Holistic evaluation of knowledge management practices in large Indian software organisations

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Abstract: This research analyses the knowledge management (KM) implementation in India software organisations from the perspective of the knowledge workers. A holistic KM evaluation was conducted by capturing the perceptions of critical success factors, process capability, and the effectiveness of KM. The parameters of the study were developed by using content analysis. A questionnaire survey was conducted to capture the knowledge worker's perception of the eight generic dimensions of critical success factors, five dimensions of KM process capability and five dimensions of KM effectiveness. The data for this research was collected from 423 knowledge workers from 66 large software firms that were listed on the Bombay Stock Exchange (BSE). The perception of each factor was converted to knowledge management index (KMI) scores for interpretation. The results indicated that the overall implementation of KM in Indian software firms was in the right direction with above average KMI scores for all factors. The critical success factors, knowledge process capability factors, and knowledge management effectiveness parameters were ranked based on their perception scores.

Keywords: knowledge management; critical success factors; process capability; effectiveness; organisational culture; technology; leadership; knowledge workers.

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1 Introduction

The importance of knowledge management (KM) in creating competitive advantage is now a well-documented fact (Singh and Soltani, 2010). Organisations are currently valued not only on the basis of traditional tangible assets such as men, machines, and materials but also on its intellectual capital. The intellectual capital can be structural and human capital where the structural capital deals with the explicit knowledge that can be easily stored, and the human capital deals with tacit knowledge which is difficult to capture. The intellectual capital can be viewed as a dynamic resource and is valuable only when it is used (Singh and Soltani, 2010). When organisations start recording their experiences routinely with constant evaluation and sharing of knowledge, it becomes an asset for the organisation.

Knowledge management has been defined from different perspectives. One of the KM definitions by Bollinger and Smith (2001, p.8) viewed KM as "a mechanism for tapping into the collective intelligence and skills of employees" to create an organisational memory. How well the 'knowledge' is managed in an organisation is critical for achieving this objective. KM is also considered as a process through which organisations create business value from their knowledge-based assets. For this to happen, the captured knowledge should be shared across the organisation and in some cases even outside the organisation to develop the best practices (Singh and Soltani, 2010). Although the KM definitions mentioned above does not directly talk about technology, it is an inherent part of KM. However, organisations, that have committed the mistake of viewing KM only as software, ignoring the people and process dimensions, saw their KM programs fail in the long run. Hence, KM is always considered as an amalgamation of people, process and technology (Wickramasinghe, 2006), where all are equally important for the sustainability of a KM program.

Indian software sector has been one of the primary drivers of the Indian economy in the post-globalisation era, and, in the fiscal year 2017, it has contributed 7.9% to the country's GDP (NASSCOM, 2018). The software sector in India was one of the early adopters of KM as the managing knowledge was critical for their survival (Singh and Soltani, 2010). Hence, there was a focused effort from these organisations to manage knowledge assets efficiently to ensure sustainability. Application of KM in the software sector has multi-fold benefits. KM helps software organisations to get valuable insights from their own experiences (Singh and Soltani, 2010). Software projects are time bound and hence rely on the knowledge and experience of employees to complete tasks on time. KM enables this process by helping the individuals to get the right knowledge at the right

time thereby reducing delay in the software development process. Having a knowledge base that the software developers can rely on improves the efficiency of their work, helping them to complete their tasks with minimum supervision. KM also facilitates group work and helps in recognising problems at a faster rate. The Software firms' competitive advantage relies on its agility to take up different kinds of projects, which are complex in nature, for which KM acts as an essential driver (Schneider, 2009).

Software sector, being one of the most knowledge-intensive industries in the current knowledge economy, relies highly on their employees' experience and knowledge. Although software organisations follow technical and functional documentation during software development, what it fails to capture is the tacit knowledge of problem identification and solving. Software organisations, in their pursuit to become knowledge-centric rather than people-centric, have tried to develop their organisational memory through capturing this tacit knowledge and converting it into an explicit form. The efficiency of this knowledge conversion is the key to the sustainability of software organisations and helps in maintaining a robust intellectual capital (Shirazi et al., 2011).

There are many approaches in which software companies carry out their development projects, and these approaches determine how the knowledge is managed. The two major approaches are: 'plan-based' or traditional, which rely primarily on managing explicit knowledge and 'agile methods' which primarily rely on managing tacit knowledge [Nerur and Balijepally, 2007 as cited in Bjørnson and Dingsøyr (2008), pp.1058]. For software development, organisations often re-use life cycle experiences, products, and processes which is often referred to as possessing an 'experience factory'. Software engineering companies capture experiences from software projects, in reusable form, and add it to their knowledge base (Basili et al., 1994). This means that tacit knowledge is converted to an explicit form for reuse. Some of the tools which are used for KM by IT companies are document and content management tools, competency management tools, and collaboration tools (Lindvall et al., 2001). The various benefits of using KM in IT organisations are that it helps in reducing risks in project management and aids in software design. KM also helps in allocation of resources, searching for competence, identification of project opportunities, skill development and promotes organisational learning (Bjørnson and Dingsøyr, 2008).

