 2011; Schumpeter 1942). From a personal characteristic perspective, an ability to possess a narrow focus on the immediate change, self-centredness and less reliance on tradition are traits that assist entrepreneurs in driving change, leading the means of production and drawing others to follow (Muller 2011). This has implications for organisational leaders looking for innovations and drivers of change when considering job design and job characteristics. The creative nature and drive of entrepreneurs is linked to the capability of leading. This, in turn, can result in creating a temporary monopoly and a consequent generation of high profits.

Recent work by Agarwal and Selen (2009) extend entrepreneurial capabilities and innovation beyond the individual to the organisation through an empirically validated, integrated framework, which includes constructs such as organisational relationship capital, collaborative organisational learning, entrepreneurial alertness, collaborative innovative capacity and collaborative agility. The transformative effects applied across industry sectors are able to demonstrate entrepreneurial and innovative capabilities in a service value network. Kastelle and Steen (2010) also suggest using network analysis to understand the process of idea generation, opportunity recognition and knowledge diffusion in a social context.

Next we draw together the strengths of each of the existing models and create the Value Creation Cube (VCC) framework.

5 Value Creation Cube (VCC) Framework

According to Sampson and Froehle (2006), the discipline of services management cannot exist and advance without theories and paradigms. The aim of this research is to create a new and improved model which includes key components of existing models, yet also overcomes existing shortcomings. We determine the different components that make up the VCC model and provide a summary of each of the scholars whose work has contributed to the conceptualisation of the VCC as shown in Fig. 3.

Next, we describe the various entities that form parts of the VCC, that is, customers, employees, managers, suppliers and shareholders, and explain the rationale for their inclusion and role in the context of the VCC framework.

Unlike some of the earlier models where *customers* were seen as separate to the production process, we accept Vargo and Lusch (2004) and Sampson and Froehle (2006) view of the customer as co-producer and, therefore, visualise customers as contributors, participants and recipients of the service process. In doing so, we also recognise customer-introduced variability and how organisations *reduce or*

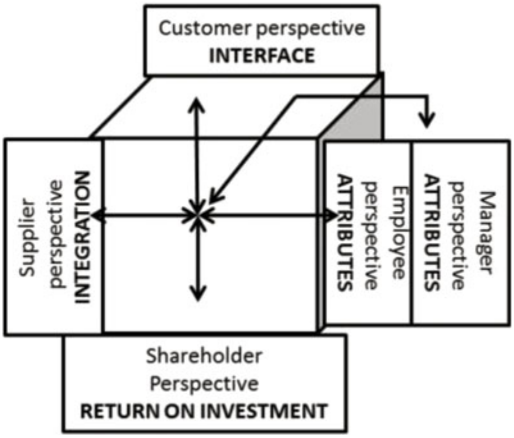

Fig. 3 Scerrri and Agarwal (Source: Original)

accommodate (Frei 2006) these into their operations. This will form a component of the VCC. It also aligns with, and improves on, Schmenner's (2004) framework, also accepts the importance of technology as described by Agarwal and Selen (2005) as an enabler-reducing variability and incorporates technology-enabled service offerings as part of the customer channel/variability constructs.

Taylor's (1911) view that *employees and managers* perform fundamentally different functions is well accepted, and therefore, this division of labour is incorporated in the VCC. However, we adopt the term "employee" in recognition that physical labour and cognitive, behavioural, and emotional elements are required to perform a job. These different dimensions of employees and managers will be incorporated into the VCC framework. Further, creativity and problem-solving capabilities as determined by Csikszentmihalyi (2008) are critical to value creation, either for dealing with customer variability or for the ability to innovate by creating new and novel products for which customers are willing to pay (Frei 2006).

Suppliers contribute to, participate in and are recipients of the service process or service value networks. We accept Agarwal and Selen's (2005) view that technology is an enabler to connect external suppliers, primarily through the automation of back office functions. However, we also recognise that the "high-low" measure is inadequate as organisations may have technical capabilities that are underutilised by suppliers or trade partners. This is supported by the notion of technology diffusion (Rogers 1962) that notes time is required for people to accept or reject new technology and/or information. We also acknowledge the importance of an open relationship with suppliers which serves to aid information exchange, improve co-ordination and expedite problem solving across different stakeholders (Baker et al. 2011; Onyx et al. 2007). The constructs for supplier integration will range from manual processing or no integration to full integration.

Whilst the importance of *shareholders* was not a focus of this chapter, we do acknowledge Rapport's (1986) view that the primary responsibility of management and business is to increase the value of its shareholder investments and that profit maximisation is one of the fundamental assumptions of economic theory (Scitovsky 1943). Hillenbrand Industries 1984 annual report states that shareholder value "is created when a company creates free cash flow in excess of the shareholder investment in business" (cited in Rapport 1986, p. 1). In addition, the performance measures set out in Kaplan and Norton's Balanced Scorecard show financial perspectives including cash flow, incomes, sales, market share and stock price (Kaplan and Norton 1992). We include each of these measures as contributions to the constructs of shareholder measures in the VCC.

Organisational processes are often represented graphically via linear input-process-output diagrams. However, the *resource configuration* for service delivery differs from this given that consumption and production occur simultaneously and require multiple interactions or conversations. Therefore, we illustrate the dynamic nature of services and the VCC as illustrated in Fig. 4 where the bidirectional nature of interactions, transactions and dialogue are transformed by decisions, actions and co-ordinated efforts (Sampson 2011; Vargo and Lusch 2004, 2008). Operations management now extends beyond the firm as resources and resource capabilities available include those owned by customers and suppliers and those that can be accessed or delivered by technical means. The configuration and constructs proposed in the VCC provide a mechanism in which to systematically provide and measure value generated for all entities. Furthermore, it delivers on the service systems view described earlier by Spoher and Maglio (2008) and the service value network view of Agarwal and Selen (2009, 2011). In relation to this, factors signifying social and societal aspects are represented, which include customer choice, levels of technology adoption, knowledge, skills, experience, levels of motivation and engagement, aspects which Pott's describes as being the *mechanisms of economic evolution* (Potts 2009, p. 2).

6 Conclusion

From a theoretical perspective, the VCC framework as depicted in Fig. 3 represents the next stage in the evolution of the transition between service- and knowledge-based industries and the emerging creative economy. The VCC framework provides a mechanism to accommodate quality, volume, variety and cost differences attributed to all stakeholder groups, all occurring simultaneously. In relation to this, the bidirectional nature allows for both inputs and outputs to be identified at the same time. The next phase of this research in service production is to define and empirically validate these underpinning constructs so that there is a generalisable and acceptable way of determining the operational efficiencies based on the intangible attributes of the service, knowledge and creative economies, work for which is currently under progress.

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Factors Contributing to Teachers' Attitude Towards Knowledge Sharing

Soofi Anwar and K. Durga Prasad

1 Introduction

Knowledge management (KM) has long been gaining organisational attention. Efforts to capture and leverage a firm's knowledge resources have become a major drive to the success of any organisation. In today's knowledge-driven economy, knowledge has become the strategic asset of an organisation. Organisations are increasingly recognising the role of knowledge resource (Smith 2001; Ofek and Sarvary 2001) in building and sustaining a firm's competitive advantage position (Kankanhalli et al. 2005; Ried 2003) in the market. In knowledge-intensive organisations, knowledge-related competencies are the primary source of competitive advantage, and focus on building pro-knowledge-sharing environment and implementing effective KM strategies to acquire and utilise explicit and tacit knowledge becomes the critical success factor. Organisations are widely adopting KM initiatives to capture and leverage the knowledge effectively.

Within the KM domain, a critical factor that needs most attention is knowledge-sharing behaviour. A successful KM implies a good combination of both human participation and IT collaboration tools. Knowledge-sharing technologies can be a facilitator for sharing and storing of knowledge resource. Unless the people are inclined towards knowledge sharing and form a favourable attitude towards sharing their knowledge, no KM tools and techniques will provide effective results. Previous empirical research findings on knowledge-sharing behaviour have identified some of the major barriers to knowledge sharing as well as motivators to share knowledge.These factors range from individual factors to organisational and technological factors. Therefore, facilitating and reinforcing actual knowledge-sharing behaviour is central to the success of KM.

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Developing pro-knowledge-sharing organisational climate and fostering actual knowledge-sharing behaviour of teachers are vital in universities and higher education institutions since faculty members are the knowledge workers. In an educational set-up, effective knowledge sharing ensures that teachers as well the management are able to realise and develop their potential to the fullest and offer quality education. The tacit knowledge that academic staff creates or gains is embedded in their minds and constitutes the storehouse of an educational institution's intellectual capital. Being a knowledge-intensive organisation, universities and higher education institutes have an enormous scope to develop and implement effective knowledge-sharing strategies and build knowledge-sharing culture to achieve academic excellence.

2 Review of Literature

Knowledge sharing is concerned with the willingness of individuals in an organisation to share with others the knowledge they have acquired or created (Gibbert and Krause 2002). A firm can successfully build a knowledge-sharing culture not only by directly incorporating knowledge in its business strategy but also by changing employee attitudes and behaviours to promote willing and consistent knowledge sharing (Connelly and Kelloway 2003; Lin and Lee 2004). The sharing of knowledge could take place through personal interaction and face-to-face communication and also indirectly through some knowledge archive. Sharing of tacit knowledge mainly takes place through socialisation, and more and more efforts need to be put to convert tacit knowledge into explicit form. Making tacit knowledge into explicit form allows it to be documented and shared within the organisation.

Most research works concerning KM acknowledge the role of knowledge sharing and the need to foster knowledge sharing (Davenport and Prusak 1998; Alavi and Leidner 2001; Bartol and Srivastava 2002; Cabrera and Cabrera 2002; Bock et al. 2005) for effective implementation of KM program. Although there are many benefits associated with knowledge sharing (Kautz and Mahnke 2003), for the most part, its facilitators are unknown (Szulanski 1996; Wiig 1997), and the organisational and individual enablers of knowledge sharing are not properly clarified (Connelly and Kelloway 2003). Unfortunately, people do not share their knowledge under all circumstances, and they have enough reasons not to share their knowledge as much as the organisation would like them to (Cho et al. 2007). Knowledge sharing cannot be forced but can only be encouraged and facilitated (Gibbert and Krause 2002). When people are motivated enough to share, a KM initiative will find its success (Connelly and Kelloway 2001).

The extensive review of previous literature on knowledge sharing recognises the existence of different influences on employee knowledge-sharing activities, such as individual, organisational and technological factors (Lee and Choi 2003; Connelly and Kelloway 2003; Taylor and Wright 2004). Referring to the individual dimension, most authors agree that knowledge sharing depends on individual characteristics, including experience, values, motivation and beliefs. Bock et al. (2005) summarise the individual factors affecting knowledge-sharing behaviour as anticipated extrinsic rewards (financial incentives or points towards promotion), anticipated reciprocal relationships (desire to maintain relationship with others) and sense of self-worth (sense of value brought by knowledge sharing through competence or power). According to Lu et al. (2006), individual factors such as greed, self-efficacy (perception of person's ability to valuable contributions and their criticality), interpersonal trust and teamwork were found to be influencing knowledge-sharing behaviour. Wasko and Faraj (2005) suggested that individual motivators may enable employee willingness to share knowledge. Employees are motivated when they think that knowledge-sharing behaviours will be worth the effort and able to help others. Therefore, the expectation of individual benefits can promote employees to share knowledge with colleagues. In individual level, knowledge sharing can also be impacted by concerns over the individual's status or 'competitive advantage' over others being lost by sharing the valuable knowledge one possesses (Huber 2001; Riege 2005; Hislop 2005; Fink and Distere 2006). According to study conducted by Sun and Scott (2005) on barriers to knowledge sharing, more significant barriers were fear of loss of ownership and fear of loss of control of knowledge. Riege (2005), Rugullies (2003) and Garfield (2006) highlighted the importance of time in knowledge sharing, referring to lack of contact time and interaction between other knowledge workers in the organisation and also lack of time to share knowledge in general.

From the organisational factors dimension, in the context of knowledge sharing, the different aspects of organisational climate are critical drivers of knowledge sharing, such as reward systems linked to knowledge sharing (Bartol and Srivastava 2002), open leadership climate (Taylor and Wright 2004) and top management support (MacNeil 2003, 2004). According to Bock et al. (2005), the organization climate that comprise of trust, open and free flow of communication, tolerance to failure, pro social norms and willingness to help each other is highly conducive for knowledge sharing. Kim and Lee (2006) found social networks and performance-based reward systems to be a significant organisational factor influencing knowledge sharing.

Finally, referring to the technological dimension, employee usage of IT applications (Kim and Lee 2006; Lu et al. 2006; Meenakshi 2002; and Sundari 2003) and user-friendly IT systems (Kim and Lee 2006) is found to influence positively on sharing knowledge. ICT can be effectively used to facilitate the codification, integration and dissemination of organisational knowledge (Song 2002).

3 Research Purpose and Methodology

3.1 Significance and Purpose of This Research

An educational institute will be able to gain and sustain its competitive advantage through developing knowledge-sharing culture and facilitating high degree of knowledge sharing among its academic staff. Though many empirical researches have been undertaken in the area of knowledge-sharing behaviour, majority of them focus on corporate executive knowledge-sharing behaviour. Very limited research studies have been carried out on knowledge sharing in higher education and factors determining teachers' knowledge-sharing behaviour. Therefore, this study focuses on seeking the faculty perspective on factors that positively and negatively influence their knowledge-sharing behaviour. This research attempts to obtain insights into the factors contributing to teachers' attitude towards knowledge sharing. The objectives of this study are as follows:

- To understand and analyse teachers' attitude towards knowledge sharing
- To identify the individual factors contributing to teachers' attitude towards knowledge sharing
- To analyse the role of organisational factors in teachers knowledge-sharing behaviour
- To determine the role of technological factors and teachers' attitude towards knowledge-sharing technologies

3.2 Research Methodology, Sample and Measurement Instruments

Both primary and secondary data were collected for carrying out this research. Secondary data was mainly used in developing the conceptual framework and designing the questionnaire and measurement constructs. As it was a faculty knowledge-sharing behaviour, a survey was undertaken to carry out this study. Full-time faculty members teaching in engineering colleges in Mangalore were chosen as the sample. Of the 100 questionnaires distributed, 72 completed and usable questionnaires were returned, representing a response rate of 72%.

The questionnaire was designed into two sections. The first part of the questionnaire was related to demographic information. The second section of the questionnaire comprised 34 scale items designed to ascertain the views of faculty members on factors contributing to their attitude towards knowledge sharing. A seven-point Likert-type scale (ranging from 1 = strongly disagree to 7 = strongly agree) was used, and the respondents were required to state the extent to which they agree or disagree with these statements. Most of the scale items validated through reliability test were either adopted from previous studies on knowledge sharing or adapted to suit the purpose of this research.

4 Data Analysis and Discussion

4.1 Demographic Profile of Survey Participants

The demographic variables used in this study are gender, age, highest qualifications and current job position. Table 1 below gives demographic details of faculty survey participants:

It can be seen from the above table that majority of participants for the survey were female faculty members. The respondents are spread around different age groups. Majority of the participants have either bachelor's or master's degree. Assistant professors constitute the highest percentage of respondents for survey.

4.2 Teachers Perception of Factors Contributing to Attitude Towards Knowledge Sharing

4.2.1 Individual Factors Contributing to Attitude Towards Knowledge Sharing

Individual factors used in this study are the perceived reciprocal benefits, reputation enhancement, rewards and incentives for knowledge sharing, fear of loss of knowledge power, enjoyment in helping others, degree of competition and seniority in the hierarchy, self-efficacy and attitude towards knowledge sharing. On a seven-point Likert-type scale, value 7 was assigned to 'strongly agree', and value 1 was assigned to 'strongly disagree'; as such, high mean score represents high intensity

Table 1 Demographic profile of survey participants

Characteristics	Frequency	Percentage
Gender		
Male	30	0.42
Female	42	0.58
Age		
21–30	20	0.28
31–40	24	0.33
41–50	16	0.22
51–60	12	0.17
Highest qualification		
Bachelor's degree	26	0.36
Master's degree	24	0.33
Doctorate degree	22	0.31
Current job position		
Assistant professor	34	0.47
Associate professor	22	0.31
Professor	16	0.22

Table 2 Role of individual factors in knowledge sharing

Individual factors influencing knowledge sharing	Mean	SD	Rank
Attitude towards knowledge sharing	6.50	0.63	1
Perceived reciprocal benefits	6.46	0.63	2
Perceived enjoyment in helping others	6.40	0.64	3
Perceived reputation enhancement	6.33	0.73	4
Self-efficacy	6.10	0.86	5
Perceived degree of competition and seniority	4.36	1.61	6
Perceived organisational rewards and incentives	3.91	1.53	7
Perceived loss of knowledge power	1.82	0.94	8

Source: Faculty Survey

of that variable in influencing knowledge sharing. Table 2 below presents these individual factors with the corresponding standard deviation (SD) value and the ranking based on its importance. The variables are arranged in descending order representing their importance influencing knowledge sharing.

The above data reveal that faculty members have basically an overall positive attitude towards knowledge sharing with the high mean score. The analysis of scale items reveals that knowledge sharing is being viewed as important and pleasant experience. Further, the major factors that influence them to have this attitude are reciprocal benefits, perceived enjoyment in helping others, reputation enhancement and self-efficacy, and their importance can be understood from the corresponding ranks shown in above table. Within perceived reciprocal benefits, affiliation with colleagues and meeting their own knowledge requirements are found to be the significant factors. Within perceived reputation enhancement, knowledge sharing leads to faculty recognition; appreciation and status improvement are the most important factors motivating to share their knowledge. It may here be noted that organisational rewards and degree of competition and seniority are not that significant in influencing faculty attitude to share their knowledge. Within rewards for knowledge sharing, sponsoring for workshops, FDP and higher studies are indicated to be the suitable rewards for knowledge sharing. However, the fear of loss of knowledge power is ranked the least indicating that it does not bear any significant impact on their knowledge-sharing behaviour.

4.2.2 Organisational Factors in Contributing to Attitude Towards Knowledge Sharing

Organisational climate guides the employee behaviour by conveying to them what behaviour is appropriate and desirable. Numerous studies have recognised the role of organisational climate as a critical driver of knowledge-sharing behaviour and emphasised the need to create knowledge-sharing organisational climate. The factors used in this are top management leadership and support, teamwork, fairness, affiliation, innovativeness, organisational rewards for knowledge sharing and facilities for

Table 3 Role organisational factors in knowledge sharing

Organisational factors influencing knowledge sharing	Mean	SD	Rank
Teamwork and cooperation	6.40	0.62	1
Organisational encouragement for innovative ideas	6.11	0.83	2
Organisational support in terms of knowledge-sharing technology	5.57	0.86	3
Organisational support in terms of rewards and recognitions	5.14	0.64	4

Source: Faculty Survey

Table 4 Role of technological factors in knowledge sharing

Technological factors influencing knowledge sharing	Mean	SD	Rank
Perceived usefulness of technology	6.11	0.63	1
Technology availability	6.02	0.86	2
Technology usage	5.82	1.23	3

Source: Faculty Survey

knowledge sharing available in the organisations. Table 3 below presents these organisational factors influencing knowledge sharing with mean scores, standard deviation (SD) value and the corresponding ranks. The variables are arranged in descending order representing their importance influencing knowledge sharing.

The above table shows that teamwork and cooperation among faculty members in their departments with mean 6.40 and SD-0.62 are ranked as the important organisational factor for knowledge-sharing attitude formation. Management's high encouragement for innovative ideas and suggestions is found to be the second important factor contributing to their knowledge sharing. Lower ranks obtained for organizational support in terms of knowledge sharing technology and rewards and recognition for knowledge sharing indicates the opportunity for strengthening and reinforcing actual knowledge sharing behavior.

4.2.3 Technological Factors Contributing to Attitude Towards Knowledge Sharing

Information and communication technology (ICT) use and knowledge sharing are closely linked, because ICT can enable rapid search, access, retrieval and sharing of knowledge. Past empirical findings emphasise the role of technological factors on influencing knowledge-sharing behaviour. The factors used in this study are perceived usefulness of technology, availability of technology and the degree of usage of ICT. Table 4 below shows the faculty perception of role and actual usage of ICT in knowledge sharing. The variables are arranged in descending order representing their importance influencing knowledge sharing.

It can be seen from the above data that teachers have a positive attitude towards technology and its contribution in knowledge sharing. Perceived usefulness of technology in knowledge sharing is high among the faculty with mean score of 6.11, SD 0.63. Technology enables them to share their knowledge easier, faster and most effectively. Availability of such technologies for knowledge sharing is rated second highest with mean score of 6.02 and SD 0.86. Technology usage by the faculty members is rated relatively low with the mean score of 5.82 and SD 1.23, thus revealing opportunity for improving the usage of technology by the teachers for knowledge sharing amongst their colleagues.

5 Implications

The top management and leadership of universities and higher education institutes plays a vital role in creating pro-knowledge-sharing climate, facilitating knowledge sharing through IT support and KS infrastructure and also fostering actual knowledge-sharing behaviour with rewards and reinforcement. Based on the findings of the study, the role of top management of universities and higher education institutes in promoting knowledge sharing can be broadly categorised into:

Firstly, at the individual level, management can significantly influence teachers' attitude towards knowledge sharing through its pro-knowledge-sharing policies and strategies. Secondly, leadership of the organisation plays a crucial role in building knowledge-sharing culture within the organisation. Collaborative planning; emphasising team works, 'community of practices', knowledge-sharing rewards and recognitions; linking knowledge sharing to performance appraisal; and increased sharing of knowledge through meetings, discussions, seminars/workshops, newsletters, magazines and data bases should be part and parcel of knowledge-sharing culture. Finally, technology support is critical in facilitating effective knowledge sharing. Knowledge-sharing technologies such as data bases, web portals, intranets, Internet, etc., will be the major enablers to knowledge sharing. IT systems can help in converting tacit knowledge from research, workshops and class room activities to explicit form, and the management should ensure the availability and usage of right IT systems and processes for knowledge sharing. Thus, the factors contributing to teachers' attitude towards knowledge sharing range from soft issues to hard issues, and in both these categories, the top management and leadership of the higher education institutes has a major role to play.

6 Conclusion

For any higher educational institution to stay ahead of their competition, they must be able to exploit the internal knowledge that resides within the human memory of their skilled faculty and academic staff. Therefore, an understanding of teachers' knowledge-sharing behaviour and the factors that either positively or negatively contribute to their attitude towards knowledge sharing will help the top management of higher education institute to build knowledge-sharing climate and encourage the degree of knowledge sharing that takes place among faculty and reinforce their actual knowledge-sharing behaviour. From the overall analysis of findings of this study on teachers' attitude towards knowledge sharing, it is revealed that individual, organisational and technological factors significantly contribute to teachers' attitude towards knowledge sharing. Knowledge-sharing behaviour is a complex process that is determined by multiple factors ranging from soft factors (organisational culture and climate, individual attitude, etc.) and hard factors (IT, organisational incentive systems, etc.). Thus, understanding of these factors influencing knowledge-sharing behaviour will help the top management and leadership of universities and higher education institutes to formulate motivational strategies to enhance knowledge-sharing behaviour of its faculties and build knowledge-sharing climate within the organisation.

Al-Alawi et al (2007) found that trust, communication, information system, rewards and organization structure is positively related to knowledge sharing in organizations. According to Bock and Kim (2002) attitude has significant influence on knowledge sharing, but extrinsic rewards do not significantly influence knowledge sharing. According to Chennamaneni (2006), individual factors such as reciprocity, reputation, enjoyment in helping others is positively associated towards knowledge sharing. Organizational climate and tools and technology for knowledge sharing also significantly influence knowledge sharing. Cummings (2003) argues that knowledge sharing has its roots embedded in the technology transfer and innovation literature and highlights the need for overcoming the factors that can impede or complicate knowledge sharing efforts. Knowledge workers are vastly different from other types of workers in their motivation, attitude and need for autonomy (Davenport Thomas 2005).

Gold et al (2001) focused on core capabilities that are needed to facilitate KM success and the findings reveal that both knowledge infrastructure capability and knowledge process capabilities positively influence organizational effectiveness. According to Kim and Ju (2008), perceptions and reward systems are the most important factor influencing knowledge sharing. Findings of Lee et al (2006) shows that organizational climate is linked to higher KM performance; rewards, top management support, IT service quality are critical managerial drivers for knowledge friendly organizational climate.

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Vocational Value Vector (V3) Management in Technical Vocational Education and Training (TVET) for Enhanced Industrial Employability

K.M. Nagendra, S. Radha, and C.G. Naidu

1 Introduction

Vocational education is an educational subsystem that specifically helps learners prepare themselves for jobs. Finch and Crunkilton (1979) explain that vocational education emphasises the development of skills, performance and preparation for jobs. It is related not only to the development of skills but also to that of all competencies that learners possess to express themselves in jobs. According to Wenrich (1974), all competencies that can be developed include all domains belonging to learners, namely, knowledge, skills and work attitudes, while learners' potentials include feeling, sight, thought and action. Therefore, vocational education is directly related to the way of empowering all potentials belonging to learners in order that they possess certain competency.

The vocational training system of India offers training through public industrial training institutes (ITIs) as well as industrial training centres (ITCs) that are private establishments. Enrolment-wise, the ITIs are much larger, while most private ITCs offer only a few trades. Therefore, in some states, the number of public ITIs is in dozens, while the number of private ITCs is in hundreds. Until recently, the numbers of private ITCs had been growing very rapidly but reached saturation very soon, and their numbers are now declining. The number of public ITIs has exhibited slow growth, while student enrolments and graduations are diminishing. The Government of India has made a considerable investment in skills development of young people through setting up the ITIs. Historically, they have been established with the major aim being to speed up the process of industrialisation

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in this country. This, however, determined the rather limited range of national vocational qualifications, the majority of which are basic industrial trades, while the non-engineering trades necessary for development of, for instance, the services sector, continue to be under-represented.

Recognising the high demand for skill in the country, the Central Advisory Board of Education (CABE) committee in its 57th meeting held on 19 June 2010 in New Delhi highlighted the need for a NVEQF to provide a common reference framework for linking various vocational qualifications and setting common principles and guidelines for a nationally recognised qualification system and standards. The National Policy on Skill Development 2009 (NPSD) of Government of India identifies National Vocational Qualification Framework (NVQF) as the main instrument for linking various education and training pathways. The NPSD inter alia states 'National Vocational Qualification Framework will be created with an open flexible system, which will permit individuals to accumulate their knowledge and skills and convert them through testing and certification into higher diplomas and degrees. NVQF will provide quality-assured learning pathways having standards, comparable with any international qualification framework. NVQF will support lifelong learning, continuous upgradation of skills and knowledge' (NPSD 2009, p. 40).

It was agreed that NVEQF can bring about necessary changes in the education and training system of the country with an aim to bridge the gap between demand and supply of skilled work force, leading to increase in the employability of the youth.

International experience on NVEQF is very recent. Until 2004, almost no country in the world had a NVEQF. Even now, just a dozen countries have a NVEQF, although more than 100 countries have initiated the process. An important consideration is that countries that have been very successful in building their education and training systems (e.g. Germany), or have experienced rapid economic growth (the East Asian 'tigers'), have done it without a NVEQF. In India itself, the IT and telecom industry and employment therein has grown rapidly in these sectors without an NVEQF in place. Therefore, it is absolutely critical that in India we think very carefully as to why we need a NVEQF and what are the problems that (a) the employers and (b) the potential employees (i.e. students) are facing—which the NVEQF will supposedly address. Building an interface between the educational system and labour market is not the easiest of things and is fraught with unintended consequences. We should attempt to anticipate as many of the consequences of implementing a NVEQF as possible.

PM's Council on National Skill Development, constituted in 2008, has set a target of creating 500 million skilled persons by 2022 with emphasis on inclusivity so as to deal with divides of gender, rural/urban, organised/unorganised, employment and traditional/contemporary workplace. It has laid down the core governing principles and operating strategies for skill development. The emphasis is on promoting multiple models of delivery that can respond to differing situations in various states and to utilise existing available infrastructure of educational institutions for skill development after school hours without affecting formal

Table 1 Employment situation of Karnataka in 2009

Job seekers participated in job melas	78,014
Total employers participated in five mega skill '*N*' job fairs	403
Employment created through mega job fairs	17,680
Training required	31,900

Source: Karnataka Vocational Training and Skill Development Corporation Ltd. (2009)

education. The state governments are encouraged to set up the state-level coordination body for skill development. But the employment situation of Karnataka in 2009 is given in the Table 1. The statistics indicate that only around 23% of the job seekers in the job melas are employable, whereas nearly 41% of the aspirants need further training in employability skills.

2 Literature Review

In a competitive workforce, it is not just having the right qualification or technical skills that will land an individual a job, it could very well be their interpersonal skills. How someone communicates is often the first impression an employer has of a possible worker. Yet, it is precisely communication skills that employers feel applicants are most lacking (Department of Education, Employment and Workplace Relations, Commonwealth of Australia 2011). In line with modern economies, workplaces are constantly changing, and as a result, employers are looking for employees who are adaptable and who have skills beyond the technical (Maxwell 2010). For example, a survey of CEOs found that 33.1% of employers consider employability skills to be the most important factor when employing graduates, whereas only 19.2% rated relevant work experience above employability skills (Australian Industry Group and Deloitte 2009).

The Australian Chamber of Industry and Commerce and Business Council of Australia define employability skills as 'skills required not only to gain employment, but also to progress within an enterprise so as to achieve one's potential and contribute successfully to enterprise strategic directions' (2002, p. 3). Their framework identifies eight main employability skills. These are communication, teamwork, problem-solving, initiative and enterprise, planning and organising, self-management, learning and technology. Despite all the attention these eight skills have received, there is still no operational definition that trainers can use when designing curricula and assessment tools. This deficiency leads to this set of skills being poorly understood by VET practitioners (Australian Flexible Learning Framework 2009), not to mention learners. Although called 'employability' skills, the abilities encompassed by these skills have broader application, being relevant to a variety of tasks in daily life, education, labour market, social networks and interpersonal relationships. Having well-developed employability skills can also be an advantage in a fluid economic climate—they can help individuals to prosper and cope with change (Callan 2003). Employability skills tend to require a high order of mental complexity since they involve an active and reflective approach to life. In this sense, they are multidimensional, comprising 'know-how, analytical, cultural and communication skills, and common sense' (Allen Consulting Group 2006, p. 12).

There are two main options for the formal introduction of employability skills into VET sector programmes—either embedded in training packages or kept separate from the technical and vocational skills. The disadvantage of a separate approach is that learners may not see the value of employability skills if they are removed from their industry context (Cleary et al. 2006). Embedding them in training packages means that they are integral and tailored to the industry-endorsed competencies. Learners' being able to see the relevance of the skills to workplaces is central to their embracing them. The Australian National Quality Council's 2005 endorsement for employability skills to be made explicit in training packages provoked debate over how they should be embedded. There had previously been some criticism about the way this was done, with teachers in particular sceptical about whether students were really gaining the skills needed to be employable in a range of jobs in different industries (Callan 2003). The Allen Consulting Group (2004) had argued that incorporating employability skills consistently across training packages could help ease this criticism, since they would demonstrate the relevance to the workplace, whatever the industry. In 2006, the key competency framework was replaced by the employability skills framework, and the provision of employability skills statements and summaries is now standard practice, with the summaries individualised to the particular industry (Wibrow 2011).

Generally, under each qualification, the employability skills and their facets are listed in an employability skills summary. The facets, which make up each of the skills, have been modified to reflect the needs of the particular qualification. The National Quality Council of Australia has developed a website which contains the summary pages for each training package (http://employabilityskills.training.com.au/).

According to Boud and Solomon (2001), competency refers to an ability to demonstrate what one has acquired before. Competency attainment depends not only on the effective implementation of a learning model but also on the assessment system. Through an integrated assessment system, schools obtain accurate information on the learning quality so that they can make up for the weaknesses. Thus, assessment plays an important role in controlling the quality of education. Substantially, Garavan and McGuire (2001) explain that competency can be viewed from the two aspects, namely, individual's attributes and learning outcomes. From the former, competency is defined as one's knowledge, skill and ability that result in performance. From the latter, it is defined as the extent to which one's performance has satisfied the necessary standard. Hoffman (1999) states that a complex job can employ the concept of competency as an individual's attributes, while a simple job can use the concept of competency as learning outcomes. Broadly speaking, there are two types of competency, namely, the generic competency and the specific or technical competency. The former, according to Wood and Lange (2000), includes the writing, numeracy, communication, problem-solving abilities and social skill. Nordhaug (1998) explains that the latter consists of knowledge of method, process and technique designed to accomplish particular tasks and abilities to use tools and equipment. According to Harris et al. (1995), competency in the educational perspective is measured in terms of three separate aspects, namely, knowledge, skill and work attitude, and it refers to specific and technical competency.

The discussion on knowledge, skill and work attitude is presented below. Boyett and Boyett (1998) define knowledge as understanding of how something works and skill as an ability to apply knowledge to put something into reality. Attitude, according to Saifudin Azwar (1988), consists of knowledge, emotion and behaviour. Feldman (1993) states that knowledge refers to one's thought of and belief in an attitudinal object, emotion to feeling of an attitudinal object, and behaviour to desire to act. A combination of knowledge and emotion can determine one's affective level. A high affective level makes one act. Sax (1980) states that attitude has an element of consistency. An attitude is a strong emotion to respond to an attitudinal object consistently. Therefore, attitude can be defined as a level of emotion that makes someone act. The action is stimulated by a strong and stable emotion. This means that an attitude has a characteristic of consistency to determine an action choice.

The affective domain according to Bloom's taxonomy (Woolfolk and Nicholich 1984) has five objectives. They include receiving, responding, valuing, organising, and characterising. The process in which someone responds to an attitudinal object starting from receiving, responding, valuing and organising to characterising reflects a careful choice of action. On the basis of a study on the concept of competency comprising knowledge, skill and attitude, it can be concluded that competency in machinery practice consists of knowledge of the principle of operating a tool machine, knowledge of the procedure of operating a lathe machine and a milling machine, the skill of operating a lathe machine and a milling machine, work accuracy and work consistency (Muhammad 2010).

3 Materials and Methods

3.1 Population and Sample

This is a descriptive study using a convenience sampling method. The population consists of students attending TVET programme at *Toyota Technical Training Institute* operated by a leading automobile OEM company near Bangalore, India. Finally, 61 candidates were selected from the list of 372 eligible students for TVET programme. They attended an intensive induction training programme (ITP) in broad areas of social skills before the actual technical vocational training (TVT) programme.

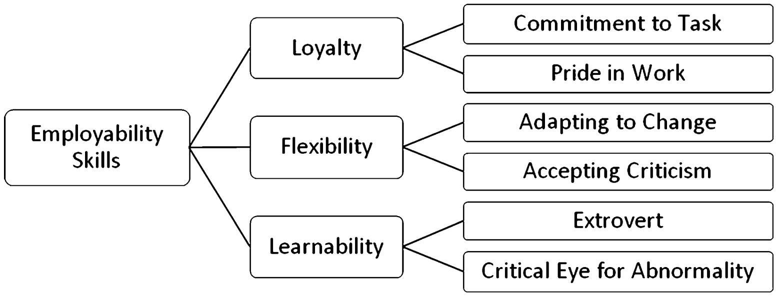

Fig. 1 Conceptual framework

3.2 Research Instrument

To assess students' employability skills, we used the instrument prepared using the psychometric parameters. The items in the instrument included most of the vocational value vectors perceived necessary by corporations and industries across the globe for enhanced employability. The employability skills instrument contained six vocational value vector constructs described in the framework given in Fig. 1.

4 Intervention Strategy

The intervention strategy for developing each of the vocational value vectors among the trainees is detailed below.

4.1 Commitment to Task

To enhance the trainees' commitment to task, sessions were conducted on 'goal setting' and 'time management'. Following it, they were given a time table of daily tasks and their accomplishment. The tasks included reporting to training sessions on time, to prepare daily training reports and some outbound activities like community services. These exercises primarily enhanced the awareness towards the tasks on hand and promoted the commitment towards completing them.

4.2 Pride in Work

As just completion of the tasks is not a true indicator of the positive attitude, efforts were made to motivate the trainees to feel proud about their accomplishments. Also, they were encouraged to share their previous achievements through creative presentations and talent exhibitions.

4.3 Adapting to Change

As the trainees came from different parts of Karnataka, they had apprehensions in new environment. To improve their adaptability to change, sessions were conducted based on ‘how to win friends and influence people’. This was supplemented by guidance based on ‘health and hygiene’ and ‘work–life management’. New industrial practices like safety, green path, walking in line, zebra crossings, dress code, physical exercise, etc., were demonstrated and implemented.

4.4 Accepting Criticism

Most essential requirement for a learner is accepting criticism. Constructive criticisms are the part and parcel of professional life. But coping with them is not very easy. Hence, sessions were conducted on ‘how to stop worrying and start living’. Also platform was provided for sharing their past experiences. During the training, rigorous feedbacks were given through constructive criticism and continuous counselling.

4.5 Extrovert

The most observable employability skill is communication. Most of the people tend to be introverts because of poor communication skills. Hence, sessions were conducted on basic communication skills and spoken English. Activities like knowing game, storytelling, experience sharing and cultural activities were conducted to improve communication skills. Every trainee was made to mandatorily participate in all these activities and thereby helping them to be extroverts.

4.6 Critical Eye for Abnormality

Most of our learning happens through observing the surroundings. If one fails to observe, then irrespective of excellent training resources, the trainee fails to succeed. To promote learning through observation, problem-solving activities were conducted for both individuals and teams. This helped the trainees to learn not only from their mistakes but also from observing other’s mistakes.

5 Results and Discussion

5.1 *What Is the Level of Employability Skills of Students at the Technical Training Institute?*

A descriptive analysis of students' vocational value vectors is shown in Table 2.

The finding showed that the overall employability skills of students at technical training institute are quite high (mean = 71.47, SD = 6.77). All the parameters of employability skills have shown an improvement in their respective mean value. All the six skill vectors have their mean value higher than the population (mean = 65.29, SD = 7.54).

Three vocational value vectors, pride in work, accepting criticism and extrovert thinking skills, have higher mean values after the training compared with overall mean value. There is more than 5% improvement in the mean value of five skill vectors except commitment to work. The highest change after training is ~7% in critical eye for abnormality. The highest change after training with respect to population is ~9% for pride in work and accepting criticism.

This showed that the system and strategy of teaching and learning in the technical training institute under study was able to increase students' pride in work, accepting criticism, critical eye for abnormality and thereby their overall employability to an appropriate level.

5.2 *Hypotheses Tested in This Study*

$H_0 1$: There are no significant differences in the levels of identified vocational value vectors among the students of TVT before and after the intensive ITP.

Students' training status used as independent variable in *t*-test was one of the two variable samples to compare students' skills during study. Scores obtained from six vocational value vectors were treated as dependent variable. Results are shown in Table 3.

As shown at Table 3, there were significant differences of three out of six aspects of students' employability skills before and after ITP. The three vocational value vectors showed the following values: as for pride in work [t (119) = 2.67, $p < 0.05$, two-tail], for accepting criticism [t (117) = 2.16, $p < 0.05$, two-tail] and for critical eye for abnormality, it is [t (116) = 2.8, $p < 0.05$, two-tail]. There was no significant difference for commitment to task [t (118) = 0.1, $p < 0.05$, two-tail], adopting to change [t (114) = 1.95, $p < 0.05$, two-tail] and extrovert [t (117) = 1.89, $p < 0.05$, two-tail] between the two groups of students.

$H_0 2$**:** There are no differences in overall employability skills level among students of TVT before and after the intensive ITP.

Table 2 Descriptive statistics of vocational value vectors

Description		Commitment to task	Pride in work	Adopting to change	Accepting criticism	Extrovert	Critical eye for abnormality	Overall employability
Mean	Po	66.47	74.78	65.12	65.84	64.81	61.07	65.29
	BI	68.58	77.87	66.26	68.72	67.90	59.43	67.20
	AI	68.85	83.61	70.90	74.73	71.99	66.39	71.47
Standard error	Po	0.82	0.75	0.72	0.73	0.73	0.70	0.39
	BI	2.12	1.59	1.48	1.81	1.65	1.91	0.70
	AI	1.87	1.44	1.87	2.11	1.41	1.59	0.87
Median	Po	66.67	75.00	66.67	66.67	66.67	58.33	66.70
	BI	66.67	83.33	66.67	66.67	66.67	58.33	66.70
	AI	66.67	83.33	75.00	75.00	75.00	66.67	70.80
Mode	Po	66.67	75.00	66.67	75.00	66.67	66.67	66.70
	BI	58.33	66.67	66.67	66.67	75.00	66.67	66.70
	AI	66.67	83.33	83.33	91.67	66.67	66.67	66.70
Standard deviation	Po	15.75	14.49	13.87	14.00	14.06	13.46	7.54
	BI	16.55	12.44	11.53	14.16	12.90	14.94	5.50
	AI	14.59	11.28	14.64	16.45	10.97	12.45	6.77
Sample variance	Po	247.98	209.97	192.46	196.04	197.75	181.19	56.89
	BI	274.06	154.83	132.93	200.59	166.29	223.32	30.22
	AI	212.74	127.24	214.40	270.76	120.45	155.02	45.85
Kurtosis	Po	−0.40	0.56	0.23	0.11	0.51	0.37	1.69
	BI	−0.11	−0.09	0.51	−0.38	−0.16	−0.02	0.15
	AI	−0.42	0.76	−0.98	0.60	0.65	−0.31	−0.70
Skewness	Po	−0.24	−0.73	−0.26	−0.27	−0.56	−0.23	−0.90
	BI	−0.20	−0.46	0.13	−0.06	−0.31	−0.08	0.03
	AI	0.05	−0.85	−0.02	−0.88	−0.61	−0.44	−0.02
Minimum	Po	16.67	25.00	8.33	16.67	16.67	8.33	33.00
	BI	25.00	41.67	41.67	41.67	33.33	16.67	52.80
	AI	41.67	50.00	41.67	25.00	41.67	41.67	56.90

(continued)

Table 2 (continued)

Description		Commitment to task	Pride in work	Adopting to change	Accepting criticism	Extrovert	Critical eye for abnormality	Overall employability
Maximum	Po	91.67	100.00	100.00	100.00	91.67	100.00	82.00
	BI	100.00	100.00	100.00	100.00	91.67	91.67	79.20
	AI	100.00	100.00	100.00	100.00	91.67	91.67	84.70
Sum	Po	24725.00	27816.67	24225.00	24491.67	24108.33	22716.67	24288.50
	BI	4183.33	4750.00	4041.67	4191.67	4141.67	3625.00	4099.10
	AI	4200.00	5100.00	4325.00	4558.33	4391.67	4050.00	4359.80
Count	Po	372	372	372	372	372	372	372
	BI	61	61	61	61	61	61	61
	AI	61	61	61	61	61	61	61
Confidence level (95.0%)	Po	1.61	1.48	1.41	1.43	1.43	1.37	0.77
	BI	4.24	3.19	2.95	3.63	3.30	3.83	1.41
	AI	3.74	2.89	3.75	4.21	2.81	3.19	1.73

Note: *Po* Population; *BI* Before induction training; *AI* After induction training

Table 3 *t*-Test results assuming unequal variances

Description	Commitment to task		Pride in work		Adopting to change		Accepting criticism		Extrovert		Critical eye for abnormality		Overall employability	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Mean	68.6	68.9	77.9	83.6	66.3	70.9	68.7	74.7	67.9	72.0	59.4	66.4	68.1	71.5
Variance	274	213	155	127	133	214	201	271	166	120	223	155	34	46
Observations	61	61	61	61	61	61	61	61	61	61	61	61	61	61
Hypothesised mean difference		0		0		0		0		0		0		0
df		118		119		114		117		117		116		118
t-Stat		0.10		2.67		1.95		2.16		1.89		2.80		2.91
$P(T <= t)$ one-tail		0.46		0.00		0.03		0.02		0.03		0.00		0.00
t-Critical one-tail		1.66		1.66		1.66		1.66		1.66		1.66		1.66
$P(T <= t)$ two-tail		0.92		0.01		0.05		0.03		0.06		0.01		0.00
t-Critical two-tail		1.98		1.98		1.98		1.98		1.98		1.98		1.98

Student's training status was used as independent variable in t-test as one of the two variable samples to compare students' skills during study. Scores obtained from overall employability score were treated as dependent variable. Results are shown in Table 3.

As shown in Table 3, there was significant difference in students' overall employability skills before and after ITP, with the following value [t (118) = 2.91, $p<0.05$, two-tail].

6 Conclusion

Results of study show that there are improvements in skills acquired by students as a result of intensive induction training programme for the TVT course during this study. Besides acquiring technical skills, students also had the opportunity to acquire employability skills.

Out of six vocational value vectors, only one vector, namely, commitment to task, has mean score as moderate, while other vectors such as pride in work, adopting to change, accepting criticism, extrovert and critical eye for abnormality tend to have high mean score values. By the result, it can be found that the intensive induction training programme of the Toyota Technical Training Institute has succeeded to equip its students with adequate vocational value vectors to enter the TVT main course. Nevertheless, there still is room for improvement during the TVT course. Research is under progress to develop a sustainable TVT model based on vocational value vector management.

7 Suggestions

During the present research, it is observed that an intensive induction training programme in the beginning of a conventional technical vocational training (TVT) course was very much effective in enhancing the overall vocational value vectors of the trainees. Further, for continuous improvement of these vectors to enhance employability, they should be continuously assessed and constructive feedback should be provided to the trainee for improvement.

Following specific activities are suggested as intervention strategies that can be easily adopted for any TVT programme run by ITIs and ITCs to inculcate vocational value vectors along with the specific technical skills in a TVT programme:

- Every trainee should be motivated to report every day on time for the training.
- Habitual late comers should be counselled for commitment to punctuality.
- Parking, walking and any such safety activities should be standardised as per contemporary industrial/statutory norms, and adhering to them should be promoted as a matter of pride.
- Instead of compelling the trainee to be the caretaker of institute property, he should be made the pride owner of a section of training/institutional resources.

- To make it easy for them to adopt, the trainees should be made to work in different groups and should be made to work with different tools and equipments on every occasion.
- Health and fitness should be part of adaptability.
- Working safely with proper safety wares should be part of skill attainment.
- Good housekeeping should be the organisation culture.
- Every day, there should be a general assembly, where a group of trainees, on rotation, will speak aloud on topics like news, experience sharing, word for the day, thought for the day, term for the day, etc. This will help in making them extrovert by improving their collective communication skills.
- Every trainee should be encouraged to find the mistakes in his own work (both trade skills and theory). He should be encouraged to avoid recurrence of same mistake over a period of time through self-monitoring. This will develop critical eye for abnormality.
- Constructive feedbacks at every stage will gradually develop the trainees to accept professional criticisms.

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Critical Factors in Managing Creativity in an SME Global Challenger

Sandhya Sastry

1 Introduction

In 2006, Boston Consulting Group predicted that ‘Companies based in rapidly developing economies such as Brazil, China, India, and Russia, will radically transform industries and markets around the world’ and in the process, referred to these companies as the *global challengers*. The global challengers follow an intense and rapid internationalisation pathway, pursuing larger deals than their peers across borders, the *global incumbents*, with approximately 60% of the M&As in developed markets. Their growth trajectory has been remarkably exponential; their future promising but unproven as yet. If they are to succeed in the long term, they would have to develop sustained bases of competitive advantage. In high-technology companies, maintaining high levels of creativity and innovation is critical in staying ahead of the game.

The body of literature on cross-border M&As (which are the favoured strategic choice of growth of SME global challenges) highlights differences in knowledge and learning culture between merging firms during PMI (Hitt et al. 2001; Finkelstein and Haleblian 2002; Hayward 2002). For executive leadership of an SME global challenger, this presents an additional dimension, one that is critical to the success of the enterprise, as conflict due to any one of these differences is enough to break the deal or the impact negatively on performance.

This study focuses on technology acquisitions.[1] It is a case study of one SME global challenger, BetaNova, a clinical research organisation (CRO), which originated in India less than a decade ago and has a presence in 50 countries and multiple

[1] Technology acquisitions is defined as transactions in which the acquired firm operates in a technology industry such as networking equipment, software, medical devices, semiconductors or biotechnology.

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operational sites and headquarters. In 2007, the Indian company, Beta India, then just a few years old, acquired a 21-year-old German CRO, Nova Germany, and merged the two companies to form BetaNova. In just 3 years, BetaNova has grown to achieve a global presence.

While this type of company is not unique in itself, it represents a new breed of multinationals, not from developed countries but from developing economies, acquiring mature, established companies with advanced, state-of-the-art technologies (Ramamurti 2008). The differing motives of the *challengers* and the *incumbents* are clear (Ghemawat and Hout 2009; Ramamurti 2012), since Beta was looking to upgrade its capabilities and gain access to developed markets, while Nova was looking for cost efficiencies and gain access to larger markets. The shared goal is to remain highly competitive through stretching innovative capability, squeezing costs and leveraging global reach. The merged company, meanwhile, has to deal with adjusting to the new identity, internally causing clash and fuse as they differ in many respects, not least being their differing experience curves, innovative capacity and culture.

The takeover of an older more established firm by an infant firm causes addition tensions. Their limited experience dictates that, especially in the very earliest stages, they will be confronted with many situations they have never seen before. Without adequate time or resources to plan fully and without a large repertoire of prior experience, they will often be forced to improvise to create or enact solutions (Churchill and Lewis 1983; Delmar and Shane 2003). This study focuses on exploring the creative and learning environment within BetaNova while in its earliest stages of its organisational life cycle.

2 Literature Review

Early research on creativity focussed on individual differences around people's backgrounds, personality traits and work styles of creative people (MacKinnon 1962). The finding was interesting but limited and was constrained as they could not be applied in practice. This approach also failed to take into account the impact of the environment on creativity and innovation. Contemporary approach to creativity research, however, asserts that social environment can and does influence both the level and the frequency of creative behaviour. This thrust is particularly strong in the creativity of an entrepreneur, typically defined in terms of innovation. Schumpeter (1934) described entrepreneurial activity as 'the creative destruction of an existing equilibrium within a particular industry'.

It is useful to be reminded about the distincton and the relationship between the two terms – creativity and innovation. Creativity is the production of novel and useful ideas. In order to be considered creative, a product or an idea must be different from what has been done before. Innovation is the successful implementation of creative ideas. Drawing the three concepts of creativity, innovation and entrepreneurship together, Amabile (1996) put forward a definition of entrepreneurial creativity:

> The implementation of novel, useful ideas to establish a new business or new programme to deliver products or sevices. The primary novel, useful ideas may have to do woth (a) the products or services themselves, (b) identifying a market for the products or services, (c) ways of producing or delivering the products or services, or (d) ways of obtaining resources to produce or deliver the products or services.

Creativity resides in people, processes and products. Leveraging the sources of creativity to orchestrate the innovation process, i.e. arranging, conducting and leveraging the sources of creativity, that makes an enterprises achieve its competitive advantage requires a dynamic capability (Teece 2007). 'Entrepreneurial activity' and 'orchestrating the innovation process' (ibid.) are very similar constructs. This chapter posits that there are two distinct dimensions to this capability – internal resource mobilisation (relating to creativity) and external environment negotiation (innovation, commercialisation of ideas). Managing creative people and creating environments that spur interactions which continually produce novel and fresh ideas is a prerequisite to ensuring long-term competitive advantage. The skills needed to make this happen are internal to the organisation, and these are different to skills required to succeed in the external environment. The extant literature on internal capabilities of multinationals is extensive (Eisenhardt and Martin 2000; D'Este 2002; Athreye 2005; Priem and Butler 2001), but in the context of an SME global challenger, it is non-existent.

An extension of the resource-based view concerns knowledge as a source of sustainable competitive advantage, as advocated in the knowledge- and learning-based views of the firm (Kogut and Zander 1992; Grant 1996; Spender 1996). Knowledge is particularly important for technology-based firms: generating and exploiting knowledge in high-technology sectors demand that knowledge be continually replenished (Lane and Lubatkin 1998). Van de Ven and Polley (1992) and Autio et al. (2000) opined that learning modes and practices do change over time, over the organisational life cycle. Consistent with this view, Autio et al. (ibid.) argued that younger firms have some 'learning advantages' because their short history provides them with less to *un*learn. Carayannopoulos (2009) confirmed these findings that the lack of experience that sometimes challenges younger firms can also create important learning advantages. Because the acquisition and exploitation of knowledge are predominantly social processes (Kogut and Zander 1992), social capital may be critical for the long-term success of technology-based firms. In general, however, the empirical evidence is suggestive rather than definitive.

By highlighting the important links between creativity, learning and communication among multicultural teams during PMI, this research seeks to contribute to further convergence between creativity exploitation, the domains of strategy and entrepreneurship in young technology-based firms growing rapidly through cross-border M&As.

Following this line of argument, the following research questions are posed based on the observations that (a) BetaNova to be in its infancy as an SME global challenger and (b) as an enterprise formed for the most part by M&As:

Given that BetaNova has been in existence in 2007,

(a) What are the creativity-related PMI challenges faced by BetaNova?
(b) How successful has it been in ensuring a creative environment?
(c) What are the implications thereof for executive leadership?

3 Methodology

The research used both qualitative and quantitative methodologies to collect data. The first question used an inductive approach and discusses key issues that emerged as a result of analysing in-depth interviews with senior managers and executives. The second question was approached deductively, analysing a data set of 58 employees surveyed, across their different country sites, finally presenting a distilled set of findings and recommendations as a response to the third research question. To pretest the questionnaire, a four-stage approach was used, as suggested by Churchill (1979) and Gray and Meister (2004).

4 Findings and Discussion

Several issues emerged from the analysis of interviews of six executives/senior managers, which in reality were inherently complex problems, two of which were highly relevant to the research questions: (a) creativity versus project deadlines (b) ensuring a sense of ownership.

4.1 Creativity Versus Project Deadlines

Perception of individual creativity and innovativeness[2] – Top management found that people individually felt that they had not been innovative. Senior managers and executives had to 'sell' the idea to individuals that they had indeed been sufficiently innovative. Interviewees, i.e. senior managers and executives were agreed on the concept of creativity, i.e. that creativity is a soft, imaginative process that starts from when the problem is brought up, including the moment when the idea to solve

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[2] The terms creativity and innovation were used interchangeably during interviews, as it provides a true reflection of how these constructs are referred to in real life.

the problem has been born, and ends with the sharing of the idea with others. The hard innovation process starts as soon as an idea is made public where organisations put together a team, prepare a budget, project description, etc.[3]

In an environment such as BetaNova's, the company cannot allow employees to take all the time in the world to go through all four phases at their own pace. In particular, the second phase, the incubation time, can be quite considerable, which often conflicts with the strict deadlines defined and agreed between client and supplier. In reality, the freedom to be creative is constrained by certain time-bound activities, and respondents admitted that this is one of the most common challenges for leadership.

Executives held a common view that a creative environment is one which enables people to share ideas and feel they know their colleagues well enough to discuss and interact freely. The challenge for management, they acknowledged, is to get the balance right, '... to enable all the random things to happen...' and to ensure there is '...enough opportunities as part of their routine work schedule...' to produce creative ideas on the one hand while adhering to project deadlines on the other.

4.2 Sense of Ownership

The findings indicate that every site needs a charter and that people of each site must own it, including the roadmap, which helps the scientists and the staff, and say, e.g. '...we are going to produce insulin in the form of tablets, we are the first site, we are the owner...' The self-esteem and the sense of ownership attached to 'owning the creative idea and making it happen' are critical to the success of teams. Conversely, a lack of sense of ownership can and does act as a barrier to creativity. Managing the expectations of individuals and of project leaders is a crucial part of leadership. A typical quote: *We have learned that we have to do that in order to do that to give them a sense of identity. We also need to ask, 'What drives the scientists, the bio-chemist, etc.?' Money is a big hygiene factor.*

The research also found that another specific barrier when working with scientists is that an ambitious scientist has two main goals in life: (a) to be the first author of the article and (b) to be the first name on the patent. These two issues are perhaps the reason that true creative scientific innovations are not shared at an early stage because scientists want to keep the idea under wraps until it is sufficiently protected by intellectual property rights and he/she is recognised as the idea generator and owner.

[3] The four phases of creativity are (1) problem identification, (2) incubation time to think about a solution, (3) the 'aha' moment when you think of an idea and (4) action to share the idea with others.

The investigation into how successful BetaNova has been in creating a creative environment yielded mixed results. The findings from the survey of 58 employees of BetaNova, who were asked a number of questions about their company's creative environment, are presented below.

4.2.1 Cluster 1: Creativity and Culture

Individuals were asked about their perceived performance when working with someone from the same or similar culture compared to working with someone from a different culture. The majority of individuals felt that (a) they work better with someone from a different culture, (b) they are more creatively motivated when they are at work away from their home country and (c) they work harder when they are away from their home country.[4]

4.2.2 Cluster 2: Communication and Change

Attitude to change and new practices is extremely positive. Over a third of those interviewed said that they constantly seek opportunities beyond the role, i.e. that they go beyond their expected roles, which indicates a need that the leadership must address if they are to retain highly creative individuals.

Findings revealed that BetaNova has a fairly open environment, where people feel comfortable to contribute to new ideas. Just over half the respondents felt valued as their ideas had been actively listened to and acknowledged as being 'valuable'. A significant number of respondents felt that BetaNova provides an environment that challenges their thinking and an equal number feel that the work culture actively encourages them to create newer and more powerful ideas. However, a fifth of individuals said they did not feel valued at all. Over two-thirds however felt that they had insufficient opportunity to share and discuss ideas with others in BetaNova, but they made time to interact with others. The finding of concern, however, is that over half of those interviewed said that they did not know people well enough to share and discuss ideas with them. This was reflected across sites and cultural settings.

Employees had different views on the manner and the amount of engagement they prefer – a third of respondents preferred to be told what to do; another one third said they would like to be consulted on the goals; and the rest of them expected to be actively engaged in the goal or plan as co-creators. The preference to be co-creators was higher among Indians and Thais than among Germans and other Europeans.

[4] Unless otherwise indicated, results were tested and found significant at the 0.05 confidence level.

4.2.3 Cluster 3: Employees' Assessment of BetaNova

Most individuals felt that BetaNova uses latest research methods and that flexibility is built into its process. This means that it can quickly reconfigure internal resources to exploit external opportunities. However, a majority of respondents felt that their team was creative but had the potential to do a lot better. Further, half of those who were interviewed were dissatisfied with BetaNova's environment for them as individuals to achieve their full creative potential.

Respondents were asked about the most important factor in achieving success, and an overwhelming majority across sites indicated 'teamwork' followed by 'interpersonal communication'. By implication, leadership must design interfaces that enable individuals and teams to communicate freely, without structural and systemic barriers. One would expect that in such a company, most people would know each other well enough to be able to share ideas; however, a third of those interviewed said they did not know others well enough to exchange ideas, and a quarter were unsure. If the situation is allowed to persist, it could lead to a feeling of isolation and disconnect with the team and company. Further, data suggests that some people find the time or make time to share ideas with others, with German staff finding it more difficult to find the time than their Indian counterparts. By and large, Indian employees were more flexible in their approach to work and work time in general and as they tend to blur the boundaries between 'work' and 'sharing ideas' compared to their German counterparts.

About half the employees find that BetaNova has the right work culture to realise their full creative potential. However, it is the other half, those who are not happy in the environment or are ambivalent, that need the attention of the leadership. As in-depth interviews revealed, the biggest force driving scientists is the ability to learn and to keep on learning new methodologies, new techniques, etc. They quite like to say, 'I have done this', with a sense of pride.

Working teams and interacting groups impact on the ability of organisations to stimulate creativity, innovation and new product development (Fong 2006). They provide conditions for a dynamic mixture of ideas and ways of work and make available complementary competencies and disciplines that favour creativity and innovation.

5 Conclusions and Recommendations

Overall, the BetaNova has achieved a qualified success in ensuring a creative environment. Managing expectations and reassuring employees of their creative prowess, where appropriate, would go some way in creating a positive perception of BetaNova's creative ability. The results from this study are directly linked to learning. New environments and new cultural contexts are platforms for new learning, and this in turn acts as a refresher or catalyst for creative thinking.

Researchers (Doz and Shuen 1990; Mody 1993) have pointed out that collaborations and partnerships can be a vehicle for new organisational learning, helping firms to recognise dysfunctional routines and preventing strategic blind spots.

The concept of dynamic capabilities as a coordinative management process opens the door to the potential for inter-organisational learning. In this case, as BetaNova has in its current state evolved rapidly through inorganic growth, its constituent parts – the Indian, the German, the Thai, the Danish, the American – are in the process of integrating into one entity, and therefore, the boundary between 'inter'- and 'intra'- organisational is blurred.

Cultural aspects affect workers' knowledge and satisfaction and their capacity to communicate and adapt to changes. Openness and dynamic contact between individuals, teams and departments facilitate the acceptance of new perspectives and are particularly relevant traits in organisational cultures able to stimulate creativity and innovation (Martins and Terblanche 2003; Mumford et al. 2002). Working under the umbrella of corporate identity does not guarantee success in sharing knowledge and generating ideas. Increasing employee mobility across international sites and creating communication opportunities should be a key priority for the executive team.

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Part 3

Part 3.1
E-Governance

E-Governance and the 'Developing' Countries: Conceptual and Theoretical Explorations

Chetan B. Singai

1 Introduction

The Nehruvian vision of a vibrant India did materialize progress in atomic energy, space exploration, communications, defence, science and technology, agriculture, etc. But post-independence euphoria began vanishing as instruments of development began yielding suboptimal results. Poverty, illiteracy and hunger, among others, kept revisiting the country's galloping population with nauseating regularity, confounding planners and policymakers alike. *Where do the fault lines lie?* Deficiencies were noticed in governance. Since the early 1990s, which incidentally coincide with the beginning of the economic reforms era in India, seven yardsticks were identified as measures of what came to be called as 'good governance'. These were public sector management, accountability, legal and regulatory frameworks, transparency and information, human rights, participatory approaches and military expenditure. Among these public sector management, transparency and information are relevant for the e-revolution within the dynamic discourse of governance in the country.

The 1992 development lending institution-induced reform agenda for governance stimulated a lot of introspection among decision-makers in India as elsewhere in the world. It was acknowledged that governance had to extend beyond conventional bureaucracies to involve citizens (irrespective of any sort of discrimination) and consumer groups at all levels actively, to empower and inform the public and disadvantaged groups and to ensure service and programme execution through autonomous elected bodies. With the coming in of globalization, it is inevitable that we ignore the dynamics of ICTs and its influences.

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India is the largest democracy of the world. Its administrative set-up is composed of the central government, state governments and local administration. To reach everybody in a diverse and highly populated country like India, e-governance seems to be an appropriate mode of better governance. E-governance has been introduced as a catalyst of change and development by the central, state and local governments to re-energize the administrative structures. The private sector, non-governmental organizations and rural sector have also taken recourse to e-governance to lift their performance levels. The objective of the introduction of e-governance has been to make the processes transparent, quantifiable, result-oriented and simple and to make them function with greater speed.

2 Conceptual Framework

E-governance involves transformation of the organizational culture of the government. Recent authors argue that governments are mandated by the citizen and business demands to operate within new structures and parameters precipitated by information technology. Current demands require cross-cutting services, which in turn require government to improve communication and interaction across traditional bureaucratic lines (Alexander and Grubbs 1998). These new requirements, which fundamentally alter the nature of government, are made possible through the strategic use of information and communications technologies. Garsons (1999) has divided the theoretical frameworks of e-governance into four main areas: decentralization/democratization, normative/dystopian, socio-technical systems and global integration theories. As far as this chapter is concerned, the first two areas will suffice to explain the basic variations in e-governance theories, facilitating administrative efficiency. The democratization/decentralization theory of e-governance revolves around the progressive potential of information and communications technologies and focuses on the positive governmental advances associated with e-governance. Normative/dystopian theory emphasizes the high rate of conflict and failure associated with information technology application and counters the positivist progressivism of decentralization/democratization theory with realist view of inherent technological limits and contradictions.

There are two camps in the arena of e-governance: cyber-optimists and cyber-pessimists. Cyber-optimists are hopeful that the development of interactive services, new channels of communication and efficiency gains from digital technologies will contribute towards the revitalization of the role of government executives in representative democracies, facilitating communications between citizen and the state. In contrast, cyber-pessimists express doubts about the capacity of governments to adapt to the new environment effectively and with positive result insofar as the questions of access and digital divide have repercussions for political participation.

E-government is a form of e-business in governance and refers to the processes and structures needed to deliver electronic services to the public (citizens and businesses), collaborate with business partners and to conduct electronic transactions within an organizational entity. In this chapter, e-governance is defined as the application of *electronic means* in, firstly, the interaction between

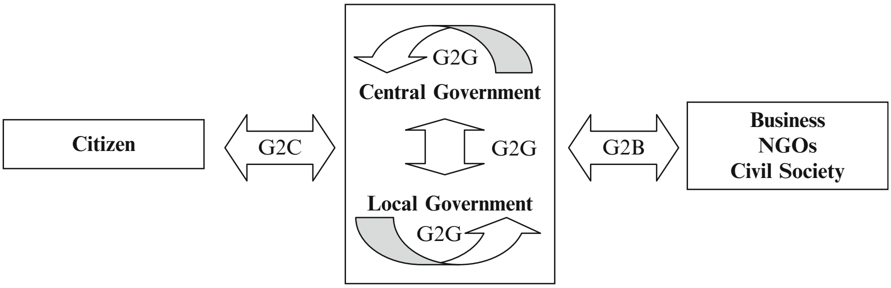

Fig. 1 Interactions between main groups in e-governance (Source: Illustration derived from Frissen (1992) cited in Backus (2001))

government and citizens (G2C) and government and businesses (G2B), as well as, secondly, in internal government operations to simplify and improve democratic, government and business aspects of governance (see Fig. 1 for illustration).

As mentioned before, e-governance is more than a government website on the Internet. E-governance can be looked upon as a tool to facilitate good governance. It has the potential to achieve better governance by bridging the gap, thereby delivering more while systematically reducing costs, time and interactions involved. E-governance drawing from the conceptual framework offers automation, informatization and transformation while simultaneously producing governance that is better and more innovative. However, while the conceptual framework or the theoretical perspectives should pass through a phase of critical test – i.e. institutional, people-centric, cost/finances and scientific dimensions – the contextual ‘*4-D*’ is discussed below. E-governance in the Indian context has evolved or is evolving across the country, but is backed with regional variations as well. The role of the respective state in augmenting the implementation of e-governance could be the main cause for such variations. In addition to this the increasing patterns of the state to rely on the various sources of funding like private sector, public-private partnership and so on, directs such variations and concerns.

Many developing countries, including India, have experienced and are experiencing what some political scientists have described as the ‘crisis of governability’.[1] The signs of the decline in the *authority* of the state are evident. These are to be found in, for instance, the decline in the quality of public services, inordinate delays and cost overruns in public projects and increasing failures of policies and plans to deliver what they promise. The administrative structure has also proved to be ***incapable*** (emphasis added) of handling effectively the multiple

[1] Kohli (1991) emphasizes on: Over the past two decades, a legitimate and moderately stable state that was confident of its ability to lay out India’s agenda for socio-economic change has evolved into a reactive state. This state is omnipresent, but feeble; it is highly centralized and interventionist, and yet seems powerless. **It has the responsibility to foster the ‘life-chances’ its many diverse social groups, but rather than initiating action, it primarily reacts *(emphasis added).*** Moreover, the state now appears capable neither of dealing with the concerns of diverse interest groups nor of directing planned development (8).

tasks assigned to it. In addition to this, the state has become financially weak because of fiscal overspending. This has further eroded its command over resources for public investment and its capacity to intervene in favour of the poor.

In line with the challenges that the modern state faces, this chapter below provides the proposed SWOT analysis for e-governance.

3 SWOT Analysis: E-Governance in India

Four SWOT analyses are presented below, with a focus on the following aspects of e-governance:

- Cost/finance
- Institutional/policy level
- People-centric
- Scientific

The SWOT analyses below are indicative of certain theoretical propositions with regard to e-governance in the developing countries. However, each of these aspects could be exemplified with few e-governance initiatives in India.

3.1 Cost and Finance

Financial aspects related to e-governance are funding, cost-savings, business models, e-commerce and spin-offs of e-governance (Table 1).

Internet access is too expensive for the poor in developing countries like India (UNDP 1999). Each telephone connection may cost as much as Rs30,000 in urban areas and Rs70,000–80,000 in villages, which is unaffordable by most low-income families (Yadav 2001). It is also very expensive to gain Internet access in India: it may cost about Rs25 per hour in cities and Rs150–1,200 per hour in rural areas (Yadav 2001). Given this context, it is important to analyze the practicality of having the paradigm of e-governance sustained. However, the wave of ICT has no doubt reached the rural areas with initiatives like e-choupal and e-bhoomi, but they are few among the much expected.

3.2 Institutional or Policy Level

Institutional aspects related to e-governance in India are the National e-Governance Plan (2003–2007) and respective state government (SAWAN – State Area Wide Network). Such strategies and policies, laws and legislations and financial support can be considered to be an important political aspect for e-governance (Table 2).

