KM capability for software development: a case study of the Indian software firms

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Abstract: Organisational knowledge management (KM) capability is developed to allow companies to share, create and disseminate their organisational knowledge resources. The paradigm shift from traditional business to information communication technology (ICT) enabled business, brought fundamental changes in business environment. Rapidly changing technology is a key feature of software industry and it may be easier for organisations to manage these changes if they develop their KM capability. However, this is not easy since most organisations in the Indian software industry compete for the same customers with knowledge worker from the same pool. In this paper, a generic model of a KM capability is proposed. This framework is used to analyse the KM capability in Indian software firms. The case study illustrates and highlights the benefits and advantages of establishing a KM capability. The results from the case study showed that KM capability is an imperative for software development. The study also suggests few recommendations that may be used to guide the development of KM capability elsewhere. This study's limitations and suggestions for future research are also discussed.

Keywords: knowledge management capability; KM; software firms; case study; India.

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1 Introduction

Today, we are in an era characterised by constant change and complex systems or processes, where knowledge centric activities or knowledge-based activities are becoming the primary source of sustainable competitive advantage. In this view, knowledge is considered as a key resource that must be managed for continues improvement of business to succeed and stay ahead in today's highly competitive global markets. In other words, in order to add real value to their organisations, managers must seek to identify, manage and leverage the company's knowledge-base. Thus 'knowledge management (KM)' becomes an emerging discipline which aims to leverage 'know-how's' across the entire organisation, for improving decision making, increasing innovation, and attain competitive advantage. KM helps companies enrich and share this knowledge residing in products, processes and people by various tools and methods. Software industry has great benefits to reap from KM. The last couple of years have seen a distinct pattern of buyer behaviour towards lesser spending resulting into lower revenues for the software vendors. Software companies meanwhile are working hard at streamlining their processes to make themselves more cost efficient, build better products, offer better customer service than their competitors and retain the best talent. KM activities in these companies can help them achieve these results. But in the research side, application of KM for software development is not established enough. Nowadays, many articles have been published for educating KM practices in general but such studies in software development context is very less. Therefore we study KM capability for software development taking three different software companies as cases.

2 Research background

Rapidly changing technology is a key feature of software industry and it may be easier for organisations to manage these changes if they collaborate with other organisations. However, this is not easy since most organisations in the Indian software industry compete for the same customers. It is difficult for these organisations to work together since they are waiting for an opportunity to grab each other's customers. The flux in technology and development methodologies makes software projects complex to manage and makes it next to impossible for an employee to be an expert in more than one technology. The interaction of employees within the organisation is structured to transfer

explicit knowledge and usually misses out on tacit knowledge. A mentoring programme facilitates the transfer of tacit knowledge. Indian culture encourages the mentoring concept as it emphasises strong social relationships between superiors and subordinates. The employees of the Indian software industry feel that they will perform better if they are trusted to interact with those outside the organisation especially to learn new technologies and solve common technology issues. Even if there is no formal interaction between organisations in the Indian software industry, there is an informal interaction between employees of different organisations based on ties established in college or outside work. Increasing competition from countries that have a cost advantage over India in software production makes it imperative for the organisations in the Indian software industry to specialise based on their competencies. Organisations need to outsource parts of software projects to other Indian organisations that have a competence and cost advantage in those fields.

The KM market is highly competitive, and it has developed considerable uncertainty and risk because of the contradictory nature of its enabling technologies and the inherent organisational and cultural difficulties embedded in its applications (Oppong et al., 2005). Successful software firms today are distinguished by their ability to consistently generate and capture new knowledge, disseminate it to the relevant points of action and embody it into their systems processes, products and services. Simply put, their success lies more in the company's intangible assets than with tangible one. Managing human intellect and converting it into useful products and services is fast becoming a critical component of competitive success (Davenport et al., 1998), state that organisations core competencies will centre on managing knowledge and knowledge workers in the future. They add that industrial growth and productivity gains will depend heavily on improvements in knowledge work.

For successful KM, Managers need to understand the various technology infrastructure aspects apart from organisational structure, culture, leadership, etc., as information communication technology (ICT) has become one of the critical factors for effective KM (Ruggles, 1998; Syed, 1998; Zack, 1999). New KM approaches are made possible by advances in information technology management and applied artificial intelligence. Examples include intranet, internet, groupware, e-groups. E-mail, text chat, voice chat, video chat, blogs, wikis, Semantic web, search engine, KM portals, KM software. Another problem faced by software firms today is the presence of historical data (Carayannis, 1999) existing in the legacy system, if properly leveraged promises of a goldmine to the organisation. In attempts to address these challenges, software firms has come up with various collaborative tools like KM portal and analytical techniques like business intelligence (BI).

Several authors have emphasised how routines and standard operating procedures are used to transfer knowledge (Cohen and Bacdayan, 1994; Huber, 1991) in a software firm. Some of this knowledge is embedded in local contexts and are residing in organising principles, routines and standard operating procedures. This perspective is pertinent because the nature and structure of software projects typically requires the task of software development to be split into smaller modules, which are then executed by organisations or groups that are based in different countries. These viewpoints raise interesting research questions, as given below:

a What are the knowledge areas in software development?

b What are the challenges KM addresses in software development?

c What is the knowledge Infrastructure for software development?

d What are the factors of KM Capability in software development?