Within the software development process, there are primarily four activities in which KM is practiced: formal routines, mapping of knowledge flows, project reviews and social interaction (Bjørnson and Dingsøyr, 2008). For the survival of software companies, it is essential to continuously improve the services they offer (Hansen and Kautz, 2004) for which knowledge sharing capability is critical. Al-Shehab et al. (2005) pointed out on how the IT organisations analysed past projects even if it had been a failure, and recorded it, and later it became a significant part in their risk management process. IT organisations that have adopted agile software development engage in sharing of knowledge and experiences during the development process itself from professionals or agile coaches (Pavlič and Heričko, 2018). Melnik and Maurer (2004) discussed the importance of conversation and social interaction which could result in knowledge sharing in the agile process. Some IT organisations gave too much focus on codification, undermining the importance of socialisation, resulting in ineffective knowledge sharing. One way of socialisation could be through mentorship (Bjørnson and Dingsøyr, 2005), which could result in tacit knowledge sharing.

Therefore, there is a need to identify and evaluate those factors that could improve KM effectiveness in IT companies. Recently, there has been thrust in KM literature

towards the evaluation and validation of knowledge management practices (Žlahtič et al., 2017). The current research is carried out in this context to evaluate KM implementation in large Indian software organisations to get a holistic picture. The KM is evaluated as a complete system, which consists of inputs, processes, and outputs. The inputs to the KM system are the critical success factors (CSFs), which are the prerequisites. The process is evaluated by analysing the knowledge management process capability (KMP), and the output is measured in terms of knowledge management effectiveness (KME). Therefore, this research tries to find answers to the following research questions:

- What are the CSFs of KM given in literature?
- Do all CSFs of KM show equally good performance in large Indian IT companies?
- What is the level of KM process capability exhibited by Indian IT companies?
- Are the KM initiatives in large Indian IT companies effective?

2 Literature review

The parameters of this study are developed based on existing theory. This section discusses the key literature used to develop the dimensions of this research.

2.1 Critical success factors of KM

All KM initiatives have not ended up as success stories, and some of them were even abandoned in the implementation phase (Liebowitz, 2016). Researchers always tried to put in place the CSFs that could minimise failure rates, or rather, result in successful KM implementations (Jennex and Olfman, 2004). KM being a strategic activity required focussing on the performance enablers to make it more useful and successful (Frappaolo, 2002). Focusing on the CSFs was critical for leading the KM project on the right track (Barquin, 2001; Frappaolo, 2002; Jafari et al., 2007).

Rockart (1979) defined the CSFs as those areas in which results if they are satisfactory, will lead to competitive performance. In the case of KM, the CSFs are those practices that need continuous attention to ensure its sustainability and these areas need to be developed if not present or nurtured if they already existed (Wong, 2005). Although researchers have listed the KM CSFs through qualitative and quantitative approaches, there exists little agreement between the research outcomes as KM is a dynamic concept and what works for one organisation need not work for a different organisation.

2.1.1 Content analysis

An attempt was made to review the existent literature to identify the CSFs to be considered for this research. The content analysis of around 72 research articles published in the last decade on KM CSFs was conducted. An inductive coding technique was used to code the factors and group them into general factors. While performing the coding process, the emphasis was not given to the words, but to the meaning of the words. Therefore, all the CSFs were noted down initially, regardless of the description, with the intention of grouping it together into like categories, at a later stage. As mentioned above, for this, an inductive coding technique had to be employed that involved breaking the

data into discrete parts, a close examination of the data, a comparison for the similarities and differences, and finally, developing concepts which reflect the underlying data (Strauss and Corbin, 2008). To gather an understanding of the CSFs existing in KM literature, the content analysis was deemed to be an appropriate approach. The content analysis followed eight steps (Finney and Corbett, 2007) as described below:

Step 1 Decide the level of analysis

The level of analysis for this research was decided to be journal articles and conference proceedings published later than 2005. The data collection phase of the literature review involved a search in the databases such as Scopus, Web of Science, EBSCO, IEEE Explore, JGATE and Google Scholar. The keywords used for the searching of these articles were CSFs of KM, CSFs of knowledge management, CSFs 'AND' knowledge management, CSFs 'AND' KM, success factors 'AND' knowledge management and success factors 'AND' KM. After reviewing the abstracts and title of papers, and if the researcher felt that the article could possibly contain CSFs of KM, it was selected for further review.

Step 2 Decide how many steps to code for

At this stage of the coding process, the researcher had to determine whether to code for a specific pre-determined set of concepts or to conduct a more interactive coding approach. For this study, it was decided that an interactive, inductive approach would be more suitable as it would help in the inclusion of any new categories of CSFs.