India has undertaken massive initiatives to introduce e-governance at the national, state and local levels. In terms of the total number of government websites,

Table 1 Cost and finance – implementation and maintaining e-governance solutions

Strengths	Weaknesses	Opportunities	Threats
E-governance good argument for external funding Transparency for businesses (procurement)	Investors Budget control	Cost-efficiency through E-governance New business More efficiency tax revenues	Corruption

Source: Backus (2001)

Table 2 Institutional aspects – implementation and maintaining of e-governance solutions

Strengths	Weaknesses	Opportunities	Threats
Combination with democratization reforms Internet as pull factor Modern image	Budget Cyber laws not available No problem owner within government No expertise about technology Slow decision-making process, hierarchy in organizations Short-term approach due to elections Integration and reform	Raise external funding Show competitive edge Transparency causes natural change of processes Reinvent government	Bureaucracy Piracy, misuse Corruption Maintaining disorder, no transparency Political instability Resistance

Source: Backus (2001)

although the advanced industrial countries top the list, India is ranked seventh in the global list (Norris 2001). The top policymakers in India tend to justify the adoption and expansion of e-governance on the grounds that it costs less, reduces waste, promotes transparency, eliminates corruption, generates possibilities to resolve rural poverty and inequality and guarantees a better future for citizens (Wadia 2000). In short, the government tends to portray e-governance as the panacea for all ranges of problems confronting India.

3.3 People-Centric

People-centric features related to e-governance are people and the socio-economic dimensions, for instance, their level of education, employment, income, digital divide, rural areas vs. cities, rich vs. poor, literacy, IT skills (Table 3).

There is a very low rate of literacy in countries like India, although the correlation between education level and use of the Internet is quite significant. In the case of Andhra Pradesh, one of the Indian states most aggressively pursuing e-governance, even the basic literacy rate is only 44% (PC World 2000). Therefore, one may become sceptical about the effectiveness of e-governance in such a context where the majority cannot even read and write.

Table 3 People-centric aspects – implementation and maintaining e-governance solutions

Strengths	Weaknesses	Opportunities	Threats
People eager to learn IT skills	Basic education poor: trainers needed	Employment increases	Brain drain IT-skilled people after training
Skilled people possible export product	No IT literacy	Education system improve	Resistance of people
	Low literacy	People learn structural job	Digital divide
	Different languages	Cheap manpower widely available	Privacy
	Public acceptance of self-service models	Promotion of Internet	
	Skill shortage: competition with private sector	Better health care	

Source: Backus (2001)

Table 4 Scientific aspects – implementation and maintaining e-governance solutions

Strengths	Weaknesses	Opportunities	Threats
Everything is new: no negative legacy	Shortage of IT-skilled people	Second-hand hardware available	Dependency of technology
Leapfrogging possible	High cost of Internet	Use one standard	
Internet as driving (pull) factor	Heterogeneous data		
Lack of IT standards?	Lack of IT standards?		
	Costs of software licences		

Source: Backus (2001)

3.4 Scientific

As discussed in the previous sections, scientific capability will be a bottleneck for e-governance in developing countries. Scientific aspects involve software, hardware, infrastructure, telecom, IT-skilled people and maintenance, safety and security issues (Table 4).

Technically, the larger population in India is Scient. According to *The Economist*, only 0.1 % of the population has Internet access at home (Kashyap 2000). According to the UNDP (2000: 200), India has one of the lowest per capita Internet hosts (0.01 per 1,000 people) in the world.

Recent concerns about the 'digital divide', the technology gap that exists between distinct groups in the India, highlight the issues associated with the move to e-government as a mode of service delivery, due to the potential consequences for unconnected or underserved populations. Several studies note racial, regional, educational, gender and age disparities among Internet users and technology owners (Norris 2001). These gaps are of great concern for public administrators, who must serve efficiently, effectively and equitably to fulfil their public charge. The SWOT analysis illustrated above provides a comprehensive illustration about the possibility of various threats and weaknesses that the paradigm of e-governance could face in India, while portraying the stages of opportunities and strengths for the people and the system, respectively.

Following the SWOT analysis from the 4-D perspective of cost/finances, institutional/policy level, people-centric and scientific dimensions, it is evident that implementing e-governance in India evidences various aspects of support and challenges. Among the four, the institutional and people-centric dimensions are central to the process of implementation. Decision-making, on one hand, and for the assortment of people for whom the decision is made, on the other, provide a paradoxical position, resulting in problems of successful implementation of e-governance projects. Considering the aspect of progressive vision (cyber-optimists) by the political agency is the most important aspect evolving e-governance models. In addition to this, the political aspect is important to scale the e-governance processes across the country, enabling acknowledgement from coalition of political ideologies and government. The people-centric dimension plays an important role as well. The diversity of people that the country accommodates is a major concern for e-governance models (Bhattacharya 2001). As the popular academic and practitioner concern states, the e-governance model is progressive for the country, but at the same time, it is exclusive. It excludes a certain section of the population who cannot and do not have access to the tools that enable use of e-governance tools, 'digital divide'. Such exclusion has resulted in a major setback to the political orientation and support to implementing e-governance.

In sum, e-governance has its own advantages and disadvantages as discussed above. In India, it is suggested to explore the key aspects of institutional and people-centric dimension in order to enhance the progressive and inclusive feature of e-governance.

The use of information communication technology (ICT) in governance has impact on the following aspects[2]:

- *Information*
  Websites are loaded with information; government websites are supposed to provide an interface to the citizens and the officials. Governments will have to collect, produce and update information daily. In the initial stage, content will be static, but eventually, the content will be dynamic.
- *Human Resources*
  The government has to support the e-governance centres with professionally trained individuals and enable a technically sound environment. Maintaining technological infrastructure requires IT-skilled resources. The government could look forward to public-private partnerships (PPPs) in hiring and training people across the country.

[2] The key to the discussions is contextualized from Michiel Backus (2001). *E-governance and developing countries: Introduction and example. Research Report # 3; however, the examples are situated to the Indian context.*

- *Safety Measures*
  The government has to strengthen its 'cyber cell' and enable robust technical strategy (preferably through private ITES in the country) to tackle security issues. Internet increases the number of entry points exponentially. Protection is possible with antivirus software, firewall at gateways, encryption technology and authentic identification tools (Backus 2001).
- *24*7 Service*
  Systems and processes have to be adapted to a completely new service model. The services delivered through e-governance model enable time-space compression. Citizen's expectations towards government's response times will change because of the new communication medium. For instance, the citizens to government interface the *Bangalore one* – 'one-stop, non-stop services'. Such services demand high technical calibre and commitment from the government professionals and the right attitude among the users.
- *Confidentiality*
  Following the extensive development and application of e-governance processes, detailed information about citizens (e.g. Unique Identification Card-UID) and businesses, are often held in multiple offices on many different computer systems posing threat to citizen's privacy. It is the responsibility of the government to restrict the utilization of private information and secure such information from access by unintended parties. Due to public concern regarding privacy, several countries have already passed data protection laws.
- *Need for IT-Enabled Services (Public and Private)*
  With the implementation of e-governance, information technology (IT) is becoming more and more important in government operations. The need for a professional IT department wills inevitable increase, not only during implementation, but also for maintenance of software, hardware and infrastructure.

Given the above context, it is vital to appreciate that the impact of ICTs in governance is not always negative though they are more evident. For instance, with the growing population who posses education in IT and similar services (service sector) and the robust human capital, in India, we have huge human resources who are skilled in ICT application. Unlike many other developing countries, the country can tap into these resources on one hand, and by successfully implementing national policies on e-governance like the 'National e-Governance Programme (Ne-GP), the human resource could be used effectively by ensuring increased employment.

4 Way Forward

Invoking the Nehruvian vision, the post-independence mission, the evolution of various commissions for developmental programmes and the hitherto omission of '*effective*' e-governance in the country, this chapter has discussed relevance of e-governance. The theoretical framework provides an overview of the existing discourses on role of e-governance and their institutional relevance. Following the theoretical dimension, the SWOT analysis (Backus 2001) situated and illustrated the *4-D perspective* that e-governance policies counter. This chapter discussed how the institutional and people-centric dimension is central and unique to India and how it is important to chalk out the meaning of e-governance in India. As a way forward, I would like to state what government should supply in addition to what it does provide through e-governance to the citizens. The government should supply performance indicators, environmental indicators, audited accounts, management reports and other relevant documents that are necessary for the citizens to assess the performance of the government. E-governance has the potential to ensure in creating a robust knowledge society (Mansell and When 1998) enabling informed and sustainable development from an inclusive perspective. There is now considerable momentum for government change along the e-government model. Governments are competing to be seen as being on the leading edge, not laggard adopters (Sprecher 2000).

Many cities across the globe (developing or less-developing) are moving away from traditional administrative emphasis on standardization, departmentalization and operational cost-efficiency, towards the ‘e-governance’ paradigm, which emphasizes coordinated network building, external association and customer services (Ho 2002). In this way, the reinventing government movement is tied to the e-governance movement. It is still too early to assess e-government in terms of effect on democracy. Clearly, there are great hopes that e-governance will provide new opportunities for widening civic engagement and participation (Milward and Snyder 1996). In principle, e-governance increases the reliability and accountability of public organizations and potentially could ensure effective governance – people-centric governance.

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Compartmentalization of E-Governance Practices

P.V. Bokad, P.M. Kuchar, and Priya V. Satpute

1 Introduction

The dictionary meaning of e-government is (*e*lectronic-*government*), a generic term for Web-based services from agencies of local, state and federal governments. Such Web sites provide a wide variety of services to the public and have been extremely helpful in reducing internal paperwork. For example, the myriad of forms that government agencies require can typically be downloaded from a Web site. When information on the site is clearly indexed and explained, the number of support calls is dramatically reduced compared to the days before the Web. To take the full use of e-governance project and spread to all common citizens, it requires a full-fledged communication network. India has taken this care through Telecom Regulatory Authority of India (TRAI). TRAI in their detail report on number of Internet connections in India said as below.

These are Internet connections and offices, and cyber cafes have many users accessing a connection so actual number of users in India is significantly greater than these numbers.

There are 19.67 million Internet subscribers in March 2011, a yearly growth of 21.59% with respect to March 2010. The broadcast users (>256 Kbps) are growing at 33.49% and were up to 11.89 million at March 2011. Dial-up and narrow band users (<256 Kbps) are growing at 5.12% and were up to 7.79 million at March 2011. Maharashtra is having (<256 Kbps) and broadband (>256 Kbps) subscriber

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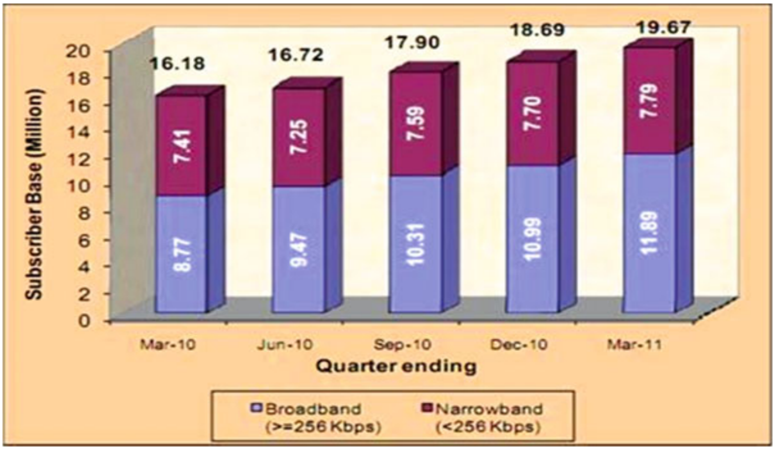

Chart 1 Showing trend in Internet/broadband subscription (Telecom Regulatory Authority of India)

base in the country. Tamil Nadu is second in Internet and broadband subscriber (Chart 1).

The use of ICT in e-governance is proved significantly. To widespread the use of e-governance services, the subscriber of using the broadband and Internet is increasing day by day in India, and it is clear from the above chart.

2 State Level Initiatives in India

Andhra Pradesh: In Andhra Pradesh *e-Seva,* centres have been established in over 200 villages and towns delivering services to citizens based on a low-cost networking model. There are total 46 bigger e-Seva centres at mandal headquarters, out of which 16 are headed by MACTS (Mutually Aided Cooperative Societies) (E-governance and Best practices) which are led by women and have at least 2,000 women members. *Bhu Bharati* (E-governance and Best practices) is an integrated land information system and has been piloted in Nizamabad district. E-*village* project is developed in Chiluvuru in Guntur district with Wi-Fi connectivity. E-village Web site and databases are the multipurpose household survey (MPHS) in the state. It includes land record management system and Pattadar passbooks, ration cards management system, cooperative bank loans management system. The state has also developed *Andhra performance tracking system* for improving delivery of services and infrastructure. Andhra is the pioneering e-governance state, improving citizen–government interface through e-governance (E-governance and Best practices).

Delhi has rolled out of 8,000 'government to citizen kiosks' in 2008 through a project called *Jeevan*. The 23 departments and 104 services have been identified to be brought under the 'Jeevan' project; 45 priority services are made available initially through computerized citizen service centres or portals with online payment gateway on a BOT basis. The services include payment of utility bills, getting licenses or certificates, issue of forms, etc., on a single online platform.

Gujarat: The one-day governance model provides eight citizen services across the counter in one hour. These eight services are income certificate, domicile certificate, addition/deletion/modification of name in ration card, etc., based on business process re-engineering and set procedures.125 out of 143 municipal centres and all 225 talukas have these one-day governance centres or *Jan Seva Kendras*. Gujarat state also developed a project named *Computerized Interstate Check Posts in Gujarat* (E-governance and Best practices).

Karnataka: has opened 800 citizen service centres offering an integrated range of services like certificates, pensions, social security payments and special packages like *Bhoomi* and *Kaveri* – registration at 'one-stop shops'. *Bhoomi* allows computerized easy access and facilities for 'mutations and updation of 20 million land records belonging to 6.7 million farmers in an efficient and transparent way based on a self-sustaining business models'. Other successful initiatives taken by Karnataka government are *khajane, an* online treasury project. *Gram Swaraj is a* project to improve service delivery and management of public resources at the panchayat level.

Haryana: The Haryana government has started the best practices on *'Integrated Workflow System* for Paperless Admission' with online off-campus counselling for all technical courses including postgraduate, undergraduate and diploma education that has obtained central award for Exemplary Horizontal Transfer of ICT-Based Best Practice category in 2007–2008. *Mustard Procurement Management System* is the agricultural-based project useful for the farmers. *Janani Suvidha Yojana* is the project for maternal health care.

Kerala: Successfully piloted rural ICT access points *Akshaya* with e-payment facilities. The *SWIFT* pilot programme provides one-point solution for 25 types of certificates. *PEARL* is for administration of registration laws and documents. *Asraya* is a community-based initiative to remove destitution.

Madhya Pradesh: Gyandoot is the community-owned rural Internet kiosks in Dhar where the entire expenditure for the Gyandoot network has been born by Panchayats and the community with no expenditure burden for the state or national government (E-governance and Best practices). Decentralizing teacher management in MP lowered teacher absenteeism and reinforced accountability. Use of para-teachers made it possible to extend a decentralized model of teacher management in MP that boosted school enrolment in a fiscally constrained setting. *Rogi Kalyan Samitis* with autonomy to charge user fees and deploy them for purchase of equipment and maintenance are other important experiments.

Maharashtra: has introduced special legislation, the Maharashtra Government Servants Regulation of Transfers and Prevention of Delay in Discharge of Official Duties Act, 2006, for improved public service delivery with time limit of 7 days for pending work with any government servant and overall time limit of 45 days for clearance of the file. Appropriate disciplinary action has been laid against defaulters. The Act also prescribes delegation with up to a maximum of three levels of submission before final decision. Maharashtra government has also started some impressive best practices including *Koshvahini* or *e-treasury* and *e-registration* package. '*Warana Wired Village*' is the well-known e-governance project of Maharashtra state (E-governance and Best practices).

Rajasthan: has set up over 500 *e-mitra* service centres on PPP basis in 31 out of 32 districts with services including certificates, payment of bills, transport ticketing, ration card, etc., with business process re-engineering in linked departments. *SARATHI* (Stamp and Registration Automation with Technology and Information) is an e-registration in an hour.

Tamil Nadu: In Tamil Nadu state, *E-Registration Star* and *Regine* are the e-governance projects on a self-sustaining basis; SARI project in Madurai district includes farming advice by the Madurai Agricultural College and Research Centre; applications for government loans; e-mail, chatting and voicemail; eye care and treatment; income, caste, birth and death certificates; old-age pension; computer education; etc., are the services made available through this project.

Tripura E Suvidha Kendras: or service facilitation centres in all SDM are offices providing 22 citizen services with tracking.

Uttar Pradesh: The *Lokvani* pilot of Sitapur district incorporated franchisee e-kiosks which offer services related to grievances, land records, employment services, tender services, court information system, etc., 15 services on a self-sustaining basis.

The project allows for registration and tracking of applications. It has been rolled out in 21 districts with over 398 kiosks, pilots in land records, e-registration, etc., underway. Over 16,000 common service centres are proposed.

West Bengal: There are gram panchayat accounts and management in 400 panchayats; GIS-based information system is at GP level. Pilots for Citizen Service Centres are ongoing. Telemedicine projects are linking Referral and District Nodal Centres or Hospitals providing teleconsultation with referral centres. There are 6,697 Citizen Service Centres for delivery of various services.

3 Improvements Expected in the Existing System

The success or the failure of the project is not only the successfully installation of the project, but the need satisfaction of the citizens is more important. The e-government projects have different lacunas which are required to be removed. The reality gaps in e-governance projects explained by Heeks (2002–2003) (Heeks 2002) are shown below which supports this fact (Fig. 1).

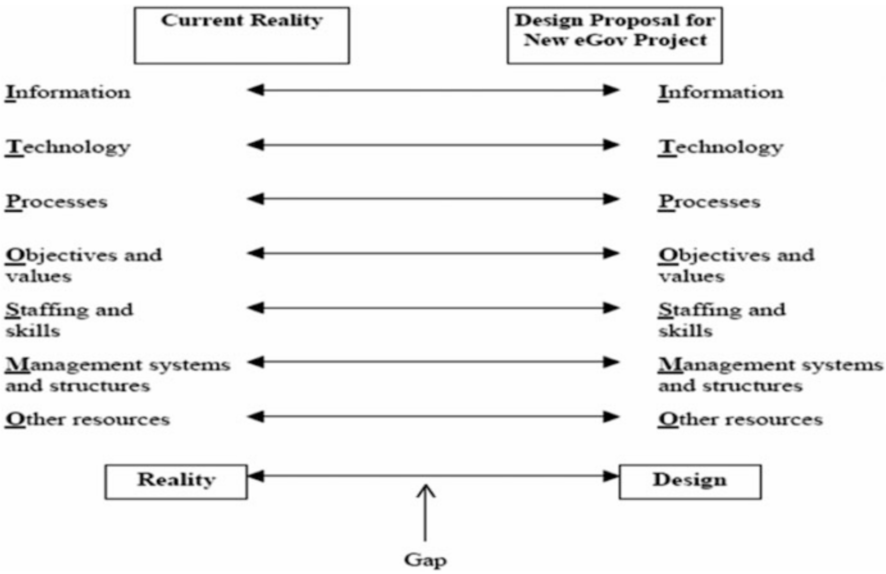

Fig. 1 Showing the need of bridging the gap between issues

The gaps shown in above model are of following nature:

Hard-soft gaps (Heeks 2003): The difference between the actual technology (hard) and the social context (people, culture, politics, etc.) in which it operates (soft).

Private–public gaps: The difference between the private and public sectors means that a system that works in one sector often does not work in the other one.

State context gaps: The gap that exists when trying to use the e-government systems for both developed and underdeveloped states.

4 Reality in E-Governance Practices

E-governance is the interaction between citizens and government through electronic media. E-governance makes use of technological tools like Internet, public kiosks, etc., to complete many government activities. In India, the waves of the e-governance start in 1990. It has undergone many changes, faces many challenges and gets updated time to time. Successful user-friendly and cost-effective implementation of e-governance practices has become the need of the hour. E-governance has successfully crossed its childhood and is stepping in the youth stage. Almost every state in the country either has a few central government e-governance projects or state e-governance projects on their name. The different countries around the world today have implemented e-governance in some manner and have their own vision and objectives for future course of strategy. In India, state governments have many commonalities in their functions, structures and processes, but even then, implementation of e-governance project has not been homogeneous, but it is state dependent. E-governance can enhance the speed and efficiency of operations by streamlining processes, lowering costs, improving research capabilities and improving documentation and record-keeping. E-governance should contribute significantly to the process of transformation of the government towards a leaner, with more cost-effective government. E-governance should lead to e-government.

The leading techno-legal expert of India is of the view that 'the Government and Indian Bureaucrats need to change their mindset and stress more upon outcomes and services rather than mere ICT procurement. India needs a services-based approach that is not only transparent but also backed by a more efficient and willing Government.

Presently the Bureaucrats and Government of India are in a "resistance mode" towards novel and effective e-governance policies and strategies and they are merely computerizing traditional official functions only. This is benefiting neither the Government nor the citizens and is resulting in wastage of thousands of crores of public money and UNDP/World Bank grants amount'.

The continued apathy, mismanagement and lack of accountability have finally shown its impact. The World Bank had refused to operationalize the e-governance support project known as 'E-Bharat' without its active management role in the same. The World Bank did not agree to the framework for implementation of E-Bharat as it was insisting on certain conditions to manage the project. For instance, against a hands-on project management approach being favoured by the World Bank, India was pushing for a programme mode where assistance could be linked to targets or milestones.

It becomes the point of thinking and should take the alarm for e-governance projects. Prevention is better than cure; hence, the Gov3 analysts have defined seven classic causes which are required to consider to avoid failure of e-governance project. These seven 'signs' are (Gov3 analysis, drawing on research published by the UK government) as follows:

1. *Lack of strategic clarity*: A strong business case, driven by a clear set of benefits owned by the key stakeholders, should be an essential precondition of any public sector ICT investment. Unfortunately, this is not always the case, and too many projects are driven by 'what the technology can do', not 'what the organization needs'.
2. *Lack of sustained leadership at political and senior management level*: Significant ICT projects require significant change, and significant change requires leadership. Yet often, this is not forthcoming either because projects fail to achieve the sustained leadership attention they need at the highest levels in government or because those in leadership positions do not have the skills they need to exercise effective leadership of ICT-enabled change.
3. *Poor understanding and segmentation of user needs*: Failure to engage closely with users – whether citizens in the case of external services or public employees

in the case of internal services – is a common cause of project failure. Every service will have very different users, each with different attitudes to and requirements from the service.

4. *Lack of effective engagement with stakeholders*: Most ICT-enabled change projects in the public sector involve complex sets of stakeholders – users, suppliers and delivery partners elsewhere in the public, private and voluntary sector. Failure to manage this complexity significantly increases risk of failure, and yet, stakeholder management is typically an activity which gets squeezed when project timescales or budgets get tight.
5. *Lack of skills*: Project management skills and transformational e-government programmes require a rich mix of broader skills, for example, in change management, process mapping and redesign, channel management and marketing and communications.
6. *Poor supplier management*: Strong partnership relationships with suppliers are essential. Yet, many common supplier management practices militate against this, leading to high risks of failure. Common mistakes include the following:

   - Evaluating proposals primarily on immediate price rather than long-term value for money (and in particular the degree of confidence that the chosen supplier will secure delivery of the expected business benefits)
   - Management of the supplier relationship being undertaken at too junior a level within the organization – on major projects, this should be an issue for the very top levels of management

7. *'Big Bang' implementation*: Finally, many projects fail because they seek to deliver too much technological and organizational change at once. Success is much more likely in a programme with initial deliverables which create as much customer value as possible for as low a level of technology expenditure and delivery risk as possible, which learns from that experience and then moves on to more sophisticated technological and organizational changes.

By using appropriate technology like Web 2.0/3.0, e-government can facilitate communication, ease in use and improve the coordination of authorities within the different tiers of government, starting with the central/federal government, state level government, municipal corporations and village panchayats. The success can be seen in the true sense when it will be linked between state to state and controlled by central government. The unnecessary separation or state-dependent projects are becoming costlier and uncontrollable. This is the only reason why more than 30% e-governance projects are not successful in achieving their objectives.

5 Compartmentalization

Compartmentalization is a principle that limits the damage and protects other compartments. It prevents others to use the services developed by one government. But more compartmentalized methods/services or organizations are the threats for flexibility, creativity and innovation. Successful user-friendly and cost-effective implementation of e-governance practices has become the need of the hour. E-governance has successfully crossed its childhood and is stepping in the youth stage. During its life cycle, it has come across and overcome number of problems like multiplicity, digital divide and compatibility. But it appears that an e-governance system functions in isolation in its number of practices. It gives birth to the compartmentalization which forbids others to take its use. It overburdens the nation as individual states are spending huge amount for the development of e-governance services for the similar purpose. It is just opposite to the claim made by the government to provide e-governances to 'anyone' and 'anywhere'.

Compartmentalization is good for the sake of security, but it should not be at the cost of exploitation of common beneficiaries. 'In today's world compartmentalization is not an option and we need to evolve from this nucleus created by Indian government. Any half measures would be very risky for us when our dream to be an IT super power seems to be within our reach. A system of oversight to audit progress made towards stated objectives and corrective steps is unavoidable' (Chaturvedi et al.).

6 Compartmentalization of E-Governance Practices

In the race of developing and implementing the e-governance projects for the better government and considered the state as e-state, state governments are spending lakhs and crores without considering its importance of the same project for the people in other state. So, the intervention of the central government is required so that any e-governance developed by the governments could be used by all the citizens in the nation. The state centric concept of the e-governance should now be replaced with really citizen centric, and the e-governance for everyone, everywhere and at anytime should be proved. It is after all the money of the common citizen which can be saved instead of giving it to the private businessman for developing the software. The Table 1 below clears how different states are developing the e-governance projects for the same service repeatedly and spending huge amount on similar development in different states.

Parallel efforts: All the above six states have developed their individual e-governance projects for the benefits of the citizens of their states. Every state has spent their individual fund for the purpose of land record administration. The individual effort leads to two important things. One is the huge investment for the common purpose, and the other is influence of local administration procedure of the state made the facility state dependent.

Other similar compartmentalized examples: The organization like Directorate of Technical Education is controlling the total admission procedure for the courses like B.E. and M.B.A. The MKCL has developed e-project for this purpose. The database developed during this process by DTE is not accessible for the reporting purpose to the A.I.C.T.E. So, the efforts are required to be duplicated for the

Table 1 Showing individual efforts in different states for similar need

State	e-Project	Service
Karnataka	Bhoomi	Allows computerized easy access and facilities for 'mutations' and updation of land records for the farmers in an efficient and transparent way
Andhra Pradesh	Bhu Bharati	An integrated land information system has been piloted in Nizamabad district
Gujarat	E-Dhara	Enhances complete computerization of land records across the state. Elimination of manual records and computer-controlled mutation process
Madhya Pradesh	Bhu-Abhilekh	It is an application software product designed and developed by NIC for the office of the commissioner, land records and settlement, Department of Revenue, Government of Madhya Pradesh to deliver excellent grass-root governance within the domain of land management. Records of 35 million khasra (plot/survey) numbers comprising of 10.5 million land owners have been computerized, till date
Maharashtra	SARITA	It is a G2C-U project with an aim to design, develop and implement a computerized application for registration of documents, received at each Sub-Registrar Office and provide data updation on timely basis to their respective Joint District Registrars and higher offices under the purview of Department of Registration, Pune, Maharashtra State
Tamil Nadu	e-Services	Welcome to anytime/anywhere e-Services of Govt. of Tamil Nadu. Users can view the Patta Copy (Chitta Extract) and A-Register Extract for the agriculture land

similar purpose. The database of universities and the DTE and AICTE have the compartments so their usability is restricted and requires double effort.

7 Few Initiatives in This Direction

Public key infrastructure (PKI): The Indian state of Uttaranchal is developing a central data repository and a public key infrastructure (PKI) to make it easier for its citizens to access government e-services (India State to Create Central Citizen Database 2006). The project is financed to the tune of US$3 million (US$1.9 million) by the state of Uttaranchal. Uttaranchal, in north India, is home to eight million citizens and 109 government departments. The project will consist of three parts – a household survey, design and implementation of the repository or Citizen Data Vault and the development of PKI for citizens to access government services online or via public kiosks. The sharing of information in turn will enable the deep integration of government processes so that e-services can be designed around the lives and needs of citizens. Citizens can enjoy reduced processing times, less paperwork and bureaucracy and improved standards of service.

Aadhaar: The unique identification number (Aadhaar) was conceived by the Indian government as a means for residents to clearly and uniquely verify their identity anywhere in the country. The mandate for the UIDAI includes defining the usage of the number across critical applications and services (Notification – Constituting the Unique Identification Authority of India'). The Public Distribution System is one such application, and the UIDAI has accordingly laid out the potential role Aadhaar can play within the PDS.

The expectation from the de-compartmentalization of the e-governance projects developed for the state citizens should be utilized for the Indian citizen. If a common man needs some financial loan or a retired person wants to apply for pension, he/she should be able to apply for the same through Internet centre without physically going to the required office. Going to a government office for a small task and waiting for a long time could be a tiresome job and should be kept away.

8 Conclusion

The idea mooted by the government and initiatives taken by the different state governments in India is worth to praise. States are also motivated for such efforts by giving best project award by the government. In some cases, the financial backing extended by World Bank, central government, or state government itself and somewhere through public support. As the idea being an innovative, eye-catching due to the use of computer technology and rewarding effort because it is for the benefit of peoples in India, the real problems like cost overrun, uniqueness and citizen centric are overlooked. All the states are putting their efforts and all their resources for developing better and better e-governance project for their own state which is the common problem for all the states. The same problem becomes the reason for the failure of some projects, and the projects are required to be withdrawn without making any discussion on why the project fails. So, to stop the mis-utilization of the e-governance projects, it is required to remove compartmentalization between the state to state and e-governance project to project.

Compartmentalization issue is unknowingly wasting money, efforts and the resources of the government. So, it is required to develop the best e-governance project for the particular service for the peoples in all the states and then link all such projects together to make centrally governed e-governance project.

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Project *Nemmadi*: The Bytes and Bites of E-Governance in Karnataka, India

Madhuchhanda Das Aundhe and Ramesh Narasimhan

'No Nemmadi[1] *at these centers' was how the popular daily newspaper of Bangalore chose to characterize the status of the high-profile e-governance initiative called 'Nemmadi', of the Government of Karnataka.*[2] Mr. Naveen, the new principal secretary, e-governance, Government of Karnataka, browsed the report, folded the newspaper and kept it aside. There were reports, in the past, of the private partners not meeting their obligations laid down in the public-private partnership (PPP) contract. A few days ago, there was a report in the press that the state of Karnataka was slipping in the ranking on e-governance in India. Naveen had been summoned by the office of the chief minister (CM) for an emergency meeting after lunchtime, to be attended by the senior officials of the concerned departments—e-governance, IT and revenue. A high-profile public project like Nemmadi was fraught with high stakes in a democratic system. Naveen quickly weighed the options in his mind. Nemmadi had to continue since it was addressing a real need of the rural citizens of the state and for the same reason also enjoyed strong political backing. He reasoned that the degree and depth of adoption by the user departments would improve the situation. But he did not have direct control over them. He wondered if everything was right with the PPP model, which was being attempted for the first time for such a large-scale project. He knew it was quite complicated to change the rules of the game midway. Naveen felt that the situation might stabilize over time as the various actors involved in the process

[1] Means 'peace of mind' in Kannada, the language spoken by the majority in the state of Karnataka.

[2] Deccan Herald, Bangalore, 30 August 2009.

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adapt and adjust to the new ways of doing things. He was aware of the challenges in harnessing IT for improving the process of governance, especially in a democracy. Mr. Naveen had, after all, served in the Department of IT, when the concept of e-governance was in its infancy. He knew that a lot of ground had been covered since then. He also knew the road ahead for e-governance was long and hard to travel. *Nemmadi* was an important milestone. He picked up the paper again and read the report in detail. Mr. Naveen decided to meet with his team to discuss the issues and prepare for the crucial meeting with the CM.

1 E-Governance in Karnataka

Karnataka had been a pioneer in e-governance in India. The e-governance strategy for Karnataka was unveiled in the year 2000, even before the NeGP[3] was in place, as part of the IT millennium policy. A detailed action plan supported this strategy. The goal was 'to enhance the use of Information and Communication Technology (ICT) in the functioning of the government in order to make required information available to all citizens and to provide all services in an efficient way and identified services on an online basis'.[4]

The e-governance department was separated from the Department of IT in 2003 and merged with the Department of Personnel and Administrative Reforms (DPAR), more popularly known as General Administration, in other states. In Karnataka, the Centre for e-Governance (CEG) was established as a society by the Government of Karnataka under e-governance secretariat, DPAR. The Centre for e-Governance is an autonomous and independent body specially formed to implement and monitor various IT-enabled services and e-governance initiatives. Karnataka is the only state, which thought e-governance should get proper amount of focused attention and decided to have a separate department.

The other entities of the e-governance department were the secretariat, which is the policy-making body, and the directorate of electronic delivery of citizen services (DEDCS), which is responsible for the operational administration of the e-governance projects. Besides the CEO of CEG, the heads of the secretariat and the DEDCS also reported to the principal secretary, e-Governance Department, Government of Karnataka.

[3] NeGP is the National e-Governance Plan unveiled by the Government of India in 2006, which has, since then, been guiding the formulation and implementation of the e-Governance projects by various state governments.

[4] Details of the e-governance strategy for Karnataka can be accessed at http://www.bangaloreit.com/, accessed on 15 December 2009.

2 Nemmadi Project

Nemmadi was the first and the largest G2C[5] e-governance project which offered to rural citizens a range of 38 services such as RTC,[6] caste, income, residence, birth, death, etc., certificates, through 800 telecentres[7] located at hoblis,[8] across the state. These certificates enabled the citizens to apply for benefits under various government schemes, apply for admission to educational institutions and government jobs, etc.

2.1 Motivation

The first attempt at e-governance in Karnataka was made in 1998 and was called Bhoomi. The Bhoomi initiative consisted of creating a database of computerized land records. Through this initiative, 20 million records of land ownership of 6.7 million farmers in the state were digitized. The farmers could obtain online printed copies of the rights and tenancy certificate (RTC) through telecentres in 177 taluk offices. Mr. Shekhar, the then principal secretary, e-governance, had single-handedly spearheaded the Bhoomi project. He *was* the main force behind Bhoomi. The trigger had been provided by the then chief minister and had been taken up by Shekhar very seriously. He was involved in it right from the inception to the details of execution. Bhoomi had become synonymous with the person.

The Bhoomi project became a sort of benchmark in the study of e-governance and ICT for development. The project was picked up as an object of study and attracted the media, the international scholars and many students to it. Most of the studies praised it as a success, though there were several critical ones too. One of the main reasons of criticism of Bhoomi was the cost and time overrun. By 2004, Bhoomi was on autopilot.

Project Bhoomi centralized land records at the taluk level. This required villagers to travel up to the nearest taluk, which could be a very long distance from the villages, to get the RTCs issued. Hitherto, the village accountant (VA) in the village issued the RTCs. The citizens would ‘pay’ the VA and get the RTCs issued. Now, they had to go all the way to the taluk office to get the same issue on payment of a fee. There had been complaints about logistics problems. Citizens wanted the delivery points to be at a closer proximity. This would also meet with the government vision of getting ‘closer to the citizens’. To improve their reach, the

[5] Refers to information, interactions, transactions, etc., between the government and citizens.

[6] Rights and tenancy certificates pertain to land ownership and play a vital role in the life of farmers, for security of tenure, seeking crop loans, and bail in crime cases. This also helps Revenue Administration and the private industry in agribusiness in planning.

[7] Telecentre is a kiosk where the citizen interface takes place—from the application for a service to its final delivery kiosks where citizens-related services are rendered.

[8] Cluster of 3–5 villages.

state government put in place a rural telecentre project, with the plan of locating the telecentres at a hobli level. The rural telecentres would not be viable with Bhoomi services alone being available on them. Therefore, Shekhar thought, other RDS[9] services, for which the citizens had been travelling to the taluk office, could also be offered through these telecentres. This would make the telecentre viable and at the same time serve as a single window for all the services. This arrangement would ensure *Nemmadi (peace of mind)* for the rural citizens. Thus, Nemmadi project was born. Buoyed by the success of Bhoomi, Mr. Shekhar took it on himself to find out more and identify every facet of service required by the villagers, which could be integrated into a village centre of information.

In May 2003, Shekhar engaged the National Informatics Centre (NIC) to conduct a preliminary study to identify the services, which could be offered to the citizens in rural Karnataka. The NIC, a Government of India organization under the ministry of IT, was entrusted with the task of supporting the government—both central and state—with services related to consultancy, development and deployment of ICT software and hardware. Its study revealed that around 40 services were being availed by the citizens at the government offices. There had been increasing demand for these services, beginning with the RTCs (under Bhoomi). This time, he also wanted to ensure that he did not repeat the mistakes made in Bhoomi. One of the major criticisms of Bhoomi was the time overrun. Therefore, to take care of that, Mr. Shekhar was convinced, and this issue could be addressed by involving the private sector in the project. As per him, what was needed was private sector partners with energy and enthusiasm to take up this task and give it the speed and vitality that, according to Shekhar, only the private sector could bring. Nemmadi's model, right from the beginning, was broader than that of Bhoomi. The concept of a rural centre, which would integrate 38 services, is accessible at hobli level and work without much government involvement while giving employment was immediately appealing. With Bhoomi, Mr. Shekhar had learnt how to make things happen. He gave Nemmadi all his energy and the benefit of his experience. He decided that the telecentres would be set up by the private entrepreneurs at the hoblis and a fee of Rs. 10 per certificate would be charged to the citizen. The government would provide the stationery, and the private party would provide the required infrastructure, which would support the delivery of these services.

2.2 Process and Technology

The e-governance department of Karnataka assigned the requirements analysis and design of the Nemmadi project to NIC. Besides, the analysis and design NIC was also asked by e-governance department to execute a pilot project at Maddur.

[9] Rural digital services is a generic term applied to any electronic service delivered to citizens in the rural areas.

Each Nemmadi telecentre had a desktop computer system, peripherals and a human telecentre operator. Besides the telecentres, Nemmadi also consisted of 176 Rural Digital Services (RDS) back offices at the taluk[10] level, where the citizen requests for services were processed. Each telecentre at hobli level was connected to the nearest RDS back office. All RDS back offices and telecentres were also connected to a central database at the State Data Centre (SDC) in Bangalore. The telecentre was not connected directly to the taluk server. All exchanges of data between the two happened through the SDC. This was designed for reasons of security.

A taluk back office could service more than one telecentre. The back office was headed by tahsildar,[11] who was assisted by a group of functionaries: (1) village accountants (VA) and revenue inspectors (RI) at the field level, (2) caseworkers at the taluk office level and (3) a back-office operator. VA collected citizen-related data, which was verified and attested by the RI. Caseworkers processed the citizen applications and provided comments and recommendations to the tahsildar regarding issue of certificates. The tahsildar was the final authority and the signatory for the issue of certificates.

A citizen visited the telecentre with a request for a certificate. The telecentre operator entered the oral request of the citizen into the system, in the required format. If the certificate had been previously issued, the operator connected to the SDC gave a search based on the key field and recovered the existing valid document from the SDC database. He issued a print of the same to the applicant.

In the case of a new application, the application along with the necessary documents was scanned and saved. The telecentre operator to the SDC uploaded the soft copy of the application. The operator at the back office in the taluk received the soft copy of the application by downloading from the SDC. The back-office operator also received the hard copies of the applications, which were delivered to him from the telecentres. He matched the hard copy and the soft copy of the application. He checked the attached documents submitted. He then sorted out the applications by moving them to respective revenue inspector (RI) login.[12] The RI referred cases to village accountants (VA) if necessary and provided field verification reports, manually, (signed physically by VA and RI; in some, hoblis digital signature of RIs was also implemented) to the back-office operator. The back-office operator accepted field verification reports and moved the corresponding applications to the caseworker login.

The caseworker entered the field verification reports into the system, generated the office note and gave his comments and recommendations. The back-office operator then moved application along with the office note to tahsildar login. The tahsildar digitally signed the certificate, and it was printed (see Fig. 1 below for the process).

[10] Subdivision of a revenue district in a state.

[11] Tahsildars are government functionaries in charge of tahsil or taluk which is the lowest unit of administration in a state.

[12] ‘Moving to a particular login’ refers to authorizing the concerned person for further processing in the system.

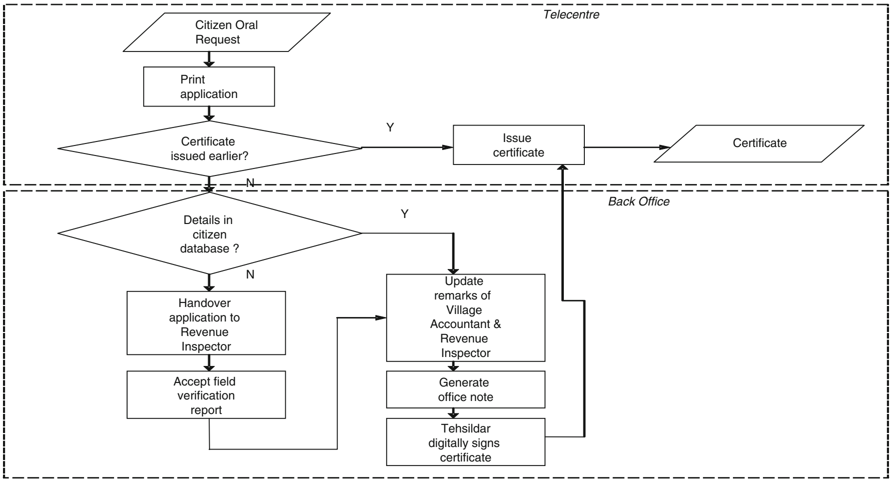

Fig. 1 Process flow of Nemmadi

Once digitally signed, these certificates were uploaded to the SDC and printed from the telecentre. The certificate, thus generated, contained a bar code, which represented a digital signature. Nemmadi also intended to incrementally build a citizen database. As part of servicing a request, the details of all the family members of an applicant, such as caste, occupation, income, etc., were collected and stored at the SDC.

2.3 *Pilot Project*

The e-governance department began the telecentre initiative in 2004 with a pilot project in Maddur, a town in Mandya district. The pilot project was executed by NIC. A prototype of two services was built first and demonstrated to a committee comprising divisional commissioners,[13] tahsildars, caseworkers and a few representatives from the industry. The services were, then, improved and piloted in March 2004. Karnataka had some existing telecentres set up by an organization named N-Logue Communication,[14] as proof of concept of telecentre technology, and were used to deliver telemedicine services. Shekhar (who was then the principal secretary of e-governance department) wanted to utilize the ten extant telecentres of N-Logue which were being run by local entrepreneurs to offer

[13] Divisional commissioners are government functionaries who are responsible for the revenue administration of two or more districts.

[14] N-Logue was an organization set up by a professor and his team from IIT, Chennai (a premier engineering college in India), which used WLL technology to deliver telemedicine services.

telecom and telemedicine services using the WILL[15] technology. These existing telecentres were used by NIC in the pilot project of Nemmadi. The connectivity to the server was established using the WLL technology solution. NIC also developed a communications framework application to link Nemmadi's telecentres with Bhoomi's database. In 2005, another 14 services were added to the two services piloted in Maddurtaluk of Mandya district. The pilot showed a success of the technology, paving the way for the roll-out of more telecentres.

2.4 Roll-Out of Telecentres: Public-Private Partnership

A big bang approach for setting up telecentres was envisaged by Shekhar, to cover 800 hoblis across Karnataka within a period of 4 months. Shekhar had planned private sector involvement to address the time overrun issue he had faced in case of Bhoomi. Therefore, he floated a request for proposal (RFP) for a vendor who could set up all the telecentres. There were several players, including established large players, who responded to the RFP. However, the deal was bagged on the basis of lowest price quoted in an open tender (in both zones of the state—north and south) by a consortium of three organizations—3i Infotech, Comat Technologies and N-Logue Communications.

3i Infotech was a global information technology company, which provided technology solutions to over 1,500 customers in more than 50 countries across 5 continents, spanning a range of verticals—banking, insurance, capital market, mutual funds and government. It was promoted by the NYSE-listed ICICI Bank, India's largest private sector bank. Comat Technologies was a private equity-funded organization. It was an IT software services organization at its inception in 1996. The initial investment of Rs. 30 crore had come from the consortium and the state government, with 3i Infotech bearing almost 90% of the cost. This amount was intended to cover the costs of all equipment, connectivity, VSAT operations, real estate leasing, power, UPS and peripherals. Comat was responsible for all the operational aspects of Nemmadi.

Comat began the roll-out of telecentres in November 2007. Hughes Communications (a telecom equipment-providing company) was also involved for providing VSAT[16] connectivity. In the first round, 740 telecentres were to be set up. 'Setting up a centre was not simple', Mr. Sanjay, VP Comat recounted.

[15] Wireless in local loop (WILL) is a telecommunication technology developed and patented by Prof. Jhunjunwala in IIT, Chennai. This technology is expected to be cost-effective and hence appropriate for application in rural India.

[16] A very small aperture terminal (VSAT) is a two-way satellite ground station equipped with a dish antenna and is used to provide internet connectivity.

We had targets like - 100 telecentres in the first month, 250 in the second and so on. We formed a Planning & Implementation Team to shortlist 2 or 3 locations in each hobli. The SLA requirement was 150 sq. ft. with a pucca[17] roof, and on the ground floor, near a bus stand or a gram panchayat office etc. There were no pucca buildings at all in many hoblis! If we did shortlist some locations – by the time we went back for negotiation, the place was not available! The moment they came to know it was a government project with some private partner, they would back out. On one side, our meter was running – monthly targets were laid down. Till long after, we were paying penalty despite the fact that we declared that there was no place of 150 sq. ft. space as per the SLA, in that particular hobli. Nobody anticipated these – no one has implemented a project of this kind. Just setting up 800 centers in 4 months flat was a humongous exercise.

There were several ordeals for Comat. For the roll-out of telecentres, Comat had to work with the VSAT vendor—Hughes Communication Ltd.—as well. VSAT vendor required the telecentre location to be registered (i.e., defence clearance obtained). VSAT connectivity could not be provided without proper earthing. For Comat, earthing was a major issue, as in the hobli areas, as there were no skilled people to do it. People had to be called from the taluk/district HQ to do the job. If a Hughes engineer (VSAT required a special engineer to instal!) visiting a location found that the earthing was not done, he proceeded further, as per his schedule, and visited again only in the next cycle. This delayed the setting up of the telecentre. Identification of telecentre locations, by itself, was very difficult, and then Comat had to synchronize several activities—registration, earthing, VSAT connection, etc., each performed by a different agency.

Comat had also to ensure that all the centres look the same—brick and mortar structure with a counter. It had to come out with a standard format of agreement with the landlords (11 months only and 3 months renewable); getting that accepted over so many locations was a challenge. There was a political angle, as well; if the telecentre location happened to be in the opposition party's stronghold, Comat faced added issues.

In the roll-out phase, 755 telecentres were made operational with rural digital service provided across 55 taluks.

2.5 Operations of Telecentres: Public-Private Partnership

Besides the roll-out, Comat was also responsible for the day-to-day operations of the telecentres. The role of the state government was limited to providing data and connectivity only. Comat was supposed to build, own and operate the telecentres for the first 5 years of the implementation. Nemmadi was governed by comprehensive service-level agreement (SLAs) signed between Comat and the e-governance department of Karnataka. For example, telecentre operators (of Comat) had to bank the cash collected within 2.5 days. The reality at the ground level was very different from the terms of the contract. More than 60% of the telecentres did not have banks within 15 kms, and it took the telecentre operator half a day to do this job. The operator, while

[17] Firm or permanent roofing, as against roofs of straw and leaves found on huts in villages.

doing the bank deposit work, missed the mandatory hourly 'ping' and had to pay penalty for the same. Sanjay said '*Despite our bringing the matter to their notice, the e-governance department continued to hold on to the SLAs in the RFP*'.

The other telecentre operations issue faced by Comat was the economics of cash management. Cash deposit in a non-home branch of the bank attracted additional deposit charges of Rs. 10/Rs. 15 per transaction. This meant that even if there was a bank near the telecentre if it was not a home branch (say, a Grameen Bank branch), Comat lost the transaction amount.

Besides the items of agreement on the operational front, Comat ended up supporting caseworkers, revenue inspectors and even the tahsildar in the taluk office for interfacing with computers. Regarding this Sanjay, VP Comat said:

> *This was just a gesture on our part to increase adoption of technology and therefore, Nemmadi. However, this was often not acknowledged and we ended up doing a thankless job.*

When asked about the SLAs, Sanjay said:

> *We should have been given some leeway in SLA formulation. It should have been a consultative and dynamic process rather than a rigid one like it was. Looking at this mammoth project and its nature, the government should have made some allowances for a dynamic relook at SLAs. Penalty meter was running, and the government was not accessible at all for any discussion.*

Attrition among telecentre operators was a big issue that Comat faced on a regular basis. Motivating people to return to work every morning took a lot of the Comat team's energy. There were technological challenges too. Since this was a multi-tiered operation, multiple interface programs (software) were required. NIC had provided some of the interface software (esp. for the RTCs), but some had to be developed by Comat—the global services infrastructure (GSI) that provided a common platform to deliver the diverse services. This also enabled both online as well as offline (by writing data into the local queue) operation of RDS. Once online, the queue was synchronized with the central database at the SDC. Comat also developed an asset tracking system for tracking consumables—like printing paper—as well as the cash collection.

On the experience in the Nemmadi project and whether it made business sense for Comat to continue the engagement, Sanjay observed:

> *It was a learning experience for all concerned. The process of SLA formulation and negotiation should have been friendlier. The period of contract should be longer. Three years have gone just discovering the engagement. By the time one figures out the nuances, the contract period would be over, and if we were not chosen in the next phase, the entire engagement would not make any business sense for us. Over the long run, it may make business sense, but for that the contract period should be longer than 5 years.*

2.6 Monitoring of Telecentres

The Karnataka government set up the Nemmadi monitoring cell (NMC), which received 3% of the share of all B2C and G2C service charges of the telecentre activities. The NMC team consisted of six members, largely, on contract from reputed private organizations—a project manager (on contract from a private consulting company), a deputy and 3 or 4 testers. The team had no one from the government. The contract employees worked full time with the government and were given salaries in line with the private sector. The NMC reported to DEDCS, and the latter was responsible for the monitoring of Nemmadi among other e-governance projects of the state. For complains related to employment, training, or infrastructure at particular telecentres, DEDCS called upon the private partner (in this case, Comat) to sort the issue out. Besides regular monitoring, if any government department (e.g., Agricultural Department) wanted to add a service (e.g., commodity price), they came to DEDCS and discussed. Based on the requirement, if some software needed to be developed, DEDCS got it developed either by NIC or any other private IT organization.

Collection from Nemmadi was also handled by DEDCS. As per the agreement, whatever proceeds the telecentre operator collected had to be deposited within 2.5 days in a special account created for this purpose. Ms. Latha, asst. director, DEDCS, said:

> *We monitored every transaction and the total amount. The private partner could retain as per a slab rate– say 60% could be retained if the revenue is in a particular slab. SLA terms were strictly enforced. Penalty was levied on the basis of attendance. The operator's attendance was recorded bio-metrically. If the money collected was not deposited in time, interest was levied. Software applications were used to calculate the penalty per telecentre. G2C accounted for only 40% of Nemmadi's revenue came, B2C services contributed the rest.*

Besides the above monitoring mechanism, DEDCS instituted a third-party audit conducted by independent organizations like NIC, STPI, Keonics,[18] etc., to deal with continued complaints of deputy commissioners, tahsildars and public regarding delays, operator training, infrastructure, etc.

3 The Nemmadi Debate

Nemmadi project dated back to pre-NeGP years, but anticipated several of the mission mode projects declared by NeGP later; hence, its relevance continued. Nemmadi invited both bouquets and brickbats. The e-governance project had bagged three prestigious awards[19] during 2007–2008, in less than a year after it

[18] STPI—Software Technology Parks of India (STPI)—is a society set up by the Ministry of Communication and Information Technology, Government of India in 1991, with the objective of encouraging, promoting, and boosting the software exports from India. Karnataka State Electronics Development Corporation Limited (KEONICS) is in existence since 1976 with the main objective of promoting electronics industries in Karnataka.

[19] National Silver Award for e-Governance, 2007–2008; Microsoft Award for e-Governance, 2007; Government Technology Award for e-Governance 2007; Microsoft e-Governance Award—IT for Rural Development, 2007.

was launched in October 2006. The citizens, the most important stakeholders of this project, had mixed opinions. Some praised the system as very convenient. Students did not have to miss school to obtain caste and income certificates; they put in an application at the telecentre and then came back to collect it. The telecentres were single window for certificate procurement, train ticket booking, mobile recharge, etc., and thus made life easy. There were others who complained about longer cycle time—earlier, the VA could provide the certificates in 3–4 days; now, the process did not take less than 2 weeks. There were complains about the whole process having become more cumbersome for users. Citizens also complained about lack of facilities at the telecentre.

The government had its own take on the Nemmadi project too. The e-governance department saw some major benefits of Nemmadi.

- Establishment of 800 telecentres had provided a good start—demonstrating the concept.
- The reduced role of village accountant and revenue inspector and the availability of an affordable alternative channel had benefited villagers.
- Awareness, literacy, and empowerment of villagers was itself a great additional benefit.
- First time creation of data and its validation was a major challenge, but repeatability of data was assured.
- It fits in neatly with NEGP. In fact, it had been a forerunner of CSCs, and CSCs in NEGP were derived from the Nemmadi success story.

The e-governance department's view was that, gradually, over time, Nemmadi would cleanse the corruption in the system. The government, thus, claimed that while the VA could not be completely done away with, as they had been in the system for more than 150 years, their efforts would be used in the creation and validation of the database. The tahsildars of various taluks also felt that Nemmadi was in a stage of infancy.

NIC, as a technology provider, had mixed feelings too. It appreciated the technological challenge in the size of the project and felt, eventually, it would help citizens. However, it was not very happy with the government's lack of attention to the inefficiencies in the processes and indecisiveness when the matter was raised. NIC had its misgivings—whether Nemmadi could ever be successful without addressing the process issues.

The private partners of Nemmadi had mixed opinions too. They felt that the government made undue demands and was rigid in its stand in the project. While in the long run, they felt they might benefit from the project; at that point, they were not sure of a meaningful business outcome.

4 Way Forward

Naveen, when he took charge as the new principal secretary for e-governance, was mandated to restore the state back to its No.1 position in e-governance. Nemmadi was his debut project. He went over some key points before his team meeting. In Nemmadi, while the infrastructure had come into place in quick time, the process of change had not been as quick. However, citizens were gradually getting familiar with the system. With that, the roles of village accountants and revenue inspectors would get marginalized. The technological hurdles of interface software had been surmounted. The process changes were, however, not in place. The relationship with the private partner was shaping up. The monitoring mechanism was in place; SLA issues needed more effort. The citizen database was getting built. With these thoughts, Naveen entered the meeting room, where his team had already assembled. . ..

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An Empirical Investigation into the Extent of Green IT Practices in Sri Lanka's Data Centers: A Case Study Approach

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1 Research Background and Objectives

Green computing, the consumption of eco-friendly computing resources, is now under the attention of environment agencies and businesses from diverse industries. Mainstream corporate initiatives to "go green" are evolving from efforts to conserve the environment by reducing carbon footprint. Computing and IT establish ments around the globe are particularly focused and alerted to go "green." Green computing refers to "supporting business critical computing needs with least possible amount of power" (Wang 2007). Harmon and Auseklis (2009) defined green computing as the "practice of using computing resources more efficiently while maintaining or increasing overall performance."

Benefits of green computing do not limit to ecological advantages. Today, IT investors and customers started exhibiting an interest of knowing a company's direct and indirect carbon footprint in terms of greenhouse gas emissions (Kurp 2008). Greening helps businesses to achieve competitive advantage. "Going green offers a vital new path to innovation and to creating enduring value and competitive advantage" cited Esty and Winston (2006). Murugesan (2008) affirmed that IT businesses can reach competitive edge by adopting green IT practices, and IT sector as a whole has a responsibility to help to create a more sustainable environment.

The electricity consumption by data centers in the USA as of 2006 was about 61 billion kilowatt-hours (kWh) which is "1.5 percent of total US electricity consumption," and this continued to grow (EPA 2007). The large amount of digital data

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generated by various industries requires massive storage, processing, and transfer facilities in data centers hosted in-house and remotely. Koomey (2008), as summarized by Paivarinta (2009), recognized that servers around the globe said to consume more than 100 TWh per year, which is more than the amount of energy consumed by Finland per annum. Heavy electricity bills in data centers mark significant expenses in enterprises to supply their ever-growing computing needs (Poess and Nambiar 2008).

For most of service sector businesses, data centers contribute to the highest GHG emissions, and if efforts are not taken to restrain emissions, it can be projected that global carbon emission of data centers to quadruple by year 2020 (Forrest et al. 2008). Such circumstances illustrate the importance of applying green practices in data centers. By employing green practices, “HP was able to decrease the number of servers by 40% while increasing processing power by 250%” (Tang 2010). Although the green endeavors in data centers are popular in western world, still research attempts kept to a minimum in local context. Today, Sri Lanka is rushing toward industrialization and also facing difficulties to supply power demand and tolerate the hike of energy costs. Gartner (2008) reported that “The total data center capacity in India is expected to reach 5.1 million square feet by 2012 and is projected to grow 31% from 2007 to 2012.” Several reports testify that India and Sri Lanka have the possibility of emerging as central data hubs and disaster recovery centers in the region.

The objective of this study is to explore the extent in which data centers in Sri Lanka apply a selected set of green practices in data centers. Nine cases were carefully chosen and studied from Sri Lanka’s financial sector, to develop comprehensive knowledge to determine the extent that they follow green practices. Degree of implementation was assessed by studying perceptions of IT managers from chosen institutes by qualitative methods.

2 Data Centers and Green IT Practices

A data center is comprised of the network, physically and virtually everything attached to it (Lyke and Cottone 2000). Arregoces and Portolani (2003) defined a data center as a “controlled environment” under “centralized management” that hosts critical computing resources, which enable business needs of the enterprise to run “around the clock.” The smallest data centers are of the size not much larger than a single rack while the biggest spread over thousands of square meters (Paivarinta 2009). Server racks in data centers are usually “6 to 8 feet tall… 6 square feet (2 ft $\times$ 3 ft)” of floor area, and the main computer area of a data center is a raised floor elevated so that “cool air can be blown in from under floor air ducts” (Mitchell-Jackson 2001). Raised floor space demands high costs and requires efficient space utilization.

Raised floor area could differ in various physical data center implementations, but in average, 50–55% of the energy density of a data center is absorbed by its computer equipment (Blazek et al. 2004), and the rest is accounted for cooling/ventilation/power supply and other physical components. The aggregated power use by data center IT equipments reported as "0.5% of world electricity consumption in 2005" (EIA 2006) added the cooling and other physical factors that figure rise to 1% (Koomey 2008).

A data center primarily comprises three variations of electrical equipment including servers, data storage equipment, and network equipment. Barth (2010) divides energy consumption of a data center into two categories: "physical" and "logical." The physical energy consumption includes power supply, AC/DC conversions, cooling, heating, and ventilation. Logical energy is consumed by servers, data storage, and network equipment. It is a common norm that 33–50% of data center power is consumed by physical devices which also indicate that 50–67% of a data center's power is consumed by logical side.

In traditional servers, even at times, the processors are idle, or less active surprisingly servers would still consume a substantial amount of power and release heat (Loper and Parr 2007). Albers et al. (2007) discussed two mechanisms "speed scaling" and "sleep states" to save processor energy at algorithmic level. The speed-scaling technique adjusts the speed of a processor on demand dynamically. The sleep-state technique shifts the server to a low power sleep-state when it is idle. In an average, a server would utilize about 30% of its peak electricity consumption when they are sitting idle (Poess and Nambiar 2008). Due to this fact, demand-driven clock speed adjustments in server processors are being popularly equipped by many vendors. A server with demand-driven options speeds up the system clock in active states and slows down the clock in inactive states, reducing energy wastage. Another green feature that can be adopted by data centers is upgrading traditional large-scale servers to standard-based servers and blade servers (ibid.).

In a virtualized data center, "one physical server hosts multiple virtual servers" (Murugesan 2008). Virtual machines operate in just the same way as physical servers by virtual networks and file systems (Heiser 2008). Consolidating virtual servers improve and simplify the "physical server infrastructure" of a data center by limiting server resources to few powerful servers that consume low power (Murugesan 2008). Benefits of virtualization include achieving quality of service, load-balancing across clusters, power management in clusters (Heiser 2008), better hardware usage, and reduction of data center floor space (Murugesan 2008). Some developers "differentiate their products based on the energy demands that result from their code" cited Loper and Parr (2007). Strong software algorithms reduces processing requirements by eliminating redundant processing and accomplish a low-power consumption. Producing energy efficient software is rapidly catching the attention of software developers. Well-designed software takes benefits of server capabilities and delivers improved green performance (Intel 2006).

"The storage subsystem is the largest power consumer," argued Poess and Nambiar (2008). Reduction of number of disk drives in storage subsystems could considerably reduce power consumption. Efforts to spin down disk drives have been significantly discussed by researchers. Large form factor (LFF) disk drives consume about 12 W per read/write operation, but small form factor (SFF) disks consume about 8 W. Surprisingly, NAND-based solid state disks (SSD) with no moving heads said to consume only about 0.03–0.06 W per read-and-write operation (Poess and Nambiar 2008). Today, several low-power viable storage technologies such as flash memory and micro-drives have been widely accepted to meet “ultra-low idle current and high capacity” (Mathur et al. 2006). Although the industry forecasted the downfall of magnetic tapes from quite a time, Chuan (2009) claimed that “tape continues to flourish as the preferred technology for long term data storage” due to significant eco-friendly attributes of tapes. Application of efficient data compression methods significantly reduces number of disks needed to store data, improving query performance and memory efficiency (Poess and Nambiar 2008).

Green IT begins with green data, but around 60% of the capacity of an average disk simply stores “stale, duplicated, contraband, or useless data” (Green Data project 2007). Improved application management would optimize server requirements and storage needs reducing power consumption for storage systems (Loper and Parr 2007). Every data center must take initiatives to manage their information life cycle. In an average organization, the probability of re-reference of data created in the same day is about 70–80%, chance of re-reference of data that is 3 days old is 40–60%, 7 days old data, 20–25%, and 1-month-old data is 1–5% where 3-month-old data re-reference rate is nearly 0% (Clarke 2010). Information life cycle management includes various strategies to manage data throughout data lifetime from data creation, active data use, semi-active use, and finally disposal or preservation (McDonald et al. 2010).

All energy efficient methods used in logical side reduce the load to network equipment. Network hosts consume large amount of power to keep “idle or unused network hosts fully powered-on only to maintain their network presence” (Jimeno and Christensen 2008). Low-cost, nonintrusive network monitoring technologies such as wireless sensor networks (WSN) provide wider network coverage and optimize energy consumption of network equipment in a raised floor (Liu et al. 2008).

Around 40% of power consumed in server farms accounted to A/C and ventilation facilities to safeguard equipment from overheating. “Computer room air-conditioning (CRAC) units blow cold air into the plenum, pressurizing the space under the racks and forcing cool air up through perforated floor tiles” (Beck 2001). Variable speed cooling systems can be designed in a “modular fashion” in which extra modules are activated when cooling requirements increase and some modules are deactivated when cooling needs decrease (ibid). Cooling capacity must match IT loads of the data center, and CRAC unit temperatures and humidity setting should be carefully handled, and “hot spots should be eliminated, and proper air velocity provided, while ensuring that all air vents are properly located” (McNamara et al. 2008). McNamara et al. further identified that “using blanking panels to limit hot air/cold air recirculation, having door ventilation on cabinets (no glass doors), unrestricted airflow in the back of the cabinets, and no shelves to block airflow” are the best practices in airflow management.

The “lights out philosophy” would work better in data centers to provide lighting only when it is required. “Standard lighting controls in combination with more sophisticated building management systems can easily achieve a 50% reduction in lighting electrical energy use” (Tschudi et al. 2004). The lighting energy cost can be reduced by inexpensive methods such as making use of "active sensors" to switch off lights when data center is not occupied and "design light circuiting and switching" to allow labor-intensive control (DCEM 2010).

Reviewing technical literature, we identified 15 standard green practices that are applied in green data centers at a global level as indicators of implementing green practices.

3 Research Methodology

This research is exploratory in nature. In researches with limited empirical evidence, "it is too early to develop testable hypothesis," argued Wong and Boon-itt (2008). Flyvbjerg (2004) criticized that "the case study is a necessary and sufficient, method for certain important research tasks in the social sciences, and it is a method that holds up well when compared to other methods in the gamut of social science research methodology." A case study approach is best suited when the scope of the study area is not well defined and when "there is no control over behavioral events" (Azevedo et al. 2011; Perry 1998; Rowley 2002). This study is scoped to one industry in a single country due to the fact that institutional norms could change from country to country and industry to industry (Kostova and Roth 2002). This research does not clearly define the variables of study. It was difficult to identify relationships between variables from past literature, and also, the research boundary for this research was vague in nature. For these reasons, a case study approach is chosen for this study.

Going in line with the latest research "the influence of green practices on supply chain performance" by Azevedo et al. (2011), this research explores the implementation extent of different green practices in the target industry. Anonymity of the company and respondents is kept to eliminate preconception and biasness of response.

Different analytical procedures assist during case study plan stated Yin (2004). "One possibility is to stipulate some pattern of findings at the outset of your case study. Your analysis would then consist of the analytic technique of *pattern-matching* the collected evidence against the initially stipulated pattern" (ibid). Based on the research methods adopted by Azevedo et al. (2011) and Wong and Boon-itt (2008), cross-case synthesis is employed to analysis individual case studies scrutinize across various cases in this research. Cross-case study analysis techniques do not come with any formulas, but statistical calculations and structured equation models can be used for evaluations (Yin 2004). This research adopts cross-case evaluations followed by fitting equation models.

3.1 Data Collection

A series of in-depth interviews were conducted to understand the current practices carried out by top level IT decision makers of data centers under study. Nine semi-structured interviews were carried out with IT heads of nine organizations.

A semi-structured interview “has a series of themes to be covered, as well as suggested questions, at the same time there is openness to changes of sequence and forms of questions in order to follow up answered given and the stories told by the subjects” (Kvale 1996).

Companies that were listed in Colombo Stock Exchange were chosen for data collection via structured interview technique, which all of them were from Bank Finance and Insurance sector of Sri Lanka. Semi-structured interviews covered by a sequence of themes, but a room is kept for openness. These empirical subjects were selected considering their large representation of business in the country and heavy operation of IT infrastructures including sound data centers. From each company, following information was obtained and categorized. Keeping the anonymity, each company is represented by a code: 1, 2, 3, 4, 5, 6, 7, 8, and 9.

3.2 Data Analysis

Cross-case analysis studies multiple cases and makes it is possible to construct a logical chain of evidence of relationships between cases cited Yin (2002). It is very important to understand that “if multiple cases are selected, each case must be treated as a single case” cited Dooley (2002). Hence, each individual company under the study has taken into consideration in isolation. The data collection and analysis methods of Azevedo et al. (2011) and Wong and Boon-itt (2008) have been closely followed in this research due to the same type of nature that has been studied.

Companies under study are represented by α ($\alpha = 1, 2, 3, 4.\ldots 9$). Fifteen (15) green technological practices that were derived from literature were indexed by symbol β ($\beta = 1, 2, 3, 4\ldots 15$). $I_{\alpha\beta}$ is the implementation of green practice (β) in the data center that belongs to company α. $I_{\alpha\beta} = 1$ if the considered green practice β is employed by α. $I_{\alpha\beta} = 0$ if the considered green practice β is not employed by α. The cumulative score of different green practices implemented by company α is denoted by

$$\mathrm{GP}_{\alpha} = \sum_{\beta=1}^{15} I_{\alpha\beta} \tag{1}$$

Equation 1 was developed taking different green practices implemented by an individual company into consideration. The sum of $I_{\alpha\beta}$ for all 15 practices adds up to GP_{α} for the considered α. It is assumed that implementation of every β weighted equally, which indicates that all practices contribute to sustainable development in a similar manner. The company with the highest GP_{α} is identified as the company with highest level of green implementation, or the company with most number of green practices in exercise.

The cumulative score of the implementation of one specific green practice (β) by all the cases is denoted by

$$\text{Cross - case IGP}_{\beta} = \sum_{\alpha=1}^{9} I_{\alpha\beta} \tag{2}$$

Equation 2 was developed considering how one green practice is implemented by all the cases. The sum of $I_{\alpha\beta}$ in all companies composes IGP_{β} for each green practice. It is assumed that each α weighted equally, which indicates that each company contributes to sustainable development in a similar manner. The green practice with the highest IGP_{β} can be identified as the most widely used green practice among all cases.