The aim of this paper is to explore these questions through an exploratory qualitative study of Indian software firms. The rest of the paper is organised as follows. In the next section, we theoretically discuss various concept related KM capability and software developments more generally and propose a research model for the study. In Section 4, we present the conceptual framework, research method followed by the case study. The section thereafter presents the case summary, discussion, findings, and conclusion of the study respectively.

3 Literature review

3.1 Knowledge

Human civilisations have been preserving and passing knowledge from generation to generation for a better understanding the past and best predicting the future. There is no consensus on a definition of knowledge. Many authors have avoided epistemological debate on the definition of knowledge by comparing knowledge with information and data (Alavi and Leidner, 2001). A commonly held view is that data is raw numbers and facts, information is processed data and knowledge is information with value (Alavi and Leidner, 2001). For some people in business, knowledge is 'economic ideas' (Wiig, 1997) or 'intellectual capital' (Stewart, 1997; Van Buren, 1999) and is talked about in terms of 'stockpiles', 'reservoirs', 'exchange', 'capture' and 'utilisation', without questioning whether it can actually be managed or understanding its epistemology- knowing it exists and understanding its context- and, hence, its importance. While a software firm has its own knowledge-base, part of its knowledge resides in the minds of the individuals and groups that make up the organisation. As such its knowledge is dynamic in nature.

At the organisational level, however we understood that knowledge takes two distinct forms: knowledge about the organisation (e.g., its resources, abilities, processes, products), and knowledge about the market (e.g., competitors. suppliers. buyers, partners, market structure, and market dynamics). Hansen et al. (1999) propose two types of strategies for harnessing corporate knowledge namely codification and personalisation. The codification strategy focuses on computers. In this instance knowledge is carefully coded and stored on database systems where it can be accessed and used by others. On the other hand, the personalisation strategy focuses on enabling social networks in order to help people communicate knowledge as opposed to storing it. Kodama, (2005) also states that "Knowledge is created through the interactions among individuals or between individuals and their environment". Carayannis (1999) posits that there are a number of tacit and explicit organisational processes and activities that encapsulate organisational knowledge at the individual and group levels (see Table 1). Knowledge has always been a valuable asset (Chase, 1998) and an important production component, but what is KM? Is it a new way to understand organising and organisations or is it a tool for exploiting knowledge, or is it just another relabeling in the ceaseless flow of fashionable management concepts? All these issues will be dealt with in its deep conceptualisation and discussion of its current stature in the following section.

Table 1 Instance of knowledge at different levels

	Individual knowledge	*Group knowledge*
Instances of explicit knowledge carriers	Rules of thumb	Drills
	Procedures	Stories
	Design rules	Best practices
	Design meta-rules	Work processes Business reengineering
Instances of tacit knowledge carriers	Common sense	Group texture
	Good judgment	Work practice
	Wisdom	Core competences
	Intuition	Organisational intelligence
	Know-how	Organisational memory
	Expertise	Expert systems

Source: Adapted from Carayannis (1999)

3.2 Knowledge management

KM, as an emerging field, is quite young – less than three decades 'young' if the milestone used to peg its beginning stems from the introduction of the phrase 'KM'. Anecdotally, the formal birth of this emerging field was ascribed by Beckman (1999) to have taken place when Karl Wiig originated the term at a 1986 United Nations ILO conference in Geneva, Switzerland. On the other hand, Koenig and Srikantaiah, (2000) have located an earlier use of the term in Marchand (1985). Some academics believe that KM has almost achieved the status of a discipline (Jennex et al., 2005; Ponzi, 2004; Stankosky, 2005). Most academics as well as practitioners agree that the term was poorly defined and ambiguously described (Den Hertog and Huizenga, 2000; Dixon, 2000). KM is considered by many as an interdisciplinary field (Al-Hawamdeh, 2005). KM is a broad and expanding topic (Rezgui et al., 2010; Scarbrough et al., 1999; Venters, 2002). KM is a challenge for a number of reasons. Those involved in this emerging field are still vexed by the lack of a single comprehensive definition, an authoritative body of knowledge, proven theories, and a generalised conceptual framework. Academics and practitioners have not been able to stabilise the phenomenon of KM enough to make sense of what it is and what it comprises (Sutton, 2007). Because of its increased visibility in any management strategy and academic research, there is a substantial feeling that KM is a significant phenomenon (Bouthillier and Shearer, 2002). (Wiig, 1993) in his paper posits that KM is defined as: "the systematic, explicit, and deliberate building, renewal, and application of knowledge to maximise an enterprise's knowledge-related effectiveness and knowledge assets". KM is knowledge creation, which is followed by knowledge interpretation, dissemination, use, retention and refinement (De Jarnett, 1996). Coombs and Hull (1998) defined KM as specific routines that shape the knowledge-base of the firm and make it accessible in the innovation process. Teece et al. (1997) states that KM is powerful environmental force reshaping the world of 21st century managers. KM is the process of critically managing knowledge to meet existing needs, exploit existing knowledge assets to develop new opportunities (Quintas et al., 1997). The crux of the KM is not information or technology but lie more with psychology and marketing of knowledge within the organisation (Peters, 1992). Sveiby (1997) defines that KM is 'the

art of creating value from an organisation's intangible assets'. KM is the process of capturing a company's collective expertise wherever it resides, and distributing it to places it can produce benefits [Blake, (1998), p.12].