Step 3 Decide whether to code for existence or frequency of a concept

In this step, rather than going for coding for the existence of a concept, it was decided to code for the frequency of a concept as it would also indicate the relative importance of each factor.

Step 4 Decide on how to distinguish among concepts

This step determined the level of generalisation of CSFs. In this step, it had to be determined, if the codes selected should be exactly as they appeared, or it could be altered or changed without changing the essence of the factor proposed. For this research, any words that implied the same meaning were grouped under the same CSF dimension. For example, the 'motivational aids' and the 'motivational practices' had similar meanings and hence were placed under the same category 'motivation'.

Step 5 Develop rules for coding texts

A set of translations rules had to be developed in this stage to ensure consistency, and to maintain internal validity while carrying out coding. These rules were applied throughout the coding process (Finney and Corbett, 2007). The following translation rules were used:

- To be more inclusive, it was decided to select articles that have both qualitative and quantitative approaches to identifying CSFs of KM. The factors proposed were then noted down in an excel sheet.

- The factors which were noted down in the excel sheet were re-read, in an attempt to categorise them based on similarity.
- The categories created in the above step were carefully reviewed once more to see if it was possible to collapse or sub-divide and establish any additional categories.
- After finalising the categories, each of them was reviewed, and a name was given for the construct taking into consideration the codes or in some cases an entirely new term was given.

Step 6 Decide what to do with 'irrelevant' information

From the first stage, the focus was only on selecting the factors which were associated with KM success; the researcher could code every concept into a category. Hence, there were no occurrences of any irrelevant factors during the analysis.

Step 7 Code the texts

The actual coding process was done during this stage. It was performed manually by following all the translation rules which were defined in step 5. Regarding the name attached to a particular category, Strauss and Corbin (1990, p.67) opined that "it is usually the one that seems most logically related to the data it represents, and it should be graphic enough to remind you quickly of its referent."

Step 8 Analyse the results

In this stage, the actual analysis of the results was carried out by reviewing the constructs. The frequency of occurrences of each CSF was also calculated to understand the relative importance of the factors as projected by past literature.

2.1.2 CSF compilation

The CSF literature was compiled to develop the dimensions by using the above steps. After the preliminary review of around 120 articles, 72 of them were found to be suitable for further analysis because of reference to 'success factors' of KM. A total of 707 factors were extracted from these 72 papers, which meant that approximately an average of ten factors was proposed per article. There were two iterations of coding performed. After the first iteration, the similar factors were grouped resulting in 20 factors. In the second iteration, an attempt was made to collapse/regroup these factors further, which finally led to the formation of nine CSF dimensions. While providing names for each category, care was taken to ensure that the names given were representative of the sub-factors, as far as possible. Table 1 shows the number of factors arrived at after iteration 1 and Table 2 shows the nine-generic CSF dimensions which were obtained after further collapsing the 20 factors of the first iteration. The sub-constructs of the generic factors which were also identified as part of the content analysis are listed in Table 3.

Table 1 Frequency analysis of CSFs in literature after iteration 1

Sl no.	*CSF category*	*Number of instances cited in the literature*
1	KM technology	99
2	KM culture	98
3	KM strategy	72
4	Leadership	72
5	KM process	53
6	KM organisation	60
7	Motivation	33
8	HRM	31
9	Training	31
10	KM resources	28
11	KM measurement	24
12	Communication	18
13	KM structure	17
14	Incentives	16
15	Employee involvement	11

Table 2 Frequency analysis of CSFs in literature after iteration 2

Sl no.	*CSF category*	*Number of instances cited in the literature*	*Collapsed categories*
1	KM culture	126	KM culture, teamwork, trust, learning organisation
2	Human resource management	122	Human resource management, motivation, training, incentives, employee involvement
3	KM technology	99	KM technology
4	KM strategy	90	KM strategy, communication
5	KM organisation	77	KM organisation, KM structure
6	Leadership	72	Leadership
7	KM process capability	62	KM process, benchmarking
8	KM resources	35	KM resources, KM experts
9	KM measurement	24	KM measurement

2.2 Knowledge management process capability

The efficiency of those processes that sustain the KM initiative is termed as KMP. This dimension in literature appears as part of the CSFs in some cases and as a measure of knowledge management success in other cases. In this research, the KMP dimension was developed for evaluating the core KM processes of the software industry. The KM processes have no universal definitions; it represents concepts such as knowledge acquisition (Gold, 2001; Hasanali, 2002; Jennex and Olfman, 2004; Chong, 2006), knowledge creation (Wong, 2005), knowledge transfer (Hasanali, 2002; Wong, 2005), knowledge application (Gold, 2001; Wong, 2005), etc. In the context of this research, the

KM process capability was evaluated with the help of five sub-dimensions vis. knowledge generation (Migdadi, 2005; Fong, 2003; Mahmoudsalehi et al., 2012; Jafari et al., 2012), knowledge distribution (Yang et al., 2010; Karami et al., 2015; Gharakhani, 2016), knowledge application (Yang et al., 2010), knowledge auditing (Akhavan et al., 2006; Bairi et al., 2011) and benchmarking (Lin and Lin, 2006; Jafari et al., 2007; Hamdy et al., 2017). KMP in the context of this research was defined as the generation, distribution, and application of audited knowledge through well-established processes that were consistently benchmarked against the best in the industry.