4 Cross-Case Comparison: Green Implementation

In this study, green implementation refers to how significantly a set of green technological practices are executed in company data centers. Given a list of commonly used green IT practices, the interviewees were requested to select technological solutions/activities that they are practicing currently with sufficient efficiency. A simple scale is chosen to record responses, where implementation of each practice by a certain company is weighted 1. To be precise, $I_{\alpha\beta} = 1$ if the considered green practice β is employed by α. $I_{\alpha\beta} = 0$ if the considered green practice β is not employed by α.

Respondents were given the opportunity to include or suggest any other practices that they are implementing to achieve data center sustainability. But all practices proposed linked to the practices in the identified list some way or the other. First, all practices exercised by one company are considered to calculate GP_{α} score for every α column-wise (refer to Table 1). Then, the implementation of one green practice by all cases is considered to calculate IGP_{β} score of every β row-wise (refer to Table 1). Respondents have selected practices that their data centers are operated on currently, from a given set of practices ($I_{\alpha\beta} = \{0, 1\}$). It is important to note that this data collection is completely based on the IT managers' perspectives on their data center operations but no other experiments were conducted. The GP_{α} for every α refers to the green implementation score, that is, implementation extent of an individual company.

Figure 1 indicates that the company 5 has scored the highest green implementation score which is 11; company 6 indicates the lowest green implementation score of 3. Results of Fig. 1 suggest that rate of implementation of green practices by different organizations ranges from 20 to 73%, which indicates a significant deviation. Green implementation scores of companies are ranging from 3 to 11, and but only four companies show above 50% rate of implementation. It was found that the average GP_{α} score percentage is 47% in considered cases. Hence, it can be concluded that average rate of implementing different green practices by data centers of financial sector companies lies below 50%.

Table 1 Cross-case comparison of technological attempts by different data centers

Green practices (β)	Company (α) 1	2	3	4	5	6	7	8	9	Cross-case IGP_β	$\frac{IGP_\beta}{9} \times 100\%$
Server virtualization	1	1	1	1	1	1	1	0	1	8	89
Sharing architectures	1	1	1	0	0	0	0	0	0	3	33
Server consolidation	1	1	1	1	1	1	1	1	1	9	100
Multicore processors	1	1	1	1	1	0	0	0	0	5	56
Adjust processer speed to demand	0	0	1	0	0	0	0	0	0	1	11
Efficient software and algorithms	0	0	1	0	0	0	0	0	0	1	11
Data compression	0	1	1	0	1	0	0	1	0	4	44
Virtualization of storage	0	1	1	1	1	1	1	1	0	7	78
Tape drives for long-term data storage	0	0	1	0	1	0	1	0	1	4	44
Information, application, and life cycle management	0	0	0	0	1	0	0	0	0	1	11
Measure, monitor thermal power loads	1	1	1	1	1	0	0	0	0	5	56
Balanced cooling and ventilation	1	0	0	1	1	0	0	0	0	3	33
Optimal lighting	1	0	0	1	0	0	1	1	1	5	56
Appropriate raised floor	1	1	0	0	1	0	1	0	0	4	44
Use of newer infrastructure products	0	1	0	0	1	0	1	0	0	3	33
GP_α	8	9	10	7	11	3	7	5	4		
$\frac{IGP_\alpha}{9} \times 100\%$	53	60	67	47	73	20	47	33	27		

IGP_β, the implementation score for each green practice β, is calculated cross-case. Server consolidation scored (100%) and ranked as the highest implemented practice in the context (refer to Fig. 2). Server consolidation indicates a presence in all the cases, in which all nine companies practicing it currently. Server virtualization receives the second highest implementation rate (89%), and even the companies that are at a low GP_α rate follow server virtualization and consolidation practices. The third highest significance received by virtualization of storage (78%). Looking at the three highest cross-case IGP_β scores, it can be concluded that consolidation and virtualization in server and storage technologies receives top most significance in the journey toward greening by data centers of financial sector companies in Sri Lanka.

Though not the highest, the use of multi-core processes (56%), optimal lighting (56%), measure and monitor power consumption, and thermal emission loads (56%) indicate average significance levels of implementation in Sri Lanka. Some practices such as information-application life cycle management (11%), use of energy efficient software and algorithms (11%), and server processor adjustments

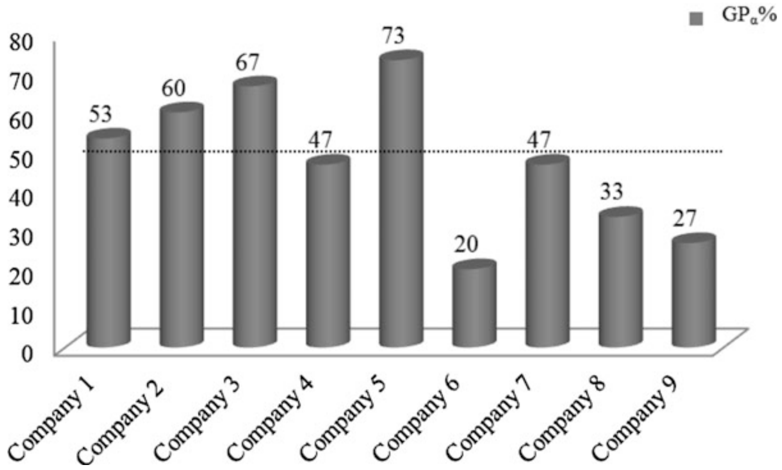

Fig. 1 Cumulative score percentages of green practices implemented by nine companies

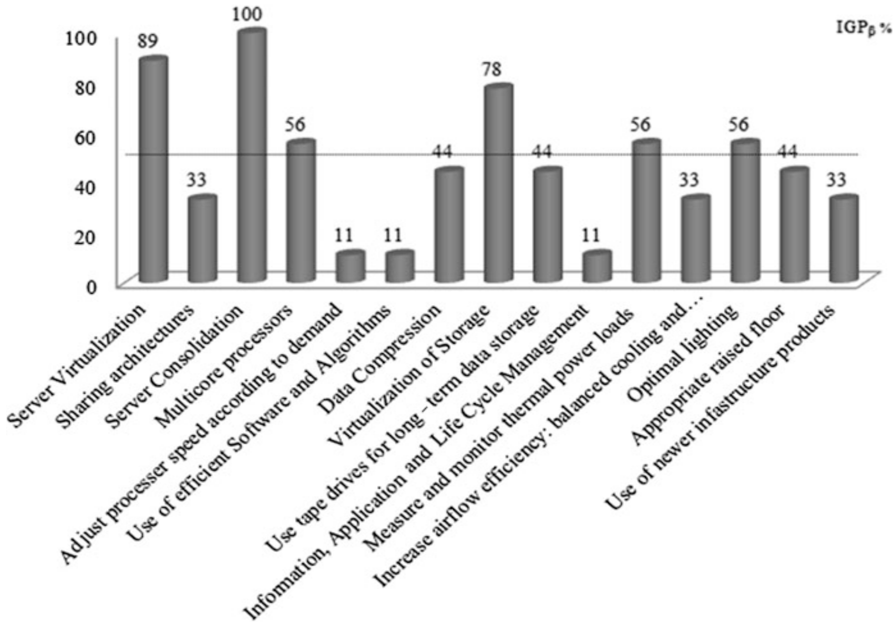

Fig. 2 Cross-case ranking of cumulative score percentages of green practices under implementation

based on the demand (11%) show the least implemented scores in the considered context. Out of the 15 practices studied, only 6 practices show a significance of implementation currently. 60% of the green practices that were considered are implemented in less than half of the cases.

5 Conclusion

Summarizing, it could be concluded that data centers of finance sector in Sri Lanka do not implement most of the green concepts in full. However, 40% of data centers in the considered context are interested in exploring some green exercises. As per the view of the respondents and empirical evidence, it can be concluded that data centers in the study group identified the importance of greenness in technological infrastructures but the implementation is in a transitional stage where some of the technological IT practices such as consolidation and virtualization are being implemented in large but other practices have received a low implementation rate.

With these results, it can be proposed that "companies in the financial sector consider adopting some green technological practices in their data centers but green implementation is not yet completed in all aspects." Further, the research should be directed to find key success factors that influence effective green data center implementation toward sustainable development.

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Part 3.2
Technology and Supply Chain Management

ICT Innovation for Buyer-Seller Relationships in International Supply Chains

Fabio Musso and Mario Risso

1 Introduction

During the last decades, there has been a growing recognition of the important role of innovation in international supply chains. However, most scholars treated this theme in reference to larger companies and to specific areas of innovation, with a primary attention placed on technological issues, particularly those relating to information and communication technology (ICT) (Kim et al. 2006; Hausman and Stockb 2003).

Few studies analyzed the phenomenon referring to small and medium enterprises (SMEs) and following a comprehensive perspective that could give the possibility to explore the connections between different fields of innovation. When SMEs are involved, it is important to consider the role of the supply chain leader. In the retail sector, this role is covered by large retailers, which can stimulate innovation along the whole supply chain.

This work aims at analyzing the ICT innovation drivers within supply chains with a perspective focused on the relationships between large retailers and SME suppliers. A suppliers' perspective was adopted by considering the point of view of small-medium manufacturers in the food sector. On the base of a literature review, it has been possible to formulate the research hypotheses, which have been tested through an empirical research on a sample of 70 firms in the food sector.

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2 Innovation in Retailers' Led Supply Chains: A Marketing Channels Issue

In the case of retailers' led supply chains, the concept of innovation must be viewed in the context of marketing channels, as a liaison between production systems and end markets. By this point of view, innovation can be seen as a strategic activity for both industrial and distribution firms to acquire a competitive advantage through a complex, multiorganizational, multidisciplinary interaction that requires collaboration across various entities within the supply network, with a substantial portion of the innovation process that occur at the buyer-seller interface level (Ganesan et al. 2009).

The analysis of technological innovation in vertical relationships can be developed with reference to three levels.

The first level is related to ICT and logistics, since through innovations like GPS tracking systems, electronic data interchange (EDI), and radio-frequency identification (RFID) it is possible to create and improve communication infrastructures and monitoring systems for materials movement (Risso 2009). However, despite the benefits associated with vertical communication standards, previous studies revealed that their diffusion among SMEs has failed to a surprising extent (Beck and Weitzel 2005).

The second level of cooperation refers to the joint management of supplying activities through collaborative planning on replenishment. In the form of vendor-managed inventory (VMI), the manufacturer gains access to the demand and inventory information of its customer (Savaşaneril and Erkip 2010). Even in this case, the diffusion of VMI systems seemed to be limited to larger firms (Kulp et al. 2004; Vaaland and Heide 2007).

The third level of collaboration in supply chain processes has a strategic relevance and refers to both end-customer analysis and the creation of joint marketing policies, through the adoption of tools like Collaborative Planning Forecasting and Replenishment (CPFR) and, in the retail sector, vendor managed category management (VMCM) (Chung and Leung 2005; Cigolini and Rossi 2006; Kaipia and Tanskanen 2003).

2.1 ICT and Logistics

The first level of cooperation that can be achieved in managing the supply chain refers to ICT and logistics, with the objective of improving the productivity of physical and information flows by improving the transportation network, the logistics centers management, the noncompliance managing processes, and by the establishment of communication infrastructures such as electronic data interchange (EDI) and Web-based EDI (Web-EDI).

In regard to logistics, some elements have resulted as changing factors that go beyond a simple technical optimization. For innovative relationships within the supply chain, logistics can be seen as an interface between strategic and tactical issues of both partners (Musso 2012). The most recent fields in logistic innovation are regarding monitoring systems for material management, both inside and outside warehouses, with the adoption of radio-frequency identification (RFID). RFID is the use of an object (typically referred to as an RFID tag) applied to a product, or a package, for the purpose of identification and tracking using radio waves.

RFID is also used in inventory systems, with relevant potential reductions in out of stocks (Hardgrave et al. 2009). Other benefits of using RFID include the reduction of labor costs, the simplification of business processes, and the reduction of inventory inaccuracies.

The basic infrastructure for coordinating logistic processes among channel partners is the EDI that has been defined as "tools which permit the automatic exchange of data between remote applications in situations where these belong to different organizations" (Martinez and Polo-Redondo 2001). The principal attraction that EDI has for companies lies in the large number of references exchanged. For large retailers, as well as wholesalers, EDI means a big saving, as they work with a large number of suppliers (and/or customers) with a great quantity of references, and all this means having to handle a vast amount of documents of different types. This is why these are the companies that have promoted the development of EDI in commercial distribution, in many cases forcing small-scale suppliers to adopt this tool.

2.2 Joint Management of Supplying Activities

The second level of collaboration in supply chain processes is the joint management of supplying activities, through techniques such as vendor-managed inventory (VMI), which includes assortments decisions, activities for reducing stock-outs, and the use of indicators to control and improve joint processes.

VMI is an operating model in which the supplier takes responsibility for the inventory of its customer. In a VMI partnership, the supplier makes the main inventory replenishment decisions for the customer. The supplier, which may be a manufacturer, reseller, or a distributor, monitors the buyer's inventory levels and makes supply decisions regarding order quantities, shipping, and timing (Waller et al. 1999). In VMI, the supplier is able to smooth the peaks and valleys in the flow of goods and therefore to keep smaller buffers of capacity and inventory. Successful VMI implementations in retailing can be found in the apparel industry. However, VMI has not gained large acceptance in the grocery supply chain.

2.3 Vertical Strategic Partnership

The third level of collaboration in SCM involves a higher degree of integration, with marked implications for marketing, both in the end-customer analysis, and the establishment of certain policies through the adoption of methodologies such as Collaborative Planning, Forecasting, and Replenishment (CPFR) and vendor managed category management (VMCM).

CPFR is a methodology for the joint purchasing management between retailers and their suppliers. It consists of joint sales forecasts and procurement schemes and includes all activities that pertain to the management of assortments, such as promotions and the introduction of new products. The CPFR encourages the sharing of market information and collaborative planning for the establishment and management of optimal assortments. The CPFR is suitable for those product categories that require a high level of promotional activity and that are characterized by significant fluctuations in demand.

VMCM is a concept for retail demand fulfillment that combines the ideas of VMI, category management, and outsourcing. The more frequent application for VMCM is on noncore product categories because the benefits of outsourcing are most obvious: For a retailer, it is expensive to maintain knowledge and skills to manage a minor product category, and the outsourcing risk is at its lowest in a noncore category (Kaipia and Tanskanen 2003).

3 Research Questions, Methodology, and Data

In order to analyze the ICT innovation drivers within large retailers' led supply chains, a quantitative survey was conducted. The research was focused on small and medium manufacturers in the agrofood sector that were involved as suppliers in national and international supply chains led by large retailers. The food sector was selected as traceability and control over suppliers requiring high level of interaction capabilities.

The analysis was conducted in 2011 on a sample of 70 Italian manufacturers. Data were collected through direct interviews with entrepreneurs and managers responsible for sales and marketing activities, responding to a semistructured questionnaire.

The sample was identified through the AIDA database by random extraction from a list of companies which resulted suppliers of large retailers. Table 1 shows the main characteristics of the sample.

Sales within the sample resulted mainly in the internal market (average 60% of total turnover). The European market absorbs an average of 26% of turnover, and extra-Europe exports are 14% of total sales. Sixty-eight percent of sales is addressed to Italian large retailers. Fifty percent of firms developed relations with international large retailers.

The relationship with retailers is more frequently indirect in international markets, with 61% of respondents connected with international wholesalers. In the internal market, only 40% of sales are intermediated by wholesalers. Small retailers are indicated as customers by half of the sample, but the turnover is very modest if compared with that developed with large retailers.

Table 1 Food SMEs sample description (%)

	Headcount			
Turnover (million euros)	Micro firms (up to 10 employees)	Small firms (up to 50 employees)	Medium firms (up to 250 employees)	Total
Less 2	17.14	7.14	1.43	25.71
2–10	5.71	30.00	2.86	38.57
11–20	1.43	10.00	4.29	15.71
21–40		5.71	4.29	10.00
41–50		2.86	2.86	5.71
Over 50			4.29	4.29
Total	24.29	55.71	20.00	100.00

The questionnaire was divided in three main sections: general characteristics of the firm, relationships with large retailers (retailers' selection criteria for suppliers, presence of intermediaries, the way in which the relationship is established, duration of the relationship, benefits from the relationship, risks and limits associated with the relationship, nature of the investments required), and ICT and logistic innovation in the relationship.

The questionnaire was planned on two research questions based on the results of the literature review.

The first research question referred to the relational issues of the supplies to large retailers (joint management of supplying activities and vertical partnership).

RQ 1 *What are critical factors considered by SME food supplier in developing relationship with large retailers?*

The second research question was related to the influence of the large retailers on ICT innovation in the supplying relationship (ICT and logistics).

RQ 2 *How do the relationships with large retailers affect ICT innovation of SME suppliers?*

The research questions have been analyzed together with some related variables: firms dimension, weight of sales to large retailers on turn over, degree of internationalization, age of the firm. To better answer to the RQs, a cluster analysis was conducted. Furthermore, an analysis of ICT innovation adopted by firms by cluster was carried out.

The questionnaire was semistructured with items referred to the mentioned research questions. A five-point Likert scale has been used for evaluation of single items (1 = low importance to 5 = high importance). Responses to open questions have been classified, and a dichotomic scale of 0/1 (0 not relevant, 1 totally relevant) has been used for each item. The measurement instrument has been developed using a combination of existing scales.

Data treatment has been made by SPSS statistical tool, and the results are shown in the following tables with both a simple description of frequencies and a more significant cluster analysis.

Table 2 Weight of retailers' selection criteria perceived by food SME suppliers

	N	Mean	Std. deviation	*t*	*df*	Sig. (2-tailed)
Quality of the products and services	70	4.44	.927	40.106	69	.000
Reliability with regard to the fulfillment of contractual conditions agree upon by the parties	70	4.39	.997	36.804	69	.000
Respect of safety and health standards	70	4.23	1.119	31.627	69	.000
Value for money of the products	70	4.04	.970	34.885	69	.000
Flexibility of producer: delivery times, lead times, etc.	70	3.93	1.121	29.332	69	.000
Technical potentiality: high volumes, innovation, quality control	70	3.87	1.154	28.075	69	.000
Contractual negotiations (discount, payment delay, special prize)	70	3.77	1.092	28.885	69	.000
Typicality of product (as made in Italy, IGP)	70	3.67	1.327	23.154	69	.000
Supplier reputation: share of market, volumes produced	70	3.61	1.107	27.312	69	.000
Brand of the supplier products	70	3.59	1.291	23.240	69	.000
Certification of the supplier/products (ISO, BRC, etc.)	70	3.59	1.222	24.556	69	.000
Financial situation of supplier to grant stability	70	3.56	1.137	26.165	69	.000
Respect of environmental standards for processes and products	70	3.54	1.163	25.481	69	.000
Respect of social and ethical standards	70	3.49	1.126	25.900	69	.000
Level of human resources of the supplier	70	3.44	1.072	26.874	69	.000
Availability to receive controls on the production processes	70	3.43	1.281	22.401	69	.000
Potentiality to develop	70	3.41	1.198	23.850	69	.000
Stock management: logistics capabilities and communication tools	70	3.37	1.119	25.216	69	.000
Wideness and attractiveness of range products	70	3.30	1.244	22.203	69	.000
Communication systems (EDI, VMI, CPFR, VMCM, etc.)	70	3.27	1.166	23.470	69	.000
Geographical proximity of supplier for short delivery lead time	70	3.24	1.185	22.898	69	.000
Vendor organizations of the producer (above all after sale)	70	3.23	1.079	25.033	69	.000
Exclusiveness or customization of products provided by supplier	70	3.21	1.284	20.942	69	.000
Supplier's power factors in the negotiations: scale economies etc.	70	3.20	1.111	24.094	69	.000
Investments required: technical endowment, minimum quantity	70	3.19	1.183	22.528	69	.000
Customer portfolio of the supplier	70	2.69	1.123	20.001	69	.000
Promotional support	70	2.64	1.192	18.547	69	.000

3.1 Critical Factors for the Relationship with Large Retailers

Table 2 shows the weight of retailers' selection criteria perceived by food SME suppliers. Retailers' evaluation criteria are referred, above all, to the ability of suppliers to manage efficient relationships. In fact, apart from the criteria strictly connected with the food sector (such as safety and health standards of products and quality), respondents mainly indicate factors linked to the efficiency of the relationship.

A cross analysis of evaluation criteria and turnover classes shows meaningful differences. The most significant deviation concerns commercial organization and communication systems. Firms who record higher turnover (more than 20 million euro) consider sales organization one of the most important criteria in order to be selected by retailers. This criterion is far less important in smallest firms.

Communication systems are highly considered by large suppliers but their importance is rather underestimated by smaller ones. The same trend has been recorded in the management of logistics capabilities. As the dimension of firms increases, a less importance of specificity of products and customization of the offer corresponds.

A cross analysis of the criteria on export turnover confirms and underpins these difference. Manufacturers with higher export turnover consider the reliability to the compliance with the negotiated conditions a fundamental requirement in order to be selected by retailers. The same criterion is less important in firms with a more limited share of export turnover. Even producer's availability to be visited and controlled by retailers is a factor that export-oriented firms consider more important, while terms of negotiations (such as discount, annual prize, payment conditions, etc.) become less important.

Most of the respondents declared that an increased retail power creates dependence among smaller suppliers. Therefore, they are forced to accept a high control from retailers, and they must respond to product and packaging adaption to retailers' requirements. Also a higher level of involvement in logistics is more often required to suppliers.

The cluster analysis was conducted to identify specific categories of manufacturers inside the sample, as the results of the empirical research showed in homogeneous behaviors.

A K-Mean methodology has been followed for the analysis, which allows minimized inertia within single groups and between clusters. The number of the singled-out cluster is 4 that results after a series of tests that show it as the value that returns the clearest differences.

The variables used to divide the sample into more homogeneous groups are total turnover, export turnover, importance of private label production for large retailers (as % of total turnover), duration of relationship with large retailer, and headcount and age of the firm.

Table 3 shows the variables that contributed to define the clusters within the sample. F-test shows that age of the firm, importance of private label production for large retailers, headcount of the firm, duration of the relationship with large retailers, and total turnover are the more significant variables.

Data on export turnover was not available from all the manufacturers. Considering their insignificant number, missing values are treated as with the option "exclude cases pairwise" that allows assignment of single cases based on distances from the variables of those that are not missing values. Cluster 3 is the

Table 3 ANOVA analysis with different significance levels

	Cluster					
	Mean square	df	Mean square	df	Error	
Age of the firm	23622.743	3	215.923	59	109.403	0.000
% product produced in private label	11834.527	3	157.973	42	74.915	0.000
Total turnover	6.603	3	1.628	66	4.055	0.010
Duration of relation with large retailers	418.949	3	86.122	66	4.865	0.004
Export turnover	1.254	3	0.962	66	1.303	0.281
Headcount classification	1.787	3	0.387	66	4.624	0.005

F-tests should be used only for descriptive purposes because the clusters have been chosen to maximize the differences between cases in different clusters. The observed significance levels are not corrected for this and thus, cannot be interpreted as tests of the hypothesis that the cluster means are equal

Table 4 Number of units per cluster

Cluster		Number of interviews
1	Young and dynamic suppliers	15
2	Old and consolidated suppliers	6
3	Younger and small suppliers	27
4	Old and small suppliers	22
Total interviews		70

Table 5 Importance of variables in the sample by cluster

	Cluster			
	1	2	3	4
Headcount (1–4)	2.20	2.67	1.74	1.86
Total turnover (1–4)	2.73	4.00	2.11	2.23
Export turnover (1–4)	2.20	2.00	1.59	1.86
Age of the firm	24.77	128.67	17.56	61.26
% of private labels	71	65	6	11
Duration relation with large retailers	11	23	9	15

more numerous one, with a total of 27 units. Cluster 4 has 22 units, cluster 1 has 15 units, and cluster 2 has 6 units (see Table 4).

In cluster 1, turnover shows an average value between 10 and 20 million euro; the importance of export sales is an average value between 20 and 40% of total turnover, sales to large retailers for private labels an average weight of 71% (Table 5), the duration of relationship with large retailers an average of 11 years, and the age of the firm an average of 25 years. Thus, the cluster 1 is named "young and dynamic."

In cluster 2, average turnover (41–50 million euro) and size and age of the firms are the highest of the sample. The export turnover is between 20 and 40% on total turnover; sales to national large retailers for private label products have an average weight of 65%. Also, the length of relationships with large retailers is the highest with 23 years. Cluster 2 is named "old and consolidated."

Cluster 3 shows the lowest average turnover of the sample (up to 10 million euro), an export turnover limited (lowest of the sample between). The firms of this cluster are the youngest of the sample, the sales to national large retailers for

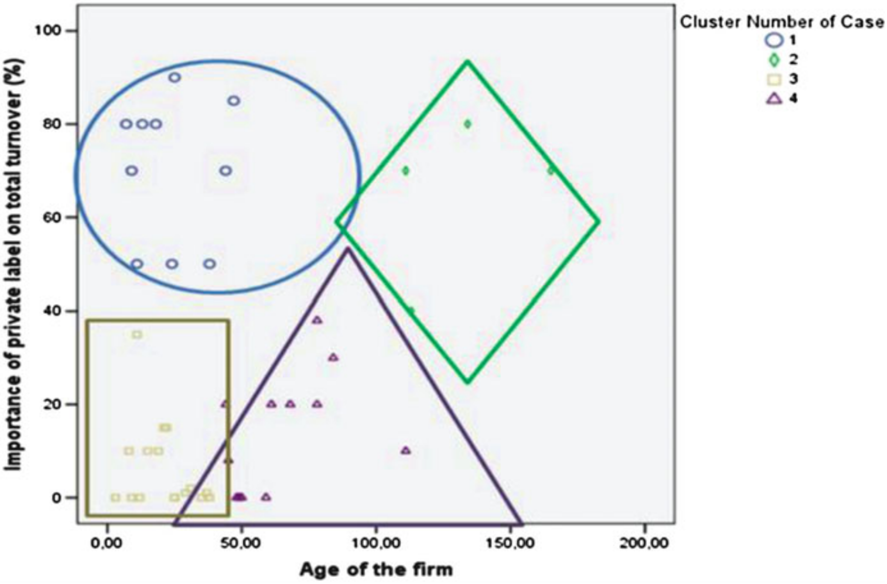

Fig. 1 Weight of private label production on turnover and age of the firm

private label products have the lowest weight on turnover in the sample (6% of the turnover), and the average of the length of relationships with large retailers is the lowest with 9 years. Cluster 3 is named "younger and smaller."

In Cluster 4, average turnover (10–20 million euro) and size of the firms are small; the export turnover accounts between 20 and 40% of total turnover. Sales to national large retailers for private label products have a limited importance (11% of the turnover). The duration of the relationship with retailers is high, and the age of the firm is elevated. Cluster 4 is named "old and small."

The four clusters differentiate from each other mainly for importance of private label on turnover and the age of the firm (see Fig. 1).

Differences in means within clusters are due to variance in responses and to different consistencies of single clusters. Figure 1 shows the precise clusterization of the sample that matches the weight of private label production on turnover and age of the firm.

3.2 Influence of Large Retailers to ICT Innovation for SME Suppliers

In regard to technological perspective, the analysis showed that for clusters 1, 3, and 4 ICT innovation was driven by the need to improve information sharing in real time and reduce waste in business processes. However, the more involved in

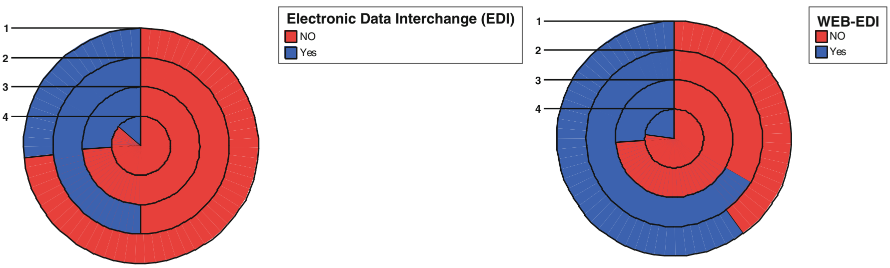

Fig. 2 The adoption of information exchange systems by clusters (EDI and WEB-EDI)

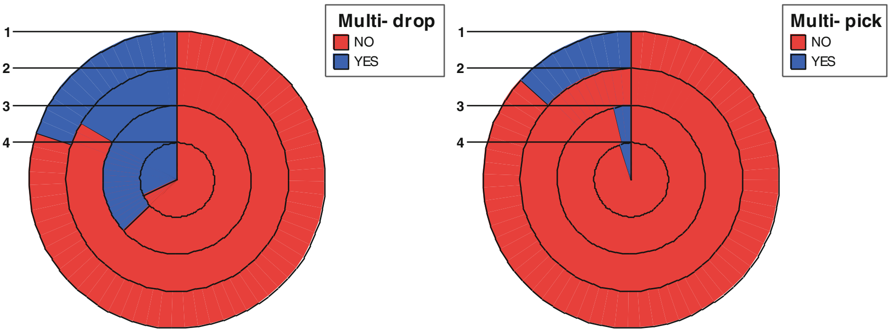

Fig. 3 The adoption of multipick and multidrop delivery systems

changes in logistic innovation and in coordination with large retailers in the last 5 years were mainly clusters 1 and 2.

ICT innovative changes are different by cluster. Cluster 1 and 2 invested in information exchange and logistic system (see Figs. 2 and 3). Less technological innovation is generally detected in clusters 3 and 4.

None of the firms in the sample use the vendor-managed inventory and VMCM, while CPFR is present in clusters 1 and 3 in a very limited extent. All firms except for some in the clusters 3 and 4 have implemented traceability tools.

4 Results

From the Italian food manufacturers' perspective, we can argue that small and medium manufacturers have different behaviors related to ICT innovation in their relationships with large retailers. Most of firms declared that the increased retail power in the supply chain creates dependence and forces SMEs to receive control, quality test and adaption of product and logistic processes to retailers' requirements.

Therefore, the level of pressure that manufacturers perceive in retailers' selection criteria differs depending on their dimension and the importance of their products for retailers' assortments.

Larger firms (cluster 2) are less influenced by retailers in the negotiation for technicalities, and they can better play their relational capabilities in order to improve innovation.

The firms more involved in the production of private label products (cluster 1), even if smaller, reveal major abilities in managing relationships with large retailers. Among them, those that are part of international supply chains have better capabilities to manage relations with large partners. Moreover, they follow a middle-/long-term perspective that brings them to recognize the need of relation-specific investments, included those on ICT.

Adaptation and collaboration seem to be the two main elements that characterized the presence of SME manufacturers in supply chains managed by international large retailers.

Large retailers prefer suppliers which have resources and willingness to invest in ICT and logistic innovation and adapt their processes.

When suppliers cannot benefit from a long-term approach of large retailers, they are asked to guarantee structures, resources, and communicational tools to manage the relationships. In this case, SMEs often face difficulties to invest in logistics and ICT solutions.

5 Conclusions

This chapter analyzed the main drivers of ICT innovation in the relationships between large retailers and SME suppliers, focusing on the collaboration criteria adopted by retailers in organizing their supply chain and adopting ICT and logistics new solutions.

The analysis on SME suppliers showed that large retailers could be a driver for innovation in ICTs connected to channel relations for SMEs. Those which seem to understand this trend are working to improve not only logistics/production management but their overall business system. In this way, they improve their capability to mange relationships and can reduce their dependence from a single retailer expanding their markets and customers opportunities.

Italian SMEs which operate continually with large retailers adapt their processes but are sensible to innovations based on a collaborative approach in supply chain. Smaller suppliers reveal a transactional approach and are remarkably oriented to price competition, showing a delay in adopting more advanced SCM tools.

Actually, we can identify a range of situations. The first relates to a supply relationship where the quality and specificity of products ensure a protective role of large retailers toward those small suppliers that can characterize their assortments (clusters 1 and 2). In such case, we can talk about a shared growth and a dynamic support by retailers where rules, reliability, and compliance of suppliers are always oriented by large partners, mostly international.

The second situation regards a supply market where a dominant price competition makes the relationship increasingly difficult. Retailers become more aggressive and tend to standardize their requirements. In this case, it is possible to identify a dual orientation. Larger suppliers belonging to cluster 4 invest in economies of scale, ICT, and logistics to favor a value for money approach. Smaller suppliers (cluster 3) are oriented to differentiation and typicality of products. They mainly focus on optimization of internal processes.

This study highlights some trends in ICT innovation from the perspective of the supplier in a retailer's led relationships. A complementary analysis should investigate the motivations for retailers to foster innovation processes through the relationship with small suppliers. A comparative cases analysis could be conducted in other sectors and with manufacturers of other countries (i.e., EU) to verify the similarities and differences.

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SCM and ICT: A Cornerstone to Sustainable Development of Agribusiness: An Analytical Study

Y.M. Raju

1 Introduction

While China represents brawn, India represents brain

By . . .. Philip Kotler

The world is moving fast towards a borderless business situation. Physical boundaries will remain, but the movements across will become absolutely free. The flow of money, men, material and information will follow economic logic and will go where the best returns are expected and agricultural products will always have evergreen demand all over the globe.

Agriculture and agribusiness situation in India has undergone rapid changes in the last two decades. Investment in agriculture both in public and private sector has risen. But the growth rate has not only to be maintained but accelerated, and fluctuations in agricultural production are to be minimized. The efforts are already under way to evolve location-specific technologies, to supply chain management and to transfer them to farmers and the agribusiness sector.

Indian agriculture is undergoing rapid transformation and low-volume agriculture is giving way to high-value agribusiness. Indian banks and state and central government are increasingly focusing on the supply chain, and this has led to milestones achievements in the Indian agriculture sector. As a result, there has been a sharp rise in foodgrain production, thanks to ‘Green Revolution’, ‘Yellow Revolution’, ‘Blue Revolution’ and ‘White Revolution’.

The great Indian rural agriculturist’s dream continues to be a pie in the sky of ‘Commercial Revolution’ in agricultural activities. Nearly 70% of the 1.21 billion strong Indians live in villages, with two out of three Indians informally

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engaged, directly and indirectly, in agriculture and other allied activities. These disadvantaged people are not using supply chain management (SCM) and information communication and technology (ICT) in their farm activities. The National Development Council and Eleventh Five-Year Plan also focus on techno-economic in agricultural sector and increase in agricultural productivity. Sustained economic growth is only possible through increased agricultural productivity and better farm management. This requires proper use of ICT and SCM in farm activities. In order to gain competitive advantage and increased productivity and profitability, these are the prerequisites like integrated farm operation, market sensing, reducing the middlemen menace, attracting young educated bloods, generating employment opportunities, time management, reduction of cost, resurrection of power from recession, farm planning, farm accounting etc.

'Commercial Revolution' and 'Evergreen Revolution' has to be proposed for the economic growth of farming fraternity. ICT and SCM have not only yielded measureable benefits to the farming communities but also provided technical and financial empowerment.

This study proposes a new model for sustainable development of agribusiness in farm activities, where ICT and SCM are the backbone engines of growth. Accesses to find global markets have created immense opportunities for the farmers to expand their agribusiness operations on foreign soils.

Against this background, this chapter makes an attempt to examine the ICT and SCM in a changed approach to farm activities and encashed demographic dividend. In order to achieve high rate of economic development, peace, prosperity and Commercial Revolution in farm activities and the farmers, innovation, ICT and SCM tools are to be used at the bottom of the pyramid. In agricultural sector, these concepts are milestones to sustainable development. Agriculture is a noble profession, and it is a core competence as well. It should attract young educated bloods in this sector, otherwise India will once again go back to an era of chronic shortage of foodgrains and 'begging bowl' status.

2 Focus of the Study

This study examines the role of SCM and ICT in agribusiness in Dakshina Kannada district in Karnataka state, India. Since the peasants are constantly facing various types of risks, mitigating these risks will be a cornerstone for the financial empowerment.

Risk is the possibility of adverse physical, mental and financial loss, especially in the day-to-day activities in the farms. Risk mitigation is essential for not only increasing the productivity but also for improving the quality of work life of the peasants and agribusiness entrepreneurs through ICT and SCM. It provides maximum socio-economic advantages. It plays a significant role in bringing about socio-economic development of peasant families. The concepts of ICT and SCM have now to be a reality for the peasants. By creating awareness of the usage of SCM and ICT in the farm sectors, our farmers and farm workers are going to get competitive advantage in the global agribusiness era.

3 SCM and ICT Contribution to Agribusiness

As we all know, SCM and ICT plays a vital role in the prevention and mitigation of risks, employment generation, and recession-proof growth and sustainable development of the poor and middle class, marginal farmers and gaining competitive advantage as well. Nowadays, small, marginal farmers and farm workers must work smarter rather than harder. It makes an enormous contribution to farming fraternity and farm workers' quality of work life, earning capacity, maintenance of stability, financial empowerment and so on. The specific contribution from SCM and ICT in the era of economic slowdown is as follows.

4 Integrated Productivity and Marketing Sensing

There is a direct correlation between SCM, ICT and agribusiness and agricultural productivity. It provides market knowledge, demand and supply mechanism, usage of resources, reduction of costs and maintenance of the law of variable proportions.

5 Time Management

Our farmers and farm workers are not practicing proper time management in their agriculture activities. SCM and ICT teach them to maintain proper time management. Time management is a critical aspect of the farming and farm-workers fraternity.

6 Competitive Advantage

We have fertile land, world famous rivers, good environment, demographic dividend, etc., but we failed to encash in the globalization. Our farmers and farm workers are not gaining any advantage in spite of all these core competitive advantages. Disadvantaged section will gain competitive advantage enormously with the help of SCM and ICT.

7 Improving the Communication

Marginalized people are put in the dark since they are not getting up-to-date and research-based or lab-based information. There is a big communication gap between urban market and rural market. The SCM and ICT are bridge the gap and boost the agribusiness in the country.

8 Improve the Logistics Management

We face problems on account of widespread nature of agribusiness, its varying size, unorganized business system and lack of management techniques. Our peasants are facing logistic management and other myriad problems. Majority of the peasants are not aware of the availability of inputs and that the agricultural outputs are to be sold timely. This leads to financial loss and reduction in the productivity. SCM and ICT need to be used properly to solve myriad problems.

9 Attract Young Bloods and Generate Employment Opportunities

Agriculture and agribusiness is a noble profession and most profitable business as well, but nowadays, many youngsters in the agricultural and farm workers' families in the rural areas have migrated to cities, towns and Gulf countries in search of Mickey Mouse jobs. By using the ICT and SCM in agriculture and agribusiness sector, the youth can be retained in the farm sector, and it ensures prosperous growth of marginal farmers with the generation of employment opportunities.

10 Reduction of Cost and Other Numerous Contributions

ICT and SCM empower the farmers, by helping them in the management of all activities in the production process in maintaining utmost customer satisfaction by using the least possible costs, great efficiency, cost saving gains, long-term profitability and minimized delay. ICT and SCM are the seamlessly coordinated and developed with the network of business.

11 Objectives of the Study

The central purpose of this empirical study is to examine the dynamic role of the SCM and ICT in agribusiness and agricultural activities in the Dakshina Kannada district of Karnataka state, India.

The specific objectives are the following:

1. To study the socio-economic profile of the respondents
2. To examine the usage of SCM and ICT in farm and agribusiness segments
3. To analyse the benefits of SCM and ICT in agribusiness

4. To study the ways and means to convert farm workers into entrepreneurs in agribusiness
5. To suggest a suitable model to mitigate stress and risks through SCM and ICT in agribusiness

12 Methodology

This study was conducted in the Dakshina Kannada (D. K.) district. D. K. district is one of the prominent districts in Karnataka state, India. Five nationalized banks took birth in the undivided district; the district has the highest literacy rate in the state, progressive farmers, growing cash crops, pioneering for adopting scientific method of farming, highest rainfall and lowest rate of suicides. The major parameters used to drawn the respondents are occupation of the respondents, education level, type of crops grown, family size, farm worker's age and income level. This is an empirical study; the sample used in the study consisted of 250 respondents drawn through cluster with multistage random sampling technique. The D. K. district consists of 5 talukas; 50 respondents are drawn randomly from each taluk on a homogeneous basis.

13 Discussion and Results

13.1 Education Level of the Respondents

Educational background plays an important role in using ICT and SCM in the farm operations. It helps the farmer's proper understanding and usage of ICT and SCM in their farm operations. The increasing internationalization of business has largely freed it from the constraints of national borders. The world is seeing a growing economic interdependence and technological advances in commercialization and transportation contributing to the emergence of large global corporate.[1] In this scenario, good educational background is prerequisite. Incidentally, the Dakshina Kannada district has the highest literacy rate in the Karnataka state, and more importantly, the peasant is highly knowledgeable compared to any other districts in the state (Table 1).

The above table shows that more than 20% of the respondents have had a college education and above 10% of the peasants are illiterates.

From the analysis, it is found that more interestingly nearly 90% of the respondents have a formal education. Thus, a majority of the peasants are literates.

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[1] Aseem Kumar (2000).

Table 1 The educational accomplishment of the respondents

Talukas	Illiterates	Educational qualifications Up to 4th Std	Up to 7th Std	Up to 10th Std	College and special trainings	Total
Bantwal	5(2.00)	9(3.6)	24(9.6)	8(3.2)	4(1.6)	50(20.00)
Belthangady	6(2.4)	7(2.8)	20(8.0)	10(4.00)	7(2.8)	50(20.00)
Mangalore	7(2.8)	3(1.2)	24(9.6)	9(3.6)	7(2.8)	50(20.00)
Puttur	3(1.2)	8(3.2)	22(8.8)	12(4.8)	5(2.00)	50(20.00)
Sullia	8(3.2)	11(4.4)	12(4.8)	15(6.00)	4(1.6)	50(20.00)
Total	**29(11.6)**	**38(15.2)**	**102(40.8)**	**54(21.6)**	**27(10.8)**	**250(100.00)**

Source: Field survey data

Table 2 Occupation of the respondents

Talukas	Agriculture only	Farm workers	Agribusiness in small quantities	Total
Bantwal	19(7.6)	13(5.2)	18(7.2)	50(20.00)
Belthangady	18(7.2)	15(6.00)	17(6.8)	50(20.00)
Mangalore	13(5.2)	16(6.4)	21(8.4)	50(20.00)
Puttur	18(7.2)	17(6.8)	15(6.00)	50(20.00)
Sullia	21(8.4)	16(6.4)	13(5.2)	50(20.00)
Total	**89(35.6)**	**77(30.8)**	**84(33.6)**	**250(100.00)**

Source: Field survey data

13.2 Occupation of the Respondents

Agriculture, fishing and other allied activities are the main occupation of the people in this district. The district receives very good rainfall and has all means of efficient transportation networks, financial networks and marketing facilities. Many talukas have proximity to Mangalore City and Mangalore port. Agriculture is the backbone of the district and highest rainfall is also one of the added values to the peasants (Table 2).

It is clear from the foregoing table that 35% of the respondents are pursuing only agriculture, 30% of the respondents are farm workers and more than 30% of the respondents are pursuing agribusiness in small quantities. To sum up, one can clearly deduce from the figures in the table that majority of the respondents were involved in agriculture and agribusiness in unorganized methods.

13.3 SCM and ICT Used in Farming and Agribusiness

SCM and ICT are very effective weapons to identify the risks and mitigate the risks. Management of risk is nothing, but earning profit, farmers and farm workers are more and more acquainted with the marketing efficiency through SCM and ICT. Marketing efficiency is essential for good market performance. It facilitates the movements of agricultural goods from producers to consumers at the lowest

Table 3 SCM and ICT in farm activities and agribusiness

Talukas	SCM and ICT are using		Total
	Yes (some extent)	No	
Bantwal	5(2.00)	45(18)	50(20.00)
Belthangady	6(2.4)	44(17.6)	50(20.00)
Mangalore	4(1.6)	46(18.4)	50(20.00)
Puttur	6(2.4)	44(17.6)	50(20.00)
Sullia	9(3.6)	41(16.4)	50(20.00)
Total	**30(12)**	**220(88)**	**250(100.00)**

Source: Field survey data

possible cost, consistent with the price of the goods desired by the consumers. It empowers firms to keep their channel members happy, loyal and well motivated towards trade by offering full assurance for the best ROI.[2] For agribusiness and farm activities SCM and ICT are complementary to each other (Table 3).

It is evident from the foregoing table that nearly 90% of the respondents are not using SCM and ICT in their farm activities and small-scale agribusiness. More than 10% of the respondents are using some extent of SCM and ICT in their day-to-day professional life to some extent.

From the above analysis, it is inferred that majority of the respondents are not using SCM and ICT. They are not aware of and do not understand its benefits and power.

13.4 Confidence Building Measure to Take-Up Agribusiness

India has three things which will gain confidence building and enhancement of skill and knowledge; these three are democracy, demography and diversity. Democracy motivates the ability to think and act free. Demography with over half of the Indian population fewer than 25 years age provides requisite environment as innovation in the agribusiness for the young. Diversity, of culture and language, provides an environment in which innovation thrives.

Marginal farmers and farm workers normally show a lack of confidence to take-up challenges and risks. Agribusiness requires strong confidence, attention, problem solving, flexibility and inner strength. Building confidence is not something that 1 day falls from the sky or a lottery that the lucky person wins. Self-confidence is a gut feeling; SCM and ICT provide a gut feeling and inner strength to the marginal farmers and farm workers. Self-confidence is an important asset for enhancing physical power and mental power to take-up challenges and risks to disadvantaged section (Table 4).

[2] Agrawal (2000).

Table 4 Confidence level and gut feeling of the respondents

Talukas	Good	Very poor	Cannot say	Total
Bantwal	5(2.00)	15(6.00)	30(12.00)	50(20.00)
Belthangady	9(3.6)	13(5.2)	28(11.2)	50(20.00)
Mangalore	7(2.8)	12(4.8)	31(12.4)	50(20.00)
Puttur	5(2.00)	15(6.00)	30(12.0)	50(20.00)
Sullia	11(4.4)	16(6.4)	23(9.2)	50(20.00)
Total	**37(14.8)**	**71(28.4)**	**142(56.8)**	**250(100.00)**

Source: Field survey data

It is clear from the above table that at least 55% of the respondents do not have gut feelings and self-confidence and more than 25% of the respondents with self-confidence and gut feeling are very poor. Less than 15% of the respondents have self-confidence and gut feeling. It is evident that most of the respondents are not having self-confidence and gut feeling. For agribusiness, self-confidence and gut feeling are very important.

13.5 Venture the Young Educated Bloods into Agribusiness

The Indian economy has been witnessing a drastic change since mid-1991; with new policies of LPG, India has great entrepreneurial potential. At present, rural educated youths' involvement in economic activities is marked as very low, by excessive concentration on Mickey Mouse jobs and migration to cities and towns in search of jobs. Development of youths plays an important role in nation building. As they constitute the large number of the total population, young population and it is demographic-dividend, youths have to play a significant role in the development of the country. Several development programmes including technical and financial support have been implemented by the state and central governments with a view to make youths job providers instead of job seekers.

Knowledge is created and sustained through the police of work, meet, collaborate, interact and socialize[3]. In D. K. district, a large number of agricultural family youths migrated to Gulf countries in search of jobs. Rural entrepreneurship in agribusiness is a prerequisite for the creation of a healthy and wealthy nation. When rural youths are empowered, society with stability is assured. It ensures peace, prosperity, sustainability and equity in the country (Table 5).

The above table divulges that more than 45% of the youths have migrated to Gulf countries. These youths are from rural agricultural backgrounds. At least 30% of the youths migrated to cities and towns. More than 15% of the youths are staying in the rural areas, but they do not venture into farm activities.

To sum up, one can clearly deduce from the above table that rural youths have not taken farm activities. These segments should be retained in their respective villages and advised to take-up agribusiness with proper training to use SCM and ICT.

[3] Paul H. Hildreth and Chris Kimbler (2004).

Table 5 Table showing rural youths migrated to Gulf countries

Talukas	Rural youths migrated to Gulf countries Migrated to Gulf	 Migrated to cities/towns	 Stay in the village but abandoned farm activities	Total
Bantwal	20(8.0)	16(6.4)	14(5.6)	50(20.00)
Belthangady	28(11.2)	15(6.00)	7(2.8)	50(20.00)
Mangalore	24(9.6)	16(6.4)	10(4.00)	50(20.00)
Puttur	29(11.6)	12(4.8)	9(3.00)	50(20.00)
Sullia	20(8.0)	23(5.2)	7(2.8)	50(20.00)
Total	**121(48.4)**	**82(32.8)**	**47(18.8)**	**250(100.00)**

Source: Field survey data

14 Findings

The following are the findings of the study:

- Nearly 90% of the respondents are literates.
- The Dakshina Kannada district is the highest literate district in Karnataka state, India.
- The district's main occupation is agriculture and fishing. In addition to fishing business, agribusiness also has vast potential.
- According to the survey, farm workers undertake agribusiness in small quantities.
- It is evident that nearly 90% of the respondents are not using any SCM and ICT in their farm activities.
- In a nutshell, the district is situated in a strategic position and possesses added advantage to take-up agribusiness.
- The survey reveals that 85% of the respondents do not have gut feeling and self-confidence.
- Two hundred and three respondents out of two hundred and fifty have migrated to cities, towns and Gulf countries.
- Rural youths should be retained in villages and asked to venture into agribusiness with proper training and incentives to use SCM and ICT; it creates wealth and employment generation in the rural areas.

15 Suggestions

Consistent with the objectives of the study and findings of the study, the following are the suggestions for sustainable development of agricultural and agribusiness with the help of SCM and ICT:

- Farming is a noble profession. It attracts educated young bloods to venture into farming activities and agribusiness through SCM and ICT.

- The D. K. district has the highest number of literates and knowledgeable youths. Therefore, village level camps should be made for fostering innovation, awareness of SCM and ICT in farm activities and agribusiness.
- Agribusiness entrepreneurship spirit should be kindled to rural youths. This should stop migration to cities and Gulf countries.
- Dynamic youngsters from farming community migrated to Gulf countries in search of Mickey Mouse jobs. These will stop and convert them as employers in agribusiness with proper training at village levels.
- Creating awareness about SCM and ICT to be used in agribusiness to college drop outs, nurture them with expert guidance and mentorship.

16 Conclusion

In the present era, there is a real boom in agribusiness and agricultural activities. Indian economy is fully depended on agriculture and allied activities. SCM and ICT are powerful tools to enhance productivity and profitability in farm activities. The PURA concept advocated by our beloved former President of India, Dr. A. P. J. Abdul Kalamji, helped us in overcoming poverty and inequality by using SCM and ICT. Success is not to be found in a technology, in market positions or in a business model; success resides in individual rural youths, to make use the available technology and their abilities. Another important ingredient of SCM and ICT are increasing creativity, self-confidence and disciplines; fostering SCM and ICT have a power to creation of wealth, value and employment generation in rural areas. Rural youths possessed three T's, that is talent, technology and tolerance. It only requires to mentoring them to practise these in the farm sector.

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A Two Stage Supply Chain Model for Multi Sources and Destinations, Incorporating Quantity and Freight Discounts with Case Study

Kanika Gandhi, P.C. Jha, and M. Mathirajan

1 Introduction

A supply chain network is a series of value chains (also called tier, state, or phase) owned by one or more businesses. The chain starts with the raw material supplier and ends with the consumer. Each intermediate tier is a supplier to its adjoining downstream tier and a customer to its upstream tier. The traditional ways like face-to-face management, manual tracking systems, paper-dominated order processing systems, and wired communication links were the primary management tools available to logistics managers, which are obsolete in current business situations. But Tan et al. (2000) pointed out that SCs are becoming complex for two reasons. First, a global imbalance in labor costs forces enterprises to source from countries with cheaper labor in order to control production costs to stay competitive. Second, consumers are becoming increasingly more sophisticated, demanding customized products that better meet their needs. The resulting increase in product variation makes demand forecasting more difficult as an enterprise now has to predict both volumes and option mix instead of a single demand pattern. Furthermore, increased product types result in a greater number of suppliers to manage and higher coordination costs. In addition to optimizing its processes within itself, the enterprises within a supply chain must now coordinate with each other. Shamim et al. (2008) discussed that adoption of information and communications technology (ICT) is

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spreading rapidly in supply chain management. As enterprises seek to improve supply chain efficiency through increased integration, ICT can be considered as a key enabler for supply chain management by supporting information sharing. The same type of integration becomes emergent in the urgency conditions, where consumers' requirement is to be fulfilled in a short span. In such conditions, the whole supply chain operates like just-in-time as time intervals for procuring and transportation are more in number but short in durations.

A variety of research papers have contributed significantly in the study of two-stage supply chains, integrated discounts, and transportation schemes among which few are as follows. Regarding the integrated discounts and transportation schemes, Monahan (1984) proposed a quantity discounts model where the vendor can determine the discount schedule and batching policy to maximize its economic gains while add no cost to the buyer. The model assumes that both buyer and vendor have the same frequency of ordering and manufacturing setup, and the vendor's inventory carrying cost is unaffected by the buyer's ordering frequency. Banerjee (1986) extended Monahan's (1984) model by incorporating vendor's inventory carrying cost. The model proposed by Halm and Yano (1992) has proposed a synchronous model, aiming to minimize the manufacturer's and buyer's inventory holding cost, manufacturer's setup cost, as well as transportation cost. Parlar and Wang (1995) presented a quantity discount schedule in which there is a unique per unit price for each quantity the buyer might choose. They considered that the vendor does not have complete information on buyer's cost parameters but have known the buyer's inventory holding cost. Assuming demand is decreasing function of buyer's selling price and the warehouse has complete information on the system, Weng (1995) studied the single-warehouse multiple identical buyers system and suggested coordinating the system using quantity discounts and franchise fees. Studying the system under both global information environment and private information environment, Chen et al. (2001) generalized Weng's (1995) extended model to heterogeneous buyers. Further, many authors have also contributed their research in the field of two-stage supply chains; Subramanya and Sharma (2009) integrated two-stage supply chain network of an automobile company, measured the performance parameters, and established the priority decision and queuing rules for improving the utilization of resources. The study restricted to measuring operational processes in a two-stage supply chain between the supplier, manufacturer, and distributors. Wang et al. (2009) examined the dynamics of a two-stage supply chain consisting of one retailer and one distributor with order-up-to-control policy. Lee et al. (2000) examined the value of information in a two-stage supply chain under an autoregressive demand process.

The current study proposes a mathematical model for a two-stage supply chain network with multisource and destinations, incorporating both quantity and freight discounts. Particularly, the objective of the model is to minimize the total incurred cost during procurement, holding at suppliers, transportation from different supply points to halt point, holding at halt point, transportation from halt point to destinations, and finally holding at destinations. To the best of our knowledge, the problem configuration considered in this study has not been considered in the earlier studies in the literature.

2 Proposed Model Formulation

2.1 Problem Statement and Assumptions

The current model demonstrates a two-stage integrated procurement-transportation model with the objective to minimize the total incurred cost movement of ordered quantity from multisources to intermediate node and further to multidestinations, where inventory carrying cost at intermediate node is higher than cost at sources and destinations.

At the time of model development, the following assumptions were taken:

- Finite planning horizon; deterministic demand; supply is instantaneous.
- Variant prices of one type of product at different destinations.
- All products are available at all the sources; initial inventory at the planning horizon is zero.

2.2 Sets

Product set with cardinality P and indexed by i
Period set with cardinality T and indexed by t
Price discount break point set with cardinality L and indexed by l
Freight discount break point with cardinality K and indexed by k
Source set with cardinality J indexed by j
Destination set with cardinality M indexed by m
Waiting time set at intermediate node with cardinality Γ and indexed by τ

2.3 Parameters

h_{ijt}	Inventory carrying cost per unit of product i for t^{th} period at source j
ϕ_{ijmt}	Unit purchase cost from j^{th} source to m^{th} destination for ith product in tth period
d_{ijlt}	Discount factor that is valid if more than a_{ijlt} unit is purchased $0<d_{ijlt}<1$
β_{jt}	Weight freight cost in t^{th} period from source j to intermediate node
f_{jkt}	Transportation freight discount factor from source j to intermediate node in period t at freight break k
O_{1jt}	Holding cost at intermediate node for first halting day in period t for source j
$(\tau - 1)O_{2jt}$	Holding cost at intermediate node from second day onward for $(\tau - 1)$ number of days in period t for source j
h_{imt}	Inventory carrying cost per unit of item i for t^{th} period at destination m
C_{mt}	Cost of transportation from intermediate node to m^{th} destination in period t

D_{imt}	Demand for item i in period t from m^{th} destination
CR_{imt}	Consumption at destination m of product i in period t
a_{ijlt}	Limit beyond which a price break becomes valid, availed from j^{th} source to intermediate node in period t for item i for j^{th} price break
b_{jkt}	Limit beyond which a freight break becomes valid from j^{th} source to intermediate node at period t for k^{th} freight break
w_i	Per unit weight of i^{th} product
IN_{ij1}	Initial inventory of the planning horizon at source j for product i
IN_{im1}	Initial inventory of the planning horizon at destination m for product i

2.4 Decision Variables

X_{ijmt}	Amount of item i ordered in period t from source j for destination m
R_{ijlt}	If the order size for all item types for period t is greater than a_{ijlt}, the quantity discount is applied $R_{ijlt} = \begin{cases} 1, & \text{if } a_{ijlt} \le X_{ijmt} < a_{ij(l+1)t} \\ 0, & \text{otherwise} \end{cases}$
I_{ijt}	Inventory level at j^{th} source for product i at the end of period t
Z_{jkt}	If the order size for all item types for period t is greater than b_{jkt}, the freight discount is applied $Z_{jkt} = \begin{cases} 1, & \text{if } b_{jkt} \le L_{1jt} < b_{j(k+1)t} \\ 0, & \text{otherwise} \end{cases}$
L_{1jt}	Total weighted quantity transported in period t from source j to intermediate node
L_{2mt}	Weighted transported quantity from intermediate node to destination m in period t
Pr_{jmt}	Proportion of ordered quantity is to be transported to destination m, out total available weight at intermediate node
I_{imt}	Inventory level at m^{th} destination for product i at the end of period t
$v_{\tau jt}$	$\begin{cases} 1 & \text{if } L_{1jt} \text{ waits at halt} \\ 0 & \text{otherwise} \end{cases}$

2.5 The Mathematical Model

Minimize

$$\sum_{t=1}^{T}\left[\sum_{j=1}^{J}\sum_{i=1}^{P}\left\{h_{ijt}I_{ijt} + \sum_{l=1}^{L}R_{ijlt}d_{ijlt}\sum_{m=1}^{M}\phi_{ijmt}X_{ijmt}\right\}\right] + \sum_{t=1}^{T}\sum_{j=1}^{J}\sum_{k=1}^{K}\left[Z_{jkt}f_{jkt}\beta_{jt}L_{1jt}\right]$$
$$+\sum_{t=1}^{T}\sum_{j=1}^{J}\sum_{\tau=1}^{\Gamma}\left[L_{1jt}\left(O_{1jt} + (\tau - 1) * O_{2jt}\right)v_{\tau jt}\right] + \sum_{m=1}^{M}\sum_{t=1}^{T}L_{2mt}C_{mt} + \sum_{t=1}^{T}\sum_{m=1}^{M}\sum_{i=1}^{P}h_{imt}I_{imt} \tag{1}$$

Subject to

$$I_{ijt} = I_{ijt-1} + \sum_{m=1}^{M} X_{ijmt} - \sum_{m=1}^{M} D_{imt}, \quad i = 1, \ldots, P;\ j = 1, \ldots, J;\ t = 2, \ldots, T \quad (2)$$

$$I_{ij1} = IN_{ij1} + \sum_{m=1}^{M} X_{ijm1} - \sum_{m=1}^{M} D_{im1}, \quad i = 1, \ldots, P;\ j = 1, \ldots, J \quad (3)$$

$$\sum_{t=1}^{T} I_{ijt} + \sum_{m=1}^{M} \sum_{t=1}^{T} X_{ijmt} \geq \sum_{m=1}^{M} \sum_{t=1}^{T} D_{imt}, \quad i = 1, \ldots, P,\ j = 1, \ldots, J \quad (4)$$

$$I_{imt} = I_{imt-1} + D_{imt} - CR_{imt}, \quad i = 1, \ldots, P;\ m = 1, \ldots, M;\ t = 2, \ldots, T \quad (5)$$

$$I_{im1} = IN_{im1} + D_{im1} - CR_{im1}, \quad i = 1, \ldots, P;\ m = 1, \ldots, M \quad (6)$$

$$\sum_{t=1}^{T} I_{imt} + \sum_{t=1}^{T} D_{imt} \geq \sum_{t=1}^{T} CR_{imt}, \quad m = 1, \ldots, M;\ i = 1, \ldots, P \quad (7)$$

$$X_{ijmt} \geq \sum_{l=1}^{L} a_{ijlt} R_{ijlt} \quad i = 1 \ldots P, t = 1 \ldots T, j = 1, \ldots, J, m = 1, \ldots, M \quad (8)$$

$$\sum_{l=1}^{L} R_{ijlt} = 1 \quad i = 1, \ldots, P,\ t = 1, \ldots, T,\ j = 1, \ldots, J \quad (9)$$

$$L_{1jt} = \sum_{m=1}^{M} \sum_{i=1}^{P} \left[w_i X_{ijmt} \sum_{l=1}^{L} R_{ijlt} \right], \quad t = 1, \ldots, T,\ j = 1, \ldots, J \quad (10)$$

$$L_{1jt} \geq \sum_{k=1}^{K} b_{j_{kt}} Z_{jkt}, \quad j = 1, \ldots, J;\ t = 1, \ldots, T \quad (11)$$

$$\sum_{k=1}^{K} Z_{jkt} = 1, \quad j = 1, \ldots, J;\ t = 1, \ldots, T \quad (12)$$

$$\sum_{\tau=1}^{\Gamma} v_{\tau jt} = 1, \quad t = 1, \ldots, T;\ j = 1, \ldots, J \quad (13)$$

$$L_{2mt} = Pr_{jmt} L_{1jt} = \sum_{i=1}^{P} \omega_i X_{ijmt}, \quad t = 1, \ldots, T,\ m = 1, \ldots, M,\ j = 1, \ldots, J \quad (14)$$

$$\sum_{m=1}^{M} \text{Pr}_{jmt} = 1, \quad t = 1, \ldots T;\ j = 1, \ldots, J \tag{15}$$

$X_{ijmt},\ L_{1jt},\ L_{2mt} \geq 0\ R_{ijlt} = 0$ or $1,\ Z_{jkt} = 0$ or $1\ v_{\tau jt} = 0$ or $1\ 0 < Pr_{jmt} < 1$
$I_{ijt},\ I_{imt}$ are intergers

In the proposed mathematical model, Eq. (1) is the objective function to minimize the cost incurred in holding ending inventory at source, cost of purchasing the multiproducts reflected by the first term of the objective function; the combination of transportation cost from the sources to the intermediate node and halting cost at intermediate node is discussed in second term. Transportation cost from intermediate node to different destinations and holding cost at destination is explained in third term. The cost is calculated for the duration of the planning horizon. The ordering cost is a fixed cost not affected by the ordering quantities and therefore is not the part of objective function.

Equations (2), (3), (4), (5), (6), and (7) are the balancing equations for sources and destinations where Eq. (2) finds that total ending inventory at each source of i^{th} product in t^{th} period is found by reducing the demand of all the destinations from total of ending inventory of previous period and ordered quantity at t^{th} period of all the destinations. Equation (3) finds that total ending inventory at each source of i^{th} product in first period is found by reducing the demand of all the destinations from total of initial inventory if the planning horizon and ordered quantity at first period of all the destinations. Equation (4) shows that total demand in all the periods from all destinations is less than or equal to total of ending inventory and ordered quantity at all the sources in all the periods, i.e., shortages are not allowed. Equation (5) calculates ending inventory at m^{th} destination for t^{th} period by reducing consumption of the same destination from the combination of ending inventory of previous period and demand at m^{th} destination. Equation (6) calculates ending inventory for the first period at m^{th} destination by reducing consumption of the same destination from the combination of initial inventory of planning horizon and demand of at mth destination. Equation (7) shows that total consumption in all the periods at mth destination is less than or equal to total of ending inventory and demand at destination m in all the periods, i.e., shortages are not allowed.

Equations (8) and (9) find out the order quantity of all products in period t which may exceed the quantity break threshold and avail discount on ordered quantity at exactly one quantity discount level. Equation (10) is the integrator for stage one's procurement Eqs. (2, 3, 4, 5, 6, 7, 8, and 9) and transportation Eqs. (11, and 12), which calculates weighted quantity to be transported from source j to intermediate node according to weights per product. Equations (11) and (12) find out the weighted transport quantity of all products in period t which may exceed the freight break threshold and avail discount on transportation quantity at exactly one freight discount break. Equation (13) finds out exact number of halting days at intermediate node.

Equation (14) calculates proportioned weighted quantity transported from intermediate node of stage one to destination. Here, L_{2jt} is the weight transported in stage two of the model, which is also equal to multiplied combination of the weight per unit and optimum ordered quantity. Whereas Eq. (15) ensures that whatever reached at intermediate node has been transported to destinations in unequal proportions.

2.6 Price Breaks

As discussed above, variable R_{ijlt} specifies the fact that when the order size at period t is larger than a_{ijlt}, it results in discounted prices for the ordered items for which the price breaks are defined as: Price breaks for ordering quantity are

$$d_f = \begin{cases} d_{ijlt} \; a_{ijlt} \leq X_{ijmt} < a_{ij(l+1)t} \\ d_{ijLt} \; X_{ijmt} \geq a_{ijLt} \end{cases}$$
$$i = 1, \ldots, P; \; t = 1, \ldots, T; \; l = 1, \ldots, L; \; j = 1, \ldots, J; \; m = 1, \ldots, M$$

Freight breaks for transporting quantity are

$$d_f = \begin{cases} f_{jkt} \; b_{jkt} \leq L_{1jt} < b_{j(k+1)t} \\ f_{jKt} \; \mathrm{L}_{1jt} \geq b_{jKt} \end{cases}$$
$$t = 1, \ldots, T; \; j = 1, \ldots J; \; k = 1, \ldots K$$

where d_f is the discount factor. And, b_{jkt} is the minimum required quantity to be transported.

3 Case Study

Pretty Heels Pvt. Ltd. is a leather shoes and bag company, who runs many stores in the northern region of India, especially in metro city Delhi and NCR. Company's claim "We sell only leather products" is well appreciated by its customers, and every store has very good footfall and revenue. Company policy is to keep all the articles in parity among all the stores. By this way, they cannot have shortage at any of its store and would be able to retain its reputation in market. In such a condition, the company really has to take care of its supply chain. Pretty Heels is running 12 stores in Delhi and NCR, and 6 outsourced manufacturing plants that are fulfilling the demand for the stores. In this current case, we are discussing a tiny environment of the full scenario by taking three stores and two manufacturing plants and three types of shoe articles especially for winter seasons: article type 1, closed belly with 3-in. heel; article type 2, back opened flat belly; and article type 3, flat closed belly. Weight (in kg) per carton per product is 5, 6, and 3 kg. Considered manufacturing plants located in Madhya Pradesh are as follows: plant I, Indore, and plant II, Bhopal. Stores located in Delhi and NCR markets are named as store I, Noida

Sec-18 market; store II, GK M-block market; and store III, Connaught Place market. The company's major concern is to check and manage the cost of moving ordered quantity from manufacturing plant to intermediate node and further to stores, as the company is spending for cost of holding at stores, cost of procurement while purchasing from manufacturer, cost of transporting ordered quantity from manufacturing point to intermediate node (Alwar, Rajasthan), halting cost at intermediate node, transportation cost from halting point to different stores, and one more cost, i.e., cost of holding at manufacturing plant because the manufacturer is providing discounts on bulk purchase so in such case he or she has to keep bulk quantity in his or her warehouse to deliver to the stores. Company requires this measurements and management especially for winter season, i.e., December (period 1), January (period 2), and February (period 3). The data for the scenario is as follows:

Table 1 Holding cost per unit at plant (Rs.)

	Period I		Period II		Period III	
	Plant I	Plant II	Plant I	Plant II	Plant I	Plant II
Article I	3.5	3.4	3.8	3.5	3.3	3.7
Article II	3.1	3.3	4	3.2	3.5	3.2
Article III	4	4.4	3.7	3.9	3	3.3

Table 2 Purchase cost for all stores (Rs.)

	Period I			Period II			Period III		
	Product I	Product II	Product III	Product I	Product II	Product III	Product I	Product II	Product III
Plant I	268	279	267	263	285	270	265	280	265
Plant II	280	260	282	271	265	272	270	260	270

Table 3 Quantity threshold and discount factor

Quantity thresholds PDT I	Discount factor	Quantity thresholds PDT II	Discount factor	Quantity thresholds PDT III	Discount factor
0–100	1	0–90	1	0–86	1
100–200	0.98	90–180	0.95	86–170	0.97
200 and above	0.95	180 and above	0.90	170 and above	0.95

Table 4 Weight threshold in all periods and plants and transportation cost per weight to halting point

Weight thresholds	Discount factor	Transportation cost	Plant I	Plant II
2,000–5,000	1	Period I	15	14
5,000–8,000	0.98	Period II	14	12
8,000 & above	0.95	Period III	13	16

Table 5 Holding cost at halting point

	Period 1		Period 2		Period 3	
	Halting day 1	Halting day 2 onward	Halting day 1	Halting day 2 onward	Halting day 1	Halting day 2 onward
Plant I	10	2	9	3	11	4
Plant II	9	4	10	7	8	4

Table 6 Holding cost at all the stores for all products (Rs.)