3.3 Software development

Software development has been described as a complex problem solving process simultaneously involving a number of individuals, teams, and organisations with competing goals, interests, and responsibilities (Curtis et al., 1988). A well-designed software process is critical to improving productivity and quality in software development projects (Xu and Ramesh, 2008). The major entities of a software process in a software project are the people who perform the tasks, various types of input and final deliverables. Pursuing software development with an inappropriate process may result in poorly designed architecture and code, expensive redevelopment, delay, or even total project failure (Jacobson et al., 1999). Designers and developers are involved in designing and writing the program, project managers are responsible for the successful completion of the project, and the end users provide the test of whether the software is acceptable to them or not. These different groups both provide and require varying forms of knowledge and expertise at different stages of the project (Dayasindhu, 2002). These 'standard' processes need to be tailored before they can be adopted in a project. The practice of adjusting processes for differences across environments is called software process tailoring (Xu and Ramesh, 2007). Waterson et al. (1997) emphasise that software development involves a variety of cognitive and organisational issues concerning the communication and coordination of knowledge relating to the program, the methodologies to be used, the domain area and various organisational practices such as reporting relationships within the project team. Managing these processes by which knowledge is acquired, shared, and integrated between these various individuals, teams and organisations is a crucial task in the process of software development (Walz et al., 1993). Software development represents 'knowledge intensive' work that requires organisations to increasingly depend on 'knowledge workers' who draw upon their cognitive abilities and their specialist resources (Blackler, 1995). However, individual team members do not have all the knowledge required for the project and they need to acquire additional information and knowledge from different sources such as relevant documentation, formal training sessions, results of trial and error exercises and other team members (Walz et al., 1993). A software process is tailored to suit the unique characteristics of a project such as business domain, customer requirements, technology, etc. (Barki et al., 2007; Xu and Ramesh, 2007). Tailoring a process for a project is a knowledge-intensive activity. Although major process frameworks seek to be tailorable, the tailoring guidelines provided by them are too coarse-grained to be of specific help to process designers. The use of knowledge repositories that codify past experiences for improving performance in knowledge-intensive tasks is well established (Basili et al., 1994; Gray and Durcikova, 2005). Recent research suggests that leveraging experience gained from successful software processes can significantly increase the effectiveness and efficiency in future projects (Henninger, 2001). Therefore, an effective way to facilitate process tailoring is to provide access to knowledge gained from past experiences in process. However, beyond an abstract framework, current research does not provide detailed implementation guidelines in terms of how to build a KM capability.

Specifically, it does not provide any strategies for codifying past experience that can improve software process.

4 Conceptual framework

The theoretical framework developed for analysing KM capability goes beyond the popular SECI Model of Nonaka and Takeuchi (1995) that focuses on four stages of knowledge development:

1 socialisation

2 externalisation

3 combination

4 internalisation.

The framework is designed to overcome the criticism that the Nonaka approach is like a highly philosophical (Wilson, 2002). Although Nonaka's knowledge creation spiral is a good starting point to understand the stages of knowledge creation in a knowledge intensive firm, it is short on specifics. It does not elaborate on the dynamics of knowledge worker, work and technology that enable building capability for the organisation. As discussed in the previous section, this theoretical framework is grounded on knowledge-based socio-technical factors in software industry. The framework explains capability building in a business context that has increasingly become knowledge intensive and human resource driven.

4.1 KM capability framework

Historically, organisations created wealth with land, labour, and capital (Drucker, 1993; Sveiby, 1997). Now, creating wealth increasingly occurs through the combination of labour, capital, and knowledge – with an emphasis on knowledge (Inkpen, 1996; Prahalad and Hamel, 1990; Stewart, 1993). Leveraging knowledge will replace exploiting physical resources (Stewart, 1993; Tichy, 1993). Effectively managing organisational knowledge is increasingly becoming a competitive advantage in post-industrial organisations (Powell and Dent-Micallef, 1997; Wiig, 1994). In the post-industrial era, when economies of scale in manufacturing have been largely achieved, the focus is on economies of speed and process. Knowledge is viewed as a prerequisite for this speed. Being able to quickly respond to changing market conditions and opportunities has become a major competitive advantage. Capabilities are organisations repeatable patterns of action in the use of its resources in pursuits of it goals (Morecroft et al., 2002). Coordinated application of the knowledge and skills of individuals in person-to-person and person-to-non-person (i.e., tangible assets, e.g., production machines and computers, etc.) interactions results in to an organisational capability (Morecroft et al., 2002). Organisational capabilities are a firm's ability to establish internal structures and processes to create competencies. The conceptual development on organisational KM capability can be considered of consisting four sub capabilities (see Figure 1) viz., knowledge-based

a work

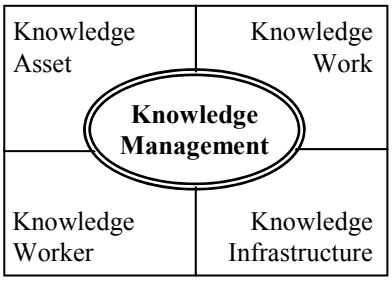
b worker

c infrastructure

d assets capability.