Table 3 Critical success factors of KM

CSF	*Description*	*Key references*
Knowledge management culture (KMC)	• A positive view on knowledge sharing • Strong social ties • Existence of teamwork culture • Existence of a collaborative environment • Trust on co-workers	Jennex and Olfman (2004), Chang et al. (2009), Yang et al. (2010), Machuca and Costa (2012), Karami et al. (2015), Zeidi and Babaheidari (2015), Margilaj and Bello (2015), Enshassi et al. (2016)
Human resource management (HRM)	• Training on knowledge management system • Motivation to share knowledge • Support for professional development • Incentives for KM activities	Jennex and Olfman (2004), Butler and Murphy (2007), Wong (2005), Gai and Xu (2009), Lehner and Haas (2010), Ahmad et al. (2011), Karami et al. (2015), Zeidi and Babaheidari (2015), Margilaj and Bello (2015), Tavallaei and Fadaei (2016), Akhondzade and Vazife (2016)
Knowledge management technology (KMT)	• Presence of collaborative tools • Search engines that give relevant results • Presence of content management tools • Ease of use of KM system	Jennex and Olfman (2004), Yu et al. (2004), Lehner and Haas (2010), Machuca and Costa (2012), Ramezani et al. (2013), Anggia et al. (2013), Huang and Lai (2014), Arif and Shalhoub (2014), Karami et al. (2015), Tavallaei and Fadaei (2016)
Knowledge management strategy (KST)	• Clearly articulated KM strategy • KM strategy aligned with organisational strategy • KM strategy linked to business performance	Jennex and Olfman (2004), Butler and Murphy (2007), Chang et al. (2009), Machuca and Costa (2012), Farzin et al. (2014), Akhavan and Zadehi (2014), Zieba and Zieba (2014), Karami et al. (2015), Tavallaei and Fadaei (2016)
Knowledge management organisation (KMO)	• Well-organised KM repository • Presence of specialised KM team • Permeable organisation structure • Existence of knowledge communities	Jennex and Olfman (2004), Wong (2005), Butler and Murphy (2007), Aujirapongpan et al. (2010), Akhavan and Zadehi (2014), Arif and Shalhoub (2014), Karami et al. (2015), Enshassi et al. (2016), Akhondzade and Vazife (2016)

Table 3 Critical success factors of KM (continued)

CSF	*Description*	*Key references*
Knowledge management leadership (KML)	• Leadership support and commitment • Role model leaders • Encouraging leaders • Resource providing leaders	Jennex and Olfman (2004), Singh (2008), Yang et al (2010), Moghaddam et al. (2013), Anggia et al. (2013), Farzin et al. (2014), Karami et al. (2015), Tavallaei and Fadaei (2016)
Knowledge management resources (KMR)	• Knowledge assets of high quality • Variety of knowledge sources • Subject matter experts • Availability of human resources	Jennex and Oflman (2004), Yu et al. (2004), Wong (2005), Akhavan (2006); Aujirapongpan et al. (2010); Zieba and Zieba (2014); Zeidi and Babaheidari (2015)
Knowledge management measurement (KMM)	• KM progress tracking • Measurement of impact of KM on financial performance • Development of KM measurement indicators • Intellectual capital valuation	Jennex and Oflman (2004), Wong (2005), Machuca and Costa (2012), Moghaddam et al. (2013), Arif and Shalhoub (2014), Zeidi and Babaheidari (2015), Karami et al. (2015)