	Period I			Period II			Period III		
	Product I	Product II	Product III	Product I	Product II	Product III	Product I	Product II	Product III
Store I	2.5	2.1	3	2.8	3	2.7	2.3	2.5	2
Store II	2.4	2.3	3.4	2.5	3.2	2.9	2.7	2.2	2.3
Store III	2.3	2.7	3.7	2.6	3.5	2.6	2.4	2	2.6

Table 7 Demand from each store in all periods for all products

	Period I			Period II			Period III		
	Product I	Product II	Product III	Product I	Product II	Product III	Product I	Product II	Product III
Store I	170	189	170	172	188	172	169	184	167
Store II	179	167	179	174	169	176	176	164	173
Store III	185	187	174	183	184	172	182	185	170

Table 8 Consumption at each store in all period for all products

	Period I			Period II			Period III		
	Product I	Product II	Product III	Product I	Product II	Product III	Product I	Product II	Product III
Store I	168	179	167	163	185	170	165	180	165
Store II	180	160	182	171	165	172	170	160	170
Store III	181	180	170	179	180	171	175	180	168

Table 9 Transportation cost per weight from halting point to all destinations

	Period I	Period II	Period III
Store I	12	11	16
Store II	15	14	14
Store III	14	16	13

Table 10 Initial inventory at destination for period I

	Product I	Product II	Product III
Store I	70	80	40
Store II	59	68	50
Store III	40	56	60

The date collected from the case study organization is employed to validate the proposed model. A LINGO code for generating the proposed mathematical models for the given date was developed and solved using LINGO 11.0. The results provide optimal solution for the decision variables: optimum ordered quantity, inventory level at sources and destinations, total weight transport from sources to halting point, proportioned weight transport to destination from halting point, and number of days to halt at intermediate node.

The total incurred cost is Rs. 37,23,490. The optimum ordered quantity from store I is 200 cartons with quantity discount of 5% for product I, 212 cartons with 10% discount for product II, and 183 cartons with 5% discount for product III. Inventory at source in period I is 66, 29, and 0 cartons for each product respectively. Inventory at store I, at the end of period I, is 72, 90, and 43 cartons for each product respectively. Weight transport up to intermediate node is 8,001, 12,310, and 2,000 kg with discounts of 5, 5, and 0% respectively. Weight transport from intermediate node to store I is 2,821, 7,130, and 510 kg. In each period total weight quantity is kept at halting point only for 1 day. Remaining managerial results are presented in the Appendix.

4 Conclusion

Though there are many studies reporting on a two-stage supply chain network with multisource and destinations, incorporating either quantity or freight discounts, the objective of minimizing the total incurred cost during procurement, holding at suppliers, transportation from different supply points to halt point, holding at halt point, transportation from halt point to destinations, and finally, holding at destinations in a two-stage supply chain network with both quantity and freight discounts is not addressed so far. So, the current study proposed a mathematical model for the literature gap identified and mentioned in this study. The proposed model was validated by applying to the real case study data.

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Appendix: Managerial Reports Based on the Optimal Solution from the Proposed Model

Exhibit 1 Ordered quantity/discount percentage availed for each manufacturing plant to halting point

	Period I			Period II			Period III		
	Product I	Product II	Product III	Product I	Product II	Product III	Product I	Product II	Product III
Store I	200/5	212/10	183/5	496/5	685/10	180/5	0/0	0/0	170/5
Store II	200/5	180/10	170/5	200/5	180/10	170/5	0/0	0/0	170/5
Store III	200/5	180/10	170/5	200/5	180/10	170/5	94/0	180/10	170/5

Exhibit 2 Inventory at each manufacturing plant

	Product I	Product II	Product III
Period I	66	29	0
Period II	433	533	0
Period III	0	0	0

Exhibit 3 Inventory at the stores

	Period I			Period II			Period III		
	Product I	Product II	Product III	Product I	Product II	Product III	Product I	Product II	Product III
Store I	72	90	43	81	93	45	85	97	47
Store II	58	75	47	61	79	51	67	83	54
Store III	44	63	64	48	67	65	55	72	67

Exhibit 4 Weight transport quantity up to intermediate node/discount availed from each plant

	Period I	Period II	Period III
Plant	8,001/5	12,310/5	2,000/0

Exhibit 5 Weight transport quantity to destinations

	Period I	Period II	Period III
Store I	2,821	7,130	510
Store II	2,590	2,590	510
Store III	2,590	2,590	980

Exhibit 6 Proportion transported from manufacturing plant to stores

	Period I	Period II	Period III
	Plant I, II	Plant I, II	Plant I, II
Store I	0.3525809	0.5792039	0.2550000
Store II	0.3237095	0.2103981	0.2550000
Store III	0.3237095	0.2103981	0.4900000

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Adoption of Freight Management System (FMS) in Logistics: An Exploratory Study

Timira Shukla and M.R. Bansal

1 Introduction

The role of technology investments in logistics is beyond doubt. It involves the integration of information, transportation, inventory, warehousing, material handling, and packaging. When there are multiple vendors, multiple locations, as well as stock points and manufacturing facilities, transportation of raw material, supplies, and good assumes great importance. The recent years have witnessed a transition from an era focused primarily on developing infrastructure toward an era that is increasingly focused on system integration and optimization in the field of freight management. The past efforts, whether it was railroads or ports, was primarily oriented toward system construction. Today, these systems are extensive and mature; the focus therefore has shifted toward designing and developing an integrated solution which can integrate different elements of back-end operations.

Freight management is a key element that links the existing production and distribution processes. It accounts for significant cost in the supply chain. In India, 13% of our GDP is sunk in logistics cost (other countries spend in single digit).[1] Though logistics business in India is still in initial stages, the scope for implementing the back-end IT systems is immense. One of the back-end solutions is FMS, that is, freight management systems. As logistics is the competency that links an enterprise with its customers and suppliers, information about the customer flows through the enterprise in the form of sales activity, forecasts, and orders. As many activities like fleet management/transport, vendors, warehouses, inventory,

[1] Source: Article in The Strategist- Business Standard dated October 31, 2011.

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packaging, documentation, etc., are involved, integration is important to build an effective system. FMS has the potential to build and strengthen these linkages in the value chain to improve the bottom line. It has the potential to be an effective enabler for the effective control of today's complex logistics, and supply chain network is beyond doubt.

It is important to mention that a successful business model encompasses strategy, customer value, information system, process, and people (employee) management.[2] However, IT by itself will not guarantee returns as adoption of a particular technology and/or software application requires complementary investments in processes as well as people who are a vital link in any change agenda. It is in this context that a study has been undertaken to identify the issues that are considered important by the employees working in transport organizations.

1.1 FMS: Meaning and Significance

The operating responsibility of logistics is the geographical repositioning of raw materials, work in process, and finished inventories where required at the lowest cost possible. Thus the process is viewed in terms of two interrelated efforts, inventory flow and information flow.

Inventory flow – The management of logistics is concerned with the movement and storage of materials and finished products. From the initial purchase of a material or component, the logistical process adds value by moving inventory when and where needed. For a large manufacturer, logistical operations may consist of thousands of movements, which ultimately culminate in the delivery of the product to an industrial user, wholesaler, dealer, or customer.

Information flow – Information flow identifies specific locations within a logistical system that have requirements. It includes **c**oordination flows and operation flows.

Coordination flow – Coordination is the backbone of the overall information system. The strategic objectives detail the nature and location of customers, which are matched to the required products and services to be performed. The forecasting utilizes historical data, current activity levels, and planning assumptions to predict future activity levels. Logistical forecasting is generally concerned with relatively short-term predictions. The overall purpose of information planning/coordination flow is to integrate specific activities within a firm and to facilitate overall integrated performance.

Operational flow – The second aspect of information requirements is concerned with directing operations to receive, process, and ship inventory as required supporting customer and purchasing orders. Operational requirements deal with order management, order processing, distribution operations, inventory management, transportation and shipping, and procurement.

[2] Weick (1993).

The FMS is expected to reduce lead times, inventories, and associated storage costs. It is scalable and can be merged with supply chain management module as well as order processing and warehouse/distribution module. FMS is a customized Windows-based software developed for the companies involved in freight or logistics business. Manpower issues are contentious as training them is also an important element of the strategy. The human aspect is often overlooked, and therefore, an empirical study of employees has been undertaken to obtain an insight into the human dimension of IT.

2 Literature Review

The dominant theoretical model pertaining to technology acceptance (in this case, FMS) is the technology acceptance model (TAM) propounded by Davis et al. (1989). The TAM model has been adapted from the classical diffusion theory propounded by Rogers (1983). The TAM posits that usefulness and ease of use are the primary drivers of technology acceptance. The usefulness dimension focuses on the user's perspective regarding utility of the IT application in improving job performance, and ease of use refers to the degree to which the user perceives the solution to be free of effort (Davis et al. 1989). Lucas and Spitler (1999) have asserted that IT impact does not materialize by themselves. Instead, it is the synergy between IT and complementary organizational investments that creates positive impact (Barua and Mukhopadhyay 2000; Zhu and Kraemer 2002; Russell and Hoag 2004).

As technology can be viewed as a kind of knowledge (Grant 1996), it has higher probability of acceptance when it can be shared with the other employees in the organization. Teece (1996) also found that technology innovation has a higher probability of acceptance when it follows a technological paradigm. A large body of research regarding factors impacting adoption suggests that individual factor and organizational context are important determinants (Damanpour 1991; Tidd et al. 1997). These authors have posited that variables affecting technology adoption can be individual, task related, and/or organization based. Individuals rarely have complete autonomy regarding adoption of work place innovations. The other factor that inhibits adoption is adopters' ability to adopt which focuses on the skill sets of the individuals in the organizations. Developing the employee skills is therefore an important dimension in respect of technology-related innovations. It can be summarized that while the adoption of information technology has been an extensive area of study, research efforts have not probed in detail the impact of end-users' perspective. An empirical study has been conducted primarily focusing on finding out the expectations of the potential adopters' with respect to technology**.**

3 Purpose of the Study

The main objective of this chapter is to study the importance of freight management system (FMS) in logistics companies in India. The main premise that is being examined is that the more useful the innovation, the more likely it is that the

Table 1 Frequency distribution of gender

	Frequency	Valid percent	Cumulative percent
Male	62	62.0	62.0
Female	38	38.0	100.0
Total	100	100.0	

Table 2 Frequency distribution of age

	Frequency	Valid percent	Cumulative percent
18–25	62	62.0	62.0
26–35	32	32.0	94.0
36–50	5	5.0	99.0
>50	1	1.0	100.0
Total	100	100.0	

Table 3 Frequency distribution of employees (function-wise)

	Frequency	Valid percent	Cumulative percent
Sales	28	28.0	28.0
Marketing	38	38.0	66.0
Finance	16	16.0	82.0
HR	8	8.0	90.0
R&D	9	9.0	99.0
Others	1	1.0	100.0
Total	100	100.0	

Table 4 KMO and Bartlett's test

Kaiser-Meyer-Olkin measure of sampling adequacy		.682
Bartlett's test of sphericity	Approx. chi-square	467.215
	Df	300
	Sig.	.000

logistics company will adopt the FMS. A structured questionnaire was administered to the employees of logistics companies in Delhi and NCR (refer to annexure) to find out their perception of FMS suite implemented in their organizations. The sample size that is included for analysis is 100; the method adopted for selecting the sampling elements is nonprobabilistic. The study is exploratory and analytical in nature. The method of EFA (exploratory factor analysis) has been used to identify the important factors that impact adoption of FMS. This method was used as it can minimize the number of variables that have high factor loadings and group the variables.

4 Analysis and Discussion

The Tables 1, 2, and 3 show the frequency distribution of various demographic variables of the employees working in the logistics company. An exploratory factor analysis was carried out to identify the important factors that are of significance in adopting the FMS. As the KMO (Table 4) value calculated is more than 0.5 (0.682), the factor analysis was carried out to extract the factors that are important for adoption (refer Tables 5, 6, and 7). The questionnaire contains 25 variables which

Table 5 Total variance explained

	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
Component	Total	% of Variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	2.940	11.761	11.761	2.940	11.761	11.761	2.171	8.684	8.684
2	2.212	8.847	20.607	2.212	8.847	20.607	1.961	7.844	16.528
3	1.969	7.877	28.484	1.969	7.877	28.484	1.847	7.389	23.916
4	1.774	7.097	35.581	1.774	7.097	35.581	1.826	7.303	31.219
5	1.546	6.183	41.764	1.546	6.183	41.764	1.747	6.988	38.207
6	1.474	5.896	47.660	1.474	5.896	47.660	1.662	6.648	44.855
7	1.261	5.045	52.705	1.261	5.045	52.705	1.522	6.090	50.945
8	1.219	4.875	57.580	1.219	4.875	57.580	1.424	5.697	56.641
9	1.152	4.609	62.189	1.152	4.609	62.189	1.387	5.548	62.189
10	.980	3.920	66.109						
11	.921	3.682	69.791						
12	.839	3.356	73.147						
13	.811	3.245	76.393						
14	.771	3.084	79.476						
15	.737	2.948	82.424						
16	.717	2.869	85.292						
17	.592	2.367	87.659						
18	.546	2.183	89.843						
19	.469	1.877	91.719						
20	.441	1.763	93.483						
21	.403	1.612	95.095						
22	.368	1.470	96.565						
23	.333	1.331	97.896						
24	.282	1.127	99.023						
25	.244	.977	100.000						

Table 6 Rotated component matrix[a]

	Component								
	1	2	3	4	5	6	7	8	9
Q5	−.675	−.107	−.142	−.120	.197	−.063	−.189	.189	.087
Q6	.048	.040	.062	.116	−.038	.840	.089	.105	.038
Q7	.272	.053	−.090	.697	.333	.080	.045	.135	−.107
Q8	.206	.072	.026	−.098	−.340	−.199	.618	.030	.088
Q9	.149	.022	.206	.227	.079	.319	−.041	.672	−.166
Q10	−.336	.015	−.037	.406	−.189	−.407	.163	−.072	−.011
Q11	.133	−.351	.200	.314	−.058	.360	−.507	.017	−.121
Q12	.615	−.024	−.360	−.085	.061	−.124	−.048	.035	.080
Q13	.027	−.082	−.090	−.781	.130	−.079	.078	−.017	−.100
Q14	.261	.324	.545	−.044	.219	.179	−.168	.097	.004
Q15	−.017	.069	.024	−.076	.743	−.066	−.003	−.094	.159
Q16	−.021	−.229	.441	−.040	.182	.050	.022	.173	−.066
Q17	.329	−.104	.119	.143	.549	.074	−.112	−.063	−.160
Q18	.095	.550	.115	−.340	.374	−.287	.038	.035	.063
Q19	−.690	.004	−.165	−.036	−.201	−.167	.023	−.008	.195
Q20	−.217	−.039	−.041	−.053	−.186	−.054	−.027	.804	.059
Q21	.250	.403	−.199	.006	−.425	−.035	−.300	−.118	.328
Q22	−.194	.031	−.014	−.032	.002	.051	.048	−.015	.811
Q23	.373	−.224	.293	.189	.156	−.294	.004	.012	.453
Q24	.105	.205	.530	−.248	−.136	−.242	−.103	.177	−.309
Q25	−.034	.725	−.012	.037	−.159	.306	−.006	−.109	.026
Q26	.312	−.149	−.063	.067	.037	.053	.354	.316	.282
Q27	−.053	.148	.760	.175	−.024	.050	.087	−.176	.168
Q28	−.029	.701	.233	.282	.068	−.157	−.027	.056	−.149
Q29	−.055	−.121	.033	.084	.097	.242	.721	−.089	−.049

Extraction method: Principal component analysis
Rotation method: Varimax with Kaiser normalization
[a]Rotation converged in 15 iterations

Table 7 Factor matrix

Factor name	Variables
Efficiency	Efficiency
Effectiveness	Less maintenance cost, reduced repetition of work, route optimization, improved traffic analysis, saves time through billing system, maintains consignee history, reduces weight on godown stock
User friendliness	Controls better inventory system, user friendly and easy to implement, provides 24 × 7 customer service, performs better tally integration, customer login, SMS alerts
Reduced cost	Efficiency, reduced ordering cost on maintaining and ordering, improves management cost of whole organization, gives expiry alerts, supports both remote and desktop application
Productivity	Improves branch profitability, maintains data between different companies, increases branch growth and productivity, improved branch growth and productivity system
Result driven	Reliability, affordable data security
Assurance	Easy freight analysis, user friendliness
Confidentiality	Privacy

denote the various parameters which impact the adoption of FMS in logistics companies. By applying varimax rotation for data reduction, eight components have been extracted; these eight components are the linear combination of 25 original variables.

5 Conclusion and Recommendation

It can be seen that efficiency and effectiveness are important dimensions of adoption. The technological factors such as flow of information, savings in cost/ time, and transfer of information are important drivers affecting FMS suite as per employee perception. The important factors that were identified from this exploratory study with regard to implementation of FMS software are the following:

- It should improve data security and assist in synchronization.
- It should minimize work repetition and improve route optimization.
- It should assist for better MIS reporting system and provide 24 × 7 customer service.

The results show that logistics companies have the willingness to adopt technologies to provide better services if it enables them to improve their performance. However, it is very important for the organization to first implement trial versions of the FMS software so that the employees can gain hands-on experience in the use of software.

5.1 Limitations

FMS application is only an enabler; it has to be leveraged to deliver value by improving the links between purchase and supply, though this aspect has not been investigated. As the study was carried out on a small sample from Delhi/NCR, it cannot be generalized. The other major limitation is that the study did not investigate all the influential factors that affect adoption of FMS.

Annexure (List of Statements)

(Scaled on a 5-point scale with 1 for strongly disagree and 5 for strongly agree)

1. FMS is reliable and affordable.
2. Maintenance cost is less in FMS.
3. FMS reduces repetition of work.
4. It improves branch profitability.
5. It improves company's route optimization.
6. It improves efficiency of company.
7. FMS is helpful in analyzing real-time traffic analysis.

8. FMS helps in making sync of data from branch to branch.
9. It makes station-wise freight analysis easier.
10. It saves time through monthly customer billing system.
11. It helps in reducing work load of the company for maintaining records of the company.
12. It helps in maintaining consignee history in an efficient manner.
13. It reduces the burden on godown stock.
14. It helps in controlling inventory management system (FIFO).
15. Privacy is maintained in FMS.
16. FMS is user friendly.
17. It improves the MIS reporting system in an organization
18. It improves data security
19. It improves the management system of the whole organization.
20. It provides 24 $\times$ 7 customer service.
21. It is user friendly and easy to implement.
22. It helps in increasing the growth and productivity of the company.
23. It supports both remote and desktop application.
24. It supports modules like booking, delivery, transshipment, good movement, management, customer login, and SMS alerts.
25. FMS – intelligence gives expiry alerts (legal documents related to transportation).

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Swap in Downstream Petroleum Supply Chain: An Effective Inventory Handling Tool

Hari Mohan Jha Bidyarthi and Laxmikant B. Deshmukh

1 Indian Petroleum Industry: An Overview

The Indian petroleum industry is one of the oldest in the world, with oil being struck at Makum near Margherita in Assam in 1867 9 years after Col. Drake's discovery in Titusville. The industry has since come a long way. For nearly 50 years after independence, the oil sector in India has seen the growth of giant national oil companies in a sheltered environment. A process of transition of the sector began since the mid-1990s, from a state of complete protection to the phase of open competition. The move was inevitable if India had to attract funds and technology from abroad into its petroleum sector. The sector in recent years has been characterized by rising consumption of oil products, declining crude production and low reserve accretion. The years since independence have, however, seen the rapid growth of the upstream and downstream oil sectors. There has been optimal use of resources for exploration activities and increasing refining capacity and the creation of a vast marketing infrastructure and a pool of highly trained and skilled manpower. Indigenous crude production has risen to 35 million tonnes per year, an addition of 14 refineries, an installed capacity of 69 million tonnes per year and a network of 5,000 km of pipelines (OPEC Annual Statistical Bulletin 2007). But with the consumption of hydrocarbons said to increase manifold in the coming decades, the liberalization, deregulation and reforms in the petroleum sector are essential for the health and overall growth of our economy (International Energy Agency Statistics 2007).

The petroleum industry traditionally had prices decided by the Government of India. Effective from 1 August 2004, the government put in a revised methodology allowing oil companies limited freedom to revise the prices of motor spirit and

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high-speed diesel (HSD). The NELP (New Exploration Licensing Policy) has been put into place, and more and more international operators are considering investing in India. The total investment estimated in the petroleum sector from 1995 till 2010 is expected to be Rs. 4,32,000 crore (US$120 billion), out of which Rs. 2,58,000 crore (US$80 billion) are for the upstream sector alone (Petroleum Planning and Analysis Cell, GOI). The petroleum, oil and lubricants (POL) product consumption is slated to touch 155 million metric tonnes (MMT) by 2006–2007 and 200 MMT by the year 2010 (HPCLs perspective plan: Vision 2020). Petrochemical industry in India employs around 40,000 people directly and around four lakhs indirectly. This sector caters to a whole host of industries like oil, gas, plastics, agrochemicals, pharmaceuticals, clothing, housing, transportation, communication, healthcare etc., diversified nature of customers demanding well thought-out strategy for enhancing customer satisfaction level. State of competition in the Indian petroleum industry final report: January 20, 2009 by Indicus Analytics Pvt. Ltd, New Delhi.

2 Supply Chain Management: A Literature Review

The Supply Chain Council defines a supply chain as a “collection of activities a company uses to plan, source, make and deliver a product or service” (Agrawal 2003). Supply chain management aims at managing the activities in the supply chain to improve profitability for the organization (Coyle et al. 2003). Supply chain management as a new business paradigm was motivated by the interest in integrating procurement, manufacturing and distribution activities—integration made possible by advances in IT (Shapiro 2004). SCM is more than a simple tool to evaluate and optimize a supply chain; it is a complex, structured business relationship model (Bay et al. 2004). It takes into consideration all aspects of the events required to produce the company’s product in the most efficient and cost effective manner possible (Quiett 2002). According to Mohanty and Deshmukh (2005), another very comprehensive definition of supply chain management is that it is a loop:

- It starts with customer and ends with customer.
- Through the loop flow all materials, finished goods, information and transactions.
- It requires looking at business as one continuous, seamless process.

This process absorbs distinct functions such as forecasting, purchasing, manufacturing, distribution, sales and marketing into a continuous business transaction (Burgess 1998).

2.1 Petroleum Supply Chain

The supply chain of the petroleum industry is extremely complex compared to other industries (Kidd et al. 2003). It is divided into two different, yet closely related, major segments: the upstream and downstream supply chains. The upstream supply chain

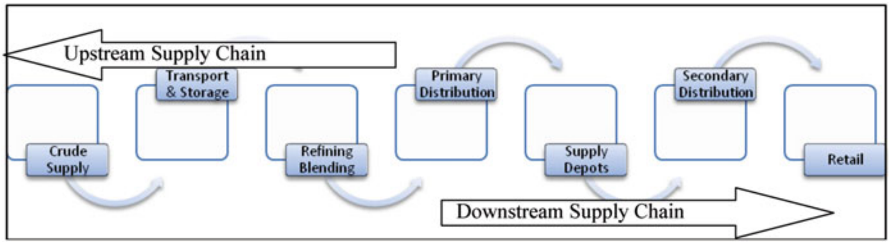


Fig. 1 Showing whole petroleum supply chain. Source: Strategic Shift in Indian Downstream Sector Technologies in Supply Chain Management; August 2005 by: Ashish Gaikwad, Director – Advanced Solutions, Honeywell Asia Pacific

involves the acquisition of crude oil, which is the specialty of the oil companies. The upstream process includes the exploration, forecasting, production and logistics management of delivering crude oil from remotely located oil wells to refineries (Fig. 1).

2.2 Inventory Management in Petroleum Supply Chain

In case of oil sector companies, especially those in the business of refining, inventories may broadly be classified as (a) raw materials (b) intermediate stock or work-in-progress or semi-finished goods and (c) finished goods stock.

(a) *Raw Material:* Raw material includes crude oil stock consisting of high-sulphur crude or low-sulphur crude or both. This may further be categorized into: indigenous crude oil, i.e. offshore such as from Bombay High, Panna-Mukta etc. or onshore crude oil such as South Gujarat, North Gujarat, Assam etc., and imported crude oil such as Bonny Light, Labuan, Arab Mix, Dubai crude etc. The main sources of procurement of imported crude oil are countries like Nigeria, Iran, Saudi Arabia, Kuwait, Malaysia etc.
(b) *Intermediate Stock:* Intermediate stock refers to the stock of goods in semi-finished form and held between manufacturing stages. At every point of time, there are certain goods that are neither fully complete nor may be categorized as raw materials.
(c) *Finished Stock:* Finished stock consists of goods complete in all respects and ready for sale or distribution in the market which are either straight run products such as petrol, diesel, kerosene, LPG etc. or specialty products such as benzene, toluene, paraffin wax etc.

The analysis of the downstream oil companies reveals that their average inventory to working capital ratio for the year 2008–2009 was 2.04 times as shown in following Chart 1.

From the above chart, it is further evident that the inventory to working capital ratio for the year 2008–2009 of IOCL and BPCL was 2.74 times and 2.78 times, respectively, which was much higher than the average ratio, i.e. 2.04 times of all oil sector PSUs taken together.

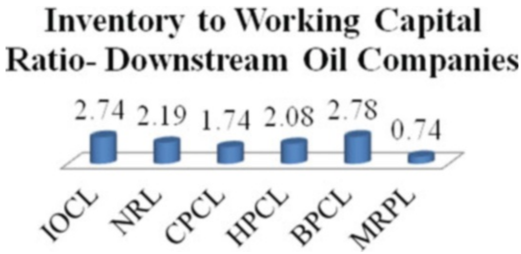
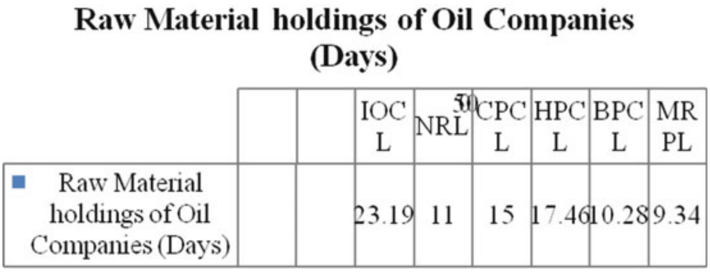


Chart 1 Showing inventory to working capital ratios of oil companies



			IOCL	NRL	CPCL	HPCL	BPCL	MRPL
Raw Material holdings of Oil Companies (Days)			23.19	11	15	17.46	10.28	9.34

Chart 2 Showing raw material holdings of oil companies

			IOCL	NRL	CPCL	HPCL	BPCL	MRPL
Age of Finish goods Inventory of Oil Companies (days)			32.83	28.01	13.03	34.34	30.7	11.14

Chart 3 Showing age of finished goods inventory of oil companies. www.cag.gov.in/html/reports/commercial/2009-10.../chap3.pdf

In the downstream oil companies, the crude oil is the major input. The crude is also a high value item, and major funds of the company are invested in crude procurement and its holding. It was observed that there was no industry practice/norm fixed by these companies for keeping the crude inventory. The average raw material holding in these oil companies was equal to 14.38 days of consumption as depicted in Chart 2.

IOCL, HPCL and CPCL were holding raw material stock equal to 23.19 days, 17.46 and 15 days stock consumption against the oil company's average of 14.38 days. MRPL was carrying raw material stock of 9.34 days only as on 31 March 2009. Reduction in the raw material holdings by IOCL, HPCL and CPCL would result in savings towards inventory carrying cost of Rs. 826.31 crore, Rs. 90.34 crore and Rs. 12.02 crore *per annum*, respectively**.** The average age of inventory of oil refining and marketing companies, i.e. IOCL, HPCL, BPCL and NRL was ranging between 28.01 and 34.34 days, whereas it was 13.03 and 11.14 days in case of refining companies, i.e. CPCL and MRPL, respectively (Chart 3).

Hence, it is critical for the companies to fix stock levels for different categories of stores, taking into account consumption pattern, lead time, storage space, market trends, carrying cost, ordering cost etc.

2.3 The Swap Practice

In a commodity-type industry such as oil and petrochemicals, the source of the commodity is often of no interest to the final customer as long as the commodity adheres to its required specifications and the delivery of that commodity is made by the promised due date. Therefore, competing oil and petrochemical companies form supply chain alliances when delivering commodities to customers in order to reduce transportation and inventory costs and improve customer service. In return, cost savings for inventories in the overall supply chain are shared amongst participating companies. This form of collaboration is referred to as shipment swapping. This kind of collaboration with competitors creates a shared solution to common supply chain obstacles and is predicted to be the "next big thing" (Morton 2003).

The swapping technique is currently applied by oil and petrochemical companies around the world in all of its different forms: asset swapping, business swapping and shipment swapping. However, because of the absence of any general analytical discussion of swap practices in the literature, the author has conducted the survey of petrol pumps in the state of Maharashtra to find out the benefits that can be sought by using this swap practices.

The present research paper attempts to study and verify that the systematic cooperative barter system of downstream supply chain management, i.e. swap, has a positive bearing on inventory cost reduction saving company's millions of dollars. It further attempts to ascertain that the swap practice improves the customer services by petroleum industry.

3 Problem Formulation

The petroleum downstream supply chain ever finds it difficult to reduce the cost of inventory from refinery to the retailers. Uncertain demand pattern, refinery capacity, inadequate transportation facility, supply depots storage capacity and so on are the constraints for inventory management in downstream petroleum supply. The swapping practices seem to be the better solution to the above constrained downstream supply chain model. Application of IMS technology further enhances efficiency of swapping practice in downstream supply chain management of petroleum industry. Hence, the authors of this chapter find an opportunity to discuss the merits of swap (often called as hospitality or sharing) along with IMS technology with respect to the inventory management by the public sector giants of petroleum industry in the state of Maharashtra.

4 Methodology of Research

The Indian petroleum industry consists of 17 public sector oil refineries and 2 private sector oil refineries in different parts of 10 states of the country. The companies under private sector units of the industry, both by their numbers and also by their years of operation, remain the dominant players in Indian petroleum industry. Rightly therefore, the investigator proposes to include public sector players of the Indian petroleum industry within the scope of the study.

Amongst the ten Indian states where petroleum refineries are located, the state of Maharashtra alone accounts for largest share of installed capacity (excluding private sector refineries in Gujarat) and also its refinery crude throughput. It is for this reason that the authors have done the study to be confined within the territory of Maharashtra so that its findings can be validly generalized for the country as a whole. There are only two petroleum giants, *BPCL* (Bharat Petroleum Corporation Limited) and *HPCL* (Hindustan Petroleum Corporation Limited), which have their refineries located at Mumbai in the state of Maharashtra. Obviously therefore, the author is left with no choice than to study only these two petroleum giants of India from amongst the four major Indian petroleum companies including IOC (Indian Oil Corporation) and GAIL (Gas Authority of India Ltd) besides HPCL and BPCL.

The physical flow of a product as highly inflammable as that of petroleum through the entire length and breadth of the country encompassing all geographical and topographical limitations to end no. of users for equally end no. of uses is a gigantic task aptly taken care of by an emerging field of management science called as supply chain management. However, petroleum product pricing being considered as a black hole of subsidies is an issue of hot debate amongst economists and oil companies. The supply chain management in this industry remains to be more concurrent and vibrant with its impact on petroleum pricing and petroleum subsidy as well.

There are numbers of products of petroleum industry. However, of these products, three, namely, HSD, LDO and lubes, are widely distributed and consumed in India as these flow through different distribution channels. Hence, for the purpose of present study, only these three products have been included within the scope for its data collection and analysis.

The retailers of Maharashtra are clustered in to four geographies popularly known as Khandesh, Marathwada, Vidarbha and West Maharashtra followed by convenience sampling. Both the refineries and Gaigaon supply depots (District Akola, Vidarbha) of HPCL and BPCL were given a structured questionnaire, and the views of oil company representatives on the issues are collected. Forty 3PL and one hundred and fifty retailers' responses are gathered through structured questionnaire and interviews of the concerns. The responses of refineries, supply depots, retailers, and 3PL are analysed in the next section where some non-value-adding activities in downstream petroleum supply chain are identified.

5 Swapping and Inventory Management in Maharashtra's Downstream Petroleum Supply Chain

5.1 Refineries' Responses

BPCL has its only refinery at Mumbai in Maharashtra where the crude oil derivatives, i.e. petroleum products, are separated. The company is having storage depots at Manmad, Miraj, Gaigaon, Borkhedi, Pakni and Mumbai to cater to the needs of the state. The transportation from refinery to the end user is generally done through pipeline tank waggons, tank lorries etc. The most critical response obtained from the company is "Oil Exchange practice is adopted by oil industry members to reduce not only the inventory carrying & ordering cost but overall supply chain cost".

HPCL also has only one refinery at Mumbai in Maharshtra where crude oil derivatives are separated. Sewree, Wadala, Vashi, Loni, Pakni, Panewadi, Gaigaon, Khapri and Hazarwadi are some of the supply depots of HPCL in the state. Again, the response of HPCL about swapping practice is "Reduced supply chain cost and improved customer service (timely delivery) are the outcomes of such SWAP practices".

5.2 Retailers' Responses

Retailers of HSD and lubes were conveniently chosen from the identified four clusters, i.e. Vidharbha, Marathwada, Khandesh and West Maharashtra. Table 1 given below shows the number of sample retailers chosen from these clusters.

An important observation about the awareness of swap practices was obtained as the awareness is only 33.33% in the state of Maharashtra, whereas more awareness (i.e. 50%) was observed in company-owned retail outlets. Table 2 shows the cluster-wise awareness of swapping practices.

As the awareness about swap found to be low, still this chapter reveals that about 19% reduction in the cost of distribution can be exhibited through swap practices. Most of the remotely placed respondents showed the positive bearing of swap on the inventory carrying cost of POL products. Availability of POL products supplies at desired time is enhanced by 22% as a result of swap practices. The most obvious finding is that swap practices reduce the lead times by 28%. All different parameters that were researched reveal that petroleum customer service level (PCSL) is or can

Table 1 Showing retailers of select petroleum products

Clusters	Vidharbha		Marathwada		Khandesh		West Maharashtra		
Category respondents	Company owned	Privately owned	Company owned	Privately owned	Company owned	Privately owned	Company owned	Privately owned	Total no. of retailers
HPCL	03	11	03	07	03	07	04	11	49
BPCL	02	07	04	11	03	10	03	10	50
Others	03	12	03	10	03	11	03	06	51
Total no. of retailers	08	30	10	28	09	28	10	27	150
Subtotal (by cluster)	38		38		37		37		150

Table 2 Showing retailers awareness about swap of select petroleum products

Clusters	Vidharbha		Marathwada		Khandesh		West Maharashtra	
Category (ownership)	Company owned	Privately owned	Company owned	Privately owned	Company owned	Privately owned	Company owned	Privately owned
Total retailers	08	30	10	28	09	28	10	27
Aware	06	05	07	08	04	07	06	07
Unaware	02	25	03	20	05	21	04	20
Subtotal (by cluster)	38		38		37		37	

Table 3 Showing ratings of supply chain parameters

Sr. no.	Supply chain parameter	Very important	Important	Slightly important	Importance	% relative importance
1	Oil prices	10	15	15	12.5	14.518
2	Lead time	22	8	10	15.4	17.88618
3	Refining margins	11	17	12	13	15.09872
4	Availability of products	19	12	9	14.9	17.30546
5	Swap	21	11	8	15.4	17.88618
6	Inventory automation	20	9	11	14.9	17.30546

be improved by 23%. And the strategic resources of these oil companies can be optimally used amongst them and with marketing intermediaries and customers as beneficiaries.

6 3PL Responses

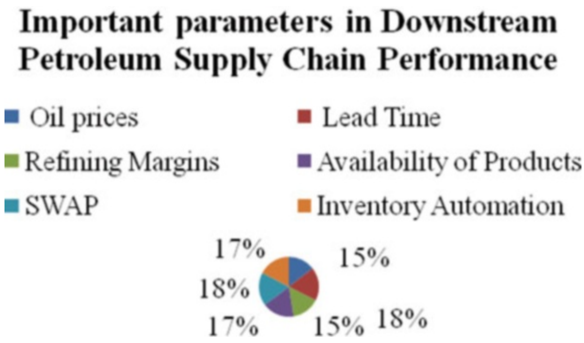
Third party logisticians are the linking elements in the downstream petroleum supply chains which include lubes dealers, LDO dealers, transporters etc. The following responses of these 3PL were analysed. Though transporters are the linking units in downstream petroleum supply chains, awareness of company's decision like swapping is very low. They work on contract and perform the assigned tasks. Very few of 3PL know about swapping, and those who are aware insist on its positive side, i.e. reduction of inventory costs. Lubes retailers and dealers find swap as the most important tool in measuring the performance of lubes supply chains. These parameters are indicated in Table 3:

Supply chain performance in HSD largely depends upon parameters shown in the following pie Chart 4, indicating their critical role in the HSD supply chain performance.

6.1 Other Critical Observations

Certain important activities and non-value-adding activities constitute the whole petroleum downstream supply chain. Some of the non-value-adding activities identified are as follows: *waiting* of finished products in the storage depots, in transit and any other storage point that increases the inventory carrying cost. Swapping can reduced this waiting time to a great extent. *Additional quality checks* performed by oil companies as a remedy to adulteration which not only increase the total landed cost but also the carrying cost associated with finish stocks. *Holding huge inventory* at refinery and storage points is another non-value-adding activity which hampers the supply chain performance at large. *Continuous overproduction* will result in

Chart 4 Showing parameters in downstream petroleum supply chain performance



inefficient use of capital and large inventories at every storing point. Hence, systematic cooperative reciprocal barter system, i.e. swapping practices amongst the oil companies, will not only eliminate the non-value-adding activities but also improve the downstream supply chain performance. The asset swapping and shipment swapping is an ideal tool for downstream petroleum inventory control.

6.2 Advantage of HPCL

With 8,329 retail outlets across the country, HPCL today boasts of a healthy network of happy and satisfied dealers as a result of initiative in indent management system automation as a part of ERP implementation across HPCL operations. HPCL and its dealers found themselves on the right end of the ordering process. The IMS has not only satisfied dealer queries but has made it easier for internal planning officers and other officials to review reports from time to time. The system has done what it sets out to do, pumped up efficiency, whereas BPCL is still having human interface in order processing. Timely availability of reports to plan further product allocation in today's competitive time definitely gives an edge. Besides, saving productive man hours can be translated into quantitative benefits and above all, a sound customer relationship. Swapping of products, information sharing amongst the intermediaries, adequate transportation planning and reduction in lead times are the proved opinions of downstream petroleum intermediaries. The following Chart 5 gives the agreement of these benefits as an outcome of IMS (indent management system).

7 Conclusions and Scope for Further Studies

There are found various pluses of swapping practices; however, very small portion of distribution system (intermediaries) is aware of swap practices. Inventory issues have ever made the task of distribution most tedious. Amongst the various inventory

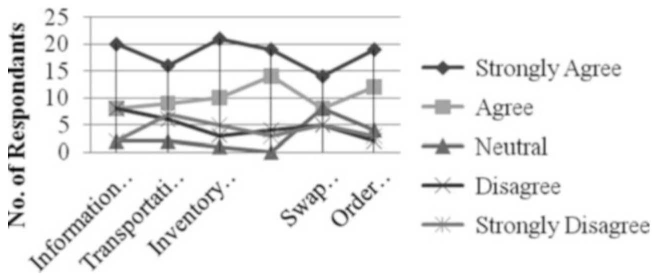


Chart 5 Primary Data

control tools, most of the techniques have lost its criticality as further cost reduction is not possible by those techniques (Sahay 2000). Systematic cooperative reciprocal barter system through swap has many advantages in downstream petroleum supply chains. It reduces lead times to great extent, increases the availability of petroleum products and reduces inventory carrying cost to a better extent which results in an improved customer service level. Swapping also enhances the capability of oil companies to identify and eliminate the non-value-adding activities like waiting line times, frequent quality checks, overproduction etc. The supply chain performance of a petroleum industry largely depends on the performances of individual intermediary, stocking points and third party logisticians and ultimately depends on the inventory control at each level. Therefore, the authors here underline the contribution of swap in improving the petroleum downstream supply chain performance. Swapping with the help of technology like IMS which is already in place with HPCL gives the other oil companies a good scope for improving their order processing.

The important aspect of measuring petroleum downstream supply chain performance needs a thorough analysis for deciding the criteria for performance measurement which can be a future scope of research. The analysis and costing part shall give the clear-cut monetary benefits sought by swapping practices which requires the attention of operations and finance specialists and hence is included in future scope of research.

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Part 3.3
Technology, Development and ICT

Implementation Issues of Aadhaar: The Human Resource Information System for India

Jesiah Selvam and K. Uma Lakshmi

1 Introduction

Human resource information system (HRIS) is a systematic procedure for collecting, storing, maintaining, retrieving and validating data needed by organisation about its human resources and personnel activities. HRIS is typically designed to enable humans to perform tasks for which the human brain is not well suited like handling large amounts of information, performing complex calculations and controlling many simultaneous processes. Information system's capabilities have grown over time from plain database management to analytical report making to forecasting. Tansley et al. (2001) examined the move towards HRM-style practices in organisations that had developed HRIS as an opportunity structure that could enable a break with the past. While HRIS benefits can be reaped even in e-governance, it is more relevant for a country like India with a massive diverse population of 1.2 billion. In many countries, technology has been successfully used in e-governance with focus on illegal immigration, crime, terrorism and identity fraud listing the top, and in each, identity abuse is a crucial component. Terrorists routinely use multiple identities up to 50 at a time to hide and confuse. Sometimes, the cross-checking overheads are more than the cost of technology infrastructure maintenance. The incidents like 9/11, 26/11 and the like have prompted the quest for more stable identity systems. 'Identity

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cards are not just technologies; they are also contemporary tools of governance which may be used to address a multiple and shifting set of social and political problems' (Bennet and Lyon 2008). Governments in the USA, the UK, Australia and several other nations are responding to perceived security threats by introducing various forms of mandatory or nearly mandatory domestic civilian national identity documents (Froomkin 2009; Greenleaf 2007).

2 Objectives of the Study

The study attempts to examine the implementation issues of Aadhaar, the unique ID for the residents of India with the implicit objective of bringing out the possible suggestions to the hindrances of implementation.

3 Identity Systems Across the World

An identity document is any document which may be used to verify aspects of a person's personal identity. If issued in the form of a small, mostly standard-sized card, it is usually called an identity card (IC). New technologies could allow identity cards to contain biometric information, such as photographs, face, hand or iris measurements or fingerprints. Electronic identity cards or e-IDs are already available in some territories such as Hong Kong, Malaysia, Estonia, Finland, Belgium, Portugal, Morocco and Spain. History shows that the main function of identity cards has been controlling labour and the workforce, to serve the objective of creating a command economy, and the political dissent has often been a 'close second' as in the case of Napoleonic identity card, the livret ID card of 1803 in France, Nazi Germany's census and statistical systems with IBM computers in identification systems (*Volkskartei* – ID card with the Reich personnel number) to find the human economic value which aided them in genocide and also in suppressing political opponents, in China during Mao period as dang'an or dossier, which compiled lifetime personal files (Allonby 2009). Of late as observed in Britain, there is an intention to integrate and coordinate different services, such as health and education, to make them function together as part of one system, sharing data. UK mooted the ID card system to help tackle crime, illegal employment, immigration abuse, ID fraud and terrorism. Though there is little hard evidence of the card helping in the fight against crime, it was found to be useful in identifying illegal immigrants. Biometric border control systems have been established in the United States and the United Arab Emirates, and the EU is introducing biometric visas. However, it should be noted that, internationally, the only requirement for biometric passports is a digital photograph.

4 Aadhaar, the Unique Identification System of India

Aadhaar (meaning foundation), the unique 12-digit identification number (Aadhaar), was conceived by the Indian government primarily as a means for residents to uniquely verify their identity anywhere in the country and secondarily as a base on which any delivery system can be built. This being a random number generated, devoid of any classification based on caste, creed, religion and geography, is issued by UIDAI (Unique Identification Authority of India), headed by Mr. Nandan Nilekani, former CEO, Infosys. Issued only once in a lifetime and for free of cost, this identification card aims to enable identifying right PDS beneficiaries, financial inclusion of marginal groups and expanded coverage of the poor through the elimination of fakes and duplicates for welfare schemes. For an instance, Andhra Pradesh state government unearthed 45 lakh bogus ration cards in 2009 (*The Hindu* 2009). The government as a result launched an identity verification drive and has made it compulsory for residents to provide the electoral roll number, a copy of the electricity bill and house rent bill to receive a ration card. This has cut off many of the poor from accessing rations, including the homeless, migrants and people living in informal housing. Aadhaar card storing demographic and biometric information in a 64-KB smart card can be used as proof of identity (PoI) and proof of address (PoA). At present, Indian citizens have 15 cards in approximates of 70 million PAN cards, 60 million passports, 90 million drivers' licence, 240 million bank account holders, 170 million LIC policyholders and 150 million Below Poverty Line cards (BPL). There are people who cannot open a bank account because he/she has no documentation that can meet a bank's KYC (know-your-customer) norms. Among Indian children, about 45% malnutrition and 75% anaemia sufferings are existing which easily explains how ineffective government welfare programmes are to reach the right. There are people who need but do not possess any card, and there are people with multiples of tens of fake cards too. And this extremity is one of the symptom as well as cause for corruption in Indian society. Research estimates that the poor pay \$10–12 billion in usurious interest each year. Even MFIs charge 20–30% interest. UID system may bring nearly 125 million people into banking system over next 5 years (CLSA 2011).

Conceived in 2006, post Kargil War, as an initiative of Planning Commission of India, Aadhaar project has evolved with reviews and updations at different stages (see Table 1). The scale of the Aadhaar initiative is unprecedented, and its implementation demands active participation of central, state and local governments, as well as public and private sector as registrars and enrolment agencies across the country. UIDAI has headquarters in Delhi and a technology centre in Bangalore. It also has eight regional offices in Chandigarh, Delhi, Lucknow, Ranchi, Guwahati, Mumbai, Hyderabad and Bangalore. Aadhaar has its logo with yellow sun with a fingerprint embedded in its centre.

4.1 Aadhaar as an Information System

Unlike businesses, government cannot function with a clear-cut goal, and rather it has to balance diverse interests of the society while maintaining individual freedom,

Table 1 Phases and milestones of Aadhaar

Phase	Details	Date
Conception	Decision to collate – the National Population Register under the Citizenship Act, 1955, and the unique identification number for Below Poverty Line (BPL) families project of the Department of Information Technology	Early 2006
	EGoM (Empowered Group of Ministers) was constituted	04 December 2006
	Sequence of meetings(4) of EGoM to make UIDAI as executive authority	Between November 2007 and 2008
	UIDAI formation, as an attached office under the aegis of Planning Commission with an initial core team of 115 officials	28 January 2009
	Appointment of chairperson (Mr. Nandan Nilekani, former CEO, Infosys) with status of cabinet minister and Mr. Ram Sewak Sharma as director general and mission director	02 July 2009
	The first meeting of the Prime Minister's Council of UIDAI Authority	12 August 2009
Phase I: UIDAI	First enrolment	September 2010
	Target population: 200mn	Target date: March 2012
Phase II: UIDAI and NPR	To begin mid of April 2012, target: remaining 400 million population	To be completed by 2017

peace, viable economy and so on. But to be a social infrastructure guarantor, there should be an integrated national information system in place. Management information systems play the crucial role of providing a wide range of streamlined options from which decision-makers are able to make their preferred choices (Vittal and Shivraj 2008). Aadhaar gives the basic identity infrastructure for residents, the authentication of which lets the right individuals to reap the social benefits. An information system is marked by input-process-output and the objective for which it exists. Aadhaar systems take the demographic and biometric data as input, stores the data in CIDR (Central Identities Data Repository) and after de-duplication process generates the Aadhaar number, which is disseminated to residents.

The intended objectives of Aadhaar include giving citizens and migrants mobility of identity, bringing those without any existing identity documents into beneficiary system through the 'introducer' system of pre-identified people, connecting the database to social welfare schemes and financial inclusion of underprivileged by reducing the overheads of KYC (know-your-customer) norms of banks through UID data and suggested micro-ATMs, resident self-service to access up-to-date information about their entitlements that are to be achieved by connecting to other databases. Thus, it reengineers the public administration to be transparent and more accountable.

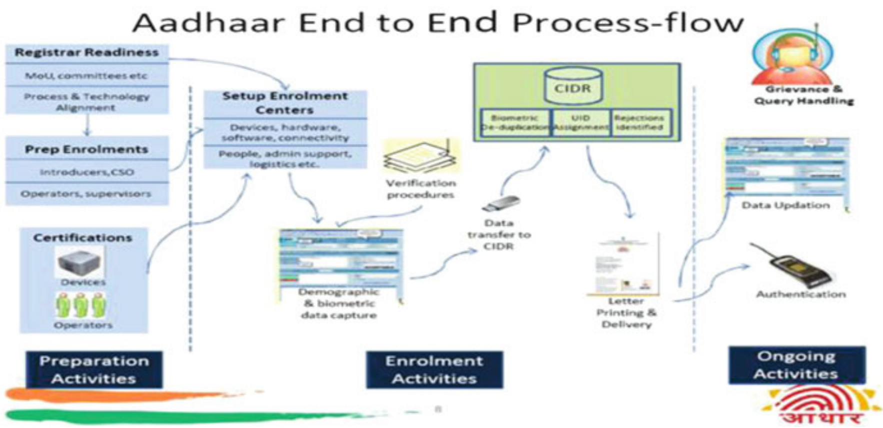

Fig. 1 Aadhaar process flow (Source: http://uid.gov.in)

4.2 *Aadhaar Implementation Process*

Implementation of Aadhaar includes preparation activities like MOUs with states and registrars, training the operators, enrolment activities where the data collected is stored in CIDR and, after de-duplication issuing the numbers, ongoing activities like data updation and authentication (see Fig. 1). Creating public awareness and publicising is also part of it.

4.2.1 Preparation Activities

UIDAI has written MOUs with states and union territories, public sector banks and LIC as registrars for successful implementation. Registrars are to be paid 50 rupees for each successful enrolment. Nodal departments for UID in each State and Union Territory identified the introducers and conducted training camps. For enrolment, enrolment needs minimum 40,000 kits, 40,000 operators, 13,000 supervisors and 4,000 technical support. L-1 and crossmatch will provide one eye scanner and one finger print scanner. Going through the client software read-me documents available on the UIDAI website, the software is currently designed for 32-bit operating systems and requires Microsoft.NET Framework 3.5 SP1 and Microsoft SQL Server 2008 R2. Aadhaar has been planned to be publicised through campaigns/advertisements to encourage enrolment through bus stops, pan shops, radio, TV, Doordarshan, retail shops, autorickshaw stands, melas, mandis, post offices, railway stations, cinema halls, sporting events, banners, posters, cable operators, satellite channels, mobile phones, SMS campaigns, etc., and a dedicated website http://uid.gov.in has been set up.

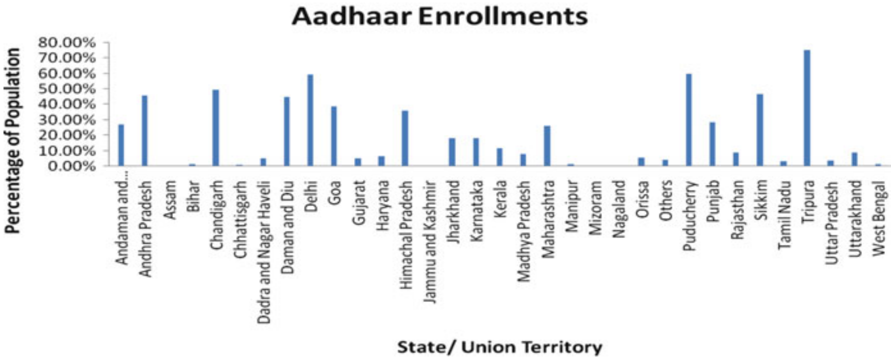

Fig. 2 Aadhaar enrolments state/territory wise (Source: UIDAI 2012)

4.2.2 Enrolment Activities

Aadhaar card containing the UID number would be issued to every resident after collecting one of the 17 documents required for identification and one of the 29 documents required for proof of residence as prescribed by the Union Government. The card is issued to people for free, and people Below Poverty Line are to be paid 100 rupees per enrolment. The process includes going to the nearest enrolment camp, submitting enrolment form with necessary documents, document verification, biometric scanning of ten fingerprints and iris, getting photographed and given an enrolment number upon completion; residents will be given acknowledgement receipt and are issued an Aadhaar UID allotment letter having unique ID no. after de-duplication by speed post within 20–30 days.

Figure 2 exhibits the magnitude of enrolments across the country. The small states and UT such as Tripura, Sikkim, Puducherry, Himachal Pradesh, Delhi and Chandigarh made headways in the number of enrolments. Andhra Pradesh among the biggest states is an exception. The enrolment performance in the states like Assam, Bihar, Chhattisgarh, Mizoram, Nagaland and West Bengal is rudimentary. The poor performance on enrolment may be due to the lack of political consensus but despite the fact that Aadhaar being one of the most rapidly adopted technologies in history and the fastest government technology rollout anywhere. The success story is that more than 12,500 transgender across the country have been issued 'Aadhaar' numbers by the Unique Identification Authority of India as on 28 October 2011. There are successful pilots of transferring cash against purchase of LPG cylinders in Mysore, for kerosene in Alwar and validation of PDS beneficiaries in Jharkhand and Aadhaar-enabled payments for various government schemes in at least 50 selected districts by the end of 2012. As of 31st March 2012, UIDAI has completed the target enrolment of 200 millions.

4.3 Implementation Issues

Aadhaar has gone through several rounds of interdepartmental and indeed wider public review and scrutiny, and the following issues are identified and discussed:

4.3.1 Strategic Issues

Multiple views and lack of coordination among government functionaries: In spite of MOUs being written with state governments and public and private sector enterprises, there are objections and doubts, conflict of interest and lack of project coordination as it was evident with home ministry's National Population Register (NPR) and RIC (Resident Identity Card), UIDAI and beneficiary programme in charges like food ministry, MGNREGA, to provide interface to residents to government programmes.

Rejection of National Identification Authority of India (NIAI) bill by Parliamentary Standing Committee (PSC) on finance: PSC's observation that the UID project as directionless and it may have far-reaching consequences for national security is a big blow for the implementation.

Not one-time project as proposed: As repeatedly claimed by UIDAI, Aadhaar may not be one-time project. Unlike pre-existing census, it has to keep up with population dynamics of births and deaths, biometric data entry for children crossing 3 years and changes in biometric systems of individuals in case of damage.

Positioning of UID towards government schemes: In the largest democracy of the world, where governments at centre and state come up with variety of populist programmes, UID has to be positioned appropriately. System should build credibility by initiating a pilot UID-based government service for real-time authentication like PDS.

Cost/benefit analysis and feasibility study: Finance Minister Pranab Mukherjee allocated Rs 1,758 crore more for the project in the Budget 2012–2013. The government has already spent Rs 14,232 on the project. The cost to cover the population of 1.2 billion is likely to be up to Rs 18,000 crores. NGOs are demanding CBI enquiry and CAG audit of the scheme. The allegation is that the actual benefits of PDS and NREGA are limited, and compared to leakages of those systems, Aadhaar is highly expensive. Individuals Below Poverty Line are handed over 100 rupees for enrolment and registrars are with 50 rupees for each successful enrolment, and the de-duplication cost has been brought down to Rs 2.75 per person (The Economic Times, 20 Jan 2012). Centre provides Rs 300,000 crore of subsidies every year to the Indian citizens, and UID can bring down pilferage to great extent. The repetition of the exercise including cost has not been explained, and corruption and leakages are given more focus.

Concerns on citizenship: Though NIAI Bill says Aadhaar is not an evidence of citizenship and it is voluntary to enrol, the collaborative exercise with NPR is turning the other way round.

Criticism that other countries scrapped the biometric cards: As for the criticism that countries like the UK and the USA have abandoned identity schemes, one cannot generalise it as there are several more European and Middle East countries which are successfully implementing it. For instance, the UK has withdrawn its National Identity Card in May 2010 because of the huge cost involved and possible cost overturns.

4.3.2 Operational Issues

Enrolment: UIDAI website is not displaying enrolment camp in respective area which is causing inconvenience to people. No electricity in remote places, and people are using generators. Most of the time, people do not come with clean hands. So, officials have to carry soap solutions and hand wash. Lack of operators in many enrolment camps slowed down the process. They often confronted protests from the NGOs and voluntary organizations of civil rights and liberties. As long as the iris pattern is visible in a blind eye, its details can be captured. It can generate superior data above all the other databases presently available. Physical hard-working people's hands would have morphed so as to not reveal fingerprints, and facial expressions should be appropriate while photographing. Always conception is easy, delivery is difficult, and huge and vast population is to be covered. Public and civil liberty forums' resistance may let some to wait and watch and in turn may slow down the enrolment process.

Authentication: Internet and mobile connectivity and power problems in rural and remote areas will be an issue. Mobile connectivity is now available in over three lakh villages, and remaining shortages may be resolved over the next few years. Illiteracy of the people to remember the 12-digit number and to safeguard Aadhaar card in general is a major issue.

Maintenance: The identity infrastructure management is an ongoing process for authentication as well as for managing UID data of individuals throughout their life cycle. A faster approach for de-duplication to reduce UID enablement lifecycle can be designed. Collaborating with other agencies to recreate application forms and cards to include UID is an important issue and requires a careful approach.

4.3.3 Legal Issues

India does not have enough data security and privacy laws. The provisions in Information Technology Act 2000 amendments 43 A and 72A are grossly inadequate. Per the NIAI bill, the violations can attract penalties in the form of fines of up to rupees one crore and imprisonment extending up to a life term.

No legal status to UID project: Unlike the projects like National Intelligence Grid (Natgrid), Crime and Criminal Tracking Network and Systems (CCTNS), National Counter Terrorism Centre (NCTC), Central Monitoring System (CMS), Centre for Communication Security Research and Monitoring (CCSRM), etc., which are not governed by any legal framework, UID being an identity provider which can connect to 21 possible databases and intending to prevent leakages in social welfare schemes has been asked for revisions on account of missing 'constitutional safeguards'.

Not just social benefits, but national security as well: According to Clause 33 of NIAI Bill, disclosure of information (including identity information of individuals) can be made (a) by order of the competent court (b) in the interest of national security. This can be done on the direction of an authorized officer of the rank of Joint Secretary or above in the central government. It also provides for the Officers of the Central Government the power to tag, profile, track and mount surveillance and use as they deem fit information-including demographic and biometric information. This clause may be prone to misuse and this may affect an individual's privacy.

Inadequacy of existing laws: Existing legal framework of India has inadequacies to address data security, privacy and identity theft.

Data security: Public-key infrastructure and randomness of the number serve for data protection, as mere number does not reveal personal information in contrast to China's 18-digit ID number that has a pattern. Data can be transmitted at the enrolment level by data collectors and accessed by registrar agencies and by the foreign organisations engaged in de-duplication work like L-1 Identity Solutions, which is connected with US intelligence agencies, and Accenture, which is on the Smart Borders project with the US Homeland Security Department. Malicious software may be developed to hack the databases. Outsourcing of the operation of the CIDR should be by regulations by identifying the outsourcing provider and thus disallowable. Any movement of CIDR data outside India should also be by regulations (Greenleaf 2010).

Privacy and civil liberties: Most criticism is directed towards the enhanced possibilities of extensive abuse of centralised and comprehensive databases with sensitive data. Distinction between what is public and private information may be lost. The trade-off between civil liberties and social development is being questioned. Misuse of the identity system in case of communal riots or terrorist violence to target group, with incidents like telephone tapping and surveillance as it happened during 1976 National Emergency using selectively, cannot be ruled out. Interested parties, such as insurance companies, may do individual profiling for business advantage.

Data breach and identity theft: Determining the link between data breaches and identity theft is challenging, primarily because identity theft victims often do not know how their personal information was obtained, 'and identity theft is not always detectable by the individual victims'. Identity theft may be used to facilitate or fund other crimes including illegal immigration (to conceal their own true identity), terrorism, phishing and espionage. There may be the tampering or superficial forging of the actual biometric identity cards and impersonation.

Responsibilities of partnering agencies and introducers: Responsibilities and the limit of introductions are not expressed for introducers. The regulations for registrars, enrollers, and de-duplicating agencies retain any information that they collect/process for the 'convergence of data from discrete silos'.

Absence of external regulator: Unlike other regulatory laws such as labour laws, where an inspectorate is created to monitor the working of an organisation, NIAI bill has no external regulator.

4.3.4 Technological Issues

As biometric attributes of the residents are going to be used as the basic signature for de-duplication (checking back the existing database for duplication) and to ensure uniqueness, the biometric information like facial image, iris – both eyes and fingerprints – all ten fingers is in the following sequence: First – left hand four finger slap, second – right hand four finger slap, and at the end, both the thumbs are captured, and for this computer system, digital camera, iris-capturing device and fingerprint scanner are used. Iris is widely believed to be the most accurate biometric. Also, the iris pattern of each eye is not correlated, so it gives two independent biometric feature sets.

Social acceptability of technology needs building trust. Parliamentary standing committee's observation is that the estimated failure of biometrics could be as high as 15%, given dependence of large population chunk on manual labour and stated that the 'technology is not error free'. As it happens with many device readers, the technical failure to authenticate Aadhaar cardholder cannot be ruled out.

According to UIDAI Chief Architect Mr. Pramod Varma, the data centres have a seamless physical as well as digital security systems in place at Bangalore and Greater Noida facilities and that UIDAI had employed 'logical security' by petitioning data centre into zones, separating them using firewall and network intrusion detection and prevention system. According to him, 'every enrolment data packet is always stored in public-key infrastructure encrypted, tamper proof files and are never decrypted or modified during transit until it reaches UIDAI's data centres'. With increasing rate of hacking and other cybercrimes, UIDAI security systems need regular updations. The process of authentication has not been studied yet. The authority shall respond to an authentication query with a yes or no 'or with any other appropriate response, or will it give a response code why it failed as in case of ATMs'.

5 Recommendations

The ability to properly identify persons to their true identity is central to the Aadhaar system. Although the efficiency and efficacy of the project is yet to be manifested, the very launch of this exercise has made it the largest biometric-based identity project in the globe. This especially necessitates the cross-checking of various arrangements done by the UIDAI in connection with identification process, to whom the information is handed over to, with whom contracts have been entered, the state of pilot studies, the non-existence of privacy law, the relationship with NATGRID and the possible connection with the Draft DNA Profiling Identity Bill, 2007.In a complex system like India, trade-offs between privacy and social development have to be accommodated. Once modern systems of population registration are implemented, with time they become progressively more developed and secure. History shows that identity systems have hidden political agenda of control and power, but in times of globalisation, symbiotic nature of public-private participation and active civil liberty movements, we cannot conclude history is going to repeat. If the enrolment centres can move to where customer resides/functions, the resentment in public for waiting in queue reduces. Unlike the UK which maintained 50 categories of information, Aadhaar has simple data to prove the identity and has well-defined levels of implementation. Portrayed as a panacea for all ills that exist in the country, government functionaries should come up with consensus for successful implementation.

6 Conclusions

Deemed to be the biggest initiative in creating the nation's human resource information system, UID may bring social transformation in a big way. In any organisation, the success of any project depends on top management support, and it is evident with Dr. Manmohan Singh and his cabinet standing by this project. Electronic voting machines and ATMs also once upon a time looked down by public. Technology will be the chief instrument of reforms. The computerisation of railway bookings two decades ago dramatically reduced the corruption, delays and harassment routinely visited upon the average traveller. Mobile and internet technologies open up possibilities for e-governance that cannot be anticipated in advance. 'It's a dramatic socio-technical system conceived to identify and recognise the residents of the country and connect them to the socio-economic benefits which they are entitled to receive from the government'. Hence, it is evident that the government stands firmly by this project despite the lack of internal coherence between the ministers and non-consensus among political parties. There was universal agreement that large-scale technology projects failed due to managerial, but not due to technical reasons. The soothing condition in India is that the climate conduciveness for technology implementation contributed positively to the extent of neutralisation of inhibitors.

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Aadhaar and Financial Inclusion: A Proposed Framework to Provide Basic Financial Services in Unbanked Rural India

Saikumar Rathod and Shiva Krishna Prasad Arelli

1 Introduction

Dr. C. Rangarajan committee's report (Report of Committee on financial inclusion and RBI 2008) says, "Financial inclusion is defined as the process of ensuring access to appropriate financial products and services needed by all sections of the society in general, and vulnerable groups such as weaker sections and low income groups in particular, at an affordable cost in a fair and transparent manner by regulated mainstream institutional players." It means that easy access to basic financial services such as credit, savings, insurance facilities and payments and remittances enables economically and socially excluded people to integrate better into the mainstream economy and to contribute to the development by protecting them from shocks. But, per national sample survey data, 45.9 million farmer households in the country out of a total of 89.3 million households do not have access to credit, either from institutional or non-institutional sources. Also, Table 1 suggests that the number of rural branches as a percentage of total branches has dropped from 50% in the year 2000 to 38.4% in 2010. In November 2005, RBI gave directive to open no-frill accounts and use of business correspondent's to reach unbanked citizens. The latest data from RBI website about business correspondents (BC)/customer service points (CSP) shows the increasing number of CSP's being opened in urban areas relative to rural places in the recent years (Table 2). Apart from the banks, players who have demonstrated their reach in rural areas in a cost-effective manner like mobile network operators (MNOs) may be allowed to offer financial services. The problem of limited presence of banks in rural areas and operating large number of tiny accounts profitably can be addressed by bringing in MNOs into the ecosystem of financial inclusion. Telecom Regulatory Authority of

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Table 1 Declining trend of rural bank branches (Presentation by Dr K.C. Chakrabarty 2011)

Year	Rural	Semi-urban	Urban	Metro	Total	Rural/total (%)
2000	32,734	14,407	10,052	8,219	65,412	50
2004	32,121	15,091	11,000	8,976	67,188	47.8
2008	31,002	17,724	14,397	13,019	76,142	40.7
2010	32,494	20,494	16,761	14,855	84,604	38.4

Table 2 Statistics of CSP's (Financial inclusion: state of the sector report 2011)

Particulars	Mar-10	Mar-11	Growth %
Total number of CSP's	33,042	58,351	76.60
Total number of rural CSP's	32,619	54,698	67.69
Total number of urban CSP's	423	3,653	**763.59**

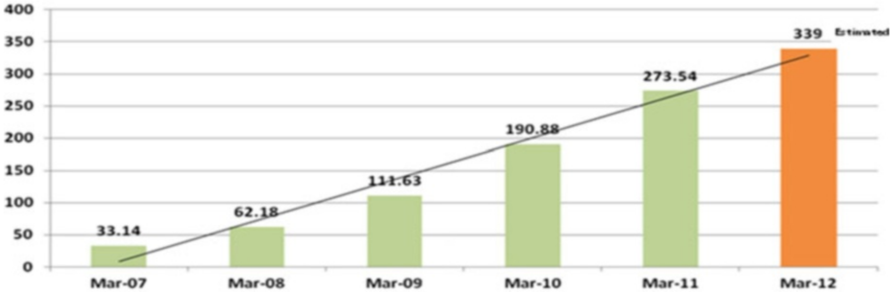

Fig. 1 Rural wireless subscriber base (in millions) (Annual Report of TRAI 2009)

India's (TRAI) annual report for the year 2010 indicates that 32.67% of total wireless subscribers as of 2010 are in rural areas. Following bar chart shows the growth of wireless subscribers from 2007 to 2011 in rural India. Mobile phones thus present an enormous opportunity in spreading financial services to the unbanked citizens of the country because of its unique feature of easy access and availability in remote places. However, a critical challenge to successfully implement this concept lies in identity verification or for completing the KYC (know your customer) requirements of RBI, to open say mobile e-money accounts. The lack of clear identity documentation for the poor creates substantial difficulties in establishing their identities to the banks (UIDAI). This issue could be addressed with the recent government initiative of providing unique identity to all the citizens under the project Aadhaar. Since RBI agreed UID number as a valid identity document for opening bank accounts (RBI Circular 2011), MNOs can leverage this as a valid source for user verification, unless otherwise stated by RBI (Fig. 1).

2 Proposed Framework

The key stakeholders who are expected to play an important role in the delivery of financial services through mobile payments framework in India are given in Table 3.

Table 3 Key stakeholders in the delivery of financial services

RBI	Regulator – grant of licences, laying down framework
Government	Facilitator
TRAI	Preventing illegal transactions with framework, basic tariff structures
Unique Identity Development Authority of India (UIDAI)	KYR and KYC, anti-money laundering program
National Payments Corporation of India (NPCI)	24 × 7 real-time remittance processing system
MNOs and banks	Service providers

2.1 Mobile E-Money

Individuals will use e-money in place of hard cash at all the access points – to make purchases, to transfer money, etc. It is held in an account under the individual's name. Therefore, it is important that e-money should satisfy the following basic properties of physical money to be robust and fool proof (Farsi 1997):

- *Double spending*: Safeguards must be in place to prevent counterfeiting.
- *Transferability*: It should be independent and portable, i.e. it should be freely transferable between any two parties regardless of network, software/hardware or storage mechanism. Most importantly it should be convenient.
- *Divisibility*: Divisibility means the ability to make change. So e-money will come in rupees and smaller denominations that can make both high-volume and small-value transactions on the mobile phone practical.