The knowledge-based work, worker, assets and technology theories provide the underlying variables that determine KM capability. This framework describes the nature of relations between each capability constituents that lead to over all KM success of a software firm. Knowledge transfer cements the relations between organisations. KM capability is a required work with strategic significance and a source for organisations to gain a sustainable competitive advantage (Fan et al., 2009; Hung et al., 2011; Lichtenthaler, 2008).

Figure 1 Generic framework for KM capability



Knowledge assets, also known as intellectual capital has become an important asset of our times. Intellectual property now comprises well over half the market value of publicly traded companies [Aston, (2002), p.58]. Knowledge assets have the potential to contribute to profit in many different ways: reducing cycle time; improving quality; lowering costs; increasing organisational learning; and improving decision making; increase innovativeness and thus core competencies (Drucker, 1993; Hamel and Prahalad, 1994; Stewart, 1993). The knowledge asset needs of an organisation in order to respond quickly and effectively to this changing business environment are becoming increasingly important (Prahalad and Hamel, 1990; Stewart, 1993).

Knowledge work can be defined as a work which involves sharing, creating, utilising, retaining tacit knowledge and archiving, discovering, disseminating and visualising explicit knowledge. It is kind of work where the organisation adopt a knowledge-based approach, of creating value and gaining competitive advantage. (Maier et al., 2005) defines Knowledge work as a work that creates, translates or applies new knowledge. One outcome of this shift from traditional to knowledge work has been the growing recognition that an organisation's wealth exists principally in the knowledge of its employees (Heraty, 2004).

Knowledge worker is someone who primarily focuses on the generation, processing, storage, and use of knowledge [Pollock, (2002), p.231]. According to Brown (1999), the globalisation of work and advances in technology has changed the work force so that we now have 'knowledge workers' who can think, work with ideas, and make better decisions. They are also identified by their professional specialty. Knowledge workers can also be described by their characteristics (i.e., people who can analyse, synthesise,

and evaluate information to solve problems and generate valuable ideas). Another way of describing knowledge workers is by their skills and abilities – people who are highly educated, creative, computer literate, and have portable skills. The role of a knowledge worker is to use their intellect to convert their ideas into products, services, or processes (Brown, 1999).

Knowledge infrastructure is to create an ICT environment for knowledge work throughout the organisation and adds that it is implemented as a part of KM initiative that comprises a number of KM tools Maier et al. (2005, p.2). For successful KM, managers need to understand various technology available for KM, as technology has become one of the critical factors for effective KM (Choi, 2000). KM collects knowledge, experiences, and technologies within an organisation and turns them into resources that are accessible to all colleagues (Chen et al., 2011). Building a KM system with databases, search, retrieval engines, collaborative tools, groupware or even with intelligent systems is very common (Wong and Aspinwall, 2006). Integrated technological framework for KM in an organisation, have five major constituents (Kammani and Hundewale, 2011) of technology framework enabling KM viz.,

1 network infrastructure

2 knowledge repository

3 knowledge systems

4 integration layer

5 user interface.

Authors like Samuel et al. (2011) in their study have identified information chain process in the development of a KM system and its implementation.

In this approach we try to conceptualise that there is constant knowledge flow (indicated by directional arrows) between components of knowledge systems and knowledge repository through the network infrastructure. It can be noticed that when the users, usually knowledge workers want to 'know' something, or make others 'know' something, they use the facilities provided by the knowledge systems. These systems are utilised to collaborate with other users or extract knowledge from repository by providing necessary keyword searches. The users also have the freedom to browse through all relevant files and acquire knowledge. In some case the organisation itself publish company wise knowledge using publication system.

5 Methodology and research strategy

Qualitative research is used since it is best suited for understanding complex socio-economic phenomena. Yin (1994), states that the case study is an appropriate tool for gathering research data when a need to focus on contemporary events is expressed. Multi-case study helped in thorough observation of the concept in real-time settings. This research follows an interpretive approach. Interpretive studies generally attempt to understand phenomena through the meanings that people assign to them. The case study methodology is used since it is best suited to the empirical inquiry that investigates bounded contemporary phenomena within the real life context (Creswell, 2003). The characteristic of a case study is that it strives towards a holistic understanding of the

phenomena under research. The case study methodology is appropriate when organisational rather than technical issues are the focus of research. This research is based on information collected via in-depth formal and informal interviews and published material. This is the best strategy to gain insights into socio-economic phenomena from the perspective of the constituents. The dearth of reliable quantitative information available also influences the choice in favour of in-depth interviews. As we already mentioned, this study is a continuation of literature survey that helped in conceptualising a few concepts and establish a theoretical background. This research paradigm, which was based on an in-depth qualitative study, has some similarity to research that derive their theoretical insights from academic and business literature survey followed by interviews or questionnaires. Especially, here the researcher tries to find out some traceable patterns that earlier studies missed to figure out. The data analysis for the research consists of four stages:

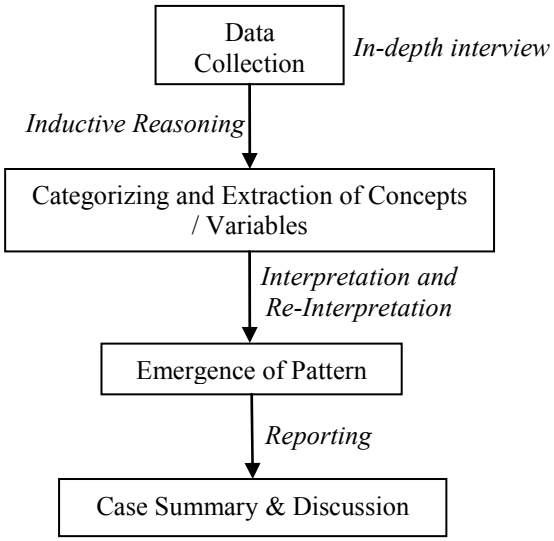
1 accumulating different data from case presentation and in-depth interviews

2 categorising and subsequent marking of different concepts

3 analysing the pattern of relationships among variables if any

4 developing a brief case summary of the company activities and origin of KM.

Figure 2 Research methodology steps involved in the study



Data used in this paper comes from a cross-sectional study examining KM adoption at three software firm in India. Here the author conducted an in-depth interview with KM managers of these organisations which have been benchmarked for successful KM implementation by Teleos and recognised as a winner of most admired knowledge enterprises (MAKE) under India and Asia region in recent years. The list of factors underwent iterative revisions and refinements until it met three criteria, namely, exhaustion of sources, saturation of categories and emergence of regularities (Chua and Lam, 2005; Lincoln and Guba, 1985). This is a highly iterative procedure that involved

moving between the in-depth case history, existing theory, and the raw data, often used in grounded theory approach (Glaser and Strauss, 1967). The grounded theory approach is based upon the researchers' interpretation and description of phenomena based on the respondent's subjective descriptions and interpretations of their experiences in a setting (Locke, 2001). This 'interpretation' strives to provide contextual relevance. The data gathered were subjected to interpretation and reinterpretation that allow patterns to emerge. Research data and insight are gained alongside or on the back of the interpretation. Figure 2 represents the research methodology steps involved in the study.

These data collection is done by interacting with the KM managers on various issues of KM. The authors were prepared with some open questions (see Table 2) that gave leads and direction to the discussion during the case study. The respondents were also administered an instrument seeking their demographic details and some closed end questions asking them mark appropriately with the necessary value. The personal details of the respondents and name of their respective organisation are kept anonymous, upon their request to keep it so.

Table 2 List of open question used in the case study

	Questions
1	What are the knowledge areas in software development?
2	Why KM was adopted for software development?
3	What are the tools and technology used for your KM activity?
4	How is a state of KM Capability achieved in your organisation

Since the 'real' and not the 'official' description are required to validate the framework it was agreed that the identity of the interviewees and their organisations will be kept in anonymity. A sample of three organisations that satisfied the requirements was selected. There were six managerial level employees of each organisation as respondents, i.e., two from each of the selected organisations. The respondents profile with their organisation is listed in Table 3. For example, A refers to organisation A, and Ax refers to the respondent x whose employer is organisation A. This case study reveals the role of different factors in the theoretical framework in the context of the Indian software industry. The case summary for each software firm and the reason behind choosing Indian software firm is elaborated in the next section.

Table 3 Profile of respondents

Organisation	*Respondents*
Case A: ISC	Ax: knowledge manager, five years experience
	Ay: KM associate, three years, experience
Case B: MTC	Bx: vice president (KM) 15 year experience
	By: manager (KM) five year experience
Case C: WTC	Cx: general manager(KM) 12 years experience
	Cy: KM – team lead – (KM) four years experience

6 Indian software firms: case summary

The Indian software industry is chosen for the case study. According to (Wikipedia, 2011) the revenue from information technology sector has risen from 1.2% of the GDP in 1997–98 to 5.8% of GDP in 2009–2010. Based on the US dollar the annual rate of growth of the Indian software industry during 2009–2010 has been 64% (NASSCOM, www.nasscom.org) while the Indian economy in the same period grew at an annual rate of about 8%. The Indian software exports during 2009–2010 grew at an annual rate of 69% in US dollar terms (NASSCOM, www.nasscom.org). The software industry that predominantly provides a range of software services has about 285 of the Fortune 500 organisations as its customers (NASSCOM, www.nasscom.org) and is probably the only globally competitive industry in the organised sector in India. About 90% of India's software exports are to the demanding markets in USA, Europe and Japan. NASSCOM also reports that 15 out of the 23 organisations worldwide that have a Software Engineering Institute-Competency Maturity Model (SEICMM) Level 5 are located in India. More than 75% of the income of the organisations in the Indian software industry is from non-Indian customers. These organisations have shown consistently increasing trends in productivity (growth in revenue per employee), innovation (largely in software development processes and human resources management) and growth (in revenue, profits, and wealth of employees and off shoot organisations) for the last 15 years. In 2010–2011, annual revenues from IT-BPO sector is estimated to have grown over US$ 76 billion compared to China with $ 35.76 billion and Philippines with $ 8.85 billion India's outsourcing industry is expected to increase to US$ 225 billion by 2020 (Wikipedia, 2011). Indian software industry in this context refers to those organisations that have a majority Indian ownership, distinctly Indian management and employees.