2.3 Knowledge management effectiveness

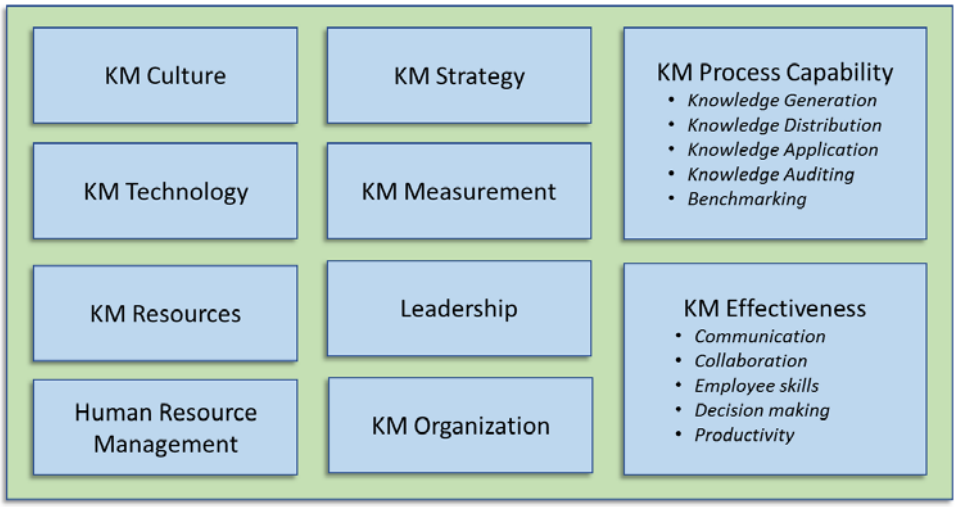
The effectiveness of KM has been measured using different perspectives. The KM effectiveness have been analysed regarding the growth of knowledge resources, increase in knowledge content and use, and financial return (Davenport et al., 1997). Another perspective of measuring the KM was regarding the innovativeness, coordination, time to market, adaptability, and responsiveness (Gold, 2001). The KME had also been measured regarding the perceived satisfaction and usefulness of knowledge workers (Chou et al., 2005). Mithas et al. (2011) explained KME regarding customer management capability, process management capability, and performance management capability. KME had also been linked to business processes, learning, product/service quality, productivity, innovation, profitability, responsiveness and cost reduction (Basu and Ray, 2014). In this research, KME was measured from an outcome point of view which consists of factors such as improved knowledge communication, enhanced collaboration, improved employees' skills, better decision-making and improved productivity (Anantatmula and Kanungo, 2005; Anantatmula, 2007).

2.4 The conceptual model

Based on the literature review a conceptual model was developed (Figure 1) which consists of three stages. The first stage of the model included the CSFs excluding KMP. The second part of the conceptual model KMP included dimensions such as knowledge generation, knowledge distribution, knowledge application, knowledge auditing, and benchmarking. The last part of the model, KM effectiveness measures, are outcome

based, which consisted of sub-dimensions communication, collaboration, employee skills, decision making, and productivity. The proposed model consists of factors which enable a holistic evaluation of KM practices in any organisation.

Figure 1 Conceptual model – a holistic KM evaluation model (see online version for colours)



3 Research methodology

This research used a quantitative approach by collecting first-hand information on KM in Indian software companies. A survey instrument was developed based on a literature review (Table 3) to measure all the constructs of this research. A Likert Scale type questionnaire was used for collecting data. Likert scale is common rating scale used for measuring the perception of respondents on a concept (Allen and Seaman, 2007). Initially, the questionnaire consisted of 83 Likert scale type questions to measure the ten constructs. The questionnaire was subjected to content validity test by five experts from the industry and the academia, who evaluated the questionnaire items on its 'representativeness,' 'specificity' and 'clarity.' Based on their recommendations, the questionnaire survey was modified to include 58 Likert scale items.

Further, a pilot study was conducted for which 46 responses were collected. The pilot data were subjected to confirmatory factor analysis and reliability tests after which the items that did not load with the construct were discarded. The final questionnaire consisted of 48 Likert scale items to measure the ten constructs of this research on a five-point scale (5-strongly agree to 1-strongly disagree). The KM culture had six items, human resource management had four items, knowledge management technology had four items, knowledge management strategy had three items, knowledge management organisation (KMO) had four items, leadership had four items, KMP had five items, knowledge management resources had four items, knowledge management measurement had four items, and KME had ten items. The concept that each questionnaire item measured is shown in the tables.

The focus of the research was large software organisations that were already practicing KM. The inclusion criteria for the companies to be included for this study was that they had to be listed on the BSE belonging to the categories 'A' and 'B' (high and medium volume shares). These two categories made the top bracket of shares based on volume and revenue. A total of 66 IT companies qualified this criterion, and the data was collected from the knowledge workers belonging to these companies using a simple random sampling method. Knowledge workers in the context of this research were defined as employees working in levels of the software engineer, team lead and project manager. The questionnaire was communicated through email to 2,000 potential respondents. After repeated reminders, 423 complete responses with a response rate of 21.2% were obtained, which were usable for data analysis.

The questionnaire captured the perception of knowledge workers of software firms on three aspects – the CSFs, KMP and KME. The data was converted to weight scores for each parameter and the sub-parameter for further interpretation. A knowledge management index (KMI) was calculated for each main factor using the following formula (Singh and Soltani, 2010):

$$KMI = \left(\frac{\sum (w * i)}{n * i * R} \right) * 100 \tag{1}$$

where

w weighted sum score

i number of sub-parameters

n number of respondents (423 in this study)

R maximum value of rating (five in this study).

The KMI was expressed in percentage, and according to the scale used for capturing the perception of knowledge workers, a score of < 20% implied bad perception, 21–40% implied poor perception, 41–60% implied Average perception, 61–80% implied good perception and 81–100% implied very good perception about a factor.