Mobile e-money will be stored like fungible talk time, which is separate from the air talk time, provided already by the MNO. MNO would issue e-money to the individual in exchange for cash deposit. Individuals can spend the e-money for all kinds of transactions, if they know the UID number of other party with whom they are transacting. Transactions like buying commodities, buying air talk time, paying utility bills, transferring money to other mobile e-money accounts, etc., can be easily done. Individuals can access their mobile e-money accounts using a simple short message service (SMS)-based application on their mobile phones.

2.2 Opening of Mobile E-Money Account

Any individual interested in opening mobile e-money account has to approach the retail shop, working on behalf of MNO or the correspondent of MNO. The necessary documents to open mobile e-money account should be similar and not as stringent as the current KYC norms of banks. A step-by-step process for enabling e-money account is shown below.

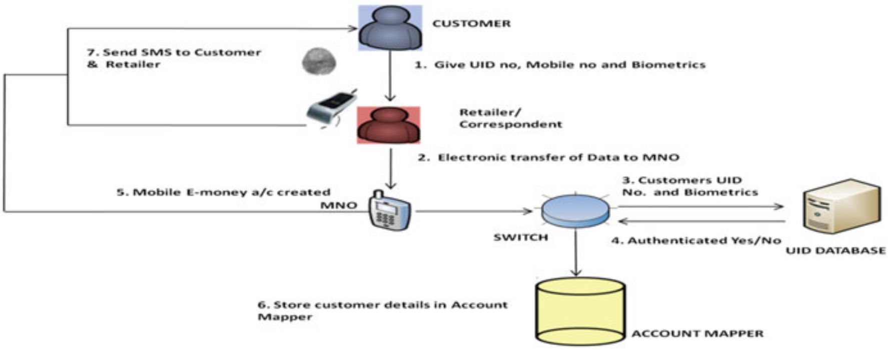

Fig. 2 Enabling mobile e-money account

Enabling Mobile E-Money Account:

1. Customer gives the retailer shop his UID number, biometrics, mobile number, and other KYC details to the retailer/correspondent of MNO.
2. Retailer/correspondent sends the information electronically to the MNO.
3. MNO sends request to verify the customer's details to UIDAI server through SWITCH.
4. MNO verifies the UID number and biometrics of the customer with the UIDAI server.
5. Mobile e-money account is created by MNO.
6. MNO stores the mobile e-money account details, customer's mobile number and UID number in the Account Mapper.
7. The customer and the retailer/correspondent are intimated via message on their mobiles.
8. MNO sends a pin number to the customer on his mobile for making future transactions with his/her mobile e-money account (Fig. 2).

2.3 Transactions over the Mobile E-Money Account

A customer should be able to perform the following basic transactions: (1) cash deposit – over the counter through a retailer or correspondent of MNO, (2) transfer money – person to person transfer using mobile phone and person to person transfer for purchase of goods and services, (3) withdraw cash – over the counter through a retailer or correspondent of MNO, and (4) balance inquiry – balance or statement of last N transactions.

2.4 Infrastructure Components

Branchless banking by MNO using mobile e-money account needs the following in place:

1. *UIDAI*: UIDAI is setting up the infrastructure for enrolment and storage of the resident's demographic as well as biometric information. UIDAI will provide real-time online authentication of identities in a cost-effective and ubiquitous manner for MNO.
2. *SWITCH*: A switch will be required to facilitate real-time transactions routing between MNOs, UIDAI, Account Mapper and monitoring system. This switch will help in executing large-volume transactions of small value between individuals in the same network of MNO or between two individuals in two different networks. Switch should be capable of talking with UID authentication service so that it can verify the identity of the customer when enabling mobile e-money account. Switch would also query the Account Mapper with UID number to obtain the details like mobile e-money account number and to proceed with transactions like cash transfer and cash withdrawal.
3. *Account Mapper*: Account Mapper is the most crucial component in this model of e-money transfers. It is essentially a database of all the citizens who have enabled their mobile e-money accounts. The Account Mapper links the various identifiers of a given individual. In the simplest form, a row would be created against each individual, when he/she enables his mobile e-money account; the row would have the UID number, the mobile number, and the mobile e-money account number. Account Mapper is a shared repository by all the MNOs who want to enter into the business of providing financial services through mobile phones. The responsibility of setting up of Account Mapper and the SWITCH can be taken up by organizations like NPCI.
4. *Monitoring system*: A monitoring system would be present to track all the e-money transactions and report those suspicious transactions which pose the threat ofmoney laundering and funding terrorist activities. The exact mechanism by which the monitoring system would work is not discussed in detail in this chapter.
5. *MNO's infrastructure*: MNO can provide basic financial services using his existing mobile phone value chain. Resources used for providing mobile services can be used to provide basic financial services. For example, existing retailers who work on behalf of MNO for mobile recharge can be used as cash-in/cash-outlets. MNO would also require other critical infrastructure components like switches, customer management systems, auditing trails, reporting, etc.

2.5 Indicative Transaction Process

An indicative transaction process is shown for the following cases, which are very basic in nature for providing financial services.

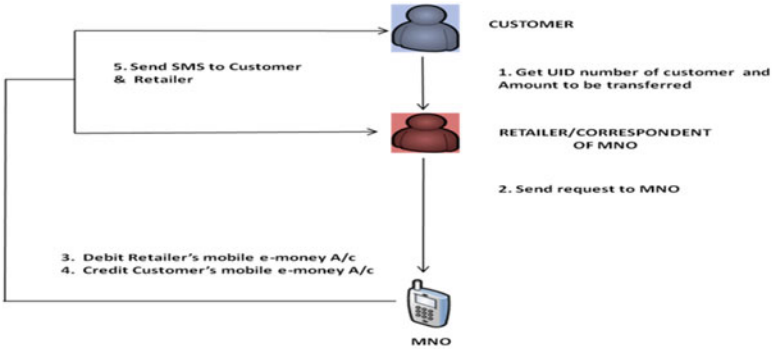

Fig. 3 Cash deposit (retailer and customer belong to same MNO)

2.5.1 Cash Deposit

Consider the case when retailer and customer belong to the same MNO. Following are the steps involved in the process of depositing cash:

1. Retailer gets the UID number and the amount to be transferred from customer.
2. Retailer sends the information to MNO through the SMS-based application.
3. MNO has the database of all the individuals who have enabled mobile e-money accounts under it, by using UID number; MNO gets the details of mobile e-money account number of customer.
4. It then performs the appropriate action of debiting retailer's e-money account and crediting customer's e-money account.
5. An SMS is sent to both customer and retailer involved in the transaction (Fig. 3).

Now consider the case when retailer and customer belong to different MNOs. Following are the steps involved in this scenario:

1. Retailer gets the UID number and the amount to be transferred from customer.
2. Retailer sends the information to its MNO (which is referred as MNO(R)) through the SMS-based application.
3. Since the customer belongs to different MNO (customer's MNO is referred as MNO(C)), MNO(R) cannot access the details of customer. So MNO(R) sends request to the SWITCH, with details of the customer to perform the transaction.
4. SWITCH, upon receiving the request, gets information (mobile e-money account number) about the customer by performing a query on the Account Mapper using the customer's UID number.
5. SWITCH then directs the MNO(C) to perform the credit operation on the customer's mobile e-money account.
6. MNO(R) receives intimation from the SWITCH about the transaction whether it was successful or not.
7. MNO(R) then performs debit operation on the e-money account of the retailer.
8. SMS will be received by both the customer and the retailer from their respective MNOs (Fig. 4).

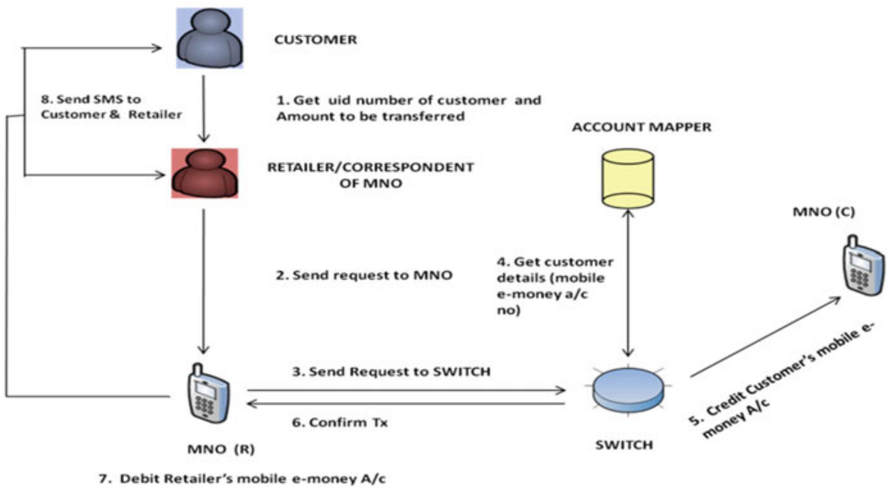

Fig. 4 Cash deposit (retailer and customer belong to different MNOs)

2.6 Integration with Existing Banking World

The framework developed for mobile e-money ecosystem should smoothly integrate with other similar financial systems. The Account Mapper links the various identities of an individual, like UID number, bank account number, mobile number, mobile e-money account number, etc., as shown in the figure below. A policy-driven approach can be used by the individual, in which the individual can set policies as to which account (bank account/mobile e-money account) to use for what type of transactions (Fig. 5).

A mobile e-money account holder can transfer money to another target individual by simply using the UID number. A command like the one shown below could be issued in the SMS application by the customer.

Transfer_Money(From_UID, To_UID, Amount);

The target individual would then receive money in any of the bank or e-money accounts based on the policy setting.

2.7 Role of Retailer/Correspondent of MNO

Individual retailers (shops were mobile recharge is done) will play a crucial role in this model in terms of providing services to the customers. In this respect, they will have the following responsibilities:

- Will act as e-money supplier by taking hard cash.
- Will act as hard cash providers by taking e-money.

Account Mapper

UID	Bank		Mobile No#	E-money Account No#
	Routing No#	Account No#		
1164 2234 8945 5562	345678901	200612356	9487476265	111345677

Fig. 5 Account Mapper

- Retailer would be responsible to enable mobile e-money account.
- Interface with customer, provide basic handholding and play a role in promoting the financial literacy through mobile e-money transfers.

2.8 Role of Other Small Business Entities

Local retailers including kirana stores play an important role in the model. It is very important to build the credibility and increase the acceptance of mobile e-money for payments on purchase of commodities. This can be done by establishing trust, showing benefits of using such a system to all the entities in village. The buyer will use the UID number of the shop owner to transfer e-money for purchasing commodity. Instant message confirmation will be sent to both. It should be noted that kirana shop owner can now go to the retailer operating on behalf of MNO to get hard cash, if needed.

2.9 Distinguishing the Role of Bank and MNO

MNO plays the principal role in the MNO-led banking model. All the aspects of banking like account opening, account maintenance, cash-in/cash-out, etc., will be performed by MNO. Clearly, the ownership of customer lies with the MNO in this model. Banks will be at the back end of the model, without any direct interaction to the customer. MNO should deposit the equivalent of e-money issued in the banks; this would limit the margin MNO would otherwise get by intermediation spreads. This is the price MNO pays for not having to incur extra cost of obtaining full banking license. Thus, banks are at the back end of the model, accepting deposit from the MNO in the form of a pooled account mechanism. This would transfer the risk of investment of funds from MNO to the bank, which is already governed under the regulation of banking laws. MNO earns the interest from its deposit in the bank, which can be passed on to the customers of MNO to make it profitable and attractive to the customers. This would also encourage the customers of MNO to use e-money accounts as a place to store and earn interest.

3 Analysis of the Framework

3.1 Understanding the Risks Involved

The four important risk factors as identified by the World Bank paper "Integrity in mobile phone services" are anonymity, elusiveness, rapidity and poor oversight. The proposed framework attempts to address these risks and also suggest a comprehensive approach in dealing with the majority of these issues.

- *Anonymity*: It is the risk of not knowing a customer's actual identity. The proposed model is based on the UID number which mitigates the risk of anonymity. UID number tagged to every account tracks all transactions and fulfils the objective of complete traceability and accountability. This prevents illegal transactions or money laundering activities to a great extent.
- *Elusiveness*: It is the ability to disguise mobile transaction totals, origins and destinations. It can be diminished by enhanced customer profiling, monitoring and reporting. Since measures like limiting the number of accounts per customer and number of transaction per month and limit on mobile e-money balance would prevent abuse of users with multiple e-money accounts, we intend to include this feature in the proposed model. Besides, an MIS system in this process would help in monitoring and reporting the mobile e-money accounts operated by particular MNO.
- *Rapidity*: It is the speed with which illicit transactions can occur. Mobile e-money transactions are usually conducted in real time, which makes them very difficult to monitor. Individuals can initiate transactions at any time. Since different steps involved in the transaction occur very quickly in the order of fractions of a second (sending instruction from mobile phone through the wireless network to the MNO, authentication of the individual, accessing the account, processing the transaction and the transaction clearance and settlement), the rapidity of the transaction does not give MNO enough time to suspend a suspicious transaction until more information is obtained. This risk can be mitigated by flagging certain types of transactions with integrated internal control systems.
- *Poor oversight*: Transparent guidelines, clear regulations and licencing with effective risk supervision of MNOs can help making the system more transparent and accountable. In the proposed model, both the banking regulators, RBI and the telecom regulator, TRAI, play a major role, so they should leverage their respective areas of expertise and agree on the areas of responsibility. This would be help in mitigating the risk of poor oversight over MNO to a large extent.

3.2 Impact of the Model on the Society

Sein and Harindranath's (2004), the first order or *primary effect* of ICT is simple substitution of old technology by the new. Primary effect thus occurs when people

Table 4 Adoption of mobile e-money (accounts)

Quarter	Adoption	Cumulative adoption
0	0	0
1	1,350,000	1,350,000
4	3,026,730	8,554,660
8	4,971,655	26,464,058
12	2,331,802	40,753,086
16	394,800	44,411,979
20	50,203	44,927,446
24	6,120	44,991,189
28	742	44,998,932
32	90	44,999,871

use their mobile e-money accounts to make transactions instead of hard currency. People in rural and poor regions do not have access to formal mechanism like savings account to store money. When the mobile e-money accounts will be launched, they would get access to basic banking facilities like store, transfer and withdraw money. Mobile e-money accounts would facilitate trade, making it easier for people to pay for, and to receive payments for, goods and services. People need not travel distances to pay their electricity bills or to buy air talk time; instead, they can perform all the transactions with the push of few button on their mobile phone. The second order or the *secondary effect* would occur when more and more people use mobile e-money accounts for making all kinds of transactions. One way of ascertaining the second-order effect would be the number of mobile e-money accounts operating; the rationale behind this is that with more number of users, there would be more number of transactions. The societal and the economic changes that may happen due to the introduction of mobile e-money accounts come under third-order or tertiary effect.

3.3 Estimating Adoption Potential for the Mobile E-Money Accounts

Per the Bass model, the population which adopts the mobile e-money account:

$$n(t) = pN + (q - p)N(t) - q[N(t)]^2/N$$

Here, $n(t)$ is the number adopting at a time t, $N(t)$ is the cumulative number of adopters at time t and N is the total potential. The two parameter innovation coefficient (p) and the imitation coefficient (q) have been taken as 0.38 and 0.03, respectively (average values measured over years). Assuming that mobile e-money accounts are first introduced in the state of Andhra Pradesh, then the market potential would be 45 million (which is the wireless subscriber base in AP of as of July 2011). Table 4 shows the pattern.

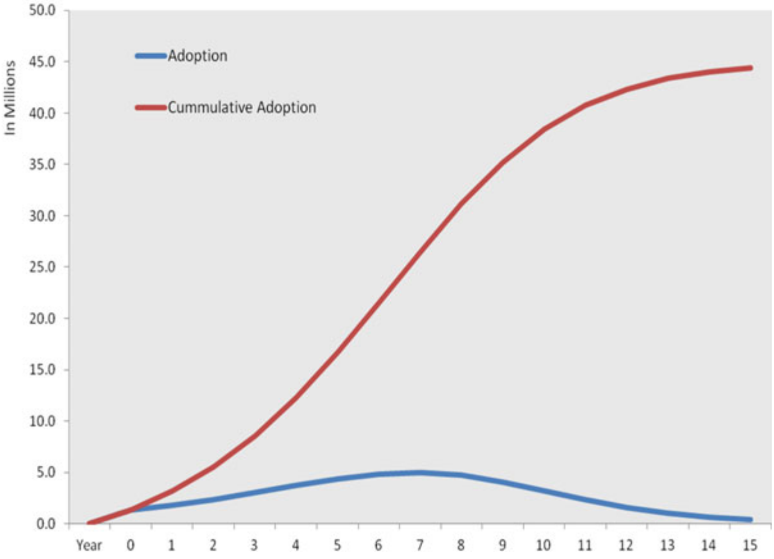

Fig. 6 Adoption of mobile e-money (curve)

From Fig. 6, it can be inferred that it would take around 14 years for the mobile e-money accounts to fully penetrate into the market. Revenues earned through this model are required to be shared between different players so as to make the system sustainable as well as profitable for all stakeholders. Table 5 describes a recommended structure for sharing of revenues between various players in the whole ecosystem.

A simple calculation (Table 6) exemplifies revenue sharing details of the proposed framework for the state of Andhra Pradesh. A very conservative estimation for number of transactions per user has been made with linear growth assumption. Few assumptions like the population are constant, and the percentage revenue shared remains the same which have been made for simplicity of calculation. Even with such assumptions, one can see the huge potential of mobile e-money accounts from the revenue sharing for different stakeholders (Table 5).

3.4 Regulatory Issues

In India, at present, MNOs are prohibited from issuing e-money to the public. MNOs can get into partnership with the banks and offer the saving accounts which are operated by banks. For MNO-led banking model to implement, there would be a need for new regulations to allow MNOs to enter in the banking sector. RBI should lay down appropriate regulatory mechanism to deal with all the concerns in the MNO-led banking model. The e-money license which will be issued to the MNO should clearly define the role and permitted activities of the MNO. MNOs should be

Table 5 Revenue sharing

Services/players	A/c opening	Deposit withdrawal transfer/ remittance	Balance inquiry
Retailer/ correspondent	Compensation to cover customer education costs	Compensation to at least cover cashmanagement costs, which will includecosts of maintaining 100% coveragefor all transactions, adequate liquidityto avoid running out of cash at theretail outlet as also the costs of securemovement of cash from remote retailoutlets to MNO	Compensation to cover transaction costs
MNO		Main player in the framework (1) Revenue earned on per transaction basis; (2) Interest income from deposits in bank	
SWITCH		Operation expenditure derived from MNO on the basis of number of transactions executed	
Account Mapper		Operation expenditure derived from MNO on the basis of number of transactions executed	
UIDAI		May charge fee for authenticating customer details during account opening and whenever authentication service is required	

Table 6 Projected revenue for MNO in Indian Rupees (INR)

Number of transactions	Revenue sharing (for retailers)	Revenue for MNO (in Indian Rupees (INR))
10	1,283,199	1,710,932
20	12,225,926	16,301,234
30	20,217,351	26,956,468
35	23,620,374	31,493,832
40	26,999,359	35,999,146
45	30,374,913	40,499,884

prohibited from engaging in intermediation of funds or asset transformation. The risk arising out of investment of funds should be transferred to fully prudential-regulated banks through pooled account mechanism. RBI must also ensure that any liabilities issued by the MNO are fully covered by the pooled account mechanism. The aspect of ownership of customer should be addressed very clearly by defining that MNO be the sole company responsible for all customer grievances. The concerns about money laundering and financial terrorism could be handled by infusing strong security and authentication mechanisms that are provided by government initiative of project Aadhaar. The UID-based micropayments offer stronger compliance with anti-money laundering laws, both to the MNO offering financial services and the regulator. Since a person's UID will be tagged to every transaction, the regulator achieves full traceability and accountability. Thus, no trade-off is made between inclusion and security. Other dimension in laying down the regulatory framework should involve fixing the tariff structures for MNOs offering basic financial services on mobile phone, ensuring that it is affordable by the poor and unbanked while it still remains profitable for MNOs.

3.5 Financing the Project

Apart from the investment by MNO, government would need to develop a supportive ecosystem for the model to viable and profitable for MNO. At the initial stage, the private players need support from the government through policy initiatives and investments to help them set up back-end infrastructure like Account Mapper, SWITCH and other ancillary installations. This could be partly supported by NPCI which is incorporated to provide a national infrastructure for payments and settlements in the country. The Universal Service Obligation Fund (USOF), created by the New Telecom Policy of 1999, can be availed as a source of investment by the government for building telecom infrastructure in rural areas (and thus taking initiatives to further enhance the rural wireless subscriber base). Per current date, the USOF position (Kashi Nath Jha (2010)) is provisionally at Rs. 14157.01 crores at the beginning of F.Y. 2010–2011 which could be effectively utilized to fund this project in initial stages. The Committee on Financial Inclusion under Dr. C. Rangarajan (Report of Committee on financial inclusion, RBI 2008) proposed to set up funds for meeting the cost of developmental and promotional interventions under the head “Financial Inclusion Fund” and another exclusive fund to meet the cost of technology adoption under the head “Financial Inclusion Technology Fund” with an approximate overall corpus of Rs. 500 crores each. In the Union Budget for 2010–2011, the corpus of these funds was enhanced by Rs. 100 crores each. These funds can be effectively used to help in developing a pilot project program to develop mobile e-money banking transactions involving MNOs.

4 Comparison with M-Pesa

M-Pesa model of Kenya, being offered by Safaricom (an affiliate of Vodafone), is similar in many aspects to the proposed model designed to enable users to complete basic banking transactions without the need to visit a bank branch. One crucial difference between the proposed model and the M-Pesa model is of the identity and authentication mechanism. The proposed model is based on the unique identity number issued by UIDAI, which provides online authentication of identities. Their model, which provides online authentication of identities based on fingerprints and iris scan, is one of a kind in the world. This strong authentication mechanism ensures that genuine and real individuals would only get registered as customers. Also, the UID-based model provides compliance with anti-money laundering laws both to the regulator and the MNO.

5 Conclusion

Inclusive growth must not suffer on the insistence of a particular model. Regulator must allow other promising models to be developed which provide extensive reach and easy accessibility as that of the case with MNO-based banking model. An MNO-based banking model developed using UID would address the issues of identity and authentication mechanism. Moreover, the proposed UID-based model offers stronger compliance with anti-money laundering laws both to the regulator and the MNO. For this model to be implemented successfully, the regulator should be proactive, in developing policies for allowing MNOs to issue e-money, a supportive ecosystem by building infrastructure (Account Mapper and SWITCH). A pilot project must be tested before developing the complete model. Learnings from the M-Pesa model of Kenya can be used to perform the test run.

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Use of Mobile Phones by Small-Scale Farmers for Price Discovery of Fresh Produce: A Case Study from the Malur Taluk in Karnataka

Navolina Patnaik

1 Introduction

Commercialization of agriculture with advent of retail chains, agro-processing firms, and changing consumer preferences can shift the small-scale farmers from self-sufficiency toward profit and income-oriented decision making (Pingali et al. 2005). However, higher transaction costs associated with commercial agriculture deter small-scale farmers from participation. In this chapter, we show that mobile phones help small-scale farmers of Malur Taluk in the state of Karnataka by reducing the transaction costs associated with marketing.

Knowledge and information are important factors for agricultural development through increased production and profitable marketing (Bertolini 2004). Various kinds of information are required throughout the cropping cycle:

- *Planning stage*: What crops to produce? capital availability and access, input requirements
- *Production stage*: Machinery and technology know-how, application of fertilizers, application of pesticides
- *Postharvest*: Storage and packing
- *Marketing*: Marketing channels, market prices, and demand information

This chapter focuses on the marketing stage where farmers in Malur Taluk of Karnataka use mobile phones while choosing marketing channel(s) to sell the produce. The study primarily focuses on vegetable growers. On a daily basis, the farmers choose to sell their produce from a variety of marketing channels available: (1) APMC *mandis* (direct and commissioned), (2) self-selling at local markets, (3) traders, (4) retail collection centers, (5) agro-processing firms, and (6) HOPCOMS cooperative. There are several *points-of-sale* for

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some of the above channels. For example, there are several traders to sell to and various retail collection centers including Reliance, Food World, Namdhari, etc. We use transaction cost economics to test the hypothesis that mobile phones help *small-scale* farmers of Malur in (1) *reducing information asymmetry* and (2) *increasing profitability*.

2 Literature Review

There are numerous studies highlighting the role of ICT (information and communication technologies) in the growth of small, medium, and microenterprises, focusing on the developing countries in Asia and Africa. Here, we briefly review the works that study the role of mobile technology for marketing of agricultural produce by farmers.

One of the first success stories of use of mobile phones by farmers is from Senegal in Western Africa (BBC 2002). An organization called Manobi implemented a project that provides market price information via mobile technology. Manobi independently collects prices and uploads them to its central database using mobile phones. Farmers in the field can use their mobile phones to check prices before they set off and find out where they will get the best offer for their produce. It was found that the farmers have secured, on average, about 15% higher profits after having paid net costs, including the price of Manobi's service (IDRC 2005). Moreover, an added benefit in reducing information asymmetry in the local context led to farmers realizing that there were often higher returns in producing for the local markets compared to the export markets.

Farmers and traders in Ghana used mobile phones to reduce transaction costs and transportation costs (Overa 2006). In addition to helping farmers in marketing their produce, mobile phones are used to coordinate logistics activities with traders, leading to considerable cost savings. Aker (2008) used the data from Sub-Saharan African country Niger to show that mobile phones reduce the price dispersion in grain markets. A mathematical model that sequentially searches for traders to maximize selling price predicts that mobile phone usage will increase the traders' reservation prices and the number of markets searched, thereby reducing the price dispersion. The model was tested with the data from Niger that showed a minimum reduction of 6.4 % in the price dispersion. Mobile phone usage by farmers in Uganda reduced the information asymmetry between farmers and traders (Muto et al. 2008). Mobile phones enabled higher market participation of farmers in remote areas and increased profitability in the sales with availability to information through mobile phones.

In India, positive evidence has been found for mobile phones usage contributing to increased productivity and profitability in agriculture (Mittal et al. 2010). It is now generally agreed that mobile phone usage by farmers can reduce information search costs and lower transaction costs, thereby enabling greater farmer participation in commercial agriculture (De Silva and Ratnadiwakara 2008). However, the usage pattern and the benefit accrued vary across different locations based on the *supply-demand* market dynamics.

Apart from agriculture, mobile phones have benefited fishermen in decreasing price dispersion. Fishermen from the state of Kerala in India use mobile technology to know the demand requirements and price information (Jensen 2007). Based on the demand requirements, fishermen change the catch pattern suiting the demand and also decide the best place to land to sell their catch. Such dynamic change in pattern based on real-time demand information is not possible in agriculture as the cropping cycle is in months. However, demand and price information at several points-of-sale can help the farmers choose the best one to trade. We show in the rest of this chapter the supply-demand dynamics of vegetables for different marketing channels in Malur Taluk and the usage of mobile phones to reduce the transaction costs.

3 Malur Taluk

Malur is located 47 km from Bangalore, and the Taluk is bound by Bangarpet Taluk, Hoskote Taluk, and Salem district of Tamil Nadu. The agroclimatic and soil conditions are conducive for development of horticulture, floriculture, sericulture, agriculture, plantation crops, aromatic plants, and medicinal plants. For the scope of this chapter, we focus only on marketing of horticulture crops like tomato, potato, onion, cabbage, carrot, brinjal, beans, green chillies, sweet potato, Kohl varieties, okra, radish, beetroot, capsicum, watermelon, gourd varieties, drumstick, leafy vegetables, etc. The moderate climate enables vegetable cultivation and harvesting throughout the year and caters to various nearby and distant markets. The methodology we adopted for primary data collection is in-depth interviews with the following players in the Malur fresh produce supply chain: farmers, retail collection centers, HOPCOMS cooperative, Innova Food Park, traders, and transport agents. Malur Taluk comprises of 28 *gram panchayats*, and we interviewed farmers from seven gram panchayats, namely, Abbenahalli, Araleri, H. Hosakote, Kudiyanur, Madiwala, Nosagere, and Santhehalli. This study focuses on various strategic and operational aspects of marketing by Malur farmers. For the scope of this chapter, we confine to operational decisions of day-to-day selling of vegetables and use of mobile phones to reduce the transaction costs.

4 Marketing Channels

The Agricultural Produce Market Committee (APMC) is a marketing board established by respective state governments in India that facilitates a fair marketing channel for farmers to sell agricultural produce. Per the Constitution of India, agricultural marketing is state governed and hence regulated under State APMC Acts. APMC Act

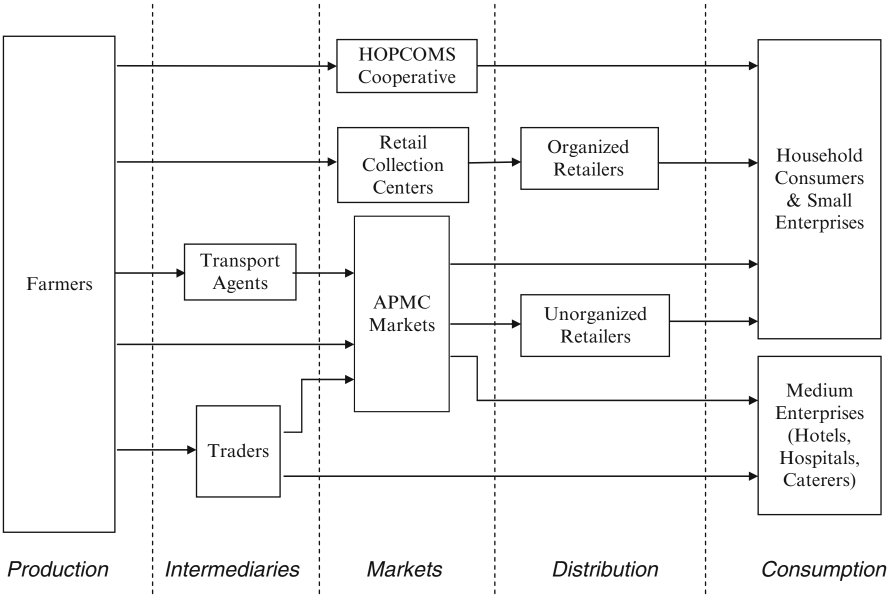


Fig. 1 Fresh produce marketing supply chain of Malur

prevents direct procurement from farmers and setting up private yards. With the advent of retail stores and agro-processing industries, several state governments amended APMC Acts, allowing direct buying from farmers. This has opened up many marketing channels for the farmers to sell their produce. With the amendment of APMC Act in Karnataka, Malur farmers have the following marketing channels: APMC markets (direct and commissioned), traders, retail collection centers, agro-processing firms, HOPCOMS cooperative, and self-selling/local merchants.

The above marketing channels include only those available for daily selling of vegetables. The strategic marketing option like contract farming is not included though it is practiced in Malur by Namdhari. The scope of this chapter is to study the impact of mobile phone usage on daily selling of vegetables, and hence, only the above channels are chosen. Figure 1 shows the marketing supply chain of vegetables in Malur as identified by our field study. In the following, we briefly describe the different marketing channels and point-of-sale available therein.

4.1 APMC Markets

The Karnataka State Agricultural Marketing Board was established on 1 September 1972 per section 100 of the Karnataka Agricultural Produce Marketing (Regulation) Act 1966 and Rules, 1968. All the major towns in Karnataka have APMC market yards with provisions for *godowns* (warehouses) and shops for traders and commission agents. However, some of the markets are nonfunctional with no trading, but only fee collection by APMC offices. Malur is one such nonfunctional market, despite the large quantities of produce available for trading. With no physical infrastructure for trading, Malur farmers sell the produce *directly* at nearby APMC markets or *commission* the sales at distant markets.

4.1.1 Direct Selling

New Kalasipalyam market and *Yeshwantpur* market in Bangalore and the *Kolar* market are preferred nearby markets for direct selling. Farmers load the produce and transport to the markets. Large farmers use their own trucks or exclusively hire trucks for transporting their own produce. Small farmers aggregate their supply and pay the truck service on the basis of load and distance. As the above markets are 3–4 h away from Malur, farmers usually leave to the market late night or early morning to participate in the auctions to sell the produce.

4.1.2 Commissioned Selling

There is no designated space for market in Malur, except for a row of shops of traders and commission agents with basic facilities of weighing and billing. There is a functional APMC office that collects fees and handles licensing to agents. The farmers can *commission* transport agents to sell their produce at distant APMC markets on their behalf. The vegetables are loaded into trucks on the roadside with no proper storage facilities or docking stations. The transport agents collect fees for transportation and represent the farmers for selling. The distant markets include Chennai, Salem, Coimbatore, Hyderabad, and Bhubaneshwar.

4.2 Traders

Traders are intermediaries who buy from farmers and sell to small and medium enterprise customers like merchants, hospitals, and hotels. Some traders speculate on the selling price of the produce for the next day and buy from farmers to sell at other markets. Based on the demand from the customers, traders contact farmers specifying quantity and quality of the produce expected. Traders are located within the village limits, and the farmers need to transport the produce on their own to the traders' shop. The trading price is negotiated on the basis of current or previous day's market price. Farmers obtain the nearby market prices, and discounting the cost of transportation and other intangible costs settles for trading price. One of the main advantages for the farmers is the immediate cash payment by traders and a higher markup over the APMC market price for high-quality produce.

4.3 Retail Collection Centers

Retail chains establish collection centers (CC) that function like private yards where farmers bring in their produce to sell. The collection centers receive their demand for various products from their respective retail stores and raise indents to be satisfied by the procurement from farmers. Collection centers maintain *supply registry* containing the information about farmers. Based on the indents, farmers are contacted through mobile phones to inform about the demand and the price. Once the price is negotiated, farmers bring in their produce to the collection centers where it is checked for quality, weighed, and traded. Depending on the arrangement, the payment is either done on the same day or on periodic basis. Traders and retail collection centers also do *on-field* trading where they visit the field with trucks and buy the produce directly at the field, thus saving on transportation and time for farmers.

4.4 Agro-Processing Firms

Agro-processing firms adopt a similar strategy like retail collection centers for the procurement of produce that merely get sorted, cleaned, and packed as high-quality vegetables to be sold at retail stores or supermarkets.

4.5 HOPCOMS Cooperative

Horticultural Producers' Co-operative Marketing and Processing Society (HOPCOMS) Limited was established under the Karnataka State Co-operative Act in 1959. HOPCOMS serves as a fair market channel for farmers through direct procurement. The societies have a network of 37,000 farmer members, with decentralized procurement centers in 19 districts. Malur has HOPCOMS procurement center which receives the demand daily along with a fixed quoted price. Based on the demand, procurement personnel of HOPCOMS give *indent* to farmer members.

4.6 Self-Selling/Local Merchants

Another marketing channel is the local market, where the farmer/farmers' family members directly sell or sell to local merchants, to cater to the needs of local consumers. The quantity sold through this channel is comparatively very less. Leftovers and rejected produce from other channels are usually sold as last resort through this channel.

Table 1 Characteristics of various marketing channels in Malur

	Price discovery	Intermediary fee	Quantity	Quality	Transportation	Payment lead time
APMC direct	Auctions	8–10 %	Unlimited	All	<100 km	2 days
APMC commissioned	Auctions	10–15 %	Unlimited	All	<750 km	3 days
Retail CC	Bargaining	None	<100 kg	A, A+	<10 km	Immediate
On-field	Bargaining	None	<100 kg	A, A+	NIL	Immediate
Trader	Bargaining	None	<150 kg	B, A, A+	<10 km	Immediate
HOPCOMS	List price	None	<100 kg	A, A+	<10 km	Immediate
Self-selling	Bargaining	None	<20 kg	All	<3 km	Immediate

5 Transaction Costs

Coase (1937) introduced the concept of *transaction costs* associated with information, negotiation, monitoring, coordination, and enforcement of contracts. Since then, several ways of defining and measuring transaction costs have been proposed. However, there is no standard definition, but it can be broadly interpreted as *costs associated with market exchange* (Singh 2008). The transaction costs vary based on the characteristics of the marketing channels or points-of-sale, and lower transaction costs encourage higher participation. Commercialization of agriculture is evident with the advent of retail and agro-processing firms. Higher transaction costs of such new marketing channels would deter the small-scale farmers to participate in commercial agriculture (Pingali et al. 2005). Here, we show that mobile phones help reduce the transaction costs and thereby increase higher market participation of small-scale farmers with increased profitability. In order to study the transaction costs, we need to first identify the drivers that influence the choice of marketing channels.

5.1 Primary Drivers that Influence the Choice of Marketing Channel(s)

Based on our in-depth interviews, the following factors are identified as the primary drivers that influence the choice of a marketing channel for the farmers of Malur: price, intermediary (brokers, commission agents) fees, quantity (accepted and rejected), quality grading, transportation cost, and payment lead time. Table 1 summarizes the characteristics of the marketing channels based on the following drivers: (1) price discovery mechanism, (2) intermediary fees, (3) quantity, (4) quality, (5) transportation, and (6) payment lead time. It should be noted that the information shown in the table refers to marketing channels in Malur and may differ for other locations. The drivers contribute to various tangible and intangible transaction costs, which we briefly describe in the remainder of this section.

5.2 Information Search Costs

Information search incurs costs with respect to *timeliness* and *quality* of information. Farmers use variety of modes for information search: *social networks*, *media*, *agricultural extension services*, and *communication technologies*. We measure the information search cost in terms of (1) *availability of information*, (2) *monetary cost spent in acquiring the information*, and (3) *time required*. For example, current market price is *unavailable* in newspaper, money is *paid* in calling on a phone or traveling to meet a person, and *time* is spent for obtaining information. Information search cost increases with unavailability of information, money, and time.

5.3 Buyer Search Costs

Search for buyers incurs cost with respect to *knowledge of potential buyers* and *obtaining price and demand information*. A farmer should firstly be aware of existence and whereabouts of potential buyers and then need to obtain the buyer's price offering and demand information. Buyer search is a specific type of information search and hence measured in the same way as above.

5.4 Transportation Costs

Cost of physical transportation of produce from farm to the point-of-sale is measured in terms of (1) *monetary cost for transportation* and (2) *time invested*.

5.5 Intermediary Fees

Fees paid in monetary value to intermediaries like brokers, commission agents, market fee, etc.

5.6 Payment Mode and Delay

It is generally perceived that immediate payment is preferred over delayed payment. Our interviews with farmers and other players revealed that this is subjective. Some farmers preferred weekly or periodic payments than immediate payments. The preference of cash over bank transfer is also subjective. Further, it also depends on the marketing channel. Farmers generally trust retail collection centers and accept late payments, whereas immediate payments are preferred with traders.

5.7 Quality Grading and Rejected Quantity

There is no automated quality grading and physical characteristics of the vegetables determine the grading as A+, A, B, and C. Usually, 10–15 % rejection is observed in marketing channels with quality restrictions (retail collection centers). We measure this transaction cost in terms of (1) *time taken for quality inspection*, (2) *time taken to sell the rejected quantity*, and (3) *monetary cost incurred to sell the rejected quantity*.

5.8 Multiparty Negotiation Cost

Negotiation or bargaining is the price discovery mechanism for many marketing channels listed in Table 1. A farmer is involved in multiparty negotiation if he negotiates with more than one buyer for selling the produce. There are two reasons for multiparty negotiation: (1) *to strike a profitable deal* and (2) *to apportion the produce among different points-of-sale*. If the aggregate supply is less than demand for a specific vegetable on a given day, the farmers negotiate with different buyers to strike a profitable deal. The prices offered by other buyers are quoted by the farmers to increase their bargaining power and get a higher price. On the other hand, if the farmer has more produce than required by a single indent, then he negotiates with multiple buyers to apportion his produce to be sold at different points-of-sale. We measure the multiparty negotiation cost in terms of (1) *time invested* and (2) *monetary cost incurred*.

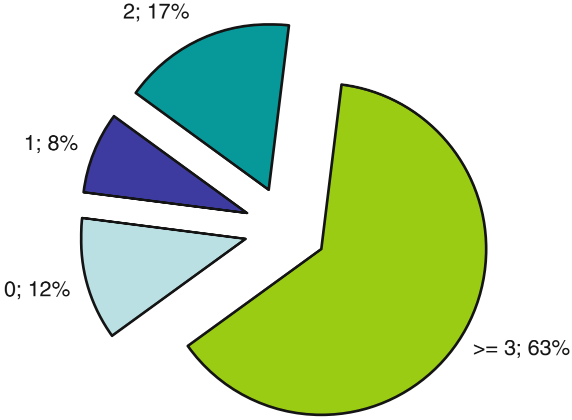
6 Reduction in Transaction Costs by Using Mobile Phones

The interviews with various players in Malur agriculture marketing supply chain revealed that mobile phones are widely used in all the stages of the supply chain, namely, *planning*, *production*, *postharvest*, *marketing*, and *distribution*. Mobile phones help in obtaining information, knowledge, networking, coordinating logistics, and marketing. In this chapter, we focus on the mobile phone usage for marketing. In particular, we test the hypothesis that mobile phones help *small-scale farmers* in (1) *reducing information asymmetry* and (2) *increasing profitability*.

6.1 Reducing Information Asymmetry

Information asymmetry creates imbalance of power in transactions where one party is better or more informed than the other. Farmers are generally perceived to be poorly informed about the market prices and demand than the buyers. This is due to the high information search costs. Any technology or process that can reduce the search cost can essentially reduce the information asymmetry. Mobile phones

Fig. 2 Number of buyers contacted before final transaction



reduce information asymmetry for Malur farmers by allowing *real-time* access to following information from the different points-of-sale: (1) *offered/expected price*, (2) *quantity demanded*, and (3) *expected quality*. It is important to note that the above *price* and *demand* information is obtained in *real time* and from local *points-of-sale* like retail collection centers and individual traders. In terms of information search costs defined in the previous section, mobile phones are the cheapest and only feasible mode of obtaining the above information in real time.

6.2 Increasing Profitability

Profitability to farmers is realized through higher sale price with reduced transaction costs by trading with the optimal buyer. Mobile phones enable increased profitability through (1) reduction in information search costs, (2) reduction in buyer search costs, (3) increased bargaining power due to reduction in information asymmetry, and (4) better deals through multiparty negotiation. Retail collection centers, traders, and agro-processing firms maintain *supply registry* containing contact information about farmers and their produce. Once indents are raised, preferred farmers are contacted through mobile phones. Farmers also call the collection centers using mobile phones to know the demand information and price offered. Thus, the buyer search costs are typically mobile phone call charges with few minutes of talking time. The APMC market price and price offered by other buyers are used as base price for negotiation, discounting transportation, and other transaction costs. The above information search is done through mobile phones which is the cheapest mode. Empowered with market and demand information, the farmer has more bargaining power with reduced information asymmetry. Further, mobile phones are used for every single negotiation, and hence, multiparty negotiation is also cheaper. Figure 2 shows the percentage of farmers who have contacted different number of buyers before final transaction. Around 63% of the farmers have contacted more than three buyers before making the final transaction using mobile phones.

6.3 Inclusive Growth by Empowering Small-Scale Farmers

Though it is widely accepted that mobile and other communication technologies reduce the transaction costs, it is not always obvious whether small-scale farmers are benefited (Pingali et al. 2005). In the case of Kerala fishermen from India, mobile phones helped prosperous fishermen (Jensen 2007), but in the grains market of Niger, mobile phones enabled inclusive growth of poor farmers (Aker 2008). We show that in the case of Malur, mobile phones help small-scale farmers engage in commercial agriculture due to the existing supply-demand dynamics. As shown in Table 1, except for the APMC markets, quantity and quality in other marketing channels are restricted. Retail collection centers and traders offer a 10–15% higher markup over APMC market price for high-quality produce. However, 10–15% of farmers' produce is rejected as unacceptable quality. Given the lower demand in quantity and higher price for good quality, small-scale farmers prefer to sell through commercialized channels. The following observations are relevant: (1) Large farmers choose to sell their produce primarily in APMC markets, (2) very few large farmers apportion their produce to sell at different points-of-sale (usually to retail collection centers or agro-processing firms), (3) small-scale farmers primarily choose to sell to retail collection centers, followed by traders based on quality, and (4) rejected quantity is usually sold at local markets or through self-selling channel.

7 Conclusions

Information and communication technologies in developing countries are helping in commercialization of agriculture. In this chapter, we showed that mobile phones help small-scale farmers in decreasing transaction costs associated with search of information, search of buyers, and negotiating a trade. The study conducted at the Malur Taluk in Karnataka showed that new marketing channels like retail collection centers and traders primarily use mobile phones for communication and negotiation with farmers. Further, lower communication cost associated with the mobile phones empowers farmers with real-time market information and enables them to conduct multiparty negotiation resulting in higher profits.

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Mobile Banking: A Study on Progress and Customer Perception in India for Financial Inclusion

S. Sudalai Muthu and T. Kadalarasane

1 Introduction and Design

1.1 Introduction

Financial inclusion is delivery of banking services at an affordable cost to the vast sections of disadvantaged and low-income groups (IDRBT 2010). Recent scenario shows that wireless infrastructures have emerged as an effective option of connecting to an ever-evolving expansive information network such as the Internet and mobile phone service in India (Market Analysis and Consumer Research Organisation 2004). In the twenty-first century, 'mobile' is not the only means of communication; it is now the means of banking and financial services (Suoranto 2003; Mattila 2002; Tiwari et al. 2006a,b; Laukkanen 2007; Zeithaml and Gilly 2002; John and Gorman 2002). Various initiatives are already taken to use mobile phones and its services to offer financial services to the unbanked and also provide the benefit of convenient financial transactions (Reserve Bank of India 2009).

1.2 Statement of Problem

India has 1,200 million people; more than 800 million are mobile subscribers, but only 400 million individuals are having bank accounts. It indicates the increase in mobile penetration in India, and this mobile penetration helps to implement the mobile banking system effectively, and it will help to bring all sections of people into the banking system.

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In India many banks are offering mobile banking services, but the number and volume of M-Banking transactions are lower than expected. There is no study on the growth of M-Banking services in India. The customers' acceptance and adoption level also is very less in India. Very few earlier works concentrated on assessing the acceptance level of M-Banking by the banks' customers. Further, most of the foreign studies are focused on adoption of M-Banking from customers' view except Lebanese bank (Daghfous and Toufaily 2002), Sudanese commercial banks (Mahdi and Dawson 2007) and Germany banks (Tiwari and Buse 2001).

Therefore, this study has been conducted to study the progress of M-Banking, to assess the customers' perception and to find out usage segment of M-Banking by the customers and their habiting and inhibiting drivers in Indian context with the following objectives.

1.3 Objectives of This Study

1. To study the present status of M-Banking system in India
2. To assess and analyse the customers perception towards mobile banking system
3. To assess and analyse the problems and difficulties in existing mobile banking system

1.4 Hypothesis

Ho: There is significant relationship between the customers' opinion towards mobile banking and their demographic characteristics of the customers.

1.5 Methodology

This research is done by adopting both analytical and empirical research design.

1.5.1 Data and Source of Data

This study is based on both primary and secondary data sources. Primary data is collected through interview schedule from the existing bank customers having mobile phones. The required secondary data are collected from the sources of RBI website, CMIE databases, books, journals, websites and other publications.

1.5.2 Study Area

Puducherry Union Territory is the sampling area for this study. It is selected for the intention of finding out the overall acceptance of M-Banking among the customers. Puducherry has 124 bank branches. Those branches become public sector (89 branches), private sector (22 branches), foreign sector bank (1 branch) and RRBs (12 branches). Moreover, 24 public and 13 private sector banks and one RRB and one foreign bank have opened their branches in Puducherry. Hence, the researcher had undertaken this study in Puducherry.

1.5.3 Sample Size

Universe (bank customers) of the present study is finite in numbers. The selection of sample customers (1,000 respondents) is taken for the study using stratified disproportionate random sampling technique.

1.5.4 Tools for Analysis

All the collected data were analysed with the help of percentage analysis, chi-square test, Garrett's ranking techniques and exploratory factor analysis using principal component analysis. The results of the analysis are given in the following three different sections.

1.6 Scheme of the Report

In order to present the report in a lucid way, it has been divided into five sections.

The first section deals with an introduction and design of this chapter, and the second section highlighted the mobile banking system and its trends in India.

The third section of this chapter presents the results of the survey conducted to assess the customer perception towards mobile banking; the fourth section explains the various mobile banking models, and the last part highlighted the concluding remarks.

2 Mobile Banking System and Its Trends in India

2.1 Mobile Banking

Mobile banking simply means performing banking transactions through mobile phones. Mobile banking is a term used for performing banking transactions, for example, money transfer, balance checks, account transactions, payments, etc., via a mobile device such as a mobile phone.

Mobile banking is seen to be an extension of the existing payment infrastructure of a bank to mobile phones as a channel for the leveraging of the mobile network and its reach, to deliver banking services to consumers (Gavin Troy Krugel 2007).

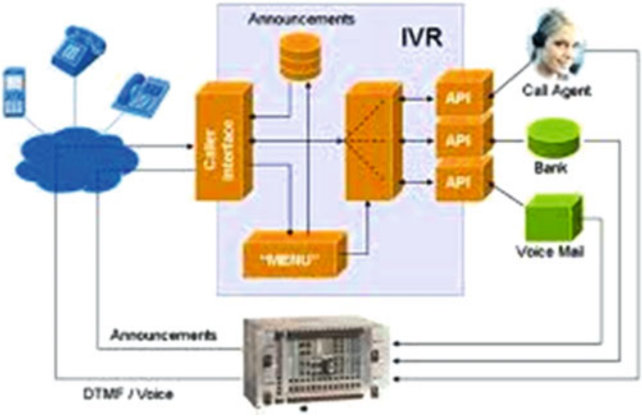
2.2 *Types of Mobile Banking Techniques*

Technically speaking, most of these mobile banking services can be deployed using more than one of the following channels.

1. IVR (Interactive Voice Response)
2. SMS (Short Messaging Service)
3. WAP (Wireless Access Protocol)
4. Standalone Mobile Application Clients

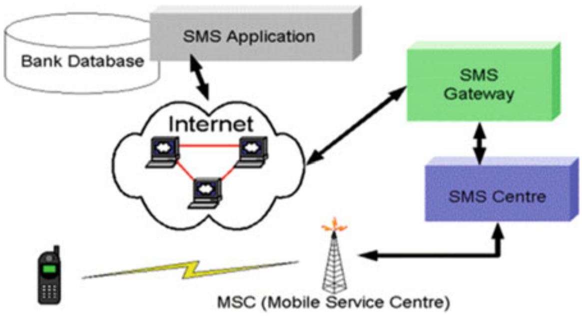
2.2.1 IVR – Interactive Voice Response

IVR or Interactive Voice Response service operates through pre-specified numbers that bank gives to their customers. Customers make a call at the IVR number and are usually greeted by a stored electronic message followed by a menu of different options. Customers can choose options by pressing the corresponding number in their keypads and are then read out the corresponding information, mostly using a text to speech programme.



2.2.2 SMS – Short Messaging Service

SMS uses the popular text-messaging standard to enable mobile application based banking. The way this works is that the customer requests for information by sending an SMS containing a service command to a pre-specified number. The bank responds with a reply SMS containing the specific information.

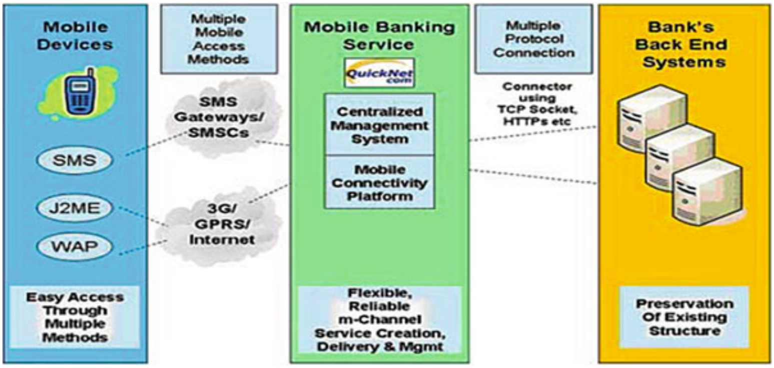


2.2.3 WAP – Wireless Access Protocol

WAP uses a concept similar to that used in Internet banking. Banks maintain WAP sites which customers access using a WAP compatible browser on their mobile phones. WAP sites offer the familiar-form-based interface and can also implement security quite effectively.

2.2.4 Standalone Mobile Application Clients

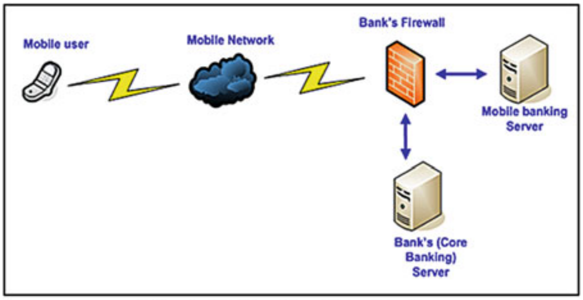
Standalone Mobile Applications are the ones that hold out the most promise as they are most suitable to implement complex banking transactions like trading in securities. They can be easily customized according to the user interface complexity supported by the mobile. In addition, mobile applications enable the implementation of a very secure and reliable channel of communication.



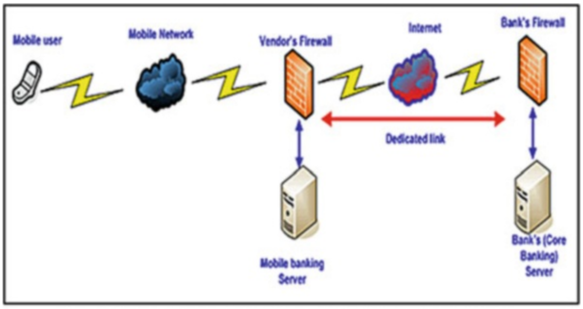
One requirement of mobile application clients is that they require to be downloaded on the client device before they can be used, which further requires the mobile device to support one of the many development environments like J2ME, Qualcomm's BREW, Ovi, Android, etc.; J2ME is fast becoming an industry standard to deploy mobile applications and requires the mobile phone to support Java. Android is one of the fast-developing user-friendly platforms.

2.3 Mobile Banking Architecture

The mobile banking architecture is based on the specific requirement that the facility is provided through GPRS-, GSM-, CDMA-, EDGE-, 3G- and CSD-enabled mobile phones. The services can be provided to customers either directly by the bank or through a 3rd-party vendor.



Direct Mobile Banking Services



Mobile Banking Services through Third Party

Third-party service architecture is the more popular architecture as banks can quickly roll out their mobile banking solutions by connecting to a 3rd party. In this architecture, the mobile banking servers are located at the 3rd-party vendor's data centre. These servers will talk to the core banking servers of the bank through a secured channel (dedicated or shared link) for authentication, authorization and transaction processing.

2.4 Mobile Banking in India

Mobile banking was introduced in India in the year 2008. Corporation bank is the first public sector bank that started mobile banking in India in the year 2008. Now, 32 banks had been granted permission to operate mobile banking in India, of which 6 belonged to the State Bank Group, 12 belongs to nationalized banks, and 13 belongs to private and one foreign banks.

2.5 Mobile Banking Services in India

The following is the comprehensive list of mobile banking services offered by various banks in India.

Services provided through mobile banking in India:

Account information	Payments and transfers	Supporting services
Transaction statement	Micropayment handling	Request for credit
Account history	Mobile recharging	Checkbook requests
Transaction alerts	Commercial payment	Locating ATMs
Monitoring of deposits.	Bill payment/other payments	*Other services*
Loan statements	*Investment services*	General information
Mutual fund statements	Portfolio management	Loyalty-related information
Check status/stopping payment	Stock quotes and personalized alerts	Various promotional and other offers and services

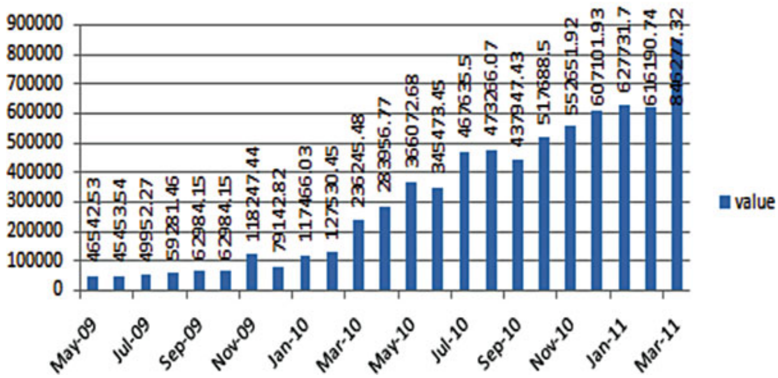
2.6 Third-Party Service Providers

Mobile banking services are offered through some third-party service providers. They played an important role in providing mobile phone services. The following are few important third-party service providers:

1. Payment service providers (*PayMate*, *Ngpay*, *Obopay*, etc.)
2. Technology providers (*Fundamo*, *Utiba*, *Mcheck*, *Accenture*, *Sybase 365 and Cell Trust*, etc.)
3. Network service providers (BSNL, Airtel, Aircel, etc.)
4. Mobile vendors (Nokia, Samsung, Sony, BlackBerry, etc.)
5. Distribution agents (Oxicash, Beam Express Points)
6. Regulators (DIT, RBI)
7. Other forums (Mobile Payment Forum)

The performance and progress of mobile banking in India is given below.

Volume of M-Banking Transactions in India



No. Of M-Banking Transactions in India

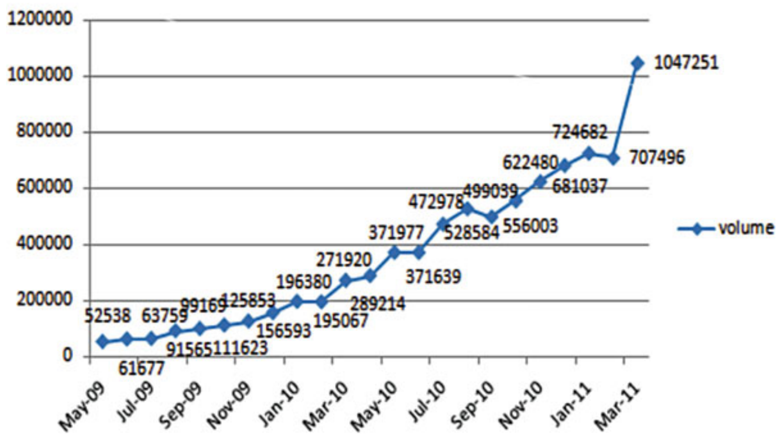
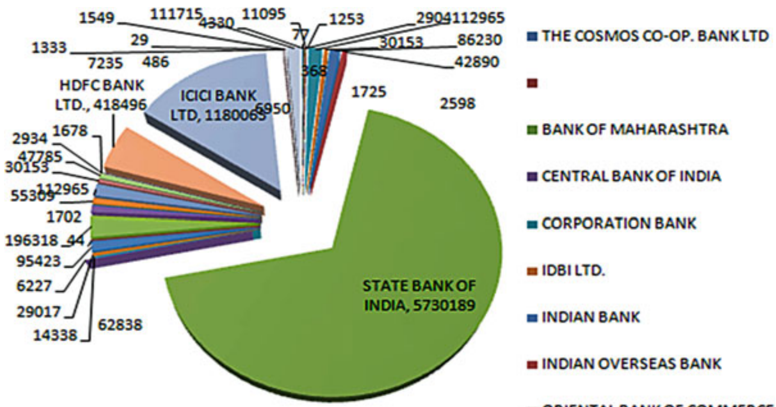


Table 1 shows the progress of mobile banking, and other given graph depicts the mobile banking transactions provided by various banks in India. From the above it is observed that the value of mobile transactions during the period is in rapid growth and in increasing trend.



3 Customers Perception Towards Mobile Banking System

3.1 Introduction

Realizing the importance of mobile-based services offered by various banks, the researcher has assessed the customers' perception towards mobile banking services offered by banks in Puducherry area. The results are shown below.

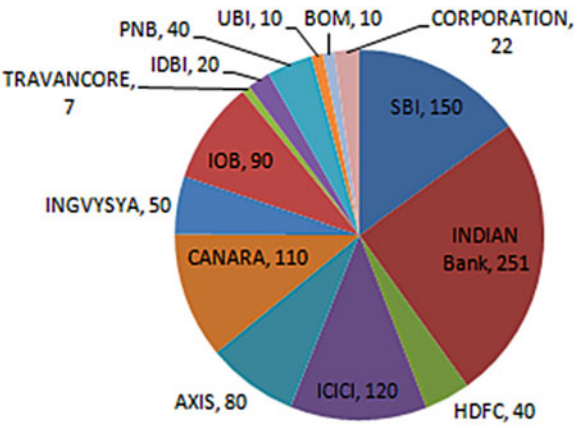


Table 1 Progress of mobile banking

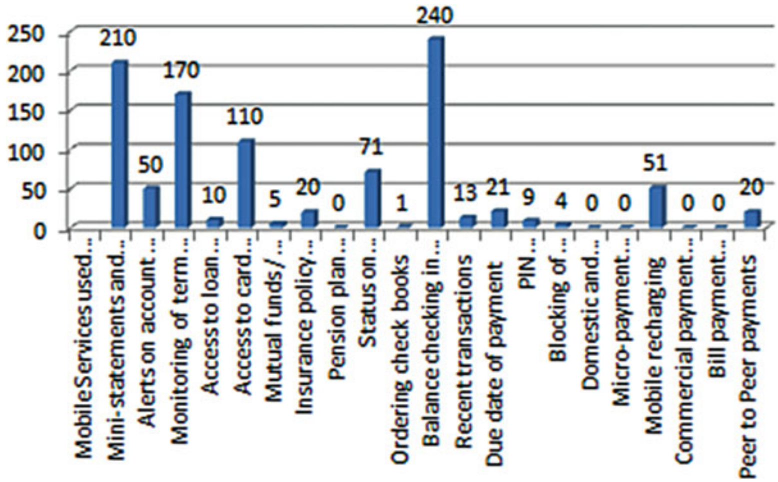
Month and year	Mobile banking (in volumes)			Percent to the total			Monthly growth rate (incre./decre.)			Monthly growth rate (% of incre./decre.)			$Y_c = 268977.87 + 33487.338X$	$Y_c = 77209.87 + 4909.19X$	$Y_c = 13746.39 + 150.94X$
	Public	Private	Foreign	Public	Private	Foreign	Public	Private	Foreign	Public	Private	Foreign	Public	Private	Foreign
May'09	6,684	35,354	10,500	0.11	1.99	3.32	–	–	–	–	–	–	−99382.85	23208.78	12086.05
Jun'09	15,477	34,183	12,017	0.25	1.92	3.80	8,793	−1,171	1,517	131.55	−3.31	14.45	−65898.51	28117.97	12236.99
Jul'09	17,340	33,980	12,439	0.28	1.91	3.93	1,863	−203	422	12.04	−0.59	3.51	−32408.17	33027.16	12387.93
Aug'09	33,074	45,530	12,961	0.53	2.56	4.10	15,734	11,550	522	90.74	33.99	4.20	1079.17	37936.35	12538.87
Sep'09	41,465	44,450	13,254	0.67	2.50	4.19	8,391	−1,080	293	25.37	−2.37	2.26	34566.5	42845.54	12689.81
Oct'09	53,843	44,069	13,711	0.87	2.48	4.34	12,378	−381	457	29.85	−0.86	3.45	68053.84	47754.73	12840.75
Nov 09'	67,668	45,718	12,467	1.09	2.57	3.94	13,825	1,649	−1,244	25.68	3.74	−9.07	101541.18	52663.92	12991.69
Dec'09	91,959	51,261	13,373	1.49	2.89	4.23	24,291	5,543	906	35.90	12.12	7.27	135028.52	57573.11	13142.63
Jan'10	122,153	59,889	14,338	1.97	3.37	4.53	30,194	8,628	965	32.83	16.83	7.22	168515.86	62482.3	13293.57
Feb'10	141,442	39,929	13,696	2.29	2.25	4.33	19,289	−19,960	−642	15.79	−33.33	−4.48	202003.19	67391.49	13444.51
Mar'10	191,065	67,696	13,159	3.09	3.81	4.16	49,623	27,767	−537	35.08	69.54	−3.92	235490.53	72300.68	13595.45
Apr'10	203,755	72,041	13,418	3.29	4.06	4.24	12,690	4,345	259	6.64	6.42	1.97	268977.87	77209.87	13746.39
May'10	247,430	90,789	13,758	4.00	5.11	4.35	43,675	18,748	340	21.44	26.02	2.53	302465.21	82119.06	13897.33
Jun'10	272,140	84,970	14,529	4.40	4.78	4.60	24,710	−5,819	771	9.99	−6.41	5.60	335952.55	87028.25	14048.27
Jul'10	350,522	107,661	14,795	5.67	6.06	4.68	78,382	22,691	266	28.80	26.70	1.83	369439.88	91937.44	14199.21
Aug'10	408,738	104,590	15,261	6.61	5.89	4.83	58,216	−3,071	466	16.61	−2.85	3.15	402927.22	96846.63	14350.15
Sep'10	396,797	88,115	14,127	6.41	4.96	4.47	−11,941	−16,475	−1,134	−2.92	−15.75	−7.43	436414.56	101755.82	14501.09
Oct'10	444,449	97,225	14,329	7.18	5.47	4.53	47,652	9,110	202	12.01	10.34	1.43	469901.9	106665.01	14652.03
Nov'10	491,763	116,718	13,999	7.95	6.57	4.43	47,314	19,493	−330	10.65	20.05	−2.30	503389.24	111574.2	14802.97
Dec'10	533,479	133,555	14,003	8.62	7.52	4.43	41,716	16,837	4	8.48	14.43	0.03	536876.57	116483.39	14953.91
Jan'11	584,953	125,639	14,075	9.46	7.07	4.45	51,474	−7,916	72	9.65	−5.93	0.51	570363.91	121392.58	15104.85
Feb'11	578,872	114,026	14,590	9.36	6.42	4.61	−6,081	−11,613	515	−1.04	−9.24	3.66	603851.24	126301.77	15255.79
Mar'11	891,423	138,439	17,368	14.41	7.80	5.49	312,551	24,413	2,778	53.99	21.41	19.04	637338.59	131210.96	15406.73

Apr’11							670825.93	136120.15	15557.67
May’11							704313.26	141029.34	15708.61
Jun’11							737800.60	145938.53	15859.55
July’11							771287.94	150847.72	16010.49
Aug’11							804775.25	155756.91	16161.43
Sep’11							838262.62	160666.10	16312.37
Oct’11							871749.95	165575.29	16463.31
Nov’11							905237.29	170484.48	16614.25
Dec’11							938724.63	175393.67	16765.19
Total	6,186,491	1,775,827	316,167	100	100	100			
Mean	268977.87	77209.87	13746.39						
SD	238058.24	34867.24	1301.00						
C.V	0.89	0.45	0.09						

The study reveals that majority of the customers were in the age group below 25 years (82.93 %); most of the customers are postgraduates (95.93 %), and 7/10th of the customers are students (70.73 %). The chart given here reveals the bank-wise respondents and their usage pattern of mobile services offered by banks in the study area.

3.2 Various Mobile Services Offered by Banks

7/10th of the customers are availed banking services through public sector banks. 24% of the customers are using M-Banking system for the purpose of account balance checking, followed by availing mini statement and monitoring of accounts. The other usage patterns are given in the figure.



3.3 Reasons for Using Mobile Banking System

Garrett's ranking technique result reveals that foremost reason for using this service is instant and immediate information availed under M-Banking facilities because it shows highest mean score (68.75) compared to other reasons. Time saving (53.85) is a second important reason, and fast and effortless shows the third rank with the mean score of 50.11. On the other hand, less cost got last reason for using M-Banking system.

Table 2 Rotated component matrix (a)

	Component			
	1	2	3	4
Educating the customer	**0.826**	0.021	0.074	0.141
Errorless	**0.813**	0.084	0.315	−0.205
Meet the needs in future	**0.790**	0.183	0.087	0.410
Low (or) no cost	**0.782**	0.421	−0.053	0.135
Security	**0.699**	0.169	0.303	−0.257
Easy to use	**0.451**	0.400	0.401	0.365
Privacy is maintained	−0.104	**0.888**	0.069	−0.157
24 × 7 Availability	0.111	**0.834**	0.324	0.069
Customer-friendly device	0.348	**0.693**	0.183	0.154
Satisfies all my banking needs	0.287	**0.686**	−0.307	−0.140
Time savings	0.446	**0.616**	0.338	0.064
Motivate the work force	0.054	0.081	**0.840**	−0.042
Fast and effortless	0.353	0.171	**0.813**	0.058
Quick decision making	0.034	−0.069	−0.010	**0.881**

Source: primary data
Extraction method: principal component analysis
Rotation method: varimax with Kaiser normalization
Rotation converged in five iterations

3.4 Customers Perception Towards Mobile Banking System

Explorative factor analysis, a multivariate statistical technique, has been used to identify the underlying factors that determine perception towards M-Banking through the customer response against 14 statements using principle component analysis. The responses are collected from the customers in the form of qualitative nature in strongly agree, agree, neither agree nor disagree, disagree and strongly disagree statements with the score of 5–1, respectively. The results are shown below.