6.1 Case A: ISC

ISC started in 1981 by seven people with US$ 250. Today, they are a global leader in the 'next generation' IT consulting services with revenues of US$ 6.04 billion. It designs and delivers technology-enabled business solutions for Global 2,000 companies. It also provides a complete range of services by leveraging business expertise and strategic alliances with leading technology providers. Their offer span business and technology consulting, application services, systems integration, product engineering, custom software development, maintenance, reengineering, independent testing and validation services, IT infrastructure services and business process outsourcing. They pioneered the global delivery model (GDM), which emerged as a disruptive force in the industry leading to the rise of offshore outsourcing. The GDM is based on the principle of taking work to the location where the best talent is available, where it makes the best economic sense, with the least amount of acceptable risk. It has a global footprint with offices and development centres in USA, India, China, Australia, Japan, Middle East, UK, Germany, France, Switzerland, Netherlands, Poland, Canada and many other countries. It and its subsidiaries have 130,820 employees (approx).

6.2 Case B: MTC

This software and consulting firm was started in 1999 by a diverse team of five professionals who came from three different nations and had already scripted successful careers. Their vision to build an institution that is among the most admired companies globally is shared and reflected in the way they do business. Their philosophy is to reinforce that their two most important stakeholders are their customers and people. It is a global IT and Product Engineering Services Company with deep knowledge in specific domains. It is acknowledged as the best mid-size software services company out of India for its capability to build, test and deploy solutions as much as emphasis on culture, customer centricity and corporate governance. It is ranked No. 1 among the MAKE India Award winners in 2010, 13th in NASSCOM's listing of Top IT Software and Services Exporters in India (excluding BPO).

6.3 Case C: WTC

WTC is a global IT services company that provides consulting, business process outsourcing, business technology services, enterprise application services, infrastructure management, testing, product engineering, engineering design and product support. Their services are spread across a range of strategic domains. They are the first CMMi Level 5 certified software services company and the first outside USA to receive the IEEE Software Process Award. It is amongst the largest global IT services, BPO and product engineering companies. It generates USD 6 billion (India GAAP figure 2009–2010) of annual revenues. Its equity shares are listed in India on the Mumbai Stock Exchange and the National Stock Exchange; as well as on the New York Stock Exchange in the USA. It makes an ideal partner for organisations looking at transformational IT solutions because of its core capabilities, great human resources, commitment to quality and the global infrastructure to deliver a wide range of technology and business consulting solutions and services, 24/7. With more than 100,000 associates from over 55 countries, its services span financial services, retail, transportation, manufacturing, healthcare services, energy and utilities, technology, telecom and media. More than 800 active clients that include governments, educational institutes, utility services, and over 150 Global Fortune 500 enterprises have benefited from this approach.

7 Discussions and findings

Software companies have recognised that knowledge is an important factor. Knowledge is gathering over time and will assist the organisation be successful. The software industry is resource-oriented and it has become an imperative to assure that knowledge in the minds of resources is safeguarded. In general during this case study, it was observed that, the respondents feels 26% of knowledge in the organisation is stored on paper and 20% digitally, an astonishing 42% in the head of the knowledge worker and the remaining 12% is the knowledge tied up in various forms in the organisation, usually invisible in various work processes or lost when knowledge workers move to newer roles, or leave the organisation. Along with the discussion they also added that their observation can also be limited and is just tip of the iceberg. We observed that KM in these software firms assists in getting the right knowledge to the right person as fast as possible and

assists in retaining employee know-how's and customers goodwill. As iterated in various studies on organisational dynamics, this study also states that the most difficult part in implementing KM is not the technology but to understand where knowledge resides within the organisation and how to culture it. It is found that the implementation of KM varies from case to case and is tailored to suit one's requirement. We also discuss in the following section the way software firms develop this complex challenge of KM Capability for software development.

7.1 Knowledge areas in software development

Software development is a heterogeneous multi-functional process. A socio-technical KM is essential for attaining success in software development projects. Managing knowledge in globally distributed teams involves managing software projects' knowledge through the life-cycle of the development of the software project. In Software development project knowledge is the main critical thing that has to be taken into consideration. The life-cycle of software development projects can be defined using the systems development life-cycle (SDLC) approach. It has been observed that this case study has reinstated the findings of Bharadwaj and Saxena (2005) that there are three major level of knowledge required in a software development process like:

a user requirements knowledge

b functional domain knowledge

c technical knowledge.

User requirement knowledge and functional knowledge is required in the planning, analysis and design phase where as technical knowledge is utilised in the design, implementation and maintenance stage. This case study observes the significance of various KM capabilities on each areas of knowledge (see Table 4).

Table 4 Pattern of emphasis on knowledge capability

Knowledge areas	*KM capability*	*ISC*	*MTC*	*WTC*
User knowledge	Work	2	2	2
	Worker	1	2	2
	Technology	1	2	1
	Assets	0	0	0
Functional knowledge	Work	2	2	2
	Worker	1	2	2
	Technology	2	2	2
	Assets	2	1	2
Technical knowledge	Work	2	2	2
	Worker	1	2	2
	Technology	2	2	2
	Assets	1	2	1

Notes: (2) Indicates most important; (1) indicates important; (0) indicates unimportant

7.2 Challenges KM address in software development

There are several challenges confronting software development. It was observed from our cases that different groups of clients, programmers, designers, testers, and project managers of a global software team are grouped in the form of project teams. These project teams are facing a continuously increasing demand for quality improvement in their products and services to compete in the competitive market. One of the major requirements of the software firm in terms of knowledge is that, to survive they need to improve their knowledge faster than their competitors. But during this process of improving their own knowledge, these cases of software firms mainly face three major challenges viz.,

a experiential learning

b embedded knowledge

c employee turnover.