4 Results and discussion

The broad objective of this study was to analyse the KM implementation in Indian software organisations. The analysis was split into three aspects of the KM – the CSFs, the KMP and KME. This would provide a holistic picture of the KM implementation in the software sector. The following sub-sections dealt with the data analysis of all the constructs depicted in the conceptual model (Figure 1).

4.1 Knowledge management culture

The KMI for KMC was found to be 80.35%. This value was obtained by substituting the values in equation (1) and then, dividing the total weighted sum score by the function of a total number of responses and pre-identified sub-factors (six in knowledge management culture). This value was then divided by the highest weight assigned, which gives the

KMI (expressed in percentage). Similarly, the KMI was calculated for all the other dimensions of the study.

As per the predefined rating scale, the performance of the KMC is very good (Table 4). From the responses, it is evident that there was a strong positive perception about the KMC in software organisations. The willingness to share knowledge, strong social ties, the existence of teamwork culture and a collaborative environment are all perceived to be right in the software sector. Knowledge workers viewed knowledge sharing as strength and hoarding as a weakness. The trust factor in the organisation was good which was a prerequisite that enabled knowledge sharing. Organisations that had good norms and practices were bound to have an effective KM in their organisation.

Table 4 Knowledge management culture

S. no.	*Description*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	Willingness to share knowledge	151	186	47	32	7	1,711	4.04	80.35
2	Positive view on knowledge sharing	115	199	70	33	6	1,653	3.91	
3	Strong social ties	144	185	64	26	4	1,708	4.04	
4	Existence of teamwork culture	151	195	57	18	2	1,744	4.12	
5	Existence of a collaborative environment	138	199	52	31	3	1,707	4.04	
6	Trust on co-workers	124	201	58	36	4	1,674	3.96	
	Total	823	1,165	348	176	26	10,197		

4.2 Knowledge management human resource management

The KMI for knowledge management human resource management came out to be 78.91% (Table 5), which was considered as Good as per the pre-defined rating scale. The perception of the knowledge workers underscored the importance of the HRM in KM activities. Training on knowledge management system should be provided to utilise the benefits of the technology entirely. The employees were highly motivated to share knowledge, and the incentives provided were found to be adequate. The support for professional development was also provided to employees who wanted to upgrade their knowledge through higher studies or courses which would, in turn, add to the intellectual capital of the organisation.

4.3 Knowledge management technology

Technology is considered as one of the critical enablers of KM in an organisation. The perception about KMT in the organisation is good as per the results indicated by a KMI of 77.46% (Table 6). However, for a technology-intensive sector like that of the software industry, one expects this to be higher. The presence of collaborative tools enables interdepartmental collaboration. Search engines help knowledge workers to find the right knowledge at the right time. Simple object access protocol (SOAP) based web applications (Benetti et al., 2004) aid knowledge sharing and collaboration in software

firms. Content management systems in the software sector are perceived to be good. Majority of the study also agreed to the fact that the KM system was easy to use which was critical for the sustainability of KM. Overall it could be assumed that although the KMT was perceived to be good, there was a scope for improvement owing to the nature of the business and its importance in KM success.

Table 5 Human resource management

S. no.	*Description*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	Training on knowledge management system	128	171	74	43	7	1,639	3.87	78.91
2	Motivation to share knowledge	147	190	53	31	2	1,718	4.06	
3	Support for professional development	118	218	57	25	5	1,688	3.99	
4	Incentives for KM activities	110	198	66	42	7	1,631	3.86	
	Total	503	777	250	141	21	6,676		

Table 6 Knowledge management technology

S. no.	*Description*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	Presence of collaborative tools	133	180	71	37	2	1,674	3.96	77.46
2	Search engines that are relevant	105	182	88	44	4	1,609	3.80	
3	Presence of content management tools	120	186	82	34	1	1,659	3.92	
4	Ease of use of KM system	108	176	94	40	5	1,611	3.81	
	Total	466	724	335	155	12	6,553		

4.4 Knowledge management strategy

Having a clear KM strategy was considered as the CSF for the success of KM. The perception about the KM strategy in software sector appeared to be good as indicated by a score of 77.30% (Table 7). The KM strategy developed should be aligned with the organisational strategy for KM to have an impact on the bottom line. Also, the KM strategy should be communicated well in the organisation making all employees aware of the same. This will increase the perceived importance of KM in the organisation. Linking the KM strategy to business performance was being done by software organisations so that the impact of KM could be measured regarding the profitability and the innovativeness.

4.5 Knowledge management organisation

The KMI for KMO was 77.80% (Table 8), which was good according to the pre-defined scale. The KM repository was perceived to be well-organised which was a requirement

for faster retrieval of relevant knowledge. The presence of specialised KM teams supported the KM activities in the organisation. Having a flexible organisational structure was required for enabling an interdepartmental knowledge transfer, which was perceived to be good in software companies. Knowledge communities were created in software organisations for sharing domain-specific knowledge. These communities had a strong presence in the software companies enabling the process of KM to flourish.