Table 2 presents the factor loadings for each variable. The variables *V13*, *V10*, *V12*, *V5* and *V9* have loading of *0.826*, *0.813*, *0.790*, *0.782*, *0.699* and *0.451*, respectively, on factor 1; this suggests that factor 1 is a combination of these variables. So factor 1 can be named ‘convenience’. In the case of factor 2, columns indicating variables V2, V6, V11 and V3 have loadings of *0.888*, *0.834*, *0.693*, *0.686* and *0.616*, respectively, on factor 2, this suggests that factor 2 is a combination of these variables. So factor 2 can be named as ‘24 × 7 Flexible Services’. In case of the factor 3, columns indicate that variables *V7* and *V8* have loadings *0.840* and *0.813* on factor 3, respectively; this suggests factor 3 is named ‘speed’ and *V14* have a single loading *0.881* on factor 4 named as ‘quick financial decision’. Hence, it is concluded that ‘convenience’, ’24 × 7 flexible services’, ‘speed’ and ‘quick financial decision’ are the factors responsible for motivating customers to use mobile banking system.

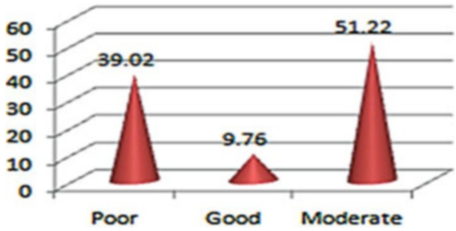
3.5 Customers Opinion About Mobile Banking System

The opinions about mobile banking system were collected from the customers in qualitative form through the five-point scaling technique. Overall scores of each

Table 3 Opinion regarding Mobile Banking System

Opinion	Frequency	Percent
Poor	48	39.02
Good	12	9.76
Moderate	63	51.22
Total	123	100

and every customer are calculated; then customer opinion was assessed based on the mean and standard deviation derived from total score of sample customers. The customers' opinion about mobile banking system is shown in Table 3.



Inferred from the above that more than half of the customers are moderately viewed about mobile banking system provided by banks, and nearly 2/5 of the customers are given poor opinion about mobile banking services, followed by 9.76% of the customers that are opined well.

3.6 Testing of Hypothesis

Pearson chi-square (χ^2) statistic should be used to test the relationship between the customers' level of opinion towards mobile banking and their demographic characteristics of the customers. The results of the test and the asymptotic value of χ^2 are given in Table 4.

3.7 Problems Faced by the Students

The problems faced by the customers while using mobile banking system are collected from the various bank customers through the seven variables. Garrett's ranking technique is used to rank the major problems faced by the customers while using M-Banking facilities, the results are shown in Table 5.

From the table, it is observed that major problem faced by the customer is mobile signal problem that leads to poor connectivity; it shows highest mean score (63.11) compared to other problems. The second problem is there is no standard software (56.09) for mobile applications. It indicates that different operating softwares are

Table 4 Relationship of demographic characteristics and level of opinion

Demographic character	χ^2	df	Asymp.sig	Result
Sex	0.924	2	0.63	NS
Age group (in years)	2.846	4	0.584	NS
Educational qualification	9.759	4	0.045*	S
Occupational status	2.521	4	0.641	NS
Family income	1.842	4	0.765	NS
Years of usage of mobile phone	1.694	4	0.792	NS
Frequency of visit to bank	0.307	4	0.989	NS

* = Significance at 5 % level

Table 5 Problems regarding usage of mobile banking system

Problems	Total score	Mean	Rank
Signal problem	7,762	63.11	I
No standard software	6,899	56.09	II
Mobile access charges	5,932	48.23	V
Security	6,039	49.10	IV
Vulnerability	6,101	49.60	III
Authentication	5,057	41.11	VII
Confidentiality	5,137	41.76	VI

Source: primary data

available, but there are no comprehensive standard softwares for providing standard services. Another important problem is vulnerability, which shows the third rank with the mean score of 49.60. So the government and banks should take necessary steps to educate the customers.

4 Mobile Banking Models and Standard

4.1 Mobile Banking Models

M-Banking models have often been falling into two primary categories, namely, bank-based model and a nonbank-based model. Each model has distinct means of operating, especially with respect to the relationship with the end customer in terms of establishing accounts, deposit taking and lending services.

4.2 Bank-Led Model

The bank-focused model emerges when a traditional bank uses nontraditional low-cost delivery channels to provide banking services to its existing customers. Examples range from use of automatic teller machines (ATMs) to internet banking or mobile phone banking to provide certain limited banking services to banks' customers. This model is additive in nature and may be seen as a modest extension of conventional branch-based banking. The bank-led model offers a distinct alternative to conventional branch-based banking in that customer conducts financial transactions at a whole range of retail agents (or through mobile phone) instead of at bank branches or through bank employees. This model promises the potential to substantially increase the financial services outreach by using a different delivery channel (retailers/mobile phones), a different trade partner (Telco/chain store) having experience and target market distinct from traditional banks, and may be significantly cheaper than the bank-based alternatives. The bank-led model may be implemented by either using correspondent arrangements or by creating a JV between bank and Telco/nonbank. In this model, customer account relationship rests with the bank.

In India in the year 2008, the Reserve Bank of India (RBI) issued mobile banking guidelines that permit only licensed banks with a physical bank presence in India to launch mobile banking using this bank-focused model.

The disadvantage of the bank-based model is that it may not be able to innovate as easily or respond as rapidly to market needs. In addition, a bank-based model is closely tied to existing services offered by a formal bank may have a more limited reach than a nonbank service.

4.3 Nonbank-Led Model

The nonbank-led model is where a bank has a limited role in the day-to-day account management. Typically, its role in this model is limited to safekeeping of funds. Account management functions are conducted by a nonbank (e.g. Telco) which has direct contact with individual customers and performs all functions.

One of the greatest advantages to the nonbank model is that it can more easily increase access to financial services for those in low-income and rural areas because the customer does not need to engage in a direct contractual relationship with the bank. An additional potential advantage may be that the company offering the service may not be subject to the more restrictive regulations imposed on a traditional bank because it does not fall under the traditional definition of a 'financial institution', or its services may not fall under the definition of a 'banking activity'.

The disadvantage to a nonbank-based model is ensuring that sufficient capital is in place to mitigate any financial risk due to a lack of funds within the system. An additional disadvantage to the nonbank model is that it often necessitates the need for further review and refashioning of banking and/or telecommunication regulations in order to provide the service, as well as to provide adequate protection for consumers.

5 Conclusion

The result of this chapter reveals that mobile banking system is enjoying a rapid growth in India. It has successfully crossed the introduction stage. Mobile banking services are growing both in terms of volume and value of transaction.

Regarding the customer perception regarding M-Banking, mostly, young and educated customers are very much interested to apply and avail mobile banking services. 'Convenience', '24 $\times$ 7 flexible services', 'speed' and 'quick financial decision' are the factors responsible for motivating customers to use mobile banking system. 7/10 of the customers are availed banking services through public sector banks. There is a significant relationship between educational qualification of the customers and their level of opinion regarding mobile banking system. The bank should take some steps to educate their customers regarding various aspects of M-Banking services. Most of the M-Banking customers are not satisfied with their mobile network, so the mobile network service providers should take care of their customers.

Regarding mobile banking models, in India, mostly bank-focused mobile banking model has been used and offered services. So the regulators may take some steps to implement more nonbank models in India to extend the mobile banking services. Effective and more user-friendly software may be introduced to simplify the uses. The existing customers are not satisfied with present security measures, so steps should be taken to introduce effective security measures to avoid mobile-transaction-based crimes which would help to bring 100% financial inclusion in India. Necessary steps are to be taken to frame guidelines related to security and privacy of transaction. New legal frameworks are also needed that should define supervisory structure of related entities and that would help to bring transparency in all activities.

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Web Resources

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Domestic Remittance: Money Transfer Anywhere and at Anytime in India

Deepak Venkatesh and Anand Kumar Bajaj

1 Overview

Financial inclusion is an integral part of India's inclusive growth strategy. The potential of remittance is tremendous in a country like India where migration to urban areas especially by the poor is prominent. Remittances are an important and stable source of external development finance (Maimbo and Ratha 2005). Its potential for stimulating economic growth has been largely neglected by those who explore such issues from the top down.

Up to 100 million circular migrant workers contribute as much as 10% to the national gross domestic product (Thorat and Jones 2011). Circular migration has become a much needed livelihood strategy (Thorat and Jones 2011). Average annual remittance amount is about 20,000,[1] and even the poorest migrant send money home (Thorat and Jones 2011). Informal remittance channels are pervasive, and migrants value security and speed of money transfers (Thorat and Jones 2011).

Bringing remittances into the mainstream of the financial system can act as an important gateway for the financial inclusion of domestic migrants. While commercial banks have the necessary technical infrastructure, they can lack convenient delivery channels. Know-your-customer principles and other banking requirements add to the inconveniences.

[1] All currencies are in Indian rupees. 1 lakh is 100,000; 1crore is 10,000,000.

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2 Problem of the Migrant Worker

The options available to migrants for remitting money home include courier service, “hawala” operators, relatives, money order, deposit into bank accounts, etc. The major share of domestic remittances continues to be channelled through trusted friends and relatives of migrants returning home (Tumbe 2011), whereas the most popular formal sector remittance instrument – post office money order – is also the most expensive mode with 5% service charge.

It is pertinent here to state the general experience of the migrant worker with the formal banking channel. Since they do not belong to the city they work in, they do not have the requisite KYC (know-your-customer) documents to open their bank accounts. In their work city, they deposit cash in their hometown accounts using anywhere banking module offered by various banks. But to do this, they have to stand in long queues because banks open only couple of counters for 3–4 h in the morning. Effectively half the day for these people is lost since they come in early at 6 a.m to stand in the queue and remain there till 11 a.m. to 2 p.m.

Overall, remitting money back home proves to be cumbersome, costly, and vulnerable to fraud for the migrants. The three key problems faced by migrants for remitting money are:

1. Insecurity due to dependence on informal channels
2. Unavailability of formal channels in non-banking hours
3. High-cost and time-consuming process

3 Solution to the Problem

YES Bank has conceptualized and designed an innovative way of providing remittance services to the so-called financially excluded segment under the “YES Money” initiative. YES Money is a multichannel and multiplatform banking product suite comprising of services such as National Electronic Fund Transfer (NEFT) based outward remittance service through business correspondent (BC) partners. Initially corporate entities could not be appointed as BCs which was later relaxed by the Reserve Bank of India (RBI) paving the way for YES Bank’s domestic remittance solution under the banner of YES Money.

The service is targeted towards people who have access to formal bank accounts at the terminating point (rural or native) but do not have such access at the originating point (urban or metro). YES Bank has utilized the BC model to bring the transaction touch point closer to the customer that is even available at non-banking hours. The end-to-end remittance takes less than 24 h. The sender can use this service to remit money to over 85,000 NEFT-enabled branches of any bank across India. This service generally costs the customer up to 1% of the transaction value.

As of November 16, 2011, domestic remittance services are being offered in major migration centres such as Mumbai, Delhi, Surat and Pune. More than 76,000 transactions have been executed amounting to 46.13 crores using this service. Money has been sent to more than 4,000 branches of 48 banks across the country.

This model is sustainable and a market principle based being fuelled by the necessity of the customers. The market forces cause this model to break even with a marginal operating profit from the first day itself.

4 Operational Process

The process at both the banking correspondent's and the customer's end has been kept very simple. It is an error-proof process where the BC administers the service to the migrant worker.

4.1 Overview of Process

1. The mobile number of the customer is registered with the BC for this service. An ID proof and a minimal one-time charge are required.
2. The hardware at the field includes a computer, printer and Internet connectivity. The software requirement is met by the BC through their own platform. There is no incremental cost that the BC outlet needs to incur for the initiative as it is an additional service.
3. The customer (sender) needs to first register the beneficiary by providing details of intended beneficiary that essentially includes the following:

   (a) Beneficiary name
   (b) Beneficiary account number
   (c) Beneficiary bank name
   (d) Indian Financial System Code (IFSC) of beneficiary bank

4. The front screen created for the BC outlets assists the sender in this process. The BC selects the city, bank and the branch from the guided drop down list in the system. Basis this selection the IFS code of the relevant bank branch is automatically displayed.
5. To ensure the accuracy of beneficiary transaction details various checks and balances are incorporated at the field level that includes short message service (SMS) confirmation through one-time password (OTP) generation, system checks on human errors, and generation of receipts.
6. The actual money transfer is initiated by the customer from any BC outlet by providing the registered mobile number. Thereafter, the sender states the registered beneficiary details and the amount to be remitted.
7. The customer receives an SMS giving the details of the amount, bank account number, bank name, branch and city, and an OTP. This OTP is entered in the system to confirm the acceptance by the sender that the details are correct.

8. The BC then receives the cash from the sender and provides him with a system-generated receipt.
9. Similar requests are submitted continuously from various BC outlets throughout the day. At the BC's back end, the system accepts these requests and in batch mode uploads the request file on the Internet banking platform of YES Bank.
10. YES Bank processes these requests through NEFT transaction cycles and sends the money into the respective accounts of other banks across the country.
11. The recipient in turn withdraws cash from the bank.

At present, this model has arrived at a stage where YES Bank is screening the requests from the BC agents who want to participate in this remittance system and selectively activating them to offer this service.

4.2 Flow Diagram of Process

The detailed steps involved in the service (Fig. 1) include the following:

1. BC agent purchases a prepaid balance from the BC against cash payment.
2. BC extends prepaid balance to agents against payments received.
3. Customer submits remittance request along with beneficiary details and makes payment.
4. BC agents submit customer request on BC e-commerce portal.
5. BC back-end operation downloads/collects request from various agents at defined time intervals and processes these in batches for uploading through the BC remittance account with YES Bank.
6. BC accounts section transfers from the current account to the remittance account an amount equivalent to all the transactions in the day obtained from the e-commerce portal.
7. BC accounts section uploads the remittance batch in the NEFT section of YES Bank Internet banking portal.
8. YES Bank back-end operations prepare a NEFT batch on RBI NEFT platform.
9. RBI NEFT platform credits beneficiary bank basis NEFT request from YES Bank.
10. Beneficiary bank credits the beneficiary account.
11. BC prefunds its parking account with YES Bank to avail limits for overnight transaction.

5 Benefits to Participants

The benefits of the solution deployed are availed by participants across the value chain that includes the migrant worker, BCs, BC agents and YES Bank. The pre-deployment and post-deployment scenario for the migrants remitting money can be seen from Table 1 below:

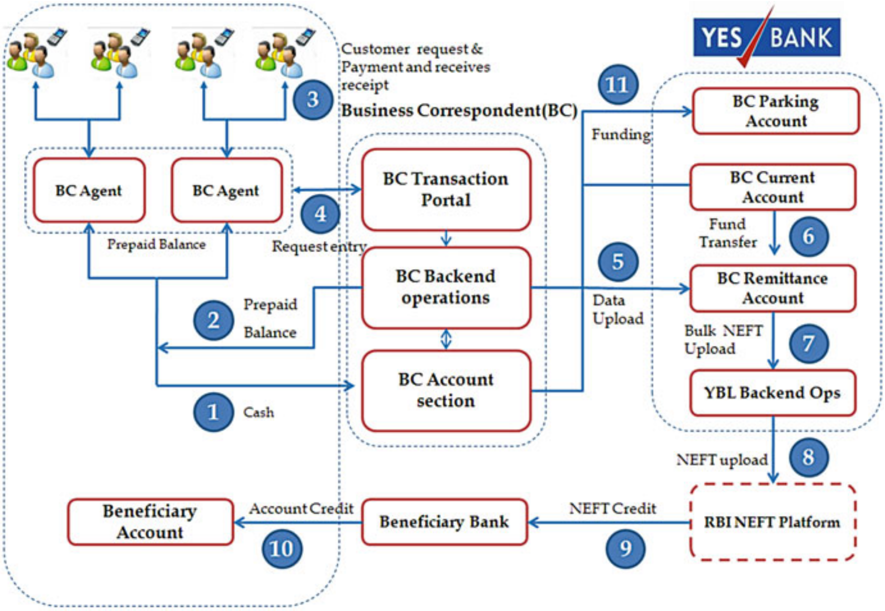

Fig. 1 Multichannel multi-partner remittance service

Table 1 Pre- vs. post-deployment of YES Money service for migrants

Pre-deployment	Post-deployment (YES Money)
Risk of losing money via informal channels	Secure electronic transfer through NEFT
Time taken for remittance is high	Speedy transfer generally within 24 h
Loss of daily wages and productivity due to queue system for limited time daily	No such loss due to numerous BC agents and availability of this service 24 h
Costly (post office money order costs 5%, informal channels are still higher)	Cost-effective (up to 1% of transaction value)
Formal channel is unavailable during non-banking/ typical working hours	Available even in non-banking hours
KYC required for opening bank accounts at work cities for remitting money	No KYC required for remitting money under this service offering

These customers need not be customers of YES Bank; in fact, the remitter need not even have any banking relationship.

5.1 Socio-economic Benefits for Other Stakeholders

For the BC and BC agent:

1. In the first 6 months of the launch, the service offering has generated revenues of more than 30 lakhs. This is shared with the BC and BC agents.

2. At the same time the retailers who have become business correspondent agents earn a transaction fee for facilitating this remittance request. Some of the BC agents do around 100 transactions per week and earn an additional income of 4,000 monthly. The retailers also have additional credibility after they have put up YES Bank's "business correspondent" board at their outlets.
3. The BC agents are able to increase footfalls and increase sales at their regular stores.

Therefore, this service deployment has promoted a multi-stakeholder inclusive ecosystem by providing the partners with remuneration commensurate to their efforts.

For the bank:

1. YES Bank has been able to participate in a business like remittance service that traditionally requires a large branch network. The idea of leveraging the BC network has worked for the bank in offering this service to non-banking customers as well as customers of other banks.
2. In banking services one of the parameters considered for growth is the day-end account balances (EOP balance – end of period). As observed nearly 50% transactions are happening during post-banking hours, and this leaves the deposit with YES Bank overnight. On an average during the initial pilot period, YES Bank had 15 lakhs of free float, and this amount is growing as the popularity of this service is emerging.
3. YES Bank has gained visibility through business correspondent retail outlets. The brand continues to build upon its reputation as a leading innovator offering convenience to the masses.
4. YES Bank is also getting leads to open accounts of good transacting customers from this platform. There are at least 1% of the users who will be sourced from this platform. This is one of the facets of financial inclusion initiatives which have been taken up by YES Bank.

6 Quantitative Results and Observations

6.1 Increasing Number of Agents and Transactions

From June 2011 to November 2011, there has been an increase of over 15 times in the number of agents under this service. The number of transactions has increased by more than 2,500% (Fig. 2, Table 2).

6.2 Transaction Times: Post-banking Hours

Forty-five percent transactions are done during "after banking hours" that is before 10 a.m. and after 4 p.m. During this time period, majority of bank branches are closed for customers (Fig. 3, Table 3).

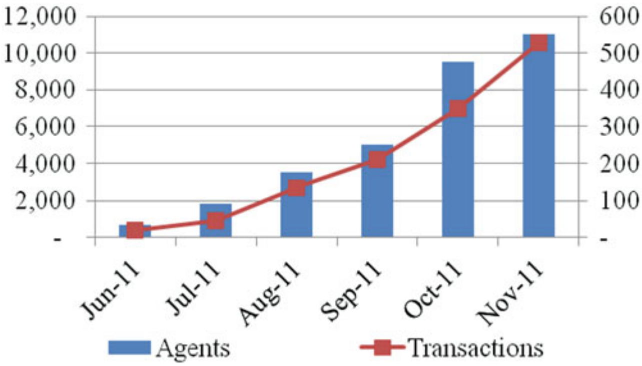

Fig. 2 Graph of growth in number of agents and transactions

Table 2 Growth in number of agents and transactions

Month	Agents	Transactions
Jun-11	35	399
Jul-11	92	942
Aug-11	175	2,689
Sep-11	251	4,226
Oct-11	476	6,998
Nov-11	552	10,590

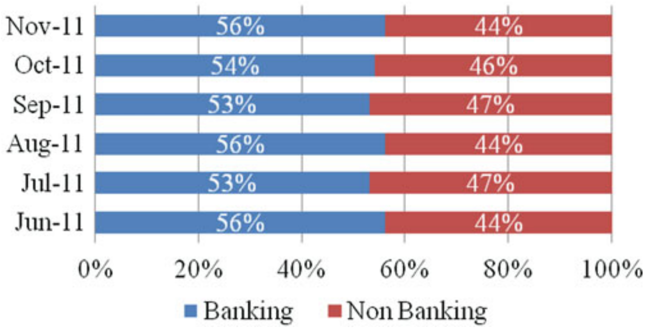

Fig. 3 Graph of distribution of transacting hours of customers

Table 3 Transacting hour patterns

Month	Banking (%)	Non-banking (%)
Jun-11	56	44
Jul-11	53	47
Aug-11	56	44
Sep-11	53	47
Oct-11	54	46
Nov-11	56	44

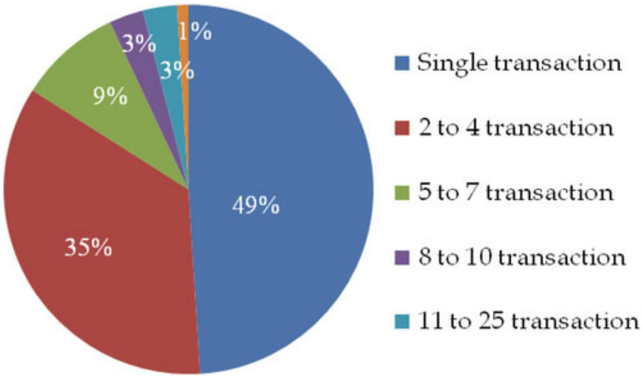

Fig. 4 Pie chart showing the repeat usage of customers

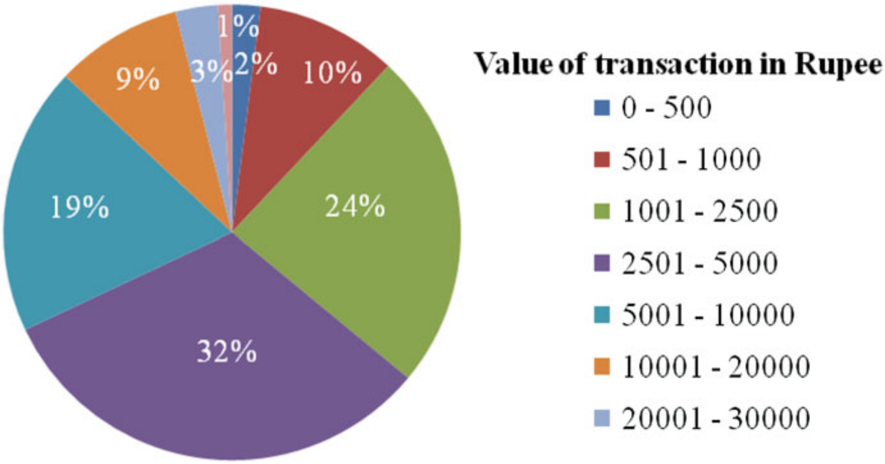

Fig. 5 Pie chart showing the average size of transactions and their distribution

6.3 Repeat Usage

Approximately 51% of the customers did more than one transaction (Fig. 4).

6.4 Transaction Size

The average ticket size of the transactions done over the period is Rs. 6,000 (Fig. 5).

This platform provides convenience of remittance to the users who do micro remittance. Around 12% transactions are of Rs. 1,000 or less. There would be a positive social impact by providing such a service to the lowest income group of the economy.

Table 4 Top beneficiary banks

Bank name	% of transactions
State Bank of India	41
Union Bank of India	31
Punjab National Bank	14

Table 5 Transaction routes

Originating region	Terminating region – share	Terminating region – share
Mumbai Metropolitan Region	Uttar Pradesh – 73%	Bihar and Jharkhand – 12%
National Capital Region	Bihar and Jharkhand – 54%	Uttar Pradesh – 29%
Surat	Uttar Pradesh – 39%	Bihar and Jharkhand – 37%

6.5 Beneficiary Banks and Transaction Routes

The top three beneficiary banks account for over 85% of the transaction volumes (Table 4).

Sixty-nine percent of the transactions are routed to Uttar Pradesh and Bihar (Table 5).

7 Challenges

7.1 Settlement Risk with BC Agents

The risk involved the failure of the BC agent to deposit the money with the bank after collecting the same from the end user. In order to eliminate the settlement risk, BCs have been asked to open an account with YES Bank and pre-fund the remittance account.

7.2 Anti-money Laundering

To deter such activities, a number of checks have been implemented. The base mitigant is that the recipient's account is KYC compliant with the beneficiary bank. The other check involves monitoring transaction amounts and frequency of transactions.

7.3 Fraudulent Refunds

To ensure that on the event of a rejection of a NEFT the customer does not lose out, a system of sending an SMS to the registered user is set up. The SMS has a password which is to be presented to the agent to claim refund. This eliminates the possibility of claiming fraudulent refunds.

8 The Way Forward

8.1 Sustainability

There is a huge opportunity for expanding the reach of this innovation. The target market segment for this service extends to all the cash payments into any bank account across the country. On a segmented level, the remittance market for migrant labourers itself is of around 116,000 crores. This model provides outreach and convenience to this segment of users. With a growth in job opportunities in towns and industrial corridors, there is mass migration of workers to these areas.

At current levels, there are around 750 transactions on a daily basis remitting an average of 6,700 per transaction. With growing numbers to about 10,000 outlets in a year's time, executing 20 transactions a day, it would mean 200,000 transactions a day. A modest fee per transaction of Rs. 10 would easily amount to Rs. 200,000 fee income on a daily basis and 80 crores in overnight float.

Fifty-two percent of customers are new and have done one transaction; this means that the portfolio is adding new and more users regularly. The remaining 48% of the customers are doing two transactions on a consistent basis which implies that there is a comfort factor which the market is getting from this service and the customers are willing to reuse this service.

8.2 Viability

During the test pilot period of 11 weeks, a modest amount of 100,000 had been earned by the bank, and around four times this amount had been generated as income for the banking correspondent agents. The point to be noted is that majority of the transactions are being done post-banking hours proving the fact that the convenience of customers is resulting in overnight float money for the bank. The model is profitable from the first day where each transaction contributes to a fee for the BC agent and the bank. This model puts to use the large banking network established in the last decade to provide seamless remittance services to migrant workers.

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Part 3.4
IT Offshoring

Power Politics in the Governance of IT Outsourcing: The Undermining of Top IT Executives

Subrata Chakrabarty and Jun Wang

1 Introduction

IT work has increasingly been outsourced by American (customer) firms to supplier firms located in foreign locations—such as India and China (Chakrabarty 2006, 2008). This chapter examines power politics within customer firms that outsource information technology (IT) work. One option for getting IT work done is outsourcing, which is defined as a customer firm paying a supplier firm to perform certain work as per stated requirements, instead of getting the same work performed in-house (Whitten et al. 2010; Zardkoohi et al. 2011). When the supplier firm is located in a foreign country, this option is termed as offshore-outsourcing. Top management power politics within a customer firm may play an important role in budgetary spending decisions that determine where and how the firm's IT work gets performed (Chakrabarty and Whitten 2011; Green et al. 2007).

Certain top management executives of a customer firm can wield the power needed to govern the outsourcing of IT work. Top executives can be classified into two groups: business leaders and IT leaders. Job titles in the *business leaders* group include the CEO (Chief Executive Officer), CFO (Chief Financial Officer), and COO (Chief Operating Officer). Job titles in the *IT leaders* group include the CIO (Chief Information Officer) and the Head of IT. The power of one group of top executives can be greater than that of another group of top executives in matters related to the governance of IT outsourcing. The research questions are as follows: (a) With regard to the outsourcing of IT work, what are the antecedents to power

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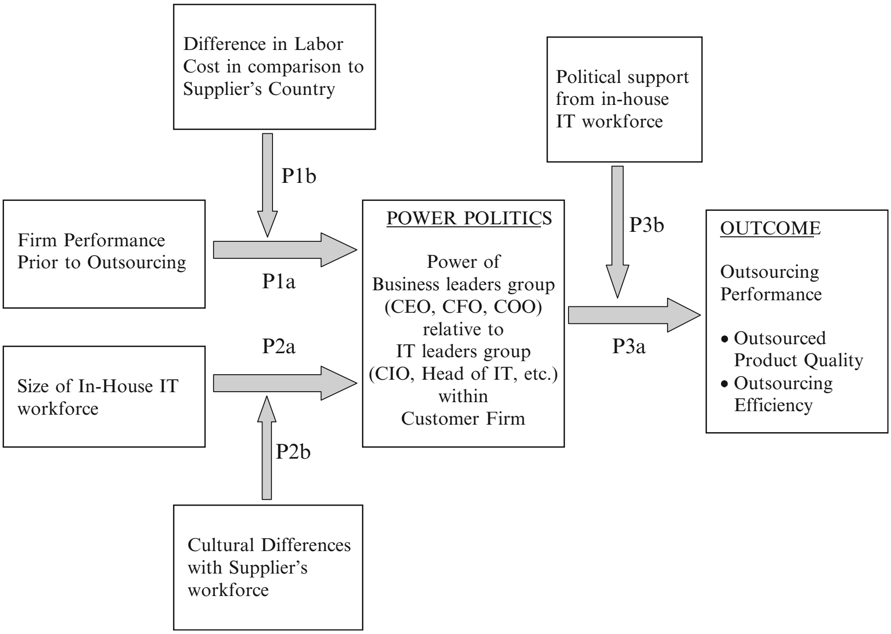

Fig. 1 Theoretical model

politics between the business leaders group and IT leaders group within a customer firm? (b) What impact does the undermining of IT leaders by business leaders within a customer firm have on outsourcing performance?

Figure 1 summarizes the theoretical model. The antecedents that can influence power politics between groups of top executives within a customer firm are the customer firm's financial performance prior to outsourcing (moderated by country cost differences) and the size of its in-house IT workforce (moderated by country cultural differences). Business leaders feel inclined to exercise greater power and control over the outsourcing of IT work when the firm's financial performance has been poor; this is especially true when they perceive their in-house IT workforce to be a cost burden (relative to the low-cost IT labor offered by suppliers from other countries such as India and China). IT leaders derive power by virtue of leading a sizeable in-house IT workforce. When the in-house IT workforce, which is usually expected to cooperate and collaborate with the supplier's IT workforce, find the cultural differences to be overwhelming, they may incite political resistance against offshore-outsourcing (Chakrabarty 2009; Green et al. 2007). They would prefer that their IT leaders (rather than their business leaders) have the power over matters related to the governance of outsourcing.

Despite resistance, however, IT leaders may eventually feel pressured to relinquish power when the firm performs poorly and the business leaders want the power. Business leaders usually have lesser knowledge in matters related to IT than the IT leaders that they have undermined (Chakrabarty et al. 2007; Green et al. 2007). When business leaders undermine IT leaders in the governance of outsourcing, it can eventually hamper both the efficiency and quality of outsourcing. This is especially true when the business leaders attempt to take over the governance of outsourcing of IT work without having the political support of the in-house IT workforce. In sum, a paradox is evident: when it comes to the "outsourcing" of IT work, the business leaders might find reasons to justify increasing their own power and lowering the power of IT leaders, even though this can ultimately be detrimental to the quality and efficiency of the outsourcing activity.

2 Propositions

2.1 Power Politics Is Influenced by Firm's Poor Financial Performance

Current geopolitical factors are such that the cost of skilled IT labor is substantially lower in economies such as India and China than in advanced economies such as the USA. Advanced economies, such as the USA, are also facing tremendous business uncertainty and cost pressures. In matters related to the governance of the outsourcing of IT work, it is possible that poor financial performance of a customer firm located in USA *prior* to outsourcing would induce greater power dominance by its business leaders and the undermining of its IT leaders. When business leaders are faced with financial underperformance and uncertainty, they tend to respond in domains over which they can wield greater control (Chakrabarty and Whitten 2011). Under conditions of poor financial performance, business leaders within a customer firm become overly conscious about efficiency and impose authority over activities such as outsourcing. This is because they see potential for cost cutting and budget tightening, which would give them a feeling of higher control and lower risk.

A firm's poor financial performance can make the business leaders insecure and fuel power politics. In the fear of losing their jobs, the COO and CFO may ally with the CEO and defend their grouping. Though business leaders (CEO, CFO, COO, etc.) tend to attribute their firm's financial success to their own personal qualities, they tend to attribute the firm's failure to other causes. An easy target for blame would be the IT leaders. Business leaders often perceive the in-house IT department to be a cost burden. Toward this end, business leaders sometimes suspect that the IT leaders will be overprotective of their turf in order to safeguard their own jobs and departments. This results in the IT leaders being given lesser representation or being kept out of the loop, while the business leaders make the critical IT outsourcing decisions.

Hence, the lower the financial performance of an American firm prior to outsourcing, the greater the possibility that the business leaders will want to negate or dilute the authority of the IT leaders and want to take over a dominant authoritative role in matters related to the governance of outsourcing of IT work. That is, the association between an American firm's past financial performance and the power of its business leaders relative to its IT leaders will be negative. Further, such undermining of IT leaders by business leaders within US-based customer firms in matters related to IT outsourcing is all the more likely when geopolitical factors are such that the cost of skilled IT labor is substantially lower in countries like India and China than in the advanced economies like USA.

Proposition 1a. *Poor financial performance prior to outsourcing increases the probability that a customer firm's business leaders will politically undermine (i.e., reduce the decision-making power of) its IT leaders in matters related to the governance of the outsourcing of IT work.*
Proposition 1b. *The above effect will be strongest when geopolitical factors are such that the cost of skilled IT labor is substantially lower in the supplier's country (India, China, etc.) than in the customer's country (e.g., USA).*

2.2 Power Politics Is Influenced by Size of IT Workforce

A sizeable in-house IT workforce can help prevent IT leaders from being undermined by business leaders in decisions regarding the governance of outsourcing. IT leaders who lead a sizeable IT workforce will have greater legitimacy to demand such power and thereby resist interference or dominance by business leaders (Chakrabarty and Whitten 2011; Whitten et al. 2010). The leader of a sizeable population is more likely to demand and obtain greater power. Across organizations, the power of the departments or representation on major committees is often a result of the size of the department. Similarly, IT leaders in a firm will find representation in the firm's important decision-making bodies if he/she leads a sizeable IT workforce. Command over a sizeable IT workforce gives legitimacy and hence power to IT leaders because it is more difficult to ignore the leader of a sizeable population. Therefore, an important source of power that a firm's IT leaders have is the sheer size of the in-house IT workforce that they lead.

Further, the resistance by IT workers from the customer's country (e.g., USA) is likely to be aided by feelings of cultural differences against IT workers from the supplier's country (India, China, etc.) (Chakrabarty 2009; Chakrabarty et al. 2007). After all, the in-house IT workforce would be expected to cooperate and collaborate with the supplier's IT workforce that is performing the outsourced work (Chakrabarty et al. 2007; Green et al. 2007). During the process of collaboration, irreconcilable cultural differences may arise between the in-house IT workforce and the supplier's IT workforce. This may result in the in-house IT workforce engaging in political rebellion against their own business leaders in matters related to the governance of outsourcing.

Hence, IT leaders who lead a more sizeable IT workforce are likely to obtain greater power in the organization, and they can use this power to resist interference or dominance by business leaders. This would be especially true when there are aggravated levels of cultural differences between the in-house IT workforce and the supplier's IT workforce. Accordingly, the association between the size of the IT workforce within the firm and the decision-making power of business leaders relative to IT leaders will be negative.

Proposition 2a. *Within a customer firm, the presence of a large-sized in-house IT workforce increases the probability that its IT leaders will politically resist attempts by the business executives to undermine them in matters related to the governance of the outsourcing of IT work.*

Proposition 2b. *Political resistance within a customer firm (where its IT leaders, supported by in-house IT workforce, resist the attempts of business leaders to undermine them) will be strongest when there are substantial cultural differences between workers from the supplier's country (India, China, etc.) and workers from the customer's country (e.g., USA).*

2.3 Power Politics Impacts Outsourcing Performance

The first two sets of propositions suggest that there are competing pressures arising from the antecedent conditions, which can determine "who has how much power" over the firm's IT spending decisions and correspondingly over the outsourcing of IT work. This section will develop propositions regarding the influence of decision-making power on the performance of outsourcing of IT work (Chakrabarty and Whitten 2011). Performance can be understood in terms of outsourcing efficiency and outsourced product quality. First, good governance of IT outsourcing requires effective decisions on IT spending in a manner that lowers transaction costs and helps achieve outsourcing efficiency. In contrast to business leaders, the IT leaders have healthy skepticism and substantial knowledge regarding current IT costs and the management of IT in order to make effective outsourcing decisions. By virtue of their expertise and experience in managing IT projects, the IT leaders are better at making governance decisions. These better decisions help minimize hidden costs, ensure operational efficiency, and ensure that the budget for product development is not exceeded during outsourcing. Hence, undermining of IT leaders in governance will hurt outsourcing efficiency.

Second, undermining of IT leaders in the governance of the outsourcing of IT work can lead to a lower outsourced product quality. Not all requirements for a complex IT product can be anticipated in advance, and much of the requirements evolve over time. As requirements evolve, there is a continual process of deal making between the customer and IT supplier. In this context, business leaders make poor deals because of their lack of competence in IT matters. This is due to business leaders falling prey to the tall promises and inducements of IT suppliers, because they do not have the in-depth expertise to understand the complexities behind the development of IT products. On the other hand, IT leaders are mindful that technology requirements change rapidly in today's fast-paced world—constant supervision and micromanagement is required to ensure the supplier develops products that meet requirements and are not obsolete.

In sum, the undermining of IT leaders by business leaders in matters related to the governance of IT outsourcing can lead to poorer outsourcing performance.

This would be especially true when the business leaders lack the political support of the in-house IT workforce. The in-house IT workforce, upset at their IT leaders being sidelined, might not be cooperative enough with their business leaders (Zardkoohi et al. 2011). This would aggravate the problems that the business leaders face and compound the deleterious effect of business leaders not having sufficient knowledge and expertise to deal with IT matters. Hence, we posit the following:

Proposition 3a. *In matters related to the governance of the outsourcing of IT work, the greater the political undermining of a customer firm's IT leaders by its business leaders, the lower will be the outsourcing performance.*
Proposition 3b. *The above effect will be strongest when business leaders do not have the political support of the in-house IT workforce.*

3 Conclusion

There is often power politics involved in the governance of the outsourcing of IT work by top management executives of customer firms. In recent times, customer firms located in advanced economies are facing a tremendous amount of business uncertainty. Geopolitical factors are such that the cost of skilled IT labor is substantially lower in countries like India and China than in the advanced economies like USA. When a US firm's financial performance has been poor, its business leaders (CEO, CFO, COO) may be tempted to undermine its IT leaders (CIO, Head of IT, etc.) in order to exercise greater power over the outsourcing of IT work. IT leaders can resist attempts by the business leaders to undermine their power when they have the support of a sizeable in-house IT workforce. The resistance by workers from the customer's country (e.g., USA) is likely to be aided by feelings of cultural differences against workers from the supplier's country (India, China, etc.). Ultimately, a consequence of business leaders undermining the IT leaders within a customer firm, especially when the business leaders lack the political support of the in-house IT workforce, is that it could hamper the quality and efficiency aspects of outsourcing performance. Given that IT work is being increasingly offshore-outsourced by American (customer) firms to supplier firms located in foreign locations—such as India and China—research should consider the implications of such power politics.

The arguments suggest that under conditions of a firm's poor financial performance, the business leaders tend to impose their power over IT leaders. The IT leaders can resist being undermined if they have the support of a sizeable in-house IT workforce. Eventually, both outsourcing efficiency and outsourced product quality suffer if business leaders impose their power and undermine IT leaders. Given the arguments, it might seem obvious that IT leaders tend to make better decisions in IT-related work (just as the business leaders would tend to make better decisions in some other business-related work). However, the primary importance of this study is in its suggestion that when it comes to the "outsourcing" of IT work, the business leaders might find reasons to justify increasing their own power and reducing the power of IT leaders, even though this can ultimately be detrimental to the outsourcing activity.

The arguments support the theoretical suggestions that when a firm's financial performance in the past was poor and the firm did not have a sizeable IT workforce, then the business leaders give themselves greater decision-making powers and undermine the IT leaders. Here, business leaders might argue that they are acting in the interest of their firm. Paradoxically however, rather than leading to positive consequences, lowering the power of IT leaders leads to poorer outsourcing performance. Outsourcing performance is most satisfactory when power is solely with the IT leaders group, second best when power is divided between the two groups (joint decision making), and worst when it is solely with the business leaders group. Hence, the governance of outsourcing should reside exclusively or at least partially with IT leaders. Governance of outsourcing benefits from the "expert minds" of IT leaders. Undermining of IT leaders therefore makes outsourcing "mindless" and consequently hurts outsourcing performance. Future research can investigate if such top management power politics in outsourcing results in downward spirals of continuing distress.

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Offshore Pricing with Onshore Management: A Case Study in Innovation and Technology Management

Gokul Bhandari, Rudra Pandey, and Gerry Kerr

1 Background

On November 18, 2011, Scott H. DeLisi—the US Ambassador for Nepal—was full of praise for DW and made the following remarks during the inauguration of the Deerwalk Institute of Technology in Kathmandu, Nepal: "In my view, the real future of Nepal is not in Singha Durbar, but in places like here at the Deerwalk campus. The future is companies like Deerwalk and other emerging businesses in promising sectors like IT. The future is in the young people here today who share Rudra's vision for developing Nepal's IT industry. It's in entrepreneurs who see opportunity in Nepal, not the naysayers who merely see problems. Like Rudra, I fundamentally believe that the IT industry can help transform Nepal's economy, creating opportunity for thousands of young Nepalis. Information technology has transformed the way we do business around the globe, spurring new innovations, breaking down communication and distance barriers, and reducing the cost of doing business. It has opened trade and investment, helping to create millions of new jobs, and transforming countries like India—and now Nepal".

In less than 3 years of its birth, DW has already established itself as one of the largest software companies in Nepal having a total of 170 employees and 30 US companies as regular clients. In order to understand the current growth of DW despite several challenges it is currently facing such as Nepal's poor infrastructure (interrupted electricity, limited Internet bandwidth and connectivity), uncertainty in national politics and policy, and limited number of software graduates available for

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hiring, it is important to know about both the personality, background, and evolution of Rudra as a visionary and software entrepreneur.

2 Profile of an Entrepreneur

Rudra was born and grew up in a lower middle-class family at Kanakot, a small mountainous village about 20 km northwest of Kathmandu, the capital city of Nepal. His father, the sole breadwinner of the family, passed away at a tender age of 35 leaving 4-year-old Rudra to be reared by his 66-year-old grandfather. His grandfather was a wise and spiritual person who would instil in Rudra a strong desire for excellence and perseverance and yet at the same time taught him the importance of holding a detached and impassive outlook towards the outcomes of one's actions. As Rudra recalls in his recent interview with *The Boss* magazine, "I knew I was the architect of my own destiny since childhood". Having clearly understood the importance of learning, his grandfather sent Rudra to Kathmandu for schooling where he would spend the next 12 years of his life. During his school days, he participated in various debate competitions and exhibited strong communication and leadership skills while maintaining a superior academic performance in classes. After receiving a scholarship from Pakistan, Rudra completed his undergraduate degree in engineering in which he developed a sophisticated database system for managing student records. After completing his engineering study, he returned to Nepal in 1989.

One thing that Rudra was really convinced of during his undergraduate days was the belief that the future would belong to the software sector and its importance would only grow in the days to come. So, as soon as he arrived in Kathmandu, he joined the National Computer Centre, which was the most prestigious computer institute in Nepal at that time. However, it did not take him long to realize that the work he would be doing there needed very little programming talent and creativity because the job involved hardware maintenance and operation tasks only, and therefore, he decided to quit the job after a week. Then, he joined Nepal Telecommunications Corporation, the only telecom service provider in the country at that time. As before, he did not see any future growth in the job because of the lack of R&D budget and left the company after 6 weeks. Then, he joined the Royal Nepal Academy of Science and Technology (RONAST) which was a premiere institute for research. However, he realized that there was very little role and scope for software engineers like him who were considered blue-collared workers compared to physicists and mathematicians. Realizing that he would not be appreciated in such an environment, he left the organization after 4 months. While working for the RONAST, he had also joined a private computer institute as a part-time instructor where he experienced the difference between private and public companies. Now he started looking for more challenging jobs where he could play entrepreneurial, innovative, and leadership roles. Fortunately, a job announcement from the World

Bank appeared a perfect fit for him, which he applied for and secured without any difficulty. In his own words:

> In the World Bank job, I developed database systems using dBaseIV and Clipper. It also gave me the opportunity to see different parts of Nepal and meet with people from all walks of life. It boosted my self-esteem and helped me develop good communications and people skills. It was the most fulfilling job I have ever had. It was also a very productive period because I founded a computer institute called Comptronix with a friend of mine. It was basically a hardware maintenance company but I was still interested in it because I was trying to learn what it takes to own a company. This gave me the first taste of ownership which is still fresh in my memory.

When the World Bank project was completed after 2 years, Rudra realized he had developed enough skills to start a much bigger computer consultancy and software development firm. With two other like-minded colleagues, he founded a company called Global Engineering and Computer Services (GECS). Rudra says, "GECS was involved in teaching programming languages, software development, and hardware import from Singapore for distribution in Nepal. It taught me how to do international trade for profit making". Rudra was planning to expand his business and came to the USA in 19 December 1993, to sign up a contract with a computer manufacturer from Austin, Texas. Once he arrived in the USA, he saw a huge opportunity in software market in the USA and decided to start his own business there. Within a week of his arrival in the USA, he registered a software development and consulting firm called *American Open Enterprises* in Boston, Massachusetts. However, as a Nepali citizen with a tourist visa, it was not possible for him stay in the USA for a long time. So, in the meantime, he secured admission in Computer Science Master's programme at Boston University Extension College and remained in the USA under student visa. However, he soon realized the programme would not teach him anything new, and so, he switched to the doctoral programme in economics in Northeastern University from which he graduated in 2001. During his study in the doctoral programme, he faced financial hardship and worked as a night security guard in a big grocery chain called Star Market for a month where he earned about $7/h. Then he worked as a parking lot attendant at Commercial Wharf, Boston Waterfront for a year. While working as an attendant, he would also hand over his resume along with parking receipts to the visitors. One day, as luck would have it, an IT recruiter got his resume in the parking lot. Impressed with Rudra's IT skills, the recruiter offered him a consulting job at Fleet Bank (now Bank of America) where he remained for 3 years. During these years, he thoroughly understood the software consultancy market and met with several charismatic and ambitious people, the most important of all being Dr. Chris Kryder. Chris was a physician who attended Georgetown Medical School and completed residency in internal medicine in the Harvard Primary Care Program, and thereafter earned an MBA from the Sloan School of Management at MIT to better understand hospital management and operations. In the late 1990s while working as chief medical officer, he began looking for software to help manage quality and cost and move information transparently. At this juncture, he realized the conspicuous absence of such products and decided to build on his own, only if someone could teach him database management tool such as Microsoft Access. His search for a database tutor ended up meeting with Rudra who then convinced Chris to jointly found a healthcare software company called D2Hawkeye.

3 Founding of D2Hawkeye Inc.

The opportunity described by Kryder immediately resonated with Pandey. A host of environmental factors were favourably lined up. American society was growing older, while pressures were being felt in healthcare to improve efficiency and contain costs. At the same time, sophisticated techniques were being developed for estimating risk exposure in the financial services industry, which were ripe for application elsewhere. Healthcare was a waiting opportunity. Moreover, the opening of international trade offered the chance to exploit lower-cost computer-programming capabilities. The only complications seemed to be the availability of human resources and the political changes underway in some areas.

Rudra was ready for the opportunity when Chris called for the meeting. Rudra was already intimately aware of the kinds of value that could be created by off-shored programmers. A network of associates from his prior company GECS (now called IT Experts Group) had been one of the key assets that Rudra brought to D2Hawkeye. A connection between Boston and Kathmandu, Nepal was critical to the initial success of the firm. However, in a matter of months after start-up when the king Gyanendra seized the power through coup, prudent management dictated that an alternative office location be based in Delhi, India for disaster recovery.

A new venture in the healthcare risk-management software industry required certain capabilities, including a deep understanding of medical needs, information technology, and risk assessment. Certainly, Chris Kryder and Rudra Pandey, representing medicine and risk assessment and information technology, respectively, were integral parts of D2Hawkeye. But, the team that was assembled represented great depth in healthcare, general management, finance, medical consulting, research, and medical informatics. Moreover, despite the considerable skill set represented at the organization, key partnerships encompassed a distribution agreement formed with Sun Life and a financing deal—after a nearly disastrous false start with a small venture capital firm—with D2Hawkeye's first customer, JSA Healthcare. All told, success at D2Hawkeye was a function of flexible experimenting, carefully built team relationships, closely managed economizing, and cherry-picked strategic alliances.

The development of the company was closely managed. Bootstrapping was the primary means of financing, interjected by the deal with Sun Life and, later, by outside financing from angel investors. The flagship product of D2Hawkeye was D2Explorer which bundled D2ReportManager, D2Analyzer, and D2BenefitAdvisor. The capitalization of D2Hawkeye was remarkably straightforward at the time growth capital was secured, allowing more latitude in the major financing deal and in the eventual merger with Verisk Analytics. However, the company was still in the growth phase. For a detailed description of the venture capital financing options the company face, please refer to the Harvard Business Case (Higgins et al. 2008).

After the acquisition by Verisk in January 2009, Rudra became the Chief Operating Officer essentially managing about 400 people from technology and operations department with three managers directly reporting to him. Although a subsidiary of Verisk, D2Hawkeye still had the primary development team called D2Hawkey Services still located in Kathmandu, Nepal, and Rudra was dreaming of making it bigger and bigger. However, he soon realized that the parent company Verisk was interested more on earnings than on growth of the newly acquired subsidiary. The management motto was "Buy, not build", but Rudra was not very happy with it because he wanted to see his brainchild prosper and grow and not just become a revenue source for the parent company. Furthermore, Rudra felt less powerful than before in Verisk in terms of decision making and realized he could not do much to change the management's view regarding D2Hawkeye. The parent company Verisk went public in October 2009. At this point, he was faced with a few alternatives. First, he could live a secured and peaceful life by continuing to work as the COO for Verisk with a handsome salary, attractive stock option, and 209 package. In this case, he would be more like an employee of Verisk and less of an entrepreneur. The second option would be to leave Verisk and initiate another round of start-ups. However, this would mean giving up all the comfort and security and start everything anew surrounded by risk and uncertainty again. On the positive side, founding another start-up with human resources being supplied from Nepal would be a step closer to his dream of running a company with 1,000 software engineers. Also, he had obtained valuable experiences in key management and technological issues involving business process outsourcing. He felt very confident in his capability and started seeing himself as the CEO of a future company. Ultimately, the thrill of the freestanding start-up, working without a net proved too powerful for Pandey to resist, and he decided to walk the untrodden path yet again. He informed Verisk of his intention to quit the company, and at their request, he agreed to function as retainer until December 2010 for the smooth hand over of responsibilities.

4 New Horizons at Deerwalk

Deerwalk Inc., with headquarter in Lexington, Massachusetts, symbolized his dream, confidence, and entrepreneurial spirit. Because of his deep understanding of healthcare software industry, he began to carve out a strategic technology base that would have competitive advantage over others. He noticed how the first product that he developed was built in Microsoft Access which was then converted into a web-based system by using Java, SQLServer, and JRun for Windows. When it was acquired by Verisk, the platform was converted to Oracle, Web Logic and Java to conform to its other products. Contemplating the evolution and current trends in software, Rudra realized that the future of IT would belong to inexpensive and flexible, and therefore, Deerwalk must adopt such framework to remain competitive. Keeping in view of the evolving and data-centric nature of healthcare informatics, Rudra made a strategic decision from the very beginning to adopt a distributed, open-source software framework such as Hadoop and a cloud-computing platform such Amazon EC2. This decision proved very insightful because with very little capital investment on hardware, DW has become a fully virtual software company capable of competing in terms of cost, quality, and responsiveness.

DW offers high-quality services to its onshore clients with its local presence in the USA and at the same time gives them the benefit of offshore pricing which is generally lower than that from the local companies. Through its wholly owned subsidiary based in Kathmandu, Nepal, DW engages in new product development and maintenance initiatives. In the US office, DW has retained a technology team to provide real-time support to its onshore customers. Rudra succinctly summarizes the competitive strategy of his company as, “Our customers have the peace of mind of working with someone from the US, while enjoying the cost savings of off-shore development”. DW prides in its two innovative flagship products *Makalu* and *Everest* which represent a data analytics platform and case management workflow solution for nurses, respectively. Both of these products integrate claims, electronic medical records, and relevant clinical data for conducting comprehensive analysis of client data. We now provide their brief description.

Makalu: It is an integrated data analytic platform that enables Third Party Administrators (TPAs), brokers, consultants, and physician groups and organizations such as Accountable Care Organization’s (ACO) in the healthcare supply chain to improve the coordination of benefits and care for members by providing insights into the quality of care, major cost drivers, and possible areas for cost, utilization, and quality improvements. There are several key features that distinguish Makalu from other products available in the markets such as deep integration of data, scalable technology platform, ease of implementation, guaranteed lowest cost of ownership, comprehensive reporting solution, data accessibility, and opportunity and risk identification. Appendix A shows the menu structure of Makalu which a user can follow to access various types of analysis and reports. Figure 1 shows the user interface of Makalu’s dashboard.

Everest: It offers a suite of tools for healthcare enterprises to cost-effectively coordinate care of their members while lowering costs. Everest provides a seamless integration of care management activities focused on wellness, disease management, case management, or utilization management into one platform. Everest’s flexible architecture supports information exchange and integration with third party data sources such as medical/pharmacy claims, HRAs, EMR/EHRs, and predictive modelling products. Figure 2 shows the user interface of Everest’s dashboard.

Recently, DW has also started developing a healthcare portal called Yala (Fig. 3) which has been designed to serve as the ultimate healthcare platform for individual members for managing their health records online. Once rolled out, it is expected to have several millions as its member base. In the following section, we discuss the opportunities and challenges that the company is currently facing and conclude this case outlining our views on the future of DW.

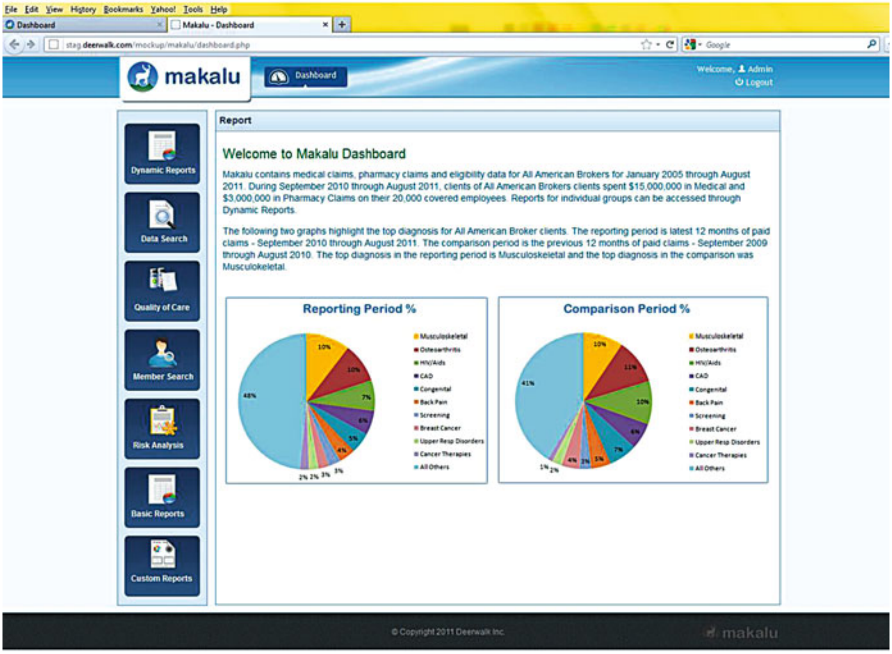

Fig. 1 Screenshot of Makalu dashboard

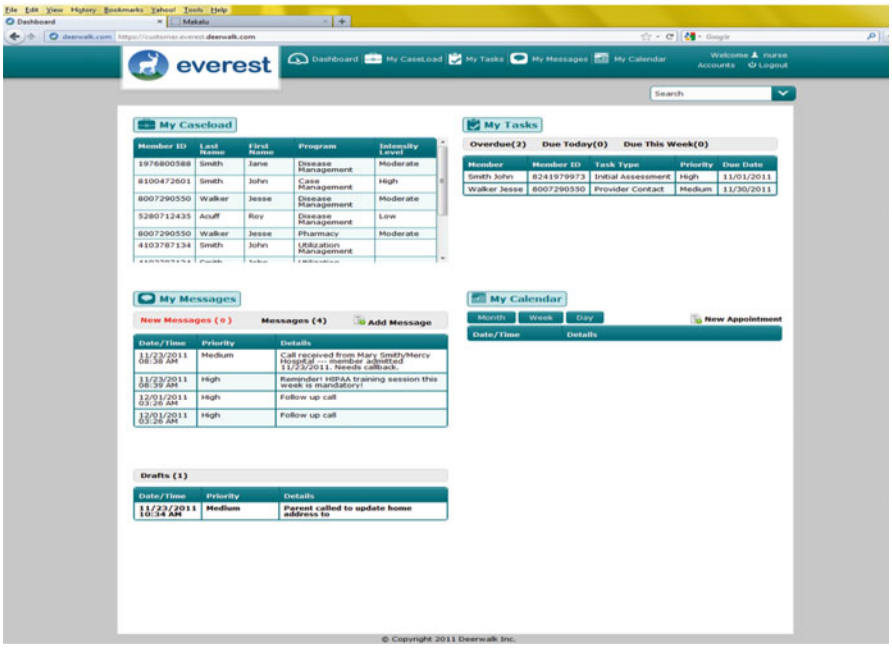

Fig. 2 Screenshot of Everest

Fig. 3 Screenshot of Yala

5 Discussion

As an offshoring company, DW has a lot of advantages over its local competitors. According to Rottman and Lacity (2006), global outsourcing and offshoring enable agile responses to business needs. Such responses can result in lower costs, increased quality, implementation of seamless sunrise-to-sunrise development, reduced response time, and dispersion in risks (Cattani et al. 2005). The importance of agile responses to emerging business needs and opportunities is also highlighted by Rudra when he says, “Given the speed of changes happening in technologies and their disruptive capacity, it is not the biggest but the fastest one who is going to be the winner in this market. Our core competency lies in our executive management team who fully understands the dynamics of healthcare markets and wastes no time in making critical strategic decisions. Our cohesive and dedicated development team has one of the fastest production cycle and customer service responses in the industry”. Rudra’s former company D2Hawkeye had the reputation of being the most innovative healthcare company in Massachusetts in 2007, and he seems very much determined to continue that legacy in DW as well. In this regard, DW has recently formed a partnership with a local hospital in Kathmandu to convert their existing paper-based system to a fully electronic healthcare information system. DW has also started venturing into telehealth with the objective of remotely providing healthcare services to the patients.

Appendix A: Drill-Down Menu Structure of Makalu

- Dynamic Reports
  - Quality Metrics
  - Top 20 Reports
    - Diagnoses
    - Procedure Group
    - Benefit Codes
    - Therapeutic Classes
    - Drugs
      - Analysis Overview
      - Network Utilization Summary
      - Benefit Cost Analysis
      - Benefit Cost (Net vs. Non Net)
      - Paid Claims Distribution
      - Diagnosis Analysis
      - Lifestyle Analysis
      - Member Relationship Analysis
      - Enrolment Activity
      - Age Group Analysis
      - Age/Relationship Analysis
      - Top 30 Providers
      - Cost Allocation Summary
      - Facility Analysis
      - Physician Analysis
      - Therapeutic Classes
      - Drugs
      - Loss Ratio
      - Medical Claim Lag
      - Monthly PMPM Trend
      - Total Healthcare Claims
    - Injectable Drugs
    - Provider List
  - Utilization Metrics
  - Healthcare Spend Quintile
  - Duplicate Claims
  - High Cost Members

Membership Distribution
Coverage by Relationship
Chronic Conditions
Data Search
Quality of Care
Member Search
Risk Analysis
Basic Reports
Custom Reports

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International Competitiveness of Russian IT Firms: Strong Rivals or Survivors at the Edge?

Irina Jormanainen, Andrey Panibratov, and Marina Latukha

1 Introduction

The competitiveness of firms from emerging markets has come increasingly to the focus of the international business research during last decades. The scholars have attempted to comprehend the foundations of their competitiveness and whether these foundations are different from those of developed market MNEs (Collinson and Rugman 2007; Luo and Tung 2007; Demirbag et al. 2009). Although literature has addressed these issues in the context of manufacturing firms from emerging economies (Jormanainen and Koveshnikov forthcoming), service sector, and in particular IT services, received significantly less attention. Indeed, only 50 academic studies for the time period of 1971–2007 were devoted to service companies (Kundu and Merchant 2008). This proves that theoretical and empirical knowledge about the patterns and determinants of international competitiveness in the service sector are still limited and the analysis of their growth potential has yet not been conducted in proper depth (Pauwels and de Ruyter 2005). Moreover, with regard to the IT services, the existing studies have been conducted on the basis of empirical evidence from Indian and Chinese firms (e.g., Narayanan and Bhat 2009), while other contexts are clearly underresearched.

In this chapter, we aim to fill this gap by taking a close look at the nature and sources of competitive advantages of Russian IT firms. We develop a framework

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explaining their international competitiveness with the objective to extend the existing theories on competitiveness of service firms from emerging markets. We ask *how Russian IT service firms use their strategic resources to create a sustainable competitive advantage to expand internationally.* Specifically, we aim to examine (a) what is the nature of sustainable competitive advantage of Russian IT firms enabling the international expansion, (b) what are the critical resources and capabilities supporting the creation of this sustainable competitive advantage, and (c) how these IT firms organize and explore the resources and capabilities when developing strategy for international markets.

Due to the lack of previous knowledge about the studied phenomenon, we adopt an explorative empirical approach and conduct a qualitative study to shed light on the objectives of this research. Hence, our main methodology is multiple-case study while using the results of the critical analysis of the existing research as guidance in data collection process. Furthermore, we carefully account for the emerging issues during the empirical investigation to be able to extend theorizing in this field.

We include in the study those Russian information technology (IT) sector firms that focus their operations on software development and intellectual services (integration, consultancy, and outsourcing). We conduct an empirical work in three phases. First, we undertake a pilot study comprised of the personal interviews with top managers of three Russian IT companies that have operations overseas. The objective at this stage is to grasp an overall understanding about the nature and the sources of Russian IT firms' competitive advantages overseas. Also, we attempt to understand the underlying features of Russian IT service sector. Second, on the basis of accumulated knowledge during the pilot phase, we further examine IT sector in order to locate more companies having international operations to include them into the main study. As a result, we include 30 companies suitable for a case investigation. Finally, at the third phase, we conduct personal interviews in selected companies to examine the nature and sources of their competitiveness in international operations. The respondents were either owners or top managers responsible for companies' international operations. Also, companies' internal documentation has been studied as an additional source of information. The empirical evidence obtained during the case investigation is used as a primary source for drawing the major conclusions of the study.

2 Internationalization and Competitiveness of Service Firms from Emerging Markets

Service firms from emerging markets are increasing their efforts to integrate into the global economy and have already started internationalization process (Panibratov 2012). Internationalization is broadly considered to be a process when a company moves from operating in domestic market to international markets (Andersen 1993; Buckley and Casson 1998). Recent studies have extensively addressed various aspects of international operations of emerging market firms in manufacturing sector context, while service sector received significantly less attention. However, it is worth noting that the growth rates of international operations in service sector have been documented to be even higher than those in manufacturing sector (Braga 1996; Svetličič and Rojec 2003). Cardone-Riportella and Cazorla-Papis (2001) have suggested that such drivers as increasingly tense competition in domestic markets, profit margin pressure, and opportunity to develop business in foreign markets stimulate a considerable growth of the service sector.

While some researchers argue that existing theoretical premises developed for manufacturing firms are applicable to service companies (Boddewyn et al. 1986; Katrishen and Scordis 1998), others suggest that direct applicability is questionable (Johanson and Vahlne 1990). Moreover, Majkgård and Sharma (1998) propose to distinguish among hard services, where production and consumption are decoupled, and soft services, for which production and consumption occur simultaneously, as they differ in the internationalization strategies. Moreover, the influence of external and internal factors on service firms' international expansion is also argued to be different from those in manufacturing context (Erramilli 1990; Sanchez-Peinado and Pla-Barber 2006).

Further, studies that focus specifically on foundations of competitiveness of service firms overseas are even scarcer. If determinants of entry mode and incentives for the international expansion have been addressed by the literature to date (e.g., Ball et al. 2008), assessment of assets and capabilities that firms need to successfully compete in international markets was largely overlooked. A traditional conceptual model of sustainable competitive advantage (SCA) in service industries is based on the research done by Barney (1991), Coyne (1985), Day and Wensley (1988), Dierickx and Cool (1989), Lippman and Rumelt (1982), and Reed and DeFillipi (1990) and highlights a firm's distinctive organizational skills, and resources are viewed as the source of a business's competitive advantages in the market (Bharadwaj et al. 1993). The characteristics of services, service sector, and firm within an industry are shown as moderating the skills and resources underlying a business's competitive positional advantages. The sustainability of a business's competitive advantages is viewed as contingent on barriers to imitation of its unique skills and resources. Bharadwaj et al. (1993) define the specific combinations of resources that are unique to service industries and IT sector in particular. They propose that the greater the complexity and co-specialization of assets needed to market a service, the greater the importance of innovation as a source of competitive advantage will become.

The SCA approach finds that firm-specific characteristics that support successful international strategy implementation (Hitt et al. 2006). Also little is said about the specific of internal resources on which international strategy implementation is based and how it manages global operations to achieve planned results (Tallman 2001). Valuable resources must be managed accurately in terms of combination and reinforcing to achieve a sustainable competitive advantage (Barney and Arikan 2001; Sirmon et al. 2007), especially in global environment. Buckley et al. (1992) note that such characteristics of services as their intangibility, inseparability of production and consumption, heterogeneity, and perishability contribute to increasing the mobility of resources and capabilities of these firms, which makes them more willing to become quickly involved in international markets. It is also argued that to compete internationally requires companies to develop new routines and organizational processes, which imply that firms must unlearn routines rooted in domestic operations before new, internationally oriented routines can be learned (Grant 1996). Domestic firms normally develop and build up resources and capabilities at home that spread into international markets (Bilkey and Tesar 1977; Cavusgil 1980; Johanson and Vahlne 1977, 1990).

Based on literature review, we can summarize different sources of SCA in service companies. Some authors discuss innovations and technology level as main sources of competitive advantage (Hitt et al. 2006; Martinez-Gomez et al. 2010; Melia et al. 2010); others define firm-specific capabilities deriving from internal environment, namely, knowledge management practices (knowledge capital), marketing and customers operations (customer capital), financial and informational resources, corporate clients (relational capital), and management characteristics (Edvardsson et al. 1993; Bharadwaj et al. 1993; Johanson and Vahlne 1977; Tallman 2001; Hitt et al. 2006).

3 Russian Context for IT Service Sector

Aiming to fill the existing gap and considering the fact that service firms from different sectors differ in their characteristics, we focus specifically on IT services. IT (information technologies) sector is often interchangeably considered together with other segments of ICT (information and telecommunication technologies) sector. In this chapter, we emphasize that it is worthwhile to examine this segment separately as its firms' operations are rather different in nature from those in other segments of ICT sector. Further, we suggest to distinguish between tangible and intangible segments of IT sector. Intangible segment consists of a broad spectrum of soft information technology services, whereas tangible segment focuses on manufacturing of hardware equipment and IT infrastructure. As software and service companies are shifting in their development toward a new stage of internationalization due to the increasing homogeneity in the world market, this sector is particularly interesting to study. IT services are conducted at the top end of a value-added chain when the competitive challenge is rooted in global standardization of products and operational procedures of software and IT service firms.

In Russian context, IT service represents a particular interest for investigation of international competitiveness as majority of studies have been conducted to analyze the overall competitiveness of Russian firms (Kalotay and Sulstarova 2010) and that of firms in natural-resource industry (Panibratov and Verba 2011). To our knowledge, top journals do not even fully recognize the existence of competitive capabilities of Russian IT firms to expand abroad. Nevertheless, this sector plays an important role in Russian economy, and it is worth 15 billion USD. The share of export has been estimated as 2.75 billion USD in 2009 despite the crisis (RUSSOFT 2010), and in 2010, the total net value of IT products and services increased by 23.4%.