Table 5 Challenges KM capability address in software development

Challenges	*KM capability*	*Activity*
Experiential learning	Work	Postmortem reviews, workflow management
	Worker	Community of practice, special interest group
	Infrastructure	Knowledge repository
	Assets	Human capital
Embedded knowledge	Work	Knowledge acquisition, retention
	Worker	Knowledge architect
	Infrastructure	Intelligent and semantic search techniques
	Assets	Process capital, customer capital
Employee turnover	Work	Knowledge integration, dissemination
	Worker	Knowledge promoters, knowledge associates
	Infrastructure	Competency database
	Assets	Knowledge associates

The experiential learning is focused on process improvement and people empowerment. It is an organisational function as much as a database, which collects, analyses, generalises, formalises, packages, stores, retrieves, and reuses collective experience of software engineers (Basili et al., 1994). Concretely this approach is enabled by tool-centred database for information storage and inference, which uses a diverse set of inputs from knowledge workers for software development. The challenge posed by the actual development of the software made it hard for the engineers to form a holistic perspective of the capability required to overcome the same. Embeddedness of knowledge in software development is another challenge that has been emphasised by various authors. Authors like Nicholson and Sahay (2004) for example, discuss how knowledge in software development is constituted and expressed in various products (such as processes and programming tools), processes (such as software development and project management methodologies), and practices (such as norms of communication) and notations (such as use of flow charts). This case study observes some activity

involved in each of the factors that KM addresses during a software development. The process of knowledge acquisition and sharing is problematic as knowledge is embedded at societal, organisation, and cognitive levels of analysis (Lam, 1997). In recent years, an increasing focus is being placed on understanding the nature of embedded knowledge and the challenges inherent in trying to acquire share and use such knowledge (Lam, 1997; Sole and Edmondson, 2002).

This case study has also observed the presence of professional jealousy hindering knowledge sharing in an organisation, which is one of the experiential learning challenges in a software development project. This challenge is taken care by activities such as community of practice, and formation of special interest groups as part of building knowledge worker capability (see Table 5).

7.3 Knowledge infrastructure for software development

Technology is the major enabler for all KM activities, even in software firms. All the three respondents of the above cases agree to the point that with the advent of latest state-of-the-art technology, knowledge work has been made much easier. The responses reinstated the major five components of the technology framework and also pointed out the examples pertaining to each module (see Table 6). Case response on the characteristics of technology infrastructure shows that network infrastructure, knowledge repository and publication systems are the most important of the entire technology component in a knowledge intensive firm. The respondent felt that almost all the components are necessary for the facilitation of the knowledge work, but the intensity of usage of a particular technology will be depending on the nature of the work an employee is entitled with. Technology used in KM, to be effective should have easy-to-use interface, solid reliability, accessibility throughout the target segment and utilities to mine relevant information (Aranganathan and Lakshmi, 2010).

Table 6 Case examples of technology components and modules

Components	*Module*
User interface	User display (GUI) and feedback system (e.g., knowledge portals)
Integration layer	Content integration, data warehousing (e.g., content management system)
Knowledge systems	Collaborative system (e.g., groupware, group decision support system)
	Learning system (e.g., online learning, e-learning)
	Expert system (e.g., artificial intelligence system, expert knowledge system)
	Discovery system (e.g., search engine, data mining)
	Publication system (e.g., remote style syndication, Blog, Twitter, e-mail)
Network infrastructure	Connectivity and communication (e.g., LAN, internet etc.)
Knowledge repository	Storage and organisation (e.g., database)

Organisation like WTC has stated of knowledge infrastructure important except ,expert system. All the components expert system. This patter is due to the complexity of extracting expert knowledge in that particular organisation. Same is the case with other two organisation, like MTC and ISC. It is also observed from Table 7 that even though

learning system, discovery system, integration layer are adopted for knowledge based work, the respondents felt it less important compare to knowledge repository, network and publication system.

Table 7 Case responses on characteristics of technology infrastructure

Variables	*Components*	*ISC*	*MTC*	*WTC*
Knowledge infrastructure	Network infrastructure	2	2	2
	Knowledge repository	2	2	2
	Publication system	2	2	2
	Collaborative system	2	1	2
	Learning system	1	1	2
	Expert system	1	0	0
	Discovery system	2	1	2
	Integration layer	1	1	2
	User interface	1	1	2

Notes: (2) Indicates very important; (1) indicates important; (0) indicates not important

7.4 Factors of KM capability for software development

For purposes of elaboration, we pick three distinct areas of software development and try to analyse how KM can effectively help companies in these areas to overcome their challenges. The three different areas of focus are

1 custom application development

2 product development

3 system integration.

Each of the areas is a plenty with challenges offered by the business environment today in the way they work. Our case study observed that irrespective of the focus of development, knowledge plays an important role in all the phases of software development. Nevertheless, the individual, group and the purpose differ from each of the different types of software development. We have noticed that custom development has less threat due to employee turnover, where as product development is very much affected. The reason for this is that custom development in these software firms are more or less similar to the development which takes place in their competitors environment, but product development is exceptionally unique, confidential and secure for each of this firm. It is observed that these firms are very selective in KM practices, when it comes to product development team. System integration type of software process benefits a lot from various KM capabilities but not as much as with the case of custom application development. Table 8 shows the case response on the significance of KM capability with respect to various areas of software development.