Table 7 Knowledge management strategy

S. no.	*Description*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	Clearly articulated KM strategy	103	193	88	33	6	1,623	3.84	77.30
2	KM strategy aligned with organisational strategy	132	173	80	34	4	1,664	3.93	
3	KM strategy linked to business performance	104	182	98	37	2	1,618	3.83	
	Total	339	548	266	104	12	4,905		

Table 8 Knowledge management organisation

S. no.	*Description*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	Well-organised KM repository	141	150	77	51	4	1,642	3.88	77.80
2	Presence of specialised KM team	99	186	76	55	7	1,584	3.74	
3	Permeable organisation structure	120	188	77	32	6	1,653	3.91	
4	Existence of knowledge communities	146	181	61	31	4	1,703	4.03	
	Total	506	705	291	169	21	6,582		

4.6 Knowledge management leadership

Any initiative in an organisation requires good leadership for its success. For a concept like KM, this is even more important as only when the management is committed; it can motivate its employees to share knowledge. Top management is the primary sponsor and promoter of KM in an organisation. As evident from the perception of knowledge workers in software firms, the knowledge management leadership (KML) was good with a score of 78.69% (Table 9). This was important for the survival of the KM program. The leaders also should exhibit knowledge sharing behaviour for their employees to follow suit. The software projects were time-bound, and hence the employees should always be encouraged to find time for KM activities along with their routine work. Project managers should use techniques such as group storytelling that would help in the externalisation of tacit knowledge through collaborative construction of stories (Gouvêa et al., 2017). The management should also provide the required resources for the employees – be it human, financial, or technological, for the sustenance of KM initiative.

Table 9 Knowledge management leadership

S. no.	*Description*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	Leadership support and commitment	118	196	73	32	4	1,661	3.93	78.69
2	Role model leaders	118	194	81	29	1	1,668	3.94	
3	Encouraging leaders	124	207	67	20	5	1,694	4.00	
4	Resource providing leaders	95	221	72	24	11	1,634	3.86	
	Total	455	818	293	105	21	6,657		

4.7 Knowledge management resources

For a knowledge-intensive software sector, the importance given to knowledge management resources was as high as the KMI score at 79.79% (Table 10). This indicated the importance of knowledge in the software sector. The knowledge assets available were perceived to be of high quality. The employees also had at their disposal a variety of knowledge sources for getting the required knowledge. The availability of the domain knowledge experts was another requirement for having a successful KM initiative. Past researchers had pointed out that the knowledge resources had a positive influence on new knowledge creation and innovation (Abbas et al., 2018). As expected, the KM resource capability was perceived to be strong in the software sector as perceived by the knowledge workers.

Table 10 Knowledge management resources

S. no.	*Description*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	Knowledge assets of high quality	143	176	71	29	4	1694	4.00	79.79
2	Variety of knowledge sources	139	187	62	33	2	1697	4.01	
3	Subject matter experts	149	192	50	27	5	1722	4.07	
4	Availability of human resources	116	180	86	38	3	1637	3.87	
	Total	547	735	269	127	14	6750		

4.8 Knowledge management measurement

The KMI for knowledge management measurement was found to be 74.95% (Table 11). Although this score was good, compared to other CSFs, this had the lowest performance as perceived by the knowledge workers. The tracking of the progress of any project was required for its sustenance. The KM initiative needed to be tracked to see if it is achieving the objectives that it had been established for. The measurement of KM should also encompass its impact on the financial performance of the organisation. The software

firms have developed clear indicators for measuring the KM performance, and it had also been linked to the incentives provided. The intellectual capital of the company which was the primary asset of the organisation was also evaluated continuously to assess its worth.

Table 11 Knowledge management measurement

S. no.	*Description*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	KM progress tracking	124	173	86	35	5	1,645	3.89	74.95
2	Measurement of impact of KM on financial performance	62	205	99	46	11	1,530	3.62	
3	Development of KM measurement indicators	85	200	89	41	8	1,582	3.74	
4	Intellectual capital valuation	78	205	98	38	4	1,584	3.74	
	Total	349	783	372	160	28	6,341		

4.9 Knowledge management process capability

The process capability dimension explained the efficiency of knowledge management practices in the organisation. The score came out to be 77.92 (Table 12), which was Good as per the predefined scale. The highest score among the sub-dimensions of KMP was for knowledge generation, which was crucial for software organisations to develop new products and services. The software organisations document experiences gained from past projects and this learning could be applied for future projects. The captured knowledge should be validated and distributed fast enough so that the employees could use this for decision-making and it also promotes knowledge re-use. Making the best practices of old projects available for current projects through KM systems will enable faster completion of projects too. Knowledge auditing is a critical process which ensures the archiving of irrelevant knowledge and assessing the quality of available knowledge. This keeps the KM system up-to-date with relevant knowledge. The process of benchmarking involves comparing the KM processes against the leaders of the industry and trying to make improvements. This can be fruitful for the organisations to enhance KM performance; however, one must note the fact that all business organisations are unique and developing their own KM best practices should be the objective in the long run.