The intangible or intellectual segment of Russian IT sector is comprised of (1) consultancy in business, IT, and information security; (2) integration (development, network integration, and distribution); (3) and operation (SW and PC maintenance, IT outsourcing, education, and training). As compared to hardware, the software production sector has been growing very fast in domestic as well as in international operations. In this sector, the Russian companies developed their capabilities in their narrow niches (e.g., IT security, speech recognition, computer-aided translation) and aimed to avoid competition with large transnational corporations in such niches as, for example, operating systems and databases. A number of Russian companies are already visible at the global market of IT outsourcing and included in world ratings. According to National ICT Sector and Policy Appraisal Report, among competitive advantages of Russian software companies are ability of Russian companies to tackle nonstandard tasks essential for troubleshooting, product development and managing high-end complex projects, and also Russia's large pool of high-skilled professionals with mathematics and science backgrounds capable of solving complex and math-intensive problems (National ICT Sector and Policy Appraisal Report 2009).

4 Theoretical Underpinning

We ground our theoretical development in the resource-based view (RBV) of the firm as it represents a central theoretical foundation to explain the origin of firms' competitive advantages (Barney 1991, 2001). The main premise of this approach is that firm's rare, valuable, and inimitable resources generating a competitive advantage and thereby an above-normal rate of return (e.g., Barney 1991). We focus on two specific types of resources – knowledge and capabilities – that are argued to be a vital source of firms' competitiveness in the global business environment (Grant 1996). This approach is particularly applicable for intangible IT sector where innovation is knowledge based and evolves rapidly. The nature of competition in this sector is rooted in the heterogeneity of innovative and organizational capabilities and knowledge across firms.

We also build on premises of the literature on internationalization of service firms that defines three groups of resources underlying the competitive and international advantage. These are firm-level resources such as market orientation, entrepreneurial orientation, and service innovation capability; management characteristics such as global mindset and international experience; and firm characteristics such as size, service type, and years in business (Javalgi and Martin 2007). However, as this framework has been developed in context of developed economies, there is a need to examine whether it can be applied to firms from emerging markets.

Further, the literature on competitiveness of emerging market firms exploring the resources and capabilities used by emerging market firms for international expansion finds that the ability to operate in environments with weak institutions (e.g., Del Sol and Kogan 2007; Cuervo-Cazurra and Genc 2008), various types of business and personal networks (Thomas et al. 2007; Kotabe et al. 2010; Manolova et al. 2010), common language with international partners (Musteen et al. 2010), and ethnic identity (Miller et al. 2008) often represents the basis of emerging market firms' competitive advantages in developing countries and assists them in overcoming the liability of foreignness that they face when operating in developed markets. Entrepreneurial motivation has also been found to be a very important resource outbalancing the lack of education, pre-internationalization experience, and technological and managerial knowledge (Liu et al. 2008; Latukha et al. 2011). With regard to the size of the companies, the literature concludes that emerging markets' SMEs tend to rely on their networks more heavily than large emerging market firms.

Further, emerging market firms often possess the ability to treat global competition as an opportunity to build missing capabilities and move into more profitable industry segments by adopting strategies that turn their latecomer status into a source of competitive advantage (Bonaglia et al. 2007). To achieve this, emerging market firms develop an adaptive capability to transform key resources into positive performance outcomes (Lu et al. 2010).

5 Empirical Results

The analysis of the extensive qualitative data from Russian IT service firms allowed for extending the discussed above premises on competitiveness of service sector firms from emerging economies. The results of this analysis enable to formulate the empirically based propositions regarding the nature and sources of international competitiveness of Russian IT service firms and develop an empirically grounded framework.

5.1 Propositions Development

The propositions were developed in such a way and order to provide an explanation of the research questions formulated for this study.

The first objective in our examination was to understand the nature of competitive advantages of Russian IT firms abroad and to analyze whether they are different from those of developed countries' firms. The results indicate that Russian firms are capable of competing on the same foundations, that is, delivery of new highly sophisticated products to the foreign markets. This finding is of value to the existing research that often emphasizes the lack of technological capabilities of emerging market firms. Further, Russian firms have an additional advantage, that is, an ability to carefully match characteristics of the product and with the time of entry to the international marketplace. Hence, our first proposition is formulated as follows:

> ***P1***: *The competitive advantage of Russian IT service firms stems from their ability to develop highly innovative products which are new to the foreign markets as well as from the ability to carefully match the product and the time of entry to the international marketplace.*

Proceeding with assessment of empirical data, we were able to further delineate the competitive strength of researched firms. It appears that an ability to differentiate the products' characteristics targeted for developed and developing markets according to the local needs and level of development represents the other competitive advantage of Russian IT service firms. We summarized this finding as:

***P2**: The competitive advantage of Russian IT service firms stems from their ability to develop a comprehensive and complex products to satisfy a broad range of customer needs in developed and developing markets.*

The other important foundation of the Russian IT firms' competitive advantage originates from their ability to provide to foreign customers a full range of supporting services at the lower price if compared with the international players. Hence, the third proposition of the study is as follows:

***P3**: The main competitive advantage of Russian IT service firms stems from the provision of competent supported services to the foreign customers at the competitive price.*

Lastly, the important strength of Russian IT service firms has its roots in the fact that their owners are highly ambitions, proactive, and risk-accepting individuals who have succeeded to establish an efficiently operating management team having similar strategic orientation and vision. Hence,

***P4**: The competitive advantage of Russian IT service firms stems from pro-activeness of owners in searching the paths for international growth.*

Further, we have proceeded in the analysis toward the understanding of sources for building mentioned above competitive advantages. The empirical evidence shows that the solid technological knowledge acquired from the home environment has allowed for development of advanced products and services to ensure competitiveness in foreign markets. Thus, we formulated the next proposition as:

***P5**: The important source allowing for building competitive advantages of Russian IT service firms is strong professional expertise of the technical personnel resulting from the high efficiency of the Soviet educational system in these specializations.*

However, at the same time, there is a negative influence of the home environment, which could be defined as a source or push factor for dedicating efforts toward international expansion. The respondents have clearly indicated that Russian market is often not ready for the consumption of the advanced IT products due to a lack of supporting infrastructure and services. Hence, our last proposition is as follows:

***P6**: The source that incentivizes for building competitive advantage internationally is a lack of readiness of domestic market for top innovative products.*

5.2 Framework Development

On the basis of the formulated above propositions, we have developed an empirically grounded framework that graphically shows the main arguments of the study. Figure 1 illustrates how the specific types of resources influenced building a sustainable competitive advantage by Russian IT service firms in their international expansion.

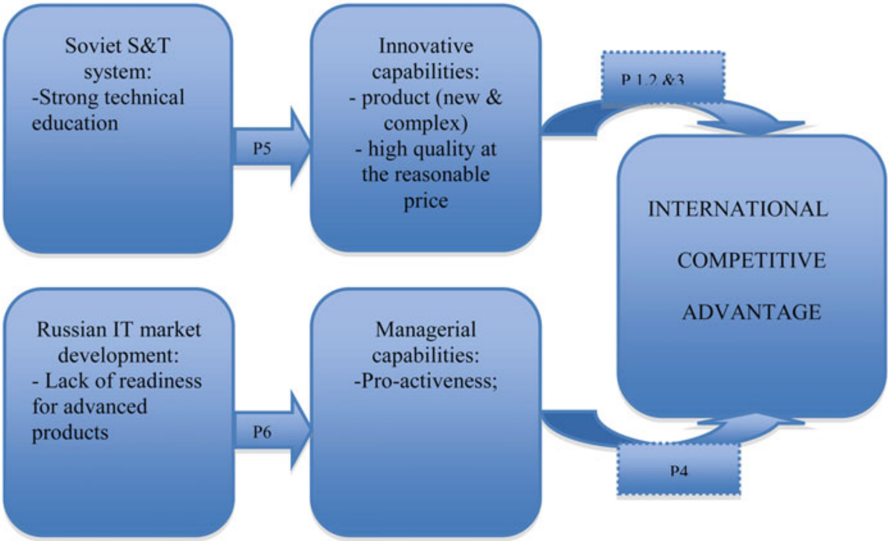

Fig. 1 Empirically grounded framework

6 Contributions

The contribution of this study is threefold. First, we extend the theorizing on international competitiveness by outlining the nature of competitive advantage of service forms from emerging economies. Hence, we contribute to the debates whether emerging market firms are distinctive in their international strategy or comply with the logic of developed market firms. Second, we bring more knowledge about the behavior of Russia firms that is currently one of the less-researched contexts in the field of international management. Third, we provide important conclusions for policy makers how to provide support for IT companies for the international expansion.

Overall, this chapter draws attention to the fact that firms from emerging markets possess a solid technology competitive advantages that allow them to become strong rivals in international business arena. This observation should raise attention of firms from developed market and to assist in planning of the further strategic expansion as well as in development of new capabilities to compete against new rivals appearing in the global business arena.

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Perspectives of Users and Service Providers on Deployment Maturity Assessment: A Study of Product Lifecycle Management Systems (PLMS)

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1 Introduction

Organizations seek to enhance their competitiveness through a variety of approaches. The management of product lifecycles is among the more important ones since it involves all entities that exist along the value and supply chains of organizations. Several factors, including (a) the globally spread demand for products, (b) intense competition for market share, (c) increasing complexity of product designs due to the tendency to embed multiple functionalities in a product, (d) globally distributed collaborative manufacturing systems, (e) higher sophistication of manufacturing and related industrial processes, and (f) use of more refined management methodologies and tools, significantly influence the management of product lifecycles. The management of product lifecycles is important since it involves all entities that exist along the value and supply chains of firms. PLM experts/researchers/product vendors hold the view that PLMS enable integration of various systems, data, and processes from all the phases/stages of NPD and all the stakeholders of the business/product through collaboration to provide the overall status/view about the product.

In this study, PLM is viewed as a resource for managing an organization's products and other resources (technology, human, knowledge and information, and organization) from conception to disposal. The practice of PLM is comprehensively enabled by PLM systems (PLMS) that comprise an integrated set of various hardware

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and software products that are blended into organizational policies and practices concerning NPD. Organizations involved in PLM product development and organizations that provide PLM consultancy or implementation service, evaluation, and customization services are termed as *PLMS service providers* and those organizations that have implemented PLMS are termed as *PLMS users*.

The business reasons for adopting PLMS in the product industry are well known. However, in practice, companies struggle with adopting and implementing PLMS, which is founded on structural, cross-functional, and long-term interactions and cooperation among all stakeholders. The primary reason for organizations' struggles in adopting and implementing PLMS is that it affects a wide range of internal and external processes. Specifically, PLM involves various modes of design sharing in different design formats and travel to virtual offices to interface with partners. PLMS benefit organizations by enabling them to progress from a sequential, functional, and loosely linked PLM process to a concurrent, cross-functional, and integrated one. The critical success of PLM is realized through its ability to purposefully deliver the right information at the right time to the right person, each and every time. Though PLMS offer several benefits, their implementation is challenging. Successful PLMS implementation should be characterized by attaining optimal PLMS deployment maturity and aligning PLMS with business goals. PLMS maturity should not be judged by only the system's technical capability since PLMS implementation also involves cultural and organization change. This should be approached in a different way, considering the existing policies and practices and, more importantly, the requirements and attitudes of the users.

Organizations seek to be evaluated on their capabilities by independent agencies. Maturity assessment frameworks serve as an easy way for organizations to gauge their relative positioning in the competition and across value chains. Maturity models provide organizations with a benchmark that could be used to gauge their relative maturity with respect others in the industry. An organization needs useful evaluations to describe its situation, in its own context. The maturity of an organization denotes the extent to which that organization consistently manages its product information assets and leverages them effectively.

2 Literature Review

Balasubramaniam et al. (2003) discussed the challenges encountered in the migration of legacy systems and how to overcome them. They also described the interactions between people, process/practices, tools/technology, and data and discussed about cultural change, multiplicity of legacy systems, and processes. Maturity levels and their components were not clearly defined. Christopher (2003) presented a maturity model on virtual product development (VPD), which defined five levels of maturity for various tools and processes, in which he addressed some components that could be adapted for PLMS deployment maturity assessments. His work involved the use of a single scale for maturity assessment and did not describe the assessment process. Saaksvuori and Immoneon (2004), in their book titled *Product Lifecycle Management*, discussed about a PLM maturity model to describe, at an aggregate level, how a company and its management team can develop and extend the use of an enterprise-wide PLM concept and related processes and information systems. Walvekar and Subbanarasaiah (2004) discussed the best practices for PLM implementation and the maturity assessment of various PLM components such as data vaulting, data classification, management and search, bill of materials, document management, multisite design collaboration, engineering change management, design/drafting process management, and customer/supplier collaboration across five levels. However, technological aspects and human resource-related aspects were not addressed, and maturity levels were not clearly defined, primarily because a single scale was used for all components and it was applicable only to very few components of PLMS deployment. Batenburg et al. (2005) discussed about how the concepts of strategic business/IT alignment and capability maturity could be used to develop a PLM framework. By using the framework, they could assess the PLM activities of 23 Dutch firms using SEI's CMM model to define the levels of maturity as level 0 – ad hoc, level 1 – departmental, level 2 – organizational, and level 3 – interorganizational. The authors could not assess the maturity of all PLMS components. The model used only one maturity scale that is not equally appropriate to all dimensions featured in it. This assessment enabled organizations to be placed in relative positions. Sharma (2005) discussed the integration of three components – collaboration, product development, and innovation. Using a technology framework, he also discussed about PLM maturity with respect to information/process management and collaboration. Other aspects of PLM were not addressed in the work. Venugopalan et al. (2009) proposed a framework, using sound conceptual foundations of resource-centric perspectives of organizations, and this has been developed based on the relevant research literature and specifically on the well-known THIO framework (Ramanathan 1988) used in technology capability assessment to assess PLMS deployment maturity. The framework proposed by the authors posits that PLMS deployment maturity can be evaluated across five maturity levels using four constituent dimensions – technology resources (integrated hardware and software systems), human resources (individual employees' professional competencies and character, teams' attributes), knowledge and information resources (training manuals, process and procedure manuals, best practices, standards), and organizational resources (policies, frameworks and practices concerning communication, evaluation, planning and decision-making, monitoring, and control systems and mechanisms) comprising 9, 6, 12, and 8 components, respectively. This framework is used for this study.

3 Objectives and Scope

This research work is confined to the context of national and multinational organizations in India that are either users of or service providers for PLMS. The deployment maturity of PLMS is assessed using the framework and the perspectives of both the users and the service providers. In India, nearly 35 different organizations have been using different PLM systems for their product development projects. These organizations have not implemented all the required components of PLM systems for their product lines. This work uses an assumption that if any organization has been using any of the PDM systems, project/program management tools, portfolio management, configuration management, computer-aided tools, and enterprise management systems for their product development activities, and then they have been practicing the PLM concept (at least in parts) and have used the systems for their product development.

The objectives of this research are the following:

1. To determine, based on the identified components (Venugopalan et al. 2009), the levels of PLMS deployment maturity prevailing among firms, at an aggregate level
2. To perform a detailed component-level analysis of PLMS deployment maturity to contrast the assessments of PLMS service providers (organizations providing PLMS services) with those of PLMS users (organizations that have implemented PLMS)

4 Description of the Research Work

This section describes the research methodology adopted for this research.

Survey instrument design and testing: The PLMS deployment maturity assessment framework (Venugopalan et al. 2009) is operationalized through a survey and pretested by experts who have several years of PLM experience. Earlier, a pilot study was conducted among academicians, users of PDM/PLM systems, and product development professionals for fine tuning and improving the questionnaire. The survey included a specific question for each of the 35 components of PLMS deployment maturity. SPSS version 17.0 has been used for all statistical analyses. Reliability analysis has shown that the overall Cronbach's alpha value is 0.973, which indicates high internal consistency (Malhotra 2004).

Scales: An ordinal 5-point scale is used in this research to represent each level of maturity. The effort, time, and cost required for improving the PLMS deployment maturity from one level to the next higher one are not the same across the five maturity levels, and hence, an interval scale could not be used.

Sample: The questionnaire, administered via e-mail, uses a format that gives a detailed description of the activities and processes for each component of each dimension in each level of PLMS deployment maturity. Keeping in mind the use of PLMS across industries, the availability of experienced professionals, the current state of research on PLMS, and the time available for the entire study, convenience sampling has been adopted. Practicing managers, and experts or senior engineers engaged in PLM-related activities in 29 well-known medium- and large-sized organizations were selected to respond to the questionnaire survey. Of the 29 organizations, 10 are PLMSSP, and the rest 19 are PLMSU.

Responses: A total of 112 sets of questionnaires were distributed, through convenience sampling, to personnel in various organizations and individually tracked over phone, e-mail, and personal interactions. A total of 59 responses were obtained, of which 56 were usable. PLMSSP, automotive, aerospace, and high-tech industries have been identified for this research on the basis of their presence in earlier literature and the professional experience and knowledge of this researcher.

5 *PLMS* Deployment Maturity: Component-Level Analysis

The analysis of PLMS deployment at the component level involves simple calculations of medians. Reviewing the results in Table 1 (given below) across all component areas at the aggregate level of all organizations, the median PLMS deployment maturity is at level 2 for five components, at level 3 for 26 components, and at level 4 for four components. All the components in organizational resources are at level 3. In particular, the respondents indicated level 2 practices with respect to "deployment architecture," "information security," "CAE," "CAT," and "CAM" practices. Interestingly, all these components pertain to technology resources. Four components, namely, "users' learning curve," "adaptation of regulatory changes," "design standardization/compliance," and "classification and release," are at level 4. By calculating the mean of the medians of the components of each dimension, a final score for each dimension is determined. Subsequently, the mean PLMS deployment maturity scores for each dimension are graphically portrayed using radar plots (Fig. 1). Interestingly, there is no component rated at level 1 or level 5. This clearly suggests that the component-level maturity scores are neither high nor low.

From Table 1 and Fig. 1, it can be easily observed that the overall PLMS deployment maturity in Indian Industry is "average" (value = 2.98).

5.1 PLMS Deployment Maturity: Component-Level Analysis Between PLMS Service Providers and PLMS Users

This research relies upon *descriptive and inferential* statistics to gain insights regarding differences among PLMS users and service providers in terms of their PLMS deployment maturity evaluated on the components described in the framework. While previous studies have relied upon simple comparisons of sample means, this study employs relatively efficient nonparametric tests to determine whether statistically significant differences exist or not among the selected groups. Finally, the comparison between groups is presented here at a

Table 1 Central tendency of maturity of each dimension

Dimensions → Central tendency ↓	Technology	Human	Knowledge and information	Organization	Mean of medians
Median	2.44	3.12	3.35	3.00	2.98
Weighted avg.	2.343	2.982	3.34	3.05	2.93

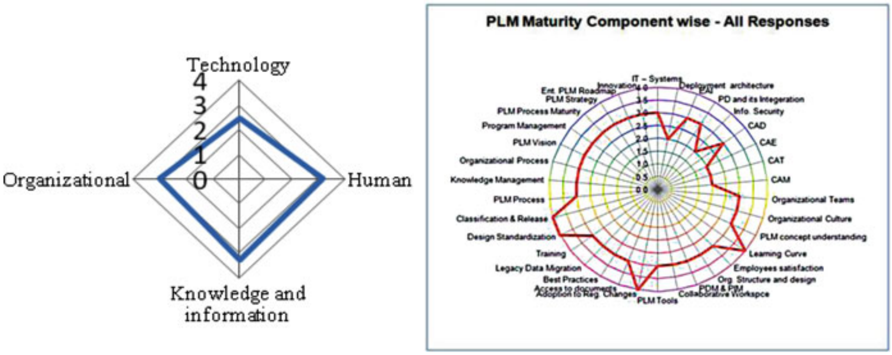

Fig. 1 Maturity of each dimension and all 35 components

Table 2 Central tendency reported by PLMSSP and PLMSU

Central tendency		Technology	Human	Knowledge and information	Organization	Overall mean
Median	Overall	2.44	3.12	3.35	3.00	2.98
	PLMSU	2.33	2.66	3.08	3.00	2.77
	PLMSSP	2.70	3.00	3.91	3.38	3.25

more detailed level than previous studies, which have addressed the differences in overall maturity or the differences associated with a single level of decomposition, at the component level.

In this section, the 37 responses collected from PLMSSP (19 different organizations) and 19 responses from PLMSU (10 different organizations) are analyzed and discussed. The results are examined in the light of Obj. 2: The central tendency of the PLMS deployment maturity levels reported by the respondents is used to compare the overall performance across each dimension (presented in Table 2), and the graphical representation of the same is presented in Fig. 2. The central tendency of the PLMS deployment maturity levels reported by the respondents is used to compare the overall performance across each dimension.

Central tendency: The median maturity of PLMSU is 2.77, and that of PLMSSP is 3.25. This clearly shows that the PLMS deployment maturity of PLMSSP is higher. This result is to be expected because PLMSSP are motivated, by design, to promote their products and services, and this is a good reason for this difference. PLMSSP

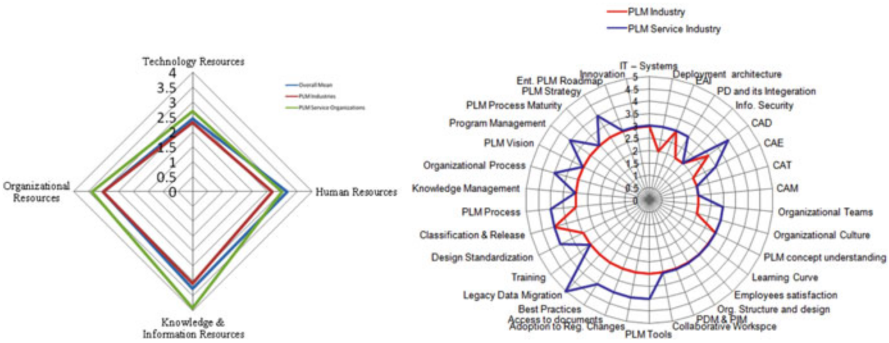

Fig. 2 Maturity of each dimension and components

claim, naturally, that their products and services are superior. The results are also graphically presented in Figs. 2 and Table 2. These results show that the maturity levels of PLMSSP and PLMSU are comparable.

5.2 *Differences Between PLMS Deployment Maturity of PLMSSP and PLMSU*

The differences between the PLMS deployment maturity levels of PLMSSP and PLMSU are identified and analyzed in this section using the following nonparametric tests:

(a) Mann–Whitney *U* test – to test the differences between the two groups of organizations
(b) Wilcoxon signed-rank test – to test the differences between the two related groups by combining (pairing) the samples

5.2.1 Differences Between PLMSU and PLMSSP – Mann–Whitney *U* Test

The results of the test are given in Table 3 and discussed below.

The two groups of organizations are found to differ statistically in terms of the 11 components identified from Table 3 above and summarized in Appendix A at the end. In most cases, the level of maturity in PLMSSP is at least one level higher than in PLMSU. This can be seen in Fig. 2, presented earlier in this chapter. PLMSSP are motivated, by design, to promote their products and services, and this is a good reason for this difference. PLMSSP claim, naturally, that their products and services are superior in terms of the following:

(a) Functional capabilities of the technology resources made available
(b) Enabling quicker learning and skill development, in terms of human resources

Table 3 Differences PLMSSP and PLMSU

Index	Components	Mann–Whitney *U*	Wilcoxon *W*	*Z*	Asymp sig. (2-tailed)
TR1	IT – systems/infrastructure/ technology	274.500	977.500	−1.418	0.156
TR2	Deployment architecture of info. system	232.500	935.500	−2.129	0.033
TR3	Enterprise application integration	294.000	997.000	−1.051	0.293
TR4	Product data (PD) and its integration	221.500	924.500	−2.349	0.019
TR5	Information security	276.000	979.000	−1.397	0.162
TR6	Computer-aided design	245.500	948.500	−1.903	0.057
TR7	Computer-aided engineering	236.500	939.500	−2.136	0.033
TR8	Computer-aided testing/ troubleshooting	339.000	1042.000	−0.225	0.822
TR9	Computer-aided manufacturing	324.500	1027.500	−0.499	0.618
HR1	Organizational teams/people their focus	259.000	962.000	−1.655	0.098
HR2	Organization culture	246.000	949.000	−1.877	0.061
HR3	PLM concept understanding	320.000	1023.000	−0.566	0.572
HR4	Learning curve of the users and support	202.000	905.000	−2.767	0.006
HR5	Employees' satisfaction and level of involvement	253.500	956.500	−1.761	0.078
HR6	Organization structure and design	257.500	960.500	−1.736	0.083
KIR1	Product data/information management.	282.500	985.500	−1.226	0.220
KIR2	Collaborative workspace	255.500	958.500	−1.755	0.079
KIR3	PLM tools	197.500	900.500	−2.763	0.006
KIR4	Adaptation to regulatory changes	229.000	932.000	−2.234	0.026
KIR5	Accessibility of the documents	200.000	903.000	−2.770	0.006
KIR6	Best practices	157.500	860.500	−3.519	0.000
KIR7	Legacy data migration and cleanup for PLM	249.000	952.000	−1.840	0.066
KIR8	Manage training requirements	256.500	959.500	−1.709	0.087
KIR9	Design standardization/compliance	250.500	953.500	−1.841	0.066
KIR10	Classification and release	293.500	996.500	−1.048	0.295
KIR11	PLM process and application trained employees	222.500	925.500	−2.291	0.022
KIR12	Knowledge management	249.500	952.500	−1.815	0.070
OR1	Organizational processes to support PLM	275.500	978.500	−1.377	0.168
OR2	PLM vision	281.500	984.500	−1.256	0.209
OR3	Program management and leadership	305.000	1008.000	−0.830	0.407
OR4	PLM process maturity	182.500	885.500	−3.052	0.002
OR5	PLM strategy	254.000	957.000	−1.744	0.081
OR6	Enterprise PLM roadmap	198.500	901.500	−2.735	0.006
OR7	Innovation	284.000	987.000	−1.198	0.231
OR8	PLM implementation	253.000	956.000	−1.842	0.065

(c) Incorporation of industry's "best practices" in their PLM systems, thus enabling better utilization of knowledge and information resources
(d) Being consistent with the higher maturity of the PLM-implemented industries' processes and roadmap

This, however, is apparently only their unfounded belief rather than being a well-researched conclusion. One of the most important observations in this research is that PLMS deployment maturity is viewed very consistently by both PLMSSP and PLMSU, with very few exceptions. Also, the above differences between their perceptions are only of the order of a single level of maturity. There is no statistically significant difference between PLMSSP and PLMSU in their views on PLMS deployment maturity levels defined across the remaining 24 of the 35 component areas. Keeping the above observations in mind, there is no strong argument to reject the null hypothesis that there is no difference between the maturity levels reported by PLMSSP and PLMSU. This should serve to encourage the two to understand each other's expectations, requirements, and capabilities to take PLM systems to more productive and sophisticated levels of application.

5.2.2 Differences Between PLMSSP and PLMSU – Wilcoxon Signed-Rank Test

Following the overall comparison presented above, the PLMS deployment maturity assessments made by the two groups of organizations are specifically analyzed. For this, the differences, if any, between the paired responses from the two groups are determined, analyzed, and explained. The responses from each PLMSSP are paired with those from the respective PLMSU that received the service. The paired data is analyzed using the Wilcoxon signed-rank test. In this test case,

H_0: *There is no difference between the PLMS deployment maturity levels of PLMSSP and PLMSU*.

The Wilcoxon signed-rank test statistics for the matched pairs are given in Table 4. There are 22 components in which a statistically significant difference is found. These are summarized in Appendix A at the end. There is no statistically significant difference between PLMSSP and PLMSU in their views on PLMS deployment maturity levels defined across the remaining 13 of the 35 components.

Here also, the level of maturity reported by the respondents from PLMSSP is at least one level higher than that reported by those in PLMSU. The 22 components for which there are statistically significant differences include the 11 components reported in the overall comparison (Mann–Whitney *U* test) made in the previous subsection. In the technology resource dimension, most of the components in IT and in the engineering design domain and tools show statistically significant differences between the two groups of organizations. In the human resource dimension, all the components except the component "PLM understanding" show differences. In the knowledge and information, and organizational

Table 4 Differences between PLMSSP and PLMSU – Wilcoxon matched pairs signed-rank test grouping variable – organization type

Components – technology	*Z*	*Asymp. sig. (2-tailed)*
TR1	−2.594[a]	0.009
TR2	−3.518[a]	0.000
TR3	−1.423[a]	0.155
TR4	−3.473[a]	0.001
TR5	−1.877[a]	0.061
TR6	−3.181[a]	0.001
TR7	−4.617[a]	0.000
TR8	−1.276[a]	0.202
TR9	−0.845[a]	0.398
Components – human	*Z*	*Asymp. sig. (2-tailed)*
HR1	−2.311[a]	0.021
HR2	−2.432[a]	0.015
HR3	−0.734[a]	0.463
HR4	−4.740[a]	0.000
HR5	−2.534[a]	0.011
HR6	−2.544[a]	0.011
Components – knowledge and information	*Z*	*Asymp. sig. (2-tailed)*
KIR1	−0.750[a]	0.454
KIR2	−1.740[a]	0.082
KIR3	−4.016[a]	0.000
KIR4	−3.427[a]	0.001
KIR5	−5.123[a]	0.000
KIR6	−5.744[a]	0.000
KIR7	−1.883[a]	0.060
KIR8	−1.520[a]	0.128
KIR9	−3.001[a]	0.003
KIR10	−2.079[a]	0.038
KIR11	−3.916[a]	0.000
KIR12	−3.061[a]	0.002
Components – organizational	*Z*	*Asymp. sig. (2-tailed)*
OR1	−2.096[a]	0.036
OR2	−0.608[a]	0.543
OR3	−0.162[b]	0.872
OR4	−5.227[a]	0.000
OR5	−1.811[a]	0.070
OR6	−4.072[a]	0.000
OR7	−1.220[a]	0.223
OR8	−3.965[a]	0.000

[a]Based on positive ranks

resource dimensions also, there are significant differences in many of the critical components including "adaptation to regulatory changes," "design standardization/compliance," "classification and release," "PLM process," "organizational processes and PLM implementation." Keeping the above observations in mind, there are sufficient reasons to reject the null Hypothesis that there is no difference between the maturity levels reported by PLMSSP and PLMSU.

The significant differences can be attributed to the following reasons:

(a) The number of responses from PLMSU is more than that from PLMSSP.
(b) Significant differences between the two groups exist when one of the groups exhibits larger dispersion of responses within the group.
(c) The number of junior-level respondents in PLMSSP is more than that in PLMSU.

The above observations point to the need for further analysis on the samples, and the same is addressed in the next subsection using senior-level respondents.

5.2.3 Differences Between Senior Management in PLMSSP and PLMSU – Wilcoxon Signed-Rank Test

The responses from senior-level respondents from PLMSSP are paired with those from the respective PLMSU that received the services. Ten responses from PLMSSP are paired with ten from the respective PLMSU and compared for differences using the Wilcoxon signed-rank test. The Wilcoxon test statistics are tabulated in Table 5. There are only two components for which statistically significant differences exist. These two belong to knowledge and information resources. The most significant difference identified in this study between the two groups occurs with respect to the two components, “best practices” and “PLM process and application trained employee’s component area.” The median maturity reported by respondents in PLMSSP for both components is 4, and the median reported by those in PLMSU is 3. The views of PLMSSP that the incorporation of industry “best practices” and PLM processes in their PLM systems, thus enabling better utilization of knowledge and information resources by PLMSU, are reflected in their higher rating of PLMS deployment maturity.

It is reiterated here that PLMS deployment maturity is viewed very consistently by both PLMSSP and PLMSU, with very few exceptions. An analysis of the remaining 33 of the 35 components reveals that there is no statistically significant difference in PLMS deployment maturity levels rated by the two groups of organizations. Based on the above observations, there is no reason for rejecting the null hypothesis that there is no difference between the maturity levels reported by PLMSSP and PLMSU. The views about PLMS deployment maturity held by respondents of PLMSSP are consistently higher by at least one level.

6 Major Research Contributions and Conclusions

This research contributes to the theoretical and empirical analysis of PLMS deployment maturity assessment. This research provides a detailed, component-level snapshot of the current levels of PLMS deployment maturity among the industries. The research helps organizations to evaluate PLMS deployment maturity with

Table 5 Differences between PLMSSP and PLMSU – Wilcoxon matched pairs signed-rank test (senior management) – grouping variable – organization type

Components – technology	*Z*	*Asymp. sig. (2-tailed)*
TR1	-1.543^{a}	0.123
TR2	-1.552^{a}	0.121
TR3	-0.730^{a}	0.465
TR4	-0.877^{a}	0.380
TR5	-0.574^{a}	0.566
TR6	-1.066^{a}	0.286
TR7	-1.634^{a}	0.102
TR8	-1.006^{a}	0.314
TR9	-0.425^{a}	0.671
Components – human	*Z*	*Asymp. sig. (2-tailed)*
HR1	-0.837^{a}	0.403
HR2	-0.960^{a}	0.337
HR3	-0.061^{b}	0.952
HR4	-1.508^{a}	0.132
HR5	-1.150^{a}	0.250
HR6	-0.552^{a}	0.581
Components – knowledge and information	*Z*	*Asymp. sig. (2-tailed)*
KIR1	-0.180^{a}	0.857
KIR2	-0.265^{a}	0.791
KIR3	-0.997^{a}	0.319
KIR4	-1.496^{a}	0.135
KIR5	-0.604^{a}	0.546
KIR6	-2.636^{a}	0.008
KIR7	-1.715^{a}	0.086
KIR8	-1.200^{a}	0.230
KIR9	-1.496^{a}	0.135
KIR10	-0.844^{a}	0.399
KIR11	-2.309^{a}	0.021
KIR12	-1.706^{a}	0.088
Components – organizational	*Z*	*Asymp. sig. (2-tailed)*
OR1	-1.474^{a}	0.140
OR2	-0.862^{a}	0.389
OR3	-1.382^{a}	0.167
OR4	-1.732^{a}	0.083
OR5	-1.631^{a}	0.103
OR6	-1.869^{a}	0.062
OR7	-1.184^{a}	0.237
OR8	-0.948^{a}	0.343

[a]Based on negative ranks

respect to other organizations. The questionnaire developed in this research can be used by industries to evaluate the PLMS maturity, which can in turn be used to compare the PLMS maturity across industries. Scales were developed and tested, and the framework was operationalized in the form of a questionnaire. This research provides a detailed, component-level snapshot of the current levels of PLMS deployment maturity with the perspective of service providers and users.

6.1 Limitations and Scope for Future Research

The total number of responses used to find the final outcomes is not sufficient to generalize the results. To make an improved validation, many more organizations need to be assessed. The measurement of outcome of PLM systems implementation is not in the scope of this work. The mutual effects of enterprise application such as ERP and PLM systems have also been kept out of scope. This research work can be extended to other industries which are adopting PLM systems. Further analysis with larger sample sizes will enable the study of industry-specific effects. With sufficient data, the framework presented and discussed here can be extended to other enterprise systems such as ERP, SCM, and CRM systems.

Appendix A Differences Between PLMSSP and PLMSU

		Components that show significant statistical differences		
S. no.	Statistical tests	Dimension	Components	Remarks
1	Mann–Whitney *U* test	Technology	Deployment architecture, product data and its integration across its lifecycle, and CAE	Accept the null hypothesis since there are no sufficient reasons to reject the null hypothesis
		Human	Learning curve	
		Knowledge and information	PLM tools, adaptation to regulatory changes, accessibility of documents, best practices, and PLM process	
		Organization	PLM process maturity and enterprise PLM roadmap	
2.	Wilcoxon signed-rank test	Technology	IT – systems and infrastructure, deployment architecture, product data and its integration across its lifecycle, CAD, and CAE	Reject the null hypothesis since there are significant differences in most of the critical components across the dimensions
		Human	Organizational team, organizational culture, learning curve, employees' support to PLM, and organizational structure and design	
		Knowledge and information	PLM tools, adaptation to regulatory changes, accessibility of documents, best practices, design standardization/ compliance, classification and release, PLM process, and knowledge mgmt.	
		Organization	Organizational process, PLM process maturity, enterprise PLM roadmap, and PLM implementation	
3.	Wilcoxon signed-rank test	Technology	Nil.	Accept the null hypothesis.
		Human	Nil.	
		Knowledge and information	Best practices and PLM process and application trained employees	
		Organization	Nil.	

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Part 3.5
New Product and Services Development

ICT in New Product Development: Revulsion to Revolution

Nityesh Bhatt and Abhinav Ved

1 Introduction

In 2011, Mahindra group entered the bike segment after success in scooter segment. Honda has launched 42 bikes in different categories like sports, adventure, motor scooter, etc., all over the world (Kanan 2010). In 2010, 60 bikes were launched in India, and 30 were about to get launched by companies like Suzuki, TVS, BMW, Bajaj, Honda, Yamaha, etc. (New Bikes in India 2010; Shravan 2009). In addition to rising customer demands and increased competition, information and communication technology (ICT) revolution can also be attributed for this scenario. ICT plays an important role in ensuring speed and quality at every stage of new product development (NPD). In today's fast-paced, competitive world, NPD with flexibility and innovation is essential for success. New products can be seen in two ways. In conventional way, new product means risk, huge investment, failure or prestige issue. But in modern era, new product means opportunity, innovation, improvement, profits and success. For example, 3 M has realised 25% of its sales from products developed in the last 5 years (Takeuchi and Nonaka 1986). With software packages like ERP and PLM, ICT not only helps in integration and information exchange but also helps in meeting deadlines and making projects profitable.

2 Literature Review

IT for NPD is necessary condition but not sufficient for potential benefits (Durmusoglu et al. 2006). New products provide increased sales, profits and competitive strength for most organisations (Sivadas and Dwyer 2000). NPD involves successive steps from

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idea generation to final launch of product to the market. The process of NPD includes the steps like idea generation, idea screening, concept development and testing, business analysis, beta testing and market testing, technical implementation and commercialization (Venture Navigator 2007). Internet and related technologies can add significant value during each stage of NPD (Howe et al. 2000).

NPD has long been recognised as one of the corporate core functions (Huang et al. 2004). During the past 25 years, NPD has increasingly been recognised as a critical factor in ensuring continued existence of firms (Biemans 2003). A study of more than 700 of the Fortune 1,000 companies indicates that new products provide approximately one-third of their profits (Booz, Allen and Hamilton 1982). The rate of market and technological changes has accelerated in the past years, and this turbulent environment requires new methods and techniques to bring successful new products to the marketplace (Goodwin 2009). Particularly for companies with short product life cycles, it is important to quickly and safely develop new products and new product platforms that fulfil reasonable demands on quality, performance and cost (Ottosson 2004). This global commitment to innovation can be seen from the growth of worldwide R&D spending from an estimated $525 billion in 1996 to approximately $1.1 trillion in 2007 (National Science 2007).

Microsoft's Chief Information Officer, Stuart Scott, notes that his firm now spends 45% of its IT budget on supporting NPD efforts, a significant increase from the 30% in the past (Murphy 2007). Durmusoglu (2009) argues that IT infrastructure is rare, imperfectly imitable and imperfectly mobile and thereby constitutes a capability of the firm that can lead to efficiencies in business processes. Three moderating factors, intensity of competition, technological turbulence and market turbulence, were posited to affect the strength of the relationship between a firm's IT infrastructure capability and the efficiency of its NPD process (Durmusoglu 2009). Higher use of IT tools in NPD was found in those companies where the importance of product or project as well as project risk was more to the firm (Barczak et al. 2007). Haverila and Ashill (2011) describe that IT helps in NPD process by gathering and disseminating product and market information (Haverila and Ashill 2011). With the examples of Xerox and Toyota's NPD process, Jusco (2010) describes the use of information technology to bridge the knowledge gap among product development team members and utilise knowledge in a way to develop products faster (Jusco 2010).

Based on literature studied, authors have created a framework shown in Fig. 1 to discuss the role of ICT in NPD. It has three broad components. First component covers the drivers for deployment of ICT tools in NPD. Second component deals with various ICT tools, while the last component highlights its impact. Drivers for IT deployment in NPD are easy to understand. With higher income and education, aspiration level of people is touching new heights. There is a cut-throat competition in every market due to privatisation and globalisation. Widespread proliferation of various kinds of media has made the customers informed about various products and services. All these factors necessitate effective utilisation of information technology resources in the most efficient and innovative way.

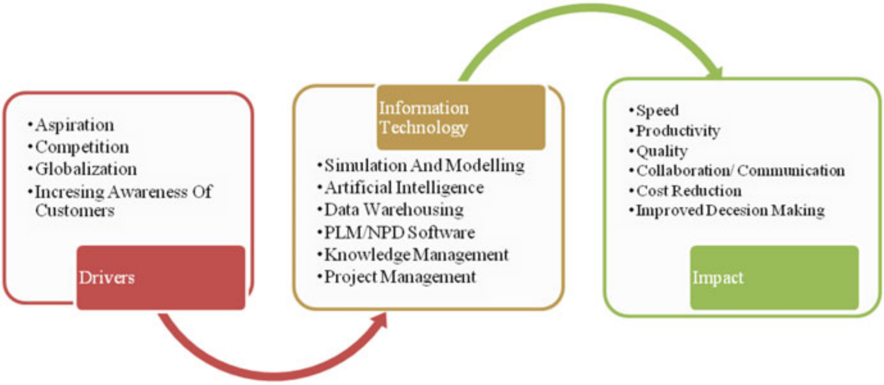

Fig. 1 Drivers of ICT in NPD and its impact

3 Effective Usage of Information Technology

All above-mentioned advantages for NPD can be achieved through effective application of ICT tools like simulation design CAD/CAM, 3D modelling, virtual team, knowledge management, data mining/warehousing, artificial intelligence and software tools like product life cycle management (PLM). These applications independently and/or in combination boost NPD process.

3.1 Simulation Design and Modelling

Simulation means creating virtual environment and testing product virtually in the environment required. It helps in product testing without actually building the design, thus results in cost saving. Another advantage is level of details one can get from simulation. Delphi automotive is working on noise comfort for passengers in cars and pedestrians around the vehicles with the help of simulation. Simulation reduces development time and more efficient design of car (Delphi 2011). Software available with Siemens for plant simulation provides benefits like 3–6% savings in initial investment, increases existing system productivity by 15–20%, reduces new system costs by 5–20%, optimises resource consumption and re-use and reduces inventories by 20–60% and throughput time by 20–60% (Plant Simulation 2011).

Automation and CAD software have helped in a great way to manufacturing and construction industry. Vonderembse et al. (1997) conducted in-depth, on-site interviews with executives from four companies to understand how these organisations cope with automation, integration and manufacturing system performance. The earthmoving company found substantial improvement in efficiency, low cost and shorter delivery time. For electric generator company, ICT not only enhanced efficiency but also helped in reduction of order delivery time because part drawings could be easily and quickly retrieved; design changes could be incorporated quickly with CAD and transferred to shop floor (Vonderembse et al. 1997).

Information technology is a platform for concurrent engineering, well known for the construction industry (Salomone 1996). It improves management of engineering process through better control of data, engineering activities, changes and product configurations. IT has enabled multinational firms to work 24 × 7 and for 365 days, operating from different time horizons. It is estimated that concurrent engineering can save around 30–40% reduction in project time and 60–80% reduction in design changes after release (Stark 1992, 1998). Engineering department at L&T is using the Intergraph 3D plant design system (PDS) software for developing a 3-dimensional model of the project encompassing all related aspects including the layout, piping, mechanical, electrical, instrumentation and civil engineering disciplines. Some of the direct benefits derived from this system include auto-extraction of piping isometrics from the 3D CAD models, auto-extraction of structural fabrication drawings through softwares such as dX-Steel, and checking of interference between various elements of piping, equipment, structural, instrumentation, etc., through the simulated 'walk-through'. It has helped in not just reducing errors but increased prestige of the company too (Larsen and Toubro 2010).

3.2 Knowledge Management (KM)

Knowledge management is the process of generating, documenting and disseminating knowledge among its employees. As the tacit knowledge is converted into explicit knowledge in KM, employee attrition does not affect the organisations too much. Employee learns from the past experiences occurred from similar projects; thus, KM helps in increasing productivity of employees in the organisation (Bharadwaj 2000). Motorola capitalised on its portable pager business to develop portable cellular telephones. Corning used its expertise in glass technology to develop optical fibres (Ozer 2000). Dow Chemical—by focusing on the active management of its patent portfolio—has generated over $125 million in revenues from licensing and other ways of exploiting their intangible assets (Knowledge Management 2010).

BP business managers attributed around $260 million of added value by using this approach. A practical example of this has been in the cost reduction in the construction of European retail sites. At the beginning of 1998, a challenge was set of reducing the build costs of retail sites in Europe by 10%. A joint venture between BP and Bovis was responsible for the management of these activities in Europe. The Alliance invited the BP KM Team to help them achieve this outcome. Finally, company realised savings of $74 million in 1998 giving them competitive advantage in the mature European marketplace. This knowledge is now also being leveraged on a global scale by project engineers in Venezuela, China, Poland and Japan (KM and British Petroleum 2011).

3.3 Virtual Team

A virtual team can be defined as a group of interdependent people and sub-teams who frequently interact through ICT channels and other means to achieve a common goal. Virtual teams offer advantages like reducing relocation and travel time and cost. It helps to utilise the best talent irrespective of geographical spread. It gives higher freedom and autonomy to individual member of the team and thus improves job satisfaction level and commitment of the employees. Many research and development (R&D) organisations currently use a specialised knowledge portal for research collaboration and knowledge management (Durmusoglu et al. 2006).

Furthermore, it can allow people to telecommute. Decathlon Systems, a software vendor, adopted the concept of telecommuting to deal with cross-platform support, training and complex customer issues for its new software. The process increased productivity, motivated people and reduced overhead costs as much as 30% (Coleman 1997).

3.4 Data Warehousing

Data warehousing is the process of storing information and using it for various purposes. Data mining is required to extract hidden pattern and trends from huge chunk of data. Today, managers demand more information from the existing data than in the past. Many companies establish their own data centres, while others host its crucial data on Infrastructure as a Service (IAAS) mode. United Arrows, one of Japan's leading retailers, used SAP BusinessObjects XI to improve its merchandising operations. The new software allowed the company to extract data needed to perform analyses and enables better decision making through real-time understanding of key performance indicators. In addition, other benefit was dramatic reduction in data analysis time (reduced by about 1,300 h per year) (United Arrow 2011). UNE, a telecommunications company, leveraged SAP BusinessObjects Profitability and Cost Management data warehousing tool. It allowed UNE to analyse the costing model of the company, which led to the decision of using time-driven activity-based costing (TDABC), a way of measuring and linking a company's costs with the goods and services it offers (UNE 2011).

3.5 Artificial Intelligence

Intelligence is the ability to think, imagine, create, memorise, understand, recognise patterns, make choices, adapt to change and learn from experience. The Robotic User Interface project is designed to create better human-machine interfaces, including robots and computer avatars that show more emotion. AI can be used to solve various kinds of problems like deduction, reasoning, problem solving, knowledge representation, planning, learning, natural language processing, motion and manipulation, perception, social intelligence, creativity and general intelligence. Various applications are developed with the AI in the field of finance, weather forecast, aviation, heavy industry and space research (Plant Simulation 2011). Gaming industry is using AI concept very intensively. Various games like ‘Medal of Honor’ and ‘Counter Strike’ show soldiers fighting like real human being. These games reflect all kinds of movements which is possible with real human being on the computer screen (Unbreakable Virtual Toys 2010).

3.6 PLM/NPD Software

Product life cycle management (PLM) software allows companies to manage the entire life cycle of a product efficiently and cost-effectively, from ideation, design and manufacturing to service and disposal. Softwares like computer-aided design (CAD), computer-aided manufacturing (CAM), computer-aided engineering (CAE) and product data management (PDM) also perform this job partially. Companies like Siemens and SAP are leading PLM vendors. PLM software helps in making informed decisions at every stage of product life cycle. Procter & Gamble (P&G), one of the world’s largest consumer products companies, with approximately 300 brands in more than 160 countries is taking advantage of the Tecnomatix plant design and optimization solution from Siemens to minimise production losses and improve the efficiency of manufacturing operations (Success 2011).

Unilever is another example of the effective use of PLM software to fight with above-given challenges. For the past 10 years, Unilever has partnered with Siemens to create a global specification management system that serves as the first major component of its PLM system supporting its product innovation process. Software helped it in specification management for improved raw material procurement efficiency, knowledge re-use and improved top and bottom line growth (Cast Study 2011).

3.7 Project Management

Project management is the discipline of planning, organising, securing and managing resources to achieve specific goals. B/E Aerospace, Inc., is a leading global manufacturer of aircraft passenger cabin interior products for the commercial and business jet aircraft markets as well as a leading global distributor of aerospace fasteners. Its Flight Structures division is focused on aircraft interior reconfigurations and integrated programme management. It faced challenge to efficiently integrate data from diverse sources which would help to complete aircraft interior reconfigurations. It replaced a series of disparate project management systems with Oracle's Primavera P6 Enterprise Project Portfolio Management, which helped to develop integrated programme schedules to plan and control deliverables on complex integration and original equipment manufacturer programmes. It leveraged earned value management (EVM) metrics to pinpoint and correct deficiencies in resources or performance on a weekly basis. It migrated 80% of resource management into Oracle Primavera P6, with future plans to include 100%, further improving efficiency (Oracle 2010).

ICT played very important role in development of Boeing 777 development. Boeing 777 team used IT in three major parts: (1) during process of design and development, (2) integration with final product and (3) for testing and training for aircraft. Through IT-enabled integration of computers, telecommunication systems, parts tracking system, robotics and material handling systems, it successfully created globally interconnected network which helped in sharing of data among the team all over the world (Sweetman 1996). It could work with virtual mock-up instead of physical mock-up, thus eliminated 65% of changes due to errors. Training modules designed based on computers helped in reducing training time to 47 days from 75 days. It helped them in quick information exchange regarding design data and changes between various suppliers and vendors. Robotic tools were designed to receive the data and respond to instructions with the precision of thousandth of an inch (Snyder and Sankar 1998).

Panasonic, a leading electronics giant, had large amount of different sources of data. The company was facing problem of data inconsistency, duplication and incompleteness. To launch a new product, it required data like photographs, product specifications, descriptions, manuals, pricing data and point of sale information to suit the needs of each country and region, which required considerable time. It created a centralised databank using master data management software (MDM) from IBM which sent information to all employees who needed it with uniformity (Research 2011). It helped in data consolidation and systemising the business processes related to data in Europe. Within one and a half years of implementation, Panasonic Europe was getting products to market faster and spending 50% less time creating and maintaining product information. Time to market for a product was reduced from 5–6 months to 1–2 months. It is estimated that Panasonic Europe improved its efficiency by a factor of 5 and anticipates saving a million euros a year while increasing sales by 3.5% (Duff 2002).

4 Impact of ICT Deployment in NPD

Technology affects NPD by shortening development time, increasing productivity, improving quality, increasing collaboration and communication, reducing cost and improving decision making. These aspects are discussed in following subsections.

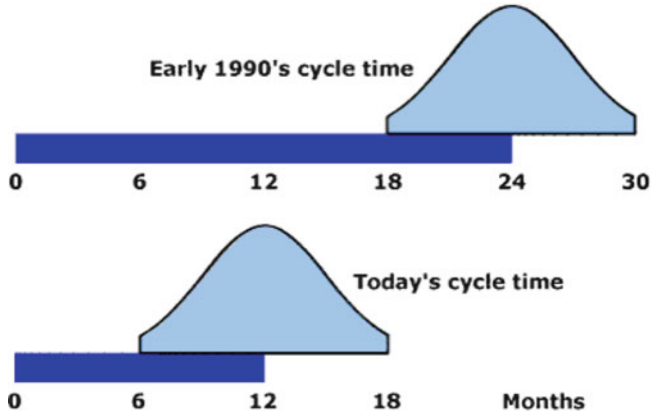

Fig. 2 Change in time taken for NPD (New Product Development and Fast Cycle Time 2011)

4.1 Speed

Due to drivers mentioned above, PLC is getting shorter day by day. Technology intervention enables firms to develop new products in lesser time and resources. The following figure shows how NPD cycle time has changed over the years (New Product Development and Fast Cycle Time 2011) (Fig. 2).

Role of IT in integration and speed can be seen from the following examples. At the time of merging, Coopers & Lybrand and Price Waterhouse formed a group of 50 people to design their new website, and though geographically dispersed, the team saved design time by 75% due to effective use of ICT. By use of group support system for idea sharing and document sharing, Novell's GroupWise division reduced NPD time from 48 to 18 months. British virtual drug development company, Protodigm, through its ICT network expects to reduce drug development cost by 30–40% and time reduction by 3–4 years. However, point of caution is that in addition to increasing the speed of the process, accuracy and quality also matter a lot. Apple computers hurriedly released personal digital assistant 'Newton' to market, but software was not completely debugged and handwriting recognition feature did not work properly which led to product failure (Ozer 2000).

4.2 Productivity

Productivity refers to a measure of output from a production process, per unit of input. Productivity improvement is one of the important reasons for increased use of ICT in NPD. Effective utilisation of existing resources helps in productivity improvement. Technology becomes useful to bridge the communication gap. Odesta, a software developer firm, used IT tools including shared database to rectify its software problems, thus increased productivity by 30–50% (Grantham et al. 1997).

4.3 Quality

Investment in ICT leads to improved product as well as service quality. In healthcare industry, ICT helps in improving diagnosis accuracy and reliability. British Petroleum has developed intense communication network throughout the world to get real-time feedback from the customers. This results in improvement of its products (Newing 1998). Qualcomm provides unique solution with the help of latest ICT application called '2 net connect'. Asthma patients who are not using smartphones or not likely to adopt them are the beneficiaries. It provides unique cloud-based service to provide seamless connectivity between medical equipments. Medication sensors are placed in equipments such as asthma pumps and inhalers, and data are recorded on real-time basis which not only helps in tracking patient's history but also assists in clinical trials for new drugs (Qualcomm 2012).

4.4 Communication and Collaboration

Collaboration and communication are the prerequisite for NPD. Increasing instances of cross-functional and cross-cultural teams have made it essential to have an excellent communication channel. ICT has enabled companies like Levi's to have design unit in the USA and manufacturing at locations like India. Consulting companies like PWC and Nielsen whose clients have wider geographical spread extensively use IT to solve their problems. British Petroleum uses a computer-based communication system named as 'digital nervous system' for effective communication among its dealers, project team and oil discovery teams. It helped in sharing information and increased communication capability and saved cost on making decisions about extending chemical plants and developing new oil fields and shutdown time for refinery. Around $25b is the expected savings from the same (Newing 1998). TI (Texas Instruments) also reduced the communication cost with the help of IT by 33% (Cole-Gomolski 1997).

Owens Corning, an American building and construction solution provider, faced challenge of integration between various departments. ERP system installation was decided as an integration mechanism, connecting diverse departments through shared database and common compatible software module. Successful implementation of ERP in turn led to 50% increase in inventory turnover and 20% reduction in administrative costs and millions of dollars in logistics savings (Hammer and Steven 1999).

4.5 Improved Decision Making

Availability of better and real-time information enables scientific decisions. IT also provides an anonymous group discussion environment that can reduce different types of biases and promotes increased participation. Duke Energy, a well-known power company in United States, revamped the way it worked with its building contractor customers. In 1996, it was able to meet only 30–50% of its commitments (e.g. laying down cables by promised time) to its customers. New system helped them with detailed information about the man power availability and commitments and helped them to negotiate commitment dates with contractors. They could achieve 98% of commitment fulfilment after implementation of the new system (Hammer and Steven 1999).

4.6 Cost Reduction

Cost reduction can be achieved by various ways with the help of ICT. Software platforms like Lotus Notes not only helps in improving communication and decision-making quality but also results in cost reduction. Texas Instruments' calculator business unit was in trouble in early 1990s. It was facing problem due to long cycle time and thus losing market share. New calculators were developed by the team of people from engineering, marketing and other departments. IT systems were established to communicate formal presentations, writings and information and informal mails among the team members. The effect of such steps was seen by successful introduction of new products by IT. The time taken to launch a new product dropped by 50%, break-even point reduced as much as 80% and the unit became market leader in that category (Hammer and Steven 1999).

It is a time of great expectation in the healthcare industry as organisations stand on the cusp of new discoveries that will advance the treatment of serious and chronic disease as well as open new commercial avenues for biotech and pharmaceutical companies. But the cost pressure is also increasing on companies which require them to speed up the NPD process. According to industry estimates, around US $1b is required for NPD in this sector (Oracle 2009). ICT can enhance efficiency and quality of clinical data with electronic data capture (EDC). It can help in streamline analysis, reporting and submission with integration of all clinical and non-clinical data. It also reduces risk via process validation and compliance and improves product quality with applications that automate compliance requirements.

Estimates that are approximately half of all trials now employ EDC, and 32% of sites use Internet-based EDC, with spending on EDC solutions set to exceed $3 billion by 2011—a 15% growth rate from 2007. It implies that companies having implemented such system are capable to run more cost-effective and complex trials. Companies always try to find a compound as early as possible and either commit to or eliminate it. One way to facilitate identification is by using adaptive clinical trial designs, where the database is periodically 'soft-locked' and sponsor can simulate a final analysis to see whether results are trending in the right way. In some cases, this happens with every patient and every visit. With products like RDC (Oracle), it is possible to visualise safety profiles early on and make decisions about the progress of the trial (Grantham et al. 1997).

Dana-Farber Cancer Institute, one of the leading cancer research and care centres in the United States, is using Oracle Healthcare Transaction Base and Oracle Fusion Middleware components as the foundation for its new translational research infrastructure. The new infrastructure is designed to maximise the value of clinical and research data and help improve disease understanding and patient care. To design new studies and address complex questions, Dana-Farber researchers need to aggregate clinical, sample and genomic data from within and beyond the organisation's collections. The new data infrastructure helps researchers investigate clinical data more thoroughly, make complex queries and more complete data analysis and improve experiment design (Oracle 2009).

With the help of ITI quality function deployment tools and services, one of the world's leading tractor manufacturers reduced two cycles of prototype, and due to improved process efficiency, development costs were cut by 30%, and the tractor was introduced in half the time of conventional development processes. It also led to increase in 25% of market share. A leader in home appliances industry could achieve 77% reduction to outer tube weight and 30 % cost reduction, and it also achieved 30% more product reliability with the help of such tools (ITI 2010).

5 Conclusion

Large number of examples mentioned above from various industries across the globe clearly shows the advantages of leveraging ICT for all the stakeholders. With easy availability of these technologies and large number of successful (as well as failure) case studies in the public domain, even medium- and small-scale industries (SMEs) have also started adopting them to achieve their strategic goals. In present dynamic era, mere adoption of ICT tools cannot provide competitive advantage, but its non-adoption will surely lead to competitive disadvantage. Further, the early adopters also need to continuously innovate to stay ahead of their competitors.

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A Study of Structural Antecedents of Product Development Teams' Flexibility on Small and Large Teams

K. Srikanth and K.B. Akhilesh

1 Introduction

Product Development (PD) organizations operate in a dynamic environment. The ever-expanding and competitive marketplace, increasing consumer demands, shorter product life-cycles and rapidly changing technologies are some of the reasons contributing to the volatility in business environment. Change and uncertainty have become prevalent, and it is essential for the organizations to device mechanisms to deal with these challenges effectively and derive competitive advantage out of it. Many strategies have been proposed to overcome the challenges of dynamic environment. Some of the prominent ones are mass customization, lean enterprises and agile organizations. The foundation of all these strategies lies in building organizational flexibility. The way to build flexibility into the organization is to build flexibility into various entities of the organization. Teams represent one such important entity. Building flexibility into PD teams would make them more responsive to market and customer demands, thereby making them more effective to cope with dynamic environment increasing.

2 Product Development

Product Development (PD), essentially, is a process of transforming an idea to a product (Ulrich and Eppinger 2004). It consists of sequence of steps ranging from identification of market opportunity to production and sale and delivery of the product (Ulrich and Eppinger 2004). In its simplest form, a PD process can be

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visualized to be made up of three phases – early, mid- and late phases (Frishammar and Ylinenpaa 2007). The 'early phase' includes activities ranging from identification of product opportunity to building product concepts. This phase is followed by 'mid-phase', wherein the concepts are developed into detailed designs leading to development, testing and validating the product. The 'late phase' involves the commercialization and launch activities. For this work, we have focused on the 'mid-phase' and shall be henceforth termed as 'design and development phase'.

In a dynamic environment, the applicability of a traditional approach becomes untenable. A traditional approach of PD involves clear-cut product definition, known as 'concept freeze', followed by execution. This approach would be suitable when the environment is fairly stable, and it is possible to accurately anticipate the required information (Bhattacharya et al. 1998; Biazzo 2009). However, in case of dynamic environment, anticipation is difficult. In such cases, it is recommended to make the PD process more 'reactive', i.e., build the ability to rapidly and efficiently introduce modifications till late in the project (Verganti 1999). This kind of approach requires PD teams to quickly and nimbly react to changes without sacrificing their efficiency. There are empirical evidences to suggest that the approach of flexibility in PD was beneficial for organizations to reduce the cost of changes, thereby minimizing the impact of forecasting errors (Thomke and Reinertsen 1998; Thomke 1997).

3 Flexibility

Flexibility, in a broad sense, is defined as the 'ability to adapt' (Golden and Powell 2000). This leads us to a question of adapt to what. The study of literature reveals that flexibility is about adapting to change (Evans 1991; Das and Elango 1995; Golden and Powell 2000; Beach et al. 2000) and uncertainty (Adner and Levinthal 2004; Olsson and Magnussen 2007; Sethi and Sethi 1990; Golden and Powell 2000). The association of flexibility with change is more apparent than with uncertainty. This is evident in the way flexibility is conceptualized. For example, in conceptual framework proposed by Golden and Powell (2000), flexibility is seen as means to deal with foreseen and unforeseen changes. The unforeseen changes can be understood to refer to uncertainty. In this paper, we consider both change and uncertainty aspects explicitly and hence define flexibility as the '*ability to deal with change and uncertainty*'.

It is to be noted that change and uncertainty represent two different scenarios an entity (say a team or organization) has to deal with, although there is a possibility of one causing the other (Smith 2007). Uncertainty represents a condition in which there is an absence or lack of complete information. Although the definition of flexibility sounds very simplistic, researchers have always found flexibility to be a 'hard-to-capture' construct (Sethi and Sethi 1990). Its polymorphous and multidimensional nature makes it domain and context specific. In this paper, the concept of flexibility is studied in the context of teams involved in PD activity, termed as PD team flexibility. This research contributes to the ongoing study on team flexibility, which is in early developmental stage Li et al. (2010).

4 PD Team Flexibility

According to Cohen and Bailey (1997), a team refers to 'A collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as a social entity embedded in one or more larger social systems and who manage their relationships across organizational boundaries'. A PD team is essentially a cross-functional team, formed with personnel from different functional departments to support the design, development and production of a new product.

The context of teams in PD organizations is an important one to understand. In a changing and dynamic environment, PD activity has increasingly become team driven to achieve higher performance. Organizations set up cross-functional teams to react quickly and effectively. Their functional diversity is presumed to provide the advantage of dealing with any challenges effectively, thus resulting in improved performance. Building the capability to deal with change and uncertainty i.e. flexibility is an important aspect of building successful PD teams.

4.1 Definition

PD team flexibility is defined as the '*Ability of a product development team to handle socio-technical changes and deal with uncertainty during course of PD by means of appropriate resources*'. This definition is more comprehensive from the earlier ones proposed by scholars (Mccomb et al. 2007; Lee and Xia 2005). It is antecedent-based, similar to definition proposed by Mccomb et al. (2007), with a focus on the resources of the team that create flexibility. Further, the scope of changes is socio-technical as in Lee and Xia (2005) and also includes the uncertainty aspects experienced by the team, which so far was not considered explicitly in earlier studies.

4.2 Conceptual Framework

Based on the findings from the literature related to flexibility and team flexibility, PD team flexibility was conceptualized to include two major capabilities: (1) ability to cope with changes, i.e. change management, and (2) ability to deal with uncertainties, i.e. uncertainty management. The change and uncertainty a team has to deal is context dependent (say the stage of PD, type of industry, etc.).To cope with these changes and uncertainty, the PD team makes use of available resources. The resource-based perspective suggests that a team can be visualized as a bundle of resources (such as people, technology and structure), each with its own enabling impact on increasing flexibility. Ultimately, team flexibility has an impact on team performance. It affects the efficiency and effectiveness of the teams. A point that should be noted is the relationship of team flexibility on performance is often dependent on other variables such as product complexity and team size, thus making the relationship situation dependent.

5 Structural Resources

There are many resources that help in building flexibility. Humans with their skills, attitude and behaviour are amongst the most flexible resources (Aggarwal 1995). The other resources include technology and organization structure. Drawing on the resource-based view, we can visualize teams to be combination of resources, each with their unique ability towards contributing to competitive advantage. Teams' structure can be considered as a resource that contributes towards team flexibility. Structure in organization design literature is viewed as a means by which organizations achieve desired objectives and performance levels through allocation of responsibilities and exercise of control over resources. It plays a central role in the way formal reporting relationships are defined; individuals are grouped together and in establishing mechanisms for communication, control and coordination amongst and between units of the organization (Daft 2007). Structural mechanisms represent the means through which an organization gets the work done (Tatikonda and Rosenthal 2000).

For this study, we identified structural practices popularly used by PD teams in managing change and uncertainty. The degree of implementation of these practices has an impact on teams' ability to deal with change and uncertainty. They are (1) Participative Decision Making (PDM), (2) Delayed Decision Making (DDM), (3) Task Autonomy (TA), (4) Formalization (FRM) and (5) Review Procedure Strictness (RPS). Although these practices do not represent the complete set of activities, they do represent an important subset. A high degree of PDM and higher DDM result in increasing the information flow (Lowin 1968; Lam et al. 2002; Bordia et al. 2004) and duration of flow (Olsson 2006; Smith 2007), respectively, thus reducing uncertainty. A high degree of TA, low degree of FRM and low RPS will provide sufficient leeway to the team in effectively managing changes (Hackman 1980; Langfred and Moye 2004; Sethi and Iqbal 2008), thereby increasing overall PD team flexibility.

6 Methodology

6.1 Questionnaire Development

We adopted an ex post facto, survey-based and cross-sectional design. A total of 120 responses were collected from PD teams in public and private sector. Convenience sampling strategy was adopted for this study. The unit of analysis was teams. The population for the study was PD teams in public and private sector companies. Public sector was represented by teams in defence-based R&D companies, whereas private sector by software PD organizations. Target respondents were team leaders or/and managers involved in design and development phase of the PD. The survey instrument for the study was developed exclusively for this study and underwent two rounds of pretesting. Majority of the items used for measuring the variables were sourced from literature. The final questionnaire consisted of 48 questions, distributed in four parts. A five-point Likert scale was employed for capturing the responses. Reliability and validity was established. Content validity was established by seeking expert opinion. Cronbach's alpha was used as a measure of reliability. A value of 0.6 or above has been recommended for exploratory study (Nunnaly 1967).

6.2 Data Collection Procedure

Data required for the study was collected in two phases (pilot and main). Companies with more than 10 years of PD experience and employing more than 1,000 employees were preferred. Contact was made with respective HR heads or through known individuals in top management. Of the companies contacted, four accorded permission (1 – private, 3 – public). The teams that participated in this study were identified by the HR heads or PD heads. The criterion for participation was based on the minimum experience level of the respondent (5 years for private sector and 8 years for public sector). The minimum limit was arrived at based on discussions with heads of the companies during the course of data collection. The questionnaire was administered personally to all the respondents.

7 Analysis and Result

Before any of the results are to be presented, it has to be emphasized that this chapter is a part of a larger study that was conducted to assess the impact of structural antecedents on the efficiency of PD teams. The results reported here are limited to only the main focus elements of this chapter, that is, participation and control (PAC) and time-bound formalization (TBF). Factor analysis was performed separately on teams' structural practices related items. Five factors were extracted which accounted for 63% of variance. These were (1) participation and control (PAC), (2) time-bound formalization(TBF), (3) review procedure strictness (RPS), (4) progressive decision making (PDM) and (5) procedural autonomy (PRA). Of these five factors, two (PAC and TBF) which accounted for major portion of variance (37% of the total 63%) of the accounted have been considered for this study. Refer to Table 1.

Table 1 Partial results of factor analysis of PD teams' structural practices

Items	1. PAC	2. TBF
Team members were actively involved in product-related decision making	**0.602**	0.050
Inputs provided by team members are given due consideration during decision making	**0.879**	0.068
Supervisors and managers are supportive of the decisions made by the team	**0.667**	0.062
Team has control over sequencing of the work activities	**0.277**	−0.196
Mostly, product-related decisions were taken just on time	−0.025	**0.263**
Formal rules exist for carrying out every task	0.114	**0.668**
Formal procedures exist to deal with every possible situation that may arise during the course of execution of tasks	0.135	**0.770**
Team does not have to strictly adhere to the procedures for doing the tasks	−0.065	**0.576**
% variance (cumulative %)	*20.298 (16.317)*	*16.317 (36.614)*
Cronbach's alpha	*0.703*	*0.631*

The figures marked bold correspond to the highest factor loading for the respective item

7.1 Participation and Control (PAC)

Factor 1 consists of items related to team members' involvement in decision making and control of PD activity. The factor represents both participation and control enjoyed by teams during design and development activity. Hence, it has been named as 'participation and control' (PAC). Participation and control are two different aspects related to decision making. While participation represents exchange of information between during decision making, control represents the actual autonomy enjoyed by the teams to take decisions collectively without any external interference. Greater team participation and greater team control would eventually lead to self-managed teams. Studies related to organization development have looked at participation and control separately while designing organizational structures. But, in this study, the factor PAC appeals for looking at these elements together in the interest of team flexibility.