This case study enhances the generic model of KM capability discussed in section 'conceptual framework' (see Figure 1) with a three tier model as given in Figure 3. This framework in Figure 3 indicates that components of KM capability like knowledge work, knowledge worker, infrastructure, and knowledge assets have a strong influence in three main types of software development like custom application, product development, and

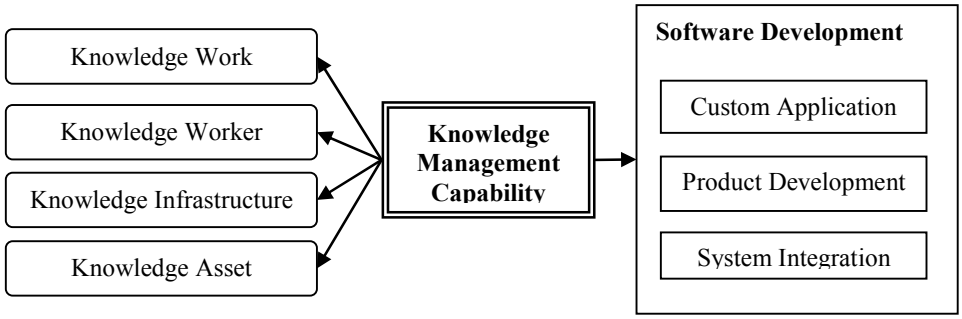
system integration. KM capabilities help in addressing main three pain areas of these software development viz., experiential learning, embedded knowledge, and employee turnover. This framework also gives way for further investigation on the impact of KM capability.

Table 8 Case responses on KM capability in various software development areas

Area of software development	*KM capability*	*ISC*	*MTC*	*WTC*
Custom application development	Work	2	2	2
	Worker	2	2	2
	Infrastructure	1	2	1
	Assets	0	0	0
Product development	Work	2	2	2
	Worker	2	2	2
	Infrastructure	2	2	2
	Assets	2	1	2
System integration	Work	2	2	2
	Worker	2	2	2
	Infrastructure	2	2	2
	Assets	1	2	1

Notes: (2) Indicates most important; (1) indicates important; (0) indicates unimportant

Figure 3 KM capability for software development



8 Conclusions

Software 'product' development requires high level of commitment especially for a firm that is building a software product for global market. The risk involved in selling a software product is enormous as against 'custom application' development activity. Specifically, the software product development company faces challenges right from the conceptual level. KM can help system integrators by helping them capture and retain the business process knowledge derived out of working on various projects and apply the learning on newer projects. Similarly creating access to individual project best practices gained 'on the job' help the software firm implement subsequent projects faster and more

effectively. Thus the benefits to be derived from KM for a software company are many. It has to be remembered however that while the KM mechanisms mentioned above are mostly aided by the use of IT, companies must learn to appreciate KM as more than that – not just a piece or module of software that records transactions and churns out reports but a innate process culture aimed at improving organisational knowledge and organisation learning.

9 Recommendation

This study would like to point out some of the recommendation KM practitioners should take a note of. First, they have to attain an unconditional management support and not over-promise. They should take things at a small scale and monitor the progress of the KM initiative. If any problems arise during this stage, they are easier to solve. Once it is stabilised, they should able to move to the next stage, where KM can be implemented in each phases of software development. However, the plan will need to be revised continuously. Most importantly, KM requires determination and perseverance. Moreover, this case study also observed KM strategist should not expect immediate returns on KM investment. It may take several iterations of real input and measurable output and subsequent updates before a good KM capability system is in place. The analysis of this case study does the articulation of key finding that can be considered important in understanding a software firms KM capabilities.

10 Limitation of the study

Several limitations are inherent within this study despite efforts to guard against it. The first limitation centres on scope of a multi case study, as the study does not encompass the entire list of software firms which have successfully adopted KM. Second, this study is focused on the overall KM capability of the organisation and does not consider exploring in detail the influence of each of the components identified for a KM capability. Third, this study examines Indian organisation and does not examine international organisation that may offer different findings based on their setting. Fourth, beliefs, attitudes, and decisions are dynamic. As a result, cross-sectional studies such as this may not fully capture the complexity or periodicity of a complete KM adoption and usage processes. Therefore, the results of this study should be viewed as only preliminary evidence of the criteria that mould a KM capability in software firm and the findings cannot be generalised across the population. Additionally, there is a need for further refinement of the results to more robustly support the conclusions of this study.

11 Future research

The results of this study could be strengthened by conducting a survey-based study on larger population, especially to find the most important factor of KM capability with respect to the three focus areas of software development as mentioned in the framework in Figure 2. Further research is warranted in the components of KM capability like knowledge work, knowledge worker, knowledge assets and knowledge infrastructure

in software development environment. Developing measurement scale to assess hypothesised relationships among components of KM capability with respect to different stages of software development could also be a way for further investigating the study. This research could be undertaken within another country. This would enable a comparison of organisational KM capability framework within these countries.

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