PAC scores were compared across small and large teams. Large teams were those which had more than ten team members. Comparison was performed both at the item level and at the factor level using 2-sample independent *t*-tests (Table 2). Comparison of items related to PAC did not result in significant difference across small and large team sizes; similar was the case at the factor level too. This suggests the extent of PAC implementation was similar in small and large teams. This was quite contrary to team-based literature, which suggests that extent of team participation will be higher in case of smaller teams compared to large teams. The result points to an interesting and prevalent aspect of organizations' implementing practices that are similar in nature across small and large teams. In other words, for the present sample, the organizations have not differentiated small and large teams'

Table 2 Team size-based comparison results of PAC

Items	Mean (SD)		p Value
	Large ($n = 45$)	Small ($n = 59$)	
Team members were actively involved in product-related decision making	3.58(0.988)	3.78(0.832)	0.273
Inputs provided by team members are given due consideration during decision making	4.09(0.733)	4.08(0.566)	0.974
Supervisors and managers are supportive of the decisions made by the team	4.07(0.759)	4.07(0.583)	0.997
Team has control over sequencing of the work activities	3.76(0.830)	3.63(0.807)	0.430
Participation and control [PAC]	0.00(1.054)	0.009(0.809)	0.927

requirement, and hence we find no significant difference. PAC contains two attributes – participation and control. Increasing PAC would require increasing both team participation and team control. The latter is much more challenging to achieve. Second interpretation of the result is possibly that in the design and development stage of PD, it is possible to achieve similar extent of participation and control in small and large teams. This in turn implies, while structuring PD teams, especially large teams, proper measures have to be adopted to bring the extent of team participation on par with the small teams. This observation is under the assumption that smaller teams enjoy a greater degree of participation.

7.2 Time-Bound Formalization (TBF)

Factor 2 has items related to existence and adherence of formal rules along with a definitive time frame for executing decisions. This factor has dimensions of time and formal rules describing it. In a broad sense, it denotes a time-bound implementation of rules and procedures during the course of PD. Hence this factor is named as 'time-bound formalization' (TBF). The factor emphasizes the importance of time limits when implementing formal rules and procedures governing task execution or decision making while handling change and uncertainty. Organization literature does talk about formalization aspects; however, there is no direct mention of timelines w.r.t. implantation of these. This factor, in the interest of team flexibility, emphasizes the need to actively consider the dimension of time in introducing formalization aspects.

In a conceptual sense, the use of formalization techniques is attributed to job standardization and reduction in variance of output. In the context of PD, a low degree of formalization would be helpful in dealing with situations in PD as each situation is unique, and hence, it can be argued that governance by rules would affect the teams' performance. This argument seems to be fine in the context of

Table 3 Team size-based comparison results of TBF

Items	Mean (SD)		p value
	Large (n = 45)	Small (n = 59)	
Mostly, product-related decisions were taken just on time	3.070(1.074)	2.830(0.931)	0.243
Formal rules exist for carrying out every task	3.290(1.100)	3.410(0.893)	0.559
Formal procedures exist to deal with every possible situation that may arise during the course of execution of tasks	3.000(0.953)	3.070(1.015)	0.727
Team does not have to strictly adhere to the procedures for doing the tasks	2.910(0.900)	3.020(0.919)	0.557
Time-Bound Formalization [TBF]	−0.033(0.924)	0.027(0.857)	0.735

small teams, but in large teams, when participation is increased, the time required for decision making also increases. In such situations, a time boundedness would be rather helpful. In other words, TBF has to be considered in the light of PAC. In the present study, the extent of TBF remained same across small and large teams, with no significant difference emerging in case of both item and factor scores. The result points to existence of TBF to a similar degree in both small and large teams, which in turn consolidates the previous finding (in PAC) regarding organizations using similar structural practice for small and large teams. The effect of TBF on small and large teams is similar (Table 3).

8 Summary

PD team flexibility is an important consideration in the currently team-driven PD industry. It provides the means to cope with change and uncertainty. PD team flexibility can be improved by designing structural practices which are predisposed to contribute to flexibility. Two such antecedents that play a crucial role in improving team flexibility are PAC and TBF. Structural practices designed around PAC and TBF can impact PD team flexibility significantly.

PAC emphasizes the importance of teams' prerogative in decision making and execution in terms of both participation and control. While achieving higher participation is possible, transferring complete control to team is a challenging one. The implementation of PAC is even more challenging in case of large teams, as it requires a considerable effort and coordination. In the present study, we could not find evidence of it. The results also point to a similar PAC adoption in the design and development stage during design stage of PD.

TBF is another antecedent that can impact flexibility. A low degree of formalization, with time-bound implementation can contribute to improving team flexibility.

This is especially helpful in case of large teams as it seeks to offset the increased time consumption due to implementation of PAC. This practice in conjunction with PAC would complement the efforts to increase flexibility. The comparative study did not yield any significant difference for impact of TBF in small and large teams suggesting that organizations use similar structural practice for small and large teams.

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Developing Sustainable IT Market Information Services: The Case of Esoko

Olayinka David-West

1 Introduction

In Africa, agriculture remains the major source of livelihood for about 60% of the population but only amounts to 17% of its total gross domestic product (GDP). The nascent nature of agriculture in developing economies vis-à-vis the potential and opportunities abound has contributed to the classification of agriculture initiatives as developmental and often the responsibility of governments and/or developmental agencies that have developed established structures and processes for agricultural extension. The need to close this gap has been identified as one of the high-level objectives of the New Partnership for Africa's Development (NEPAD) through investments in numerous initiatives including "soft" infrastructure projects that facilitate access to accurate price and market information (Harsch 2004) and hence market information services (MIS).

MIS are part of a group of innovative farmer advisory services supporting the collection and dissemination of agricultural information to farmers and other stakeholders using voice, radio, mobile, etc. (Gakuru et al. 2009). MIS aim to increase the efficiency of agricultural markets and contribute towards overcoming issues of market failure based on inconsistent access (Ferris et al. 2008). As such, MIS assist farmers in their ability to monitor market conditions, make better decisions on where to sell their produce, and negotiate for improved prices rather than being compliant price takers. MIS are beneficial to rural and travelling traders who have less access to market information than their urban counterparts and in need of assistance in decision-making and identification of opportunities. MIS market data is also useful to

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financial institutions providing them the ability to monitor the long-term health of the economy and, in the short term, assess the risk of lending to both large-scale individual farmers and cooperative farming groups. For policy makers and researchers, current and historical market information from MIS are used to review shifting market patterns and to assist in planning processes such as finding ways to foster market growth, planning for provision of appropriate marketing institutions, and making decisions on when and where to invest in new marketing infrastructure (Ferris et al. 2008).

In spite of the benefits to farmers, financial institutions, and policy makers, the long-term support of MIS is fraught with scepticism from donors and government agencies for reasons including but not limited to (1) poor historical performance of government-managed MIS, (2) long-term funding requirements, (3) lack of evidence to show the value of market information as a tool to assist farmers and farmer groups to make better marketing decisions and increase their incomes, and (4) bias towards farmers and rural traders (the major MIS beneficiaries) (Ferris et al. 2008). Typically deployed by public sector government agencies and/or donor-supported agencies, MIS failures are associated with:

- Over emphasis on MIS design as opposed to commercial viability and sustainability (Shepherd 1997)
- Time- or project-bound nature of donor-supported MIS where initiatives expire once funds or timeframe elapse (Ferris et al. 2008; Shepherd 1997)
- Operational difficulties and challenges in the collection, processing, transmission, and dissemination of MIS data (Shepherd 1997)

Recent advancements in information and communications technologies and their opportunities in enhancing operations and extending reach have not gone unnoticed by development agencies. As such, IT-based MIS using the Internet, mobile technology, etc., are gradually evolving, whilst issues associated with sustainability and the short-term nature of MIS remain. The resultant impact of these MIS challenges has led to a significant shortage of services amongst needy beneficiaries. These vulnerabilities are confirmed in Garku et al.'s (2009) inventory of MIS in Africa, where of 61 MIS reviewed, 41 (75%) were classified as active, 4 (6%) either undergoing design or implementation, 5 (8%) as completed (expired), and 6 (10%) unknown. Of the active projects, further analysis revealed that 7 (17%) have since elapsed, 2 (5%) continued independently, and donors were substituted in 3 (7%) of the projects. However, whilst commercially viable and sustainable MIS are feasible, they are not widespread. This chapter seeks to identify factors for the development and sustainability of agricultural MIS as well as to propose an exploratory model for sustainable and commercially viable MIS is in emerging economies.

This study was conducted as part of a larger project on inclusive business models, an initiative of the Growing Inclusive Market (GIM) team of the UNDP. Through research initiatives, the GIM initiative seeks to understand inclusive markets from enterprises in Africa, Asia and the Pacific, Eastern Europe (EE), and the Confederation of Independent States (CIS), as well as Latin America and the Caribbean, in a bid to foster the development of inclusive markets that will create opportunities for the world's poor. Using the case study method in the study of

Esoko, the objectives stated earlier were addressed in the quest for identifying factors influencing MIS sustainability. Based on a single MIS case, this chapter proposes an exploratory model of sustainable MIS that can be further developed with multiple cases that facilitate cross-case analysis and theoretical saturation (Eisenhardt 1989). The remainder of this chapter is set out as follows: Sect. 2 introduces Esoko and extant literature on sustainability in general and with reference to IT initiatives. Section 3 presents an overview of the method employed, and Sect. 4 outlines the results. Section 5 discusses these results. Finally, Sect. 6 summarises and concludes this chapter and identifies implications for future research.

2 Sustainable Market Information Services

2.1 Introducing Esoko

Esoko, or markets in Swahili, is an MIS that evolved from its earlier version called TradeNet. Initially conceptualised as a single MIS operated by a central entity such as a government agency, Esoko offers extension services for multi-market, multi-commodity, multi-currency, and multilingual markets. Using global systems for mobile (GSM) technologies, Esoko collects and distributes (pushes) market information as short message service (SMS) alerts or text messages to subscribers. Esoko is complemented by a website (www.esoko.com) that distributes market information such as commodity prices, buy/sell offers, etc., on a self-service basis and also provides institutional farmer communities access to the web market sites. In addition to the recipients of market information (sellers), additional MIS stakeholders are present across the agriculture value chain, including agricultural processors, farming associations/communities, buyers, governmental and non-governmental agencies such as development partners, etc. Esoko facilitates the development of commodity marketplaces that can be deployed and operated by franchise and/or association partners, development agency projects, and public sector government services for the benefit of farmers and/or traders that receive the information over mobile networks. A summary of Esoko services, audience, and distribution channel is included in Table 1.

The Esoko system is developed in Accra, Ghana, by a team of local and international professionals. To date, Esoko has been deployed in support of projects such as the Market Information Systems and Traders' Organisations of West Africa (MISTOWA) project funded by the United States Agency for International Development (USAID) and as an independent service in countries like Afghanistan, Ghana, and Nigeria.

2.2 Sustainability

Sustainability simply refers to a capacity to maintain an entity, outcome, service, or process over time. Jenkins (2009) identifies three sustainability factors – economic,

Table 1 Summary of Esoko services

Service	Description	Target	Channel
Mobile alert	SMS text alerts of prices and offers despatched to subscribers based on defined preferences	Individual farmer/ trader/buyer	SMS
Direct marketing	SMS-based direct marketing platform available to business subscribers to facilitate information sharing	Farming/trade association/community	Internet SMS
Scout	Applications that can be used to build polls by providing participants in the field send information back. This application can facilitate Q&A and other services	Farming/trade association/ community, FMCG	Internet SMS
Market sites	Promotional website for business subscribers such as farming/ agricultural communities offering them a web presence	Farming/trade association/community	Internet
Prices	Historical collection of market-based commodity process	Individual farmer/ trader/buyer	Internet
Buy/sell offers	Offers are user-generated notifications/ solicitations for products available for sale or purchase, respectively	Individual farmer/ trader/buyer	Internet SMS
News and Library	General information resources dedicated to sharing/distribution of multimedia content	All	Internet

environmental, and political. Economic factors explain the natural, financial, and capital aspects; ecological factors define the biological diversity and ecological integrity; and political factors aim at social systems that realise human dignity.

From the IT perspective, the assessment of sustainability in the evaluation of success and failure of IS projects resulted in the identification of ten elements and classified as either critical success factors (CSF) or critical failure factors (CFF) (Heeks and Bhatnagar 1999). This group of ten factors includes environmental and political factors but excludes the economic perspective. Other elements include information, technical, people, management, process, cultural, structural, and strategic. The information factor relates to the quality and quantity of the information content; the technical factor defines the technology including hardware and software infrastructure and configurations. People and managerial factors encapsulate the employee skills and competencies both at the operational and managerial levels, respectively. Process factors seek to ensure that information serves cross-functional groups and provides the relevant feedback. Organisational cultures in the workplace permeate IS projects as cultural factors. Complementary organisational structures that support the flow of information make up structural factors. Strategic factors are defined by a strategic and cross-functional approach to IS deployments. Political factors mask themselves in both public and private sector projects in the form of executive leadership and championing of the IS initiatives. Finally, environmental factors are present when the IS projects support environmentally friendly initiatives.

In rural India, Kumar and Best (2006) exploited the CSF and CFF model in the specification of the sustainability failure model for e-Government projects. They identified 5 factors of sustainability – financial, cultural/social, technological, political/institutional, and environmental. Economic factors define the financial and capital resources required to sustain the IS project; political factors relate to the institutional support mechanisms to avert project failure; cultural/social factors define the social impacts of the project which if negative to groups or stakeholders may affect project sustainability. Environmental/ecological factors are cognisant of environmental impacts, and technological factors define hardware and software resources.

Harmon and Auseklis (2009) introduce the second wave of sustainable IT services extend IT sustainability beyond data centre efficiency and the minimisation of carbon footprint to include the long-term importance of IT to organisations, customers, and society at large. In this context, dimensions of sustainable IT services include service, temporal, cost, organisational, and environmental. Service factors refer to the processes for the delivery and continuous operation of IT services; temporal factors to the clear understanding of the business, customer, and/or societal value derived from the deployment of IT services. Cost services are associated with the financial costs associated with the acquisition and operation of IT services that are supported by organisational factors such as innovation in a rapidly changing environment. Finally, environmental factors refer to the inclusion of environmental choices in the delivery of IT services.

Whilst economic, environmental/ecological, and political factors are common, in the IS context, technology and culture are integral characteristics in the operations of IS that have been defined by Kumar and Best (2006) and Heeks and Bhatnagar (1999). The roles of process, strategy, structure, people, management, and information defined in the CSF and CFF and partly by Harmon and Auseklis (2009) cannot be underestimated in enterprise IS projects that have been known to fail for non-technical problems such as incompatible structures (Heeks and Bhatnagar 1999) and many others. The summary of factors in Table 2 shows that whilst all ten factors proposed by Heeks and Bhatnagar (1999) are relevant, finance cannot be understated. Although the environmental definitions somewhat vary, the support MIS render to the environment is more appropriate than that proposed by Harmon and Auseklis (2009). Thus, the ten factors including economic form the initial list to be employed in the data analysis.

3 Method

This study employs the case study method (Yin 2003) for an in-depth analysis of an emerging market MIS, Esoko. The case study method is based on the research design developed by the UNDP GIM programme (UNDP Growing Inclusive

Table 2 Summary of sustainability factors

Harmon and Auseklis (2009)	Jenkins (2009)	Kumar and Best (2006)	Heeks and Bhatnagar (1999)
Cost	Economic	Economic/ financial	
	Political	Political	Political
			Information
		Technological	Technical
Organisation			People
			Management
			Structural
Service			Process
		Social/cultural	Social/cultural
Temporal			Strategic
Environmental	Environmental/ecological	Environmental	Environmental

Markets Initiative 2009) that sought to understand the business model and identify the role of actors or participants and the results of inclusive business models using in-depth structured interviews. The depth of analysis provided by the case study method makes it an appropriate strategy for the analysis and understanding of sustainability in business models such as Esoko. The case-based research approach adopted for the entire GIM project corresponds with the nine activities elaborated by Eisenhardt (1989). However, in the case of this study, the primary activities conducted include case selection, fieldwork (data collection), and within-case analysis.

3.1 Case Selection

From over 1,000 inclusive businesses identified as possible case study candidates, 100 possibilities were short-listed by the GIM core team. Criteria used in the selection of the 50 cases included human development and poverty alleviating impact, commercial viability, environmental sustainability, potential for growth, replication, and significant impact, stakeholder relationships, and innovation (UNDP Growing Inclusive Markets Initiative 2009).

3.2 Data Collection

Semi-structured interviews were conducted in September 2009 at the Esoko Ghana offices with members of the Esoko team in using the GIM research protocol comprising of questions seeking the creation, distribution of value alongside actors, and impacts (UNDP Growing Inclusive Markets Initiative 2009). In addition to the interview with the CEO and founder of Esoko, additional interviews were conducted with personnel in product development, franchisee business development, partner development, enumeration manager, monitoring and evaluation, and financial management. Internal company documents were also acquired during the course of the interviews.

3.3 Data Analysis

Transcripts of the recorded interviews were produced and imported into qualitative data analysis tool, Nvivo version 9, for subsequent analysis. Using the list of extant dimensions of sustainability as a starter list of codes (Miles and Huberman 1994), provisional and holistic coding techniques (see Saldaña 2008) were applied to the data in two coding cycles. The first cycle of coding was used to generate Nvivo nodes for extant sustainability categories whilst the second cycle employed in vivo and versus coding techniques comprising of direct phrases from interviewees and comparisons, respectively. Although the absence of multi-case data made cross-case analysis impossible, within-case analysis was facilitated by the various roles of the interviewees within the organisation. The analysis of the documents and interview transcripts resulted in 14 emergent factors of MIS sustainability that are presented in the results section and substantiated by quotations.

4 Results

The exploratory model of sustainable MIS illustrated in Fig. 1 comprises of 14 factors in 3 dimensions – consumer, organisational, and institutional.

4.1 The Consumer Dimension of Sustainability

Information and usability impacted by culture are evident at the consumer level. Information that is foundational to MIS is characterised by multiple markets, agricultural commodities, and currencies – that are consumed by farmers, traders, etc., and subject to usability factors such as ease of use, reliability, accuracy, etc.:

> And the other thing is that most of the people from the market told us consistently from the start that they never trusted government data, that they felt that government data was first of all very difficult to access and it was frequently inaccurate and the best data that they can get is from themselves and from their traders.

The ICT orientation of MIS also subjects usability to technology adoption factors that are embedded in culture:

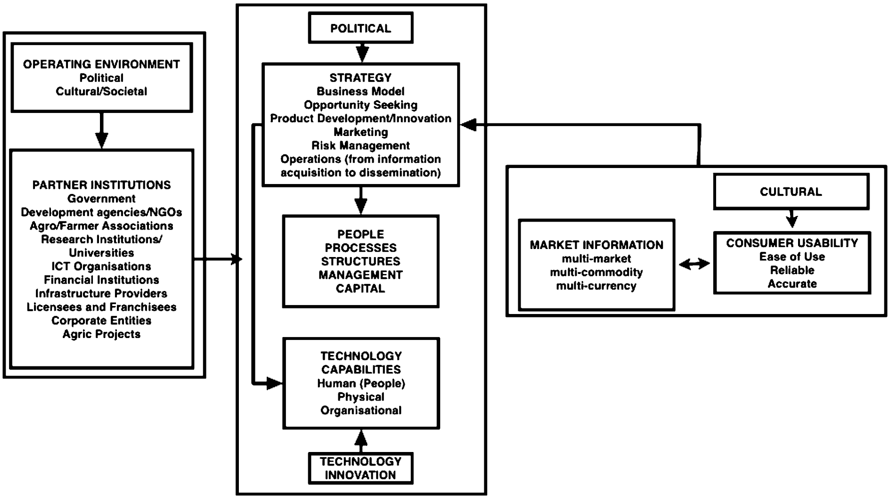

Fig. 1 Exploratory model of sustainable MIS

> We are dealing with mostly conservative communities that have done things in a specific way and aren't particularly tuned in the new technologies.

The demand for accurate, reliable, and usable information influences the organisational strategy and the MIS provider organisation. The embodiment of field-based enumeration services into the MIS organisation not only ensures information accuracy, timeliness, etc., but also serves as a feedback loop from the monitoring and evaluation perspective:

> Another reason we have the enumeration staff is not only to gather market information but also to make sure that those information reach the top management as a feedback and they proffer ideas on what will make the company move forward.

4.2 The Organisational Dimension of Sustainability

At the organisational level, sustainability is expressed through strategic thinking and orientation, people, processes, structures, management, capital, and technology that are directly influenced and driven by political will and determination. The elements of strategy are founded in the conceptualisation of Esoko as a commercial entity enforcing the focus on strategic attributes like the business model that encompasses the value proposition; financial, distribution, and operational models; risk management; competition; etc. The significance of the business model is succinctly described as a fundamental of any business venture:

> I think MIS never had a business model. I mean Bloomberg does.

The opportunities abound in the ICT-based MIS were also evident in the conceptualisation of Esoko:

> Agriculture projects were trying to build software and that was a recipe for disaster. As a software and businessperson, I thought that was a great opportunity to build a product that will be cheaper and better for all of these products and projects to use.

Whilst Esoko's founder quickly identified the opportunities in MIS, capacity differences between software development and agricultural initiatives were evident:

> Software companies build software and agriculture projects do capacity building or seed distribution. So it is different kinds of skills for different companies.

Embedded in this business model are consumer and partner engagement strategies that are also commercially oriented and can be implemented as business entities. Consumer engagement is facilitated by the organisation structure where enumeration agents responsible for collecting market prices also seek feedback and through monitoring and evaluation (impact assessment) initiatives. For partner engagement, the Esoko team have developed a toolkit comprising of business development aids for commercial operations:

> We have tried to develop a franchise model that presents it as a profitable business opportunity and we are looking to attract individuals, companies, organisations, partners in countries to do it that way.

The presence of a strategy influences the organisation and its operations including the human resources, business processes, organisational structures, management capacities, capital, and technology as explained by Esoko founder:

> Software is never finished and when you launch a product, that is when it actually begins because that's when you actually have people using it and nobody uses it in a way you imagine they will. So you have to be listening, you've got to be watching and you've got to have the capacity to continue your technical development. So from our point of view, we have not developed a product, we have developed a capacity and a team.

With technology rapidly advancing, technological innovations that ensure usability and conformance with global standards are mandatory:

> So as we better understood the market and as we began also witness some of the ways in which technology was evolving with social networks like Facebook and Twitter, and where we saw more user generated content and I think that's how we began to understand how we can use technology.

4.3 The Institutional Dimension of Sustainability

Institutional sustainability, although derived through various partnerships, is constrained by the operating environment comprising of political and cultural factors. The development of Esoko would have been challenging without agriculture extension expertise and funding from developmental agencies; however, additional institutional relationships, such as those with mobile telecommunications operators whose networks facilitate the distribution of SMS market information, are mandatory. In addition to the transmission of SMS messages, the dispersion of mobile networks can also facilitate the direct and independent retail of Esoko and Esoko subscription fees debited from mobile call credit:

> We are looking at having an agreement with the mobile service providers to upgrade our service as an option in their network.

In contrast to enterprise IT systems and services, the service-oriented nature of MIS forms their dependence on institutional alliances that distribute the service, provide access to farmers, capital, etc., that are however influenced by environmental, political, and societal/cultural factors in developing countries like Ghana where this is evident in the absence of a high-tech industry and personnel:

> One of the difficulties we are facing is in the highly skilled sector like software, which is mostly non-existent in Ghana, is bringing in some of the capacity to train up local staff. I think that some of the immigration issues has been problematic for us and I think that we need help advocating with the government that we are not displacing a local industry, we are actually creating a local industry and that if you don't bring in that expertise.

Informed understanding of the cultural and adoption issues has influenced the development and deployment of Esoko, which according to the product development manager is complemented with appropriate teaching aids, processes, and structures:

> It's not just releasing software and saying ok anybody can use it. It is also providing guidance and putting people there to make sure they have access to the platform.

Although technology knowledge is an important factor in the adoption of ICT-based MIS, the Esoko founder establishes the relationship between the value proposition and technology adoption:

> You also can see that given the right value proposition, every single one of them is capable of learning those technology tools and using them to their advantage.

Finally, even though environmental factors are not explicitly derived from the interviews, ICT-based MIS are not damaging to the environment in the provision of alternative (non-paper) distribution channels for extension information:

> I'm sure people will be sending out wedding and death notices on the SMS. I think that they will be saving fuel costs and not in adding to the pollution, with transport, we'll be able to allow people to find trucks that are moving back and forth and reduce the number of trucks. So indirectly the impacts on the environment could be significant because you're just making markets work more efficiently.

5 Discussion of Results

The proposed 14-factor model of sustainable MIS illustrated Table 3 can be associated with Harmon and Auseklis' (2009) definition of societal sustainable IT services – "the aggregate value available to society from the systematic integration

Table 3 Emergent factors of MIS sustainability

Consumer	Institutional	Organisational
Information: multi-market, multi-commodity, multi-currency market information	*Environmental*: initiatives that protect the environment	*Strategy*: of commercially oriented tactics
usability: initiatives that ensure market information are accessible and usable by farmers	*Political*: the political constraints in the environmental environment and executive leadership in the MIS provider organisation	*Technology*: hardware, software, and technical skills and competencies
	Societal/cultural: social and cultural perspectives of the operating environment and the consumers	*Structures*: structures that ensure all required activities are conducted
	Partnerships: the various institutional relationships required to maintain the MIS	*Management*: managerial skills and competencies
		Processes: processes to support MIS activities
		People: operational skills and competencies
		Capital: financial resources required develop and support innovation capacities
		Technology Innovation: the wherewithal to extend the MIS features in given technological advancements

and alignment of the individual IT service components for the purpose of creating superior societal value". In conclusion, whilst organisational factors positively influence MIS, inhibitors are typically in the external institutional factors, and depending on the inclusion of feedback mechanisms, the consumer factors may be either influencing or inhibitive.

6 Limitations, Future Research, and Conclusion

Although commercially viable MIS are not widespread, this study shows that, using services such as Esoko that offer dynamic distribution models, MIS can easily be deployed globally. Although these findings, based on a single-case, are a limitation, it serves as a research opportunity where data will not only facilitate cross-case analysis but also ensure theoretical saturation. The exploratory model proposed could serve as a guide to governments and development agencies considering the transformation of current agricultural services to ICT-based environments and could also guide the development of ICT-based social ventures especially in the agriculture sector. In sum, in addition to the 11 previously identified constructs, consumer usability and partnerships are just as important to the viability and longevity of MIS.

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Design and Development of an Online Database Management System (AGRI-TECHBASE): For Agricultural Technologies of ICAR

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1 Introduction

The Agricultural Research Institutions under the Indian Council of Agricultural Research (ICAR) play a lead role in spearheading the scientific and technological development of the country. With the advancements made by the information technology and the increasing use of computers for the efficient management and dissemination of knowledge, the information systems began to play a vital role in agricultural planning and development (Sunil 2006). As the importance of databases and their management in agriculture is well recognized and as information processing has become the basis of a good decision support system, there arouse a need for finding an ideal solution for creating a well-crafted data management system that gives the power to efficiently direct the intellectual assets of an R&D organization.

The Zonal Technology Management–Business Planning and Development (ZTM-BPD) Unit established at Central Institute of Fisheries Technology, Cochin is the zonal hub for R&D information management in ICAR for South India. The unit caters to the needs of 21 ICAR research institutions that are specialized in areas

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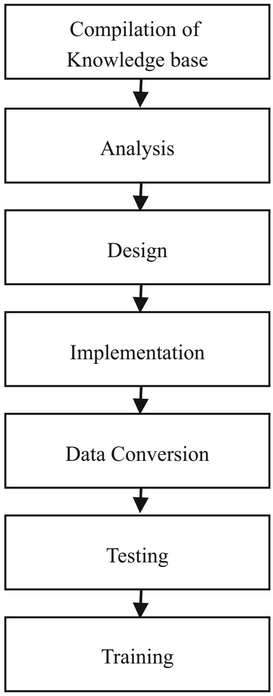
like crop science, horticulture, animal science, fisheries and natural resource management. The role of the zonal institute includes the development and use of a data management system for managing the intellectual assets of member institutes; securing and safeguarding the IPRs; sensitization and capacity building to generate, identify, and protect the IP generated; development of technology evaluation tools; guidance in formulation of model business plans/project reports; technology transfer/commercialization; business promotion through incubation; and reporting the relevant institutional activities to ICAR. In an effort to strengthen the information management capabilities of the member institutes under the zone and to effectively address the related issues and concerns, the ZTM-BPD Unit responded to a call for a new thrust and direction, for providing accurate and timely information, and thereby rationalizing the data management processes in a cost-effective manner. With this objective, the ZTM-BPD Unit conceptualized and developed the Online Zonal Database Management System christened AGRI-TECHBASE, which provides active linkages with all member institutes through a facilitative environment for information processing and technology management.

Without an effective database management system, there will be lack of adequate coordination within the research system, duplication of effort and lack of continuity in building a knowledge base. The process of database management includes the application of management on the deliberate sourcing and organization of information arrangement with the objective of providing the information needed for decisions, through improved efficiency and time effectiveness. AGRI-TECHBASE is a complete database management system that is useful to a research system from the level of the research institute up to the national level. The 21 member institutes can individually access the database through the project website for updating, reviewing and monitoring the complete information database relevant to the respective institute and thereby develop and organize the practice of technology management and innovation. The system can help ICAR in understanding and evaluating the potential technologies and scientific know-how developed and the commercialization and revenue generation activities taken up by the member institutes.

2 Methodology

The methodology followed in the development of AGRI-TECHBASE is based on the nature and assessment of technological assets of member institutions under South Zone. AGRI-TECHBASE was developed using the rapid-prototyping method, using which an application can be developed one component at a time and evaluating it simultaneously. After evaluation, the changes were incorporated, and the process was repeated, eventually leading to the finished application. Each step was iterated for about 2 or 3 months for perfecting the methods used. The rapid prototyping provided frequent checkpoints for monitoring the development process and also for experimenting with troublesome aspects of design and implementation. The different phases involved in the development of AGRI-TECHBASE are depicted in the following flow chart (Fig. 1).

Fig. 1 Phases in database development



Compilation of knowledge base: The first phase consisted of the compilation of the IP assets in the agriculture research institutes in South India. A survey was conducted by the ZTM-BPD team among all the member institutes to collect information regarding the R&D institution and its expertise and facilities; IP assets and their commercial viability were collected through structured schedules created for the purpose. Details of technologies/products developed, products commercialized and IPR portfolios like patents, plant/animal varieties, copyrights, trademarks, consultancy and contract services including analytical, trainings and capacity for imparting training were collected. The process of technology development and status of refinement of technology for commercialization were also recorded. The basic data on the commercial aspects including the investment cost for setting up of a viable commercial venture for making a business plan or a commercial project report were gathered with respect to selected technologies of the zone. The target market, market size and potential as evaluated by the inventors were also compiled.

Analysis: The second phase included assessment of information collected, evaluation of technologies, analysis of requirements and their detailed specification. The existing information management system was reviewed to assess its capabilities and constraints, for identifying alternative system concepts. During the development of online database, heavy emphasis was placed on end-user requirements.

Design: In the next phase, the focus was shifted from an emphasis on the real world to techniques for realizing the application. The data was converted to database table model using an architecture that was simple and easy to understand. As the database covered a wide and diverse range of agricultural information, suggestions of subject experts were taken on case to case basis. As part of involving the end users in the development activity, a demonstration of the sample prototype model was given to the members, to ensure the development of a system that is fully responsive to the needs of the end user.

Implementation: The implementation phase consisted of developing all of the system components like data entry forms and procedures, screens, back-end programming, transfer/processing procedures and quality control procedures (Caldwell 2009). The design model developed during the previous phase was driven into the database structure. As the rapid-prototyping approach was followed in the development of database, it was necessary to field-test each subsystem before going full scale. This field testing involved not only the programme but all aspects of the system (e.g. data collection procedures, training and quality control).

Data conversion: During the data conversion phase, existing data was added to the database. The cases where source data structure did not match the target data structure were identified, and many source databases that had data flaws were repaired.

Testing: After implementation, AGRI-TECHBASE was carefully tested before it was commissioned for actual use. In this phase, the original management requirements were verified, and the system delivers the proper functionality. Testing also uncovered the accidental errors that were introduced during data entry. The application was also tested on multiple operating system platforms before releasing the trial version.

Training: In order to accelerate the users on the system learning curve, a user manual was developed and given to all the institutes. The users were given an initial demonstration on the use of AGRI-TECHBASE, and the user queries were addressed on a case to case basis.

The architecture of AGRI-TECHBASE consists of (1) user interface layer, (2) server layer and (3) database layer. The user interface layer was developed using tools like Dreamweaver, Photoshop, Flash, JavaScript and Ajax. The server layer programming was done using the language PHP. The database layer was developed using the relational database management system MySQL. The web server used is Apache.

3 Results and Discussion

The AGRI-TECHBASE is designed to get more direction and accountability on data management process and to streamline the flow of information from the member institutes to the zonal institute and then to the central headquarters. The system is used by the individual researchers, innovators and other practitioners to locate possible sources of recorded information on R&D activities and technologies, share and exchange information and also identify the potential innovations and

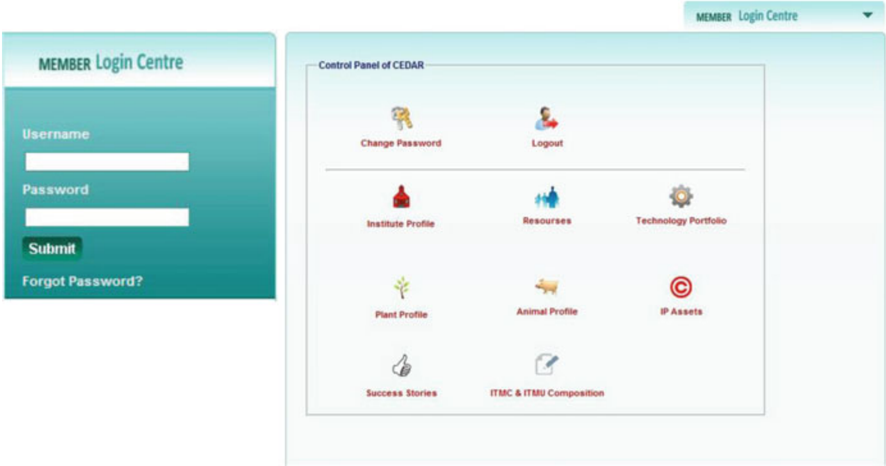


Fig.2 Login area and control panel of the database

breakthroughs. The AGRI-TECHBASE provides a user-friendly environment for evaluating the potential technologies and scientific know-how developed and the commercialization and revenue generation activities of the member institutes.

AGRI-TECHBASE consists of a user console and an administrative console. The member institutes are given permission to access the database through the user console using the unique user ids and passwords assigned to the individual institute.

User console: In this section, the users can input, update, modify and view information regarding technology portfolio, IP assets, success stories, institute profiles, etc. The online documentation provides the ease of reproduction of the documents, maintenance and easy access irrespective of the location.

Administrative console: This console gives access to the administrative module, where the authorized person can view and manage all the master files in the database. The administrator can control the user console and also monitor the data management activities of each member institute (Fig. 2).

3.1 Information Centre

The information centre of AGRI-TECHBASE consists of subsections like Institute Profile, Resources, Technology Portfolio, Plant Variety, Plant Germplasm, Patents, Trademark, Copyrights and Design. The information provided in these sections were finalized with the help of subject experts specialized in the respective fields.

Institute profile: The information given in this section is based on the basic profile details of the particular institute, like the mandate, regional centres, divisions, staff strength, awards received and contact details.

Resources: The details of resources available with an institute includes training programmes, expertise for training, campus facilities, testing, equipment, pilot plant, experimental fields and services offered.

Plant variety: Under the zone, there are research institutions dealing with horticulture crops, plantation crops and tuber crops. In order to include the details of different varieties and hybrids of these plants, details such as name of the crop, year of development, year of central release, inventors profile, parentage, characteristics of the variety like soil type, pH range, disease/pest resistance, unique/distinctive features, period of cultivation and years were included in this section. From a commercialization point of view, information about the market aspects, availability and costs of planting material/seed /propagule, etc., were included. It also includes details of IP protection and technology transfer initiatives for that particular plant variety or hybrid.

Plant germplasm: This section includes details like name of the crop, genetic material, inventors' profile, pedigree of the genetic stock, salient characteristics/chief botanical and morpho-agronomic description, and details of technology transfer.

Animal breed: This section deals with the technologies developed by the institutes under the animal science division. The details given include name of the breed and species, year of development, inventors' profile, present area of distribution, parent stock/pedigree involved in the breed development, mode of breed development, economic traits, status of protection and details of technology transfer.

Animal germplasm: The details include title and nature of genetic material, inventors' profile, pedigree of the genetic stock, salient characteristics and details of technology transfer.

Technology portfolio: The technology portfolio highlights the complete information about a particular technology, including its year of development, name and contact details of inventors, brief description of technology and its claims/highlights/advantages. The market aspects of the technology are also given significance from a commercialization point of view. These include details about the target segment, end-user profile, market size, sales and production capacity, and economics including fixed capital and working capital. The portfolio also covers the former technology transfer initiatives of that particular technology. The user interface of the technology portfolio is depicted in Fig. 3.

Patents: The profile of patents includes details like title, status of protection, date of filing, patent application number, date of grant, patent number, country, applicant, inventors' profile, date of last renewal, amount of renewal fee submitted and date of next renewal.

Trademarks: This section includes details like trademark title, class, type, status of protection, date of filing, application number, date of registration, registration number, country and inventor's profile.

Copyrights: The data consists of copyright title, class, language, contributors' profile, description of work, status of publication, year of publication, country of first publication, publishers' profile and details of income generated from priced publications.

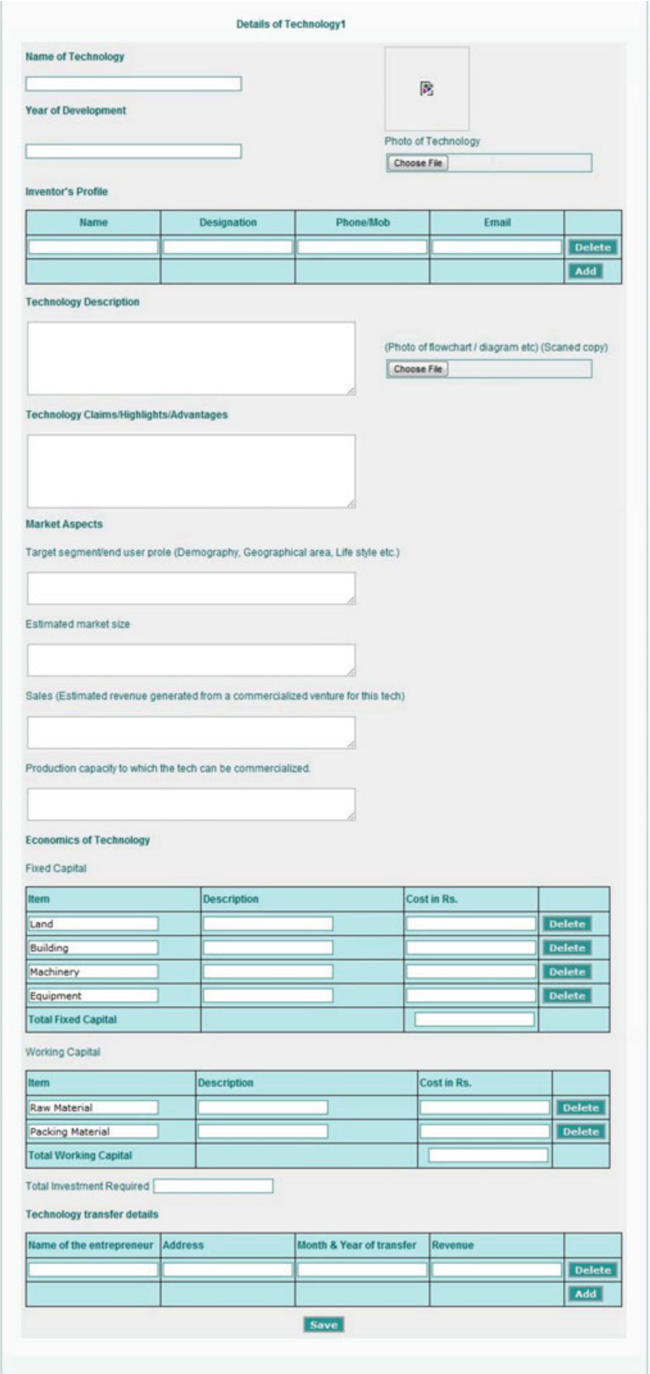


Fig. 3 User interface for technology portfolio

Design: This section is regarding information about an industrial design developed by the institute. The fields are title, description, novelty of design, contributors' profile, details of licensing/transfer of rights, status of protection, date of filing, application number, date of registration, registration number and country.

The benefits of AGRI-TECHBASE can be viewed in two ways: (1) they support the functions of zonal institute, and (2) they support the information and technology management needs of various member institutes under the zone. The adoption of the online zonal database management system has helped in increasing the effectiveness and efficiency of information used by the institutes. As AGRI-TECHBASE is incorporated in the project website, no special hardware are required; any computer with a web browser can access the database. The database runs on a web server so the user can access it from any computer connected to the internet. The development cost was typically lower than stand-alone software. One of the greatest benefits of databases is that data can be shared or secured among different users. There is more control and accountability over how the data is managed because the data all resides in one database.

AGRI-TECHBASE provides good reference for documenting technologies and evaluating which technologies are appropriate for various development zones. It presents advantages, salient features and cost-benefit analysis of technologies in various levels of development. The system provides a simple platform for assessing the existing R&D programs and the current resources. The additional advantages that will accrue are low cost of operation, quick access to all relevant information, integrated, direct and personalized (Singh et al. 2008). Having access to the database at all times from multiple locations is another major advantage of this type of database. With an online database, you could theoretically access the information in the database from any computer. The information is also available 24 h a day, 7 days a week.

A crucial aspect of the system operation phase is the fact that the database design team will end their involvement once the system is completely functional. At that point, it is important that the end user have the technical know-how and resources to continue operation of the system, maintain it and improve it, without further assistance from the project team. Because of the inherent changes in the delegation of posts in a government institution, it became necessary to develop a system that is easy to use and improve and that will not collapse with the departure of a key government person. To accomplish this goal, training materials and procedures were developed, for assuring the continued operation of the system in the future. As an online database is easier to hack and can more easily receive viruses and other malware, there is a need for greater security as well as constant monitoring of the database by knowledgeable personnel (Dizon 2004). With regard to the content management of the website and the database, there are no specialized personnel in the project for web development. This has resulted in the delay in updating of database content due to other official overload.

ICAR has put in serious efforts to develop database management systems for providing information about the current agricultural development, availability and utilization of various economic resources and R&D activities in education sector.

The Indian Agricultural Statistics Research Institute, New Delhi has designed an online management of database on Indian Agricultural Education System through NISAGENET (National Information System on Agricultural Education on Internet). An online data management module has been developed for maintaining and disseminating information on various activities of the agricultural universities like academic, research and extension. The system is capable of maintaining an up-to-date agricultural education data bank of all SAUs and deemed universities of ICAR (Sharma et al. 2006). The National Academy of Agricultural Research Management (NAARM) under ICAR had developed an integrated information system, incorporating the data on academic, research and extension activities of agricultural universities, AGRIUNIS, with support from Department of Science and Technology (Murlidhar and Rama 1996). Indian Agricultural Statistics Research Institute had developed a stand-alone software system NISAGE for storing the information concerning education sector of NARS (Goyal 1998).

4 Conclusion

AGRI-TECHBASE is a unique database management system to help individual researchers, innovators and other practitioners to locate possible sources of recorded information on R&D literature, activities and technologies; share and exchange information, identify potential innovations and breakthroughs; and identify possible sources of support. It helps in analysing, packaging and synthesizing information for various users; refers services on ongoing researches, published literature and technologies; identifies potential users of information; fosters public awareness and understanding of trends in agricultural research, and disseminates, packages and transfers technologies for utilization.

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Integrated AHP-TOPSIS Model for Software Selection Under Multi-criteria Perspective

Santanu Kumar Misra and Amitava Ray

1 Introduction

In today's increasing competitive business climate, information technology plays a major role in success of companies. In today, markets having a great number of competitors and therefore the competition are so fierce. Quality and cost do not suffice in competition, and therefore, new competition parameters are needed like delivery date in right time and customised product (Yusuf et al. 2006). Software automates and integrates business processes and allows information sharing in different business functions. In addition, software supports the finance, human resources, operations and logistic, sale and market in functions through and effective and productive business process. At the same time, it improves the performance of organisation's functions by controlling those (Hallikainen et al. 2006). Although organisations can develop their own software, other ones may prefer ready product to shorten application cycle. The vendors sell software which is developed in different operating systems and available database in market. When an organisation prefers to purchase software, it is going to be higher in cost (Verville and Halingten 2003). The best suitable software product selection yields positive results like increasing productivity, timely delivery, reduction of setup time and reduction of purchasing cost. Other perspectives on software selection focus on the criteria that organisations consider in selecting commercial software (Wei et al. 2005a, b). Therefore, in this selection, multi-criteria decision-making approach plays an important role. The analytical model integrated with AHP (Lai et al. 2002; Wei et al. 2005a, b); Ahmad and Phillip 2006; Salo and Hamalainen 1997; Yurdakul 2004; Norita and Laplante 2006) model and technique for order

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preference by similarity to ideal solution (TOPSIS) (Balli and Korukoglu 2009; Saghafian and Hejazi 2005; Ray et al. 2010; Chen 2000) will help to determine the right judgment in software selection for an organisation based on organisation-specific requirements. This chapter proposes an integrated model of AHP-TOPSIS methodology considering both qualitative and quantitative factors. In the following sections, we present the past research works done by the researchers. AHP method and TOPSIS method have been discussed briefly. After that, the proposed analytical model has been discussed including a numerical application of proposed model. Finally, the sensitivity analysis and conclusion of the research are highlighted.

2 Literature Survey

In recent literature regarding the software selection, Sen et al. (2009) emphasised a fuzzy quality function deployment approach for determining which of the non-functional requirements reported by earlier studies are important to a company's software selection decision based on and integrated with its functional requirements. Solution provided in this study not only assists decision-makers in acquiring software requirements and defining selection criteria but also supports in determining the relative importance of these criteria. Previously, the authors Sen et al. (2009) in their paper 'An integrated decision support system dealing with qualitative and quantitative objectives for enterprise software selection' proposed a hierarchical objective structure that contains both qualitative and quantitative objectives that are used to evaluate software products systematically. This approach uses a heuristic algorithm, a fuzzy multi-criteria decision-making procedure and a multi-objective programming model to make final selection decision. Dias-Neto and Travassos (2009) proposed a strategy to select model-based testing approaches for software projects called Porantim. Porantim is based on a body of knowledge describing model-based testing approaches and their characterisation attributes and a process to guide by adequacy and impact criteria regarding the use of this sort of software technology that can be used by software engineers to select model-based testing approaches for software projects. Petri Kettunen and Maarit Laanti in their literature proposed a comparative selection model. Some real-life project case examples are examined against this model. The selection matrix expresses how different process models answer to different questions, and indeed, there is not a single process model that would answer all the questions. This chapter investigates the software process model selection in the context of large market-driven embedded software product development for new telecommunications equipment. Li et al. (2009) proposed selection technique for ABE (PSABE) which decomposes whole project into small subset that consists only representative projects. The proposed methods are validated on four datasets (two real-world sets and two artificial sets) and compared with conventional ABE, feature-weighted ABE (FWABE) and machine learning methods.

Jadhava and Sonarb (2011) emphasised (1) generic methodology for software selection, (2) software evaluation criteria and (3) hybrid knowledge-based system (HKBS) approach to assist decision-makers in evaluation and selection of the software packages. That also evaluates and compares HKBS approach with the widely used existing software evaluation techniques such as analytic hierarchy process (AHP) and weighted scoring method (WSM). Ayalaa et al. (2011) discusses about the actual industrial practice of component selection in order *to* provide an initial empirical basis that allows the reconciliation of research and industrial endeavours. Yazgan et al. (2011) proposed an ANN model that has been designed and trained with ANP results in order to calculate ERP software priority. The artificial neural network (ANN) model is trained by results obtained from ANP. In literature, majority of methods tried to reduce the comparisons required to evaluate the appropriate one from many applications against many requirements with the help of some process. Ghorbani and Rabbani (2009) proposed multi-objective algorithm for project selection problem by increasing expected benefits and minimising the absolute variation of allotted resource between each successive time periods. Vidal et al. (2011) define a measure of project complexity in order to assist decision-making when analysing several projects in a portfolio, or when studying different areas of a project. Wei et al. (2005a, b) proposed an AHP-based solution for ERP (enterprise resource planning) selection. Badri and Davis (2001) presented a 0–1 goal programming model to select an IS (information system) project considering multiple criteria including benefits, hardware, software and other costs, risk factors, preferences of decision-makers and users, completion time and training time constraints. Lai et al. (1999) discussed a case study for selecting a multimedia authoring system using the AHP method. Javier Otamendi et al. (2008) proposed an AHP-based model for software selection in smooth functionality of an international airport. After gone through all these literature, it is clear that there is hardly any literature which focuses on the selection of software product based on organisational requirements. Rather, maximum literatures focus on to reduce the complexity of risk factors, reduce complexity of selection process and motivates on quantitative and qualitative factors for software selection. Some of the literature focuses on the AHP-based priority ranking but do not get indexation using sensitivity analysis for robustness of the selection process. Since AHP is based on the subjective judgment of the decision-makers, therefore, error is inevitable in the system. To reduce the error, researchers use integration of subjective factor measure and objective factor measure. In this model, TOPSIS decides the rank of the software based on the concept that the alternatives are close to the positive ideal solution and away from the negative ideal solution which is influenced by the personal preference of the experts. TOPSIS is one of very efficient multi-criteria decision-making method but hardly appears in the past literature review for software selection purpose. After pointing out all these drawbacks of the past literatures, authors are motivated on designing a simple selection model which gives crisp results when all the alternatives follow same organisational requirements. So this model will help to increase managerial skill for software selection.

3 Methods

3.1 Analytical Hierarchy Process (AHP)

The analytical hierarchy process is a powerful and flexible multi-criteria decision-making method that can be applicable in a variety of decision-making situations from simple to complex situation. It is especially used to quantify managerial judgment of the relative importance of each of several conflicting criteria used in decision-making process. In this method, a problem is put into a hierarchical structure as follows:

(a) The overall objective of the decision
(b) Factors or criteria for the decision
(c) Sub-factors under those factors
(d) Decision option

The steps involved in AHP model are as follows:

Step-1: List the overall goal, criteria and decision alternatives. Step-2: Develop a pairwise comparison matrix. Rate the relative importance between each pair of decision alternatives based on Saaty's nine-point scale. The matrix lists the alternatives horizontally and vertically and has the numerical rating comparing the horizontal (first) alternative with the vertical (second) alternative. Step-3: Develop a normalised matrix by dividing each number in a column in the pairwise comparison matrix by its column sum. Step-4: Develop a priority vector. Average each row of the normalised matrix. The row average forms the priority vector of alternative preferences with respect to the particular criterion. Step-5: Calculate the consistency ratio [CI, RI and CR]. Calculate the eigenvector or the relative weights and for each matrix of order 'n'. Compute consistency ratio using $\mathrm{CI} = (\beta_{\max} - n)/(n - 1)$, RI = random inconsistency $= 1.987\,(n - 2)/n$ and $\mathrm{CR} = \mathrm{CI}/\mathrm{RI}$. The acceptable CR range varies according to the size of matrix.

That is, 0.05 for the 3 by 3 matrix, 0.08 for a 4 by 4 matrix and 0.1 for all larger matrices, $n \geq 5$. Step-6: Develop the overall priority vector by multiplying normalised matrix of criteria with the priority matrix of decision alternatives which is formed with priority vectors of different criteria. With this priority values, judgment has been taken care of. Acceptable consistency value helps to ensure the decision-maker reliability to determine the priorities for the set of criteria.

3.2 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS is a useful technique in the field of multi-criteria decision management. The fundamental principle of the method is that the selected alternative should have the shortest distance from PIS and the farthest distance from NIS. Suppose multi-criteria decision system having m alternatives and n decision criteria, then the decision matrix is presented by $[x_{ij}]_{m \times n}$, where x_{ij} is the numerical outcomes obtained from ith alternative with respect to jth criteria. The steps involved in the TOPSIS methods are as follows:

Step-1: Construct the normalised decision matrix(R) as $r_{ij} = X_{ij} \Big/ \sqrt{\sum_{i=1}^{m} X_{ij}^2}$, where $i = 1, 2\ldots, m$ and $j = 1, 2\ldots$, n and where r_{ij} is the element of the matrix. This process tries to transform the attribute dimensions into non-dimensional attributes which allows comparison across the attributes. Step-2: Calculate weighted normalised decision matrix. Weights $W* = (W_1, W_2, W_3, \ldots, W_j, \ldots, W_n)$ and $\sum_{j=1}^{n} W_j = 1$. The matrix can be calculated by multiplying each column of the matrix R with its associated weights W_j. Therefore, the weighted normalised decision matrix V is as $\begin{pmatrix} W_1 r_{11} & \cdots & W_n r_{1n} \\ \vdots & \ddots & \vdots \\ W_m r_{1m} & \cdots & W_n r_{mn} \end{pmatrix} \approx \begin{pmatrix} V_1 & \cdots & V_{1n} \\ \vdots & \ddots & \vdots \\ V_{m1} & \cdots & V_{mn} \end{pmatrix}$. Step-3: Determine ideal and negative ideal solutions. Let the two alternatives A^+ and A^- be defined as

$$\begin{aligned} A^+ &= \left\{ \left(\max_i V_{ij} | j \in J \right), \left(\min_i V_{ij} | j \in J' \right) | i = 1, 2, 3, \ldots, m \right\} \\ &= \left\{ V_1^+, V_2^+, V_3^+, \ldots, V_n^+ \right\} \end{aligned} \tag{1}$$

$$\begin{aligned} A^- &= \left\{ \left(\min_i V_{ij} | j \in J \right), \left(\max_i V_{ij} | j \in J' \right) | i = 1, 2, 3, \ldots, m \right\} \\ &= \left\{ V_1^-, V_2^-, V_3^-, \ldots, V_n^- \right\}. \end{aligned} \tag{2}$$

where $J = \{j = 1, 2, 3, \ldots, n \mid j$ associated with benefit criteria$\}$
$J' = \{j = 1, 2, 3, \ldots, n \mid j$ associated with benefit criteria$\}$

Step-4: Calculate the separation measure. The separation between each alter can be measured by the n-dimensional Euclidian distance. The separation of each alternative from the ideal one is then given by $S_i^+ = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^+ \right)^2}$, where $i = \{1, 2, 3, \ldots, m\}$. Similarly, the separation from negative ideal one is given by $S_i^- = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^- \right)^2}$, where $i = \{1, 2, 3, \ldots, m\}$. Step-5: Calculate the relative closeness to the ideal solution. The relative closeness of Ai with respect to A^+ is defined as $C_i^* = S_i^- / \left(S_i^+ - S_i^- \right), 0 < C_i^* < 1$ and $i = \{1, 2, \ldots, m\}$. It is clear that $C_i^* = 1$ if $A_i = A^+$ and $C_i^* = 0$ if $A_i = A^-$. An alternative A_i is closer to A^+ as C_i^* approaches to 1. Step-6: Rank the preference order. A set of alternative can now be preference ranked according to the descending order of C_i^*.

4 Proposed Analytical Model

The stepwise approach for the current analytical model is as follows:

Step-A: Identify the decision-making team for selection purpose. The team then analyses and identifies the organisational requirements from the software product. At the same time, they also shortlist the tentative products for the organisation.

In our model, we announce them as decision criteria and decision alternatives. Step-B: Identify the goal. The current job is focused on the selection of software products from a pool of products. Step-C: Identify the decision criteria. Decision criteria are totally based on organisation orientation, and weights are assigned with a nine-point scale as mentioned in Table 2 to set importance among different decision criteria. Step-D: Computation of priority ranking among all decision criteria by using AHP model. It has been shown in Table 5. Step-D01: Composition of the pairwise comparison matrix between decision criteria is shown in Table 3. In this comparison matrix, if W weight is assigned to criteria1 with respect to criteria 2, then 1/*W* weight is assigned to the criteria2 with respect to criteria1. Step-D02: Construct the normalised matrix for criteria. This matrix representation is shown in table form in Table 4. Step-E: In traditional TOPSIS, the weights of the criteria are known precisely and are treated as important numerical data. The obtained priority values of criteria by AHP as presented in Table 5 are introduced as the weight values for the TOPSIS method. Step-F: Applying the different mentioned steps of TOPSIS method, the computation of closeness values of all alternatives from PIS (positive ideal solution) as well as NIS (negative ideal solution) has been calculated and shown in Table 1. Step-G: Finally, apply sensitivity analysis to achieve software index. Based on software index, suitable software can be selected for the organisation. The flow diagram of the proposed model is shown in Fig. 1.

Table 1 Relative closeness to ideal solution

Decision alternatives	Closeness index	Closeness values
SOFT1	C_1^*	0.740
SOFT2	C_2^*	0.222
SOFT3	C_3^*	0.080
SOFT4	C_4^*	0.772
SOFT5	C_5^*	0.148
SOFT6	C_6^*	0.775
SOFT7	C_7^*	0.261
SOFT8	C_8^*	0.825

Table 2 Saaty's nine-point scale

Compared to 2nd entity, 1st entity is	Numerical ratings
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Equally preferred	1
Intermediate judgment between two adjacent judgments	2,4,6,8

Table 3 Pairwise comparison matrix for criteria

	Reliability	User friendly	Security
Reliability	1	7	9
User friendly	1/7	1	7
Security	1/9	1/7	1

Table 4 Normalised matrix for criteria

	Reliability	User friendly	Security
Reliability	63/79	49/57	9/17
User friendly	9/79	7/57	7/17
Security	7/79	1/57	1/17

Table 5 Priority vectors for criteria

Criteria	Priority values
Reliability	0.729
User friendly	0.216
Security	0.055

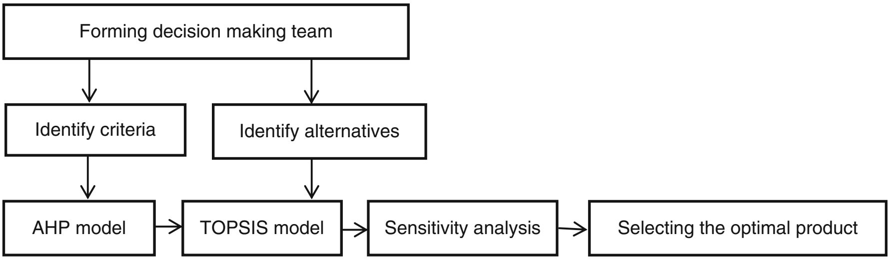

Fig. 1 Flow diagram of proposed analytical model

5 Numerical Application of Proposed Model

In this section, a hypothetical case study has been discussed as the validation of proposed model by following all stepwise approaches. As an assumption, the criteria like reliability, user friendly and security are considered as identified criteria decided by the decision-making team for software selection. All the shortlisted software are roughly named as SOFT1, SOFT2, SOFT3, SOFT4, SOFT5, SOFT6, SOFT7 and SOFT8. Roughly, their costs are taken as 600(USD), 625(USD), 695(USD), 620 (USD), 640(USD), 720(USD), 644(USD) and 650(USD). Table 2 represents Saaty's nine-point scale. Based on Saaty's nine-point rating scale, pairwise comparison matrix is formed by considering horizontal alternatives versus vertical alternatives. The result of pairwise comparison of 'n' criteria can be summarised in a $[n \times n]$ matrix 'A' in which each element a_{ij} $(i, j = 1, 2, 3)$ is the quotient of weights of the criteria as shown. In this case, value of 'n' is 3:

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}, \quad \text{where } a_{ij} = 1 \text{ for } i = j \text{ and } a_{ij} = \frac{1}{a_{ij}} \text{ for } a_{ij} \neq 0.$$

To follow Step-3 mentioned in AHP section, the formation of normalised matrix (A') is being done by dividing each element in a column of pairwise comparison matrices (A) by its column sum. Sum of every column of correct pairwise comparison matrix will be always 1:

$$A' = \begin{bmatrix} \frac{a_{11}}{\sum_3 a_{i1}} & \frac{a_{12}}{\sum_3 a_{i2}} & \frac{a_{13}}{\sum_3 a_{i3}} \\ \frac{a_{21}}{\sum_3 a_{i1}} & \frac{a_{22}}{\sum_3 a_{i2}} & \frac{a_{23}}{\sum_3 a_{i3}} \\ \frac{a_{31}}{\sum_3 a_{i1}} & \frac{a_{32}}{\sum_3 a_{i2}} & \frac{a_{33}}{\sum_3 a_{i3}} \end{bmatrix}.$$

This normalised matrix is shown in Table 4. In the next step, priority vector (P) of criteria is formed by averaging each row of normalised matrix. These values will also add up to 1:

$$P = \begin{bmatrix} P_1 \\ P_2 \\ P_3 \end{bmatrix}, \quad \text{where } P_k = \mathrm{Avg}(k \text{ th row of } A').$$

This priority vector is shown in Table 5. These priority values are treated as the weight factors of TOPSIS method, which is represented in TOPSIS as $W^* = (W_1, W_2, W_3) = \left(W_{\text{reliability}}, W_{\text{userfriendly}}, W_{\text{security}}\right) = (0.729, 0.216, 0.055)$. One decision matrix ($D$) has been formed with eight alternatives and three criteria represented as $[x_{ij}]_{8 \times 3}$. Here, x_{ij} is the numerical outcomes obtained from ith alternative with respect to jth criteria using Saaty's nine-point scale as

$$D = \begin{bmatrix} \text{Reliability} & \text{User friendly} & \text{Security} \\ 9 & 2 & 3 \\ 3 & 7 & 4 \\ 3 & 2 & 8 \\ 8 & 5 & 3 \\ 3 & 5 & 5 \\ 9 & 3 & 5 \\ 3 & 8 & 8 \\ 8 & 8 & 2 \end{bmatrix}$$

Then construct the normalised decision matrix (R) as $r_{ij} = x_{ij} \Big/ \sqrt{\sum_{i=1}^{m} X_{ij}^2}$, where $i = 1, 2, \ldots, 8$; $j = 1, 2, 3$; and $m = 8$ and where r_{ij} are elements of the matrix. This normalised matrix is shown as

$$R = \begin{bmatrix} \text{Reliability} & \text{User friendly} & \text{Security} \\ 0.4984 & 0.1280 & 0.2042 \\ 0.1662 & 0.4481 & 0.2722 \\ 0.1662 & 0.1280 & 0.5445 \\ 0.4432 & 0.3201 & 0.2042 \\ 0.1662 & 0.3201 & 0.3403 \\ 0.4984 & 0.1920 & 0.3403 \\ 0.1662 & 0.5121 & 0.5445 \\ 0.4432 & 0.5121 & 0.1361 \end{bmatrix}$$

Then weighted normalised matrix (V) is calculated by multiplying each column of the matrix R with its associated weight W_j. It can be expressed as

$$V = \begin{pmatrix} W_1 r_{11} & \cdots & W_n r_{1n} \\ \vdots & \ddots & \vdots \\ W_m r_{1m} & \cdots & W_n r_{mn} \end{pmatrix} \approx \begin{pmatrix} V_{11} & \cdots & V_{1n} \\ \vdots & \ddots & \vdots \\ V_{m1} & \cdots & V_{mn} \end{pmatrix}$$

$$= \begin{bmatrix} \text{Reliability} & \text{User friendly} & \text{Security} \\ 0.3633 & 0.0276 & 0.0112 \\ 0.1211 & 0.0967 & 0.0149 \\ 0.1211 & 0.0276 & 0.0299 \\ 0.3230 & 0.0691 & 0.0112 \\ 0.1211 & 0.0691 & 0.0187 \\ 0.3633 & 0.0414 & 0.0187 \\ 0.1211 & 0.1106 & 0.0299 \\ 0.3230 & 0.1106 & 0.0074 \end{bmatrix}$$

As per Step-3 and Step-4 mentioned in the TOPSIS section, the ideal and negative ideal solutions are calculated (Eqs. 1 and 2), and with these values, the separation between each alternative is measured by n-dimensional Euclidian distance. Then relative closeness to the ideal solution is obtained as per Step-5 of TOPSIS section. Ultimately, all the developers are ranked up with the descending order of their relative closeness value from ideal and negative ideal solutions. This relative closeness value is shown in Table 1 mentioned below.

Considering final results from AHP-TOPSIS model (Table 1) as subjective factors and cost as objective factor, the sensitivity analysis is accomplished and plotted in Fig. 2. With that index values' optimum, one can be easily identified.

6 Sensitivity Analysis

A mathematical model introduced by Bhattachariyya et al. (2005), Ray et al. (2007, 2008), Dhar et al. (2010) is also applied here to combine the weighted rating obtained from AHP-TOPSIS model with the software cost, to get the appropriate solution of the proposed model:

$$\mathrm{DI}_i = \alpha \times \mathrm{SFM}_i + (1-\alpha) \times \mathrm{OFM}_i \tag{3}$$

where $\mathrm{OFM}_i = 1 \Big/ \left[\mathrm{OFU}_i \sum_{i=1}^{n} \left(\frac{1}{\mathrm{OFU}_i}\right)\right]$.

OFM is the objective factor measure. OFU is the objective factor utility which is the software cost. SFM is the subjective factor measure. SI is the software index. 'α' is the objective factor decision weight, $\alpha \geq 0$ but $\alpha \leq 1$. 'n' is the number of alternatives. SFM values are the weighted rating values from the AHP-TOPSIS model for each software, and OFM values are calculated from the cost values using mentioned formula. Using Eq. 1, software index can be calculated. The choice of

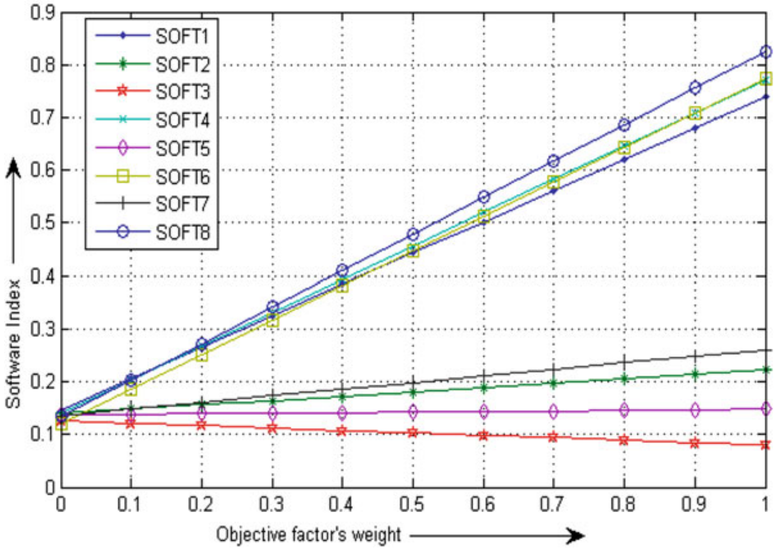

Fig. 2 Sensitivity plot

suitable software is an important issue, for that selection mostly depends on the decision maker's preference regarding the importance of objective and subjective factor measures. However, the selection procedure may delineate different sets of result for different values for the same decision criteria values. Thus a sensitivity plot to analyze the effect of software selection problem is strongly recommended. From Fig. 2 of sensitivity plot, it is easily understood that SOFT8 (software 8) is having the highest index value. So, it is the optimal one.

7 Discussion and Conclusion

Literature survey reveals varieties of software selection models. An efficient assessment system is essential for appropriate software selection problem. Firstly, in all previous models, the selection of software is basically to reduce complexity and encounter the suitable qualitative and quantitative requirements. But in the current research, we proposed selection mechanism in a different way where we not only focus on mentioned features, rather we form ranking among all. Secondly, the hybrid approach of AHP/TOSIS in the proposed model takes into account the concept that the alternatives are close to the positive ideal solution and away from the negative ideal solution which is influenced by the personal preference of the experts of each alternative software, with the subjective factor making the system robust. Finally, sensitivity analysis of the proposed model provides the decision-maker a robust decision support system to evaluate the performance of the software. Therefore, the proposed software selection models overrule the traditional model in the sense that the error generated due to the subjective judgment of the decision-makers rectified by the proposed model. The advantages of the proposed model are as follows: it is well suited for dealing appropriate ranking of software based on organisational requirements, it is simple and straightforward and it takes minimum time for calculation and ultimately for choosing candidate. Some weakness of our proposed method might be as follows: it does not include the detailed segmentation of software development activities which play important role for selection. So there is scope for further research in these areas.

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