Table 12 Knowledge management process capability

S. no.	*Description*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	Knowledge generation	130	203	61	29	0	1,703	4.03	77.92
2	Knowledge distribution	116	198	77	31	1	1,666	3.94	
3	Knowledge application	123	201	66	30	3	1,680	3.97	
4	Knowledge auditing	98	173	91	56	5	1,572	3.72	
5	Benchmarking	126	155	90	47	5	1,619	3.83	
	Total	593	930	385	193	14	8,240		

Table 13 Knowledge management effectiveness

S. no.	*Main factor*	*Items*	*5*	*4*	*3*	*2*	*1*	*Weighted sum*	*Weighted average*	*KMI (%)*
1	Communication	Good knowledge communication	152	194	43	30	4	1,729	4.09	78.81
2	Collaboration	Enhanced organisational learning	106	199	84	27	7	1,639	3.87	
		Inter-departmental collaboration	97	208	79	34	5	1,627	3.85	
3	Employee skills	Specialised learning tools	131	204	52	33	3	1,696	4.01	
		Employee skill development	131	211	52	23	6	1,707	4.04	
4	Decision-making	Improved decision-making	89	215	72	43	4	1,611	3.81	
		Informed decision-making	109	205	79	27	3	1,659	3.92	
		Collaborative decision-making	89	219	73	37	5	1,619	3.83	
5	Productivity	Innovation ability	110	211	69	30	3	1,664	3.93	
		Increased profitability	137	202	57	26	1	1717	4.06	
		Total	1,151	2,068	660	310	41	16,668		

4.10 Knowledge management effectiveness

The indicators used to measure the KM effectiveness were outcome-based as proposed by Anantatmula and Kanungo (2005). The KMI for KME came out to be 78.81% (Table 13), which was good as per the predefined scale. There was excellent knowledge communication in the organisation. There was a focus on converting individual knowledge to organisational learning. The interdepartmental collaboration was good and was supported by specialised tools. The employees' skills had improved, and there was improved decision-making. The knowledge workers could make informed decisions, and they could participate in collaborative decision-making. Overall the perceived KM effectiveness in software organisations was found to be high.

5 Findings and managerial implications

It had been found that the perception about the CSFs of KM had been good for all the factors although variations in the perception were observed (Figure 2). The knowledge management culture was one factor which had been considered as very good and topped the list of CSFs. This underscored the importance given by software organisations on creating a congenial culture to support KM. IT organisations aiming to be successful in KM implementation should focus on creating culture as a prerequisite. Creation of culture implied creating a knowledge sharing environment in the organisation. Sharing of knowledge should not be imposed on individuals as it may not gather the desired results. The culture of knowledge sharing should become the norm in the organisations, where it becomes inherent in the work practices of individual knowledge workers. The management should promote knowledge sharing activities and create avenues, where employees can share their experiences, and it is worthwhile to record this tacit knowledge as it could help in developing an organisational memory.

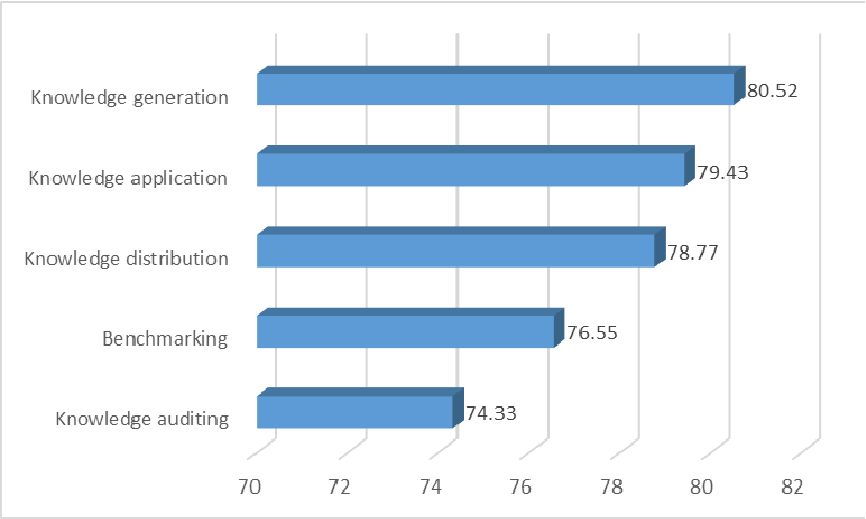
Figure 2 KM critical success factors comparison (see online version for colours)

The second-ranked factor according to perception was KM resources. This was an expected result since the software sector relied heavily on knowledge resources on a day-to-day basis. The survival of IT organisations depended on how quickly and efficiently they created knowledge. This could be a small piece of code, which could result in saving millions of dollars for the client. For creating value for the customer, IT organisations seek to improve their in-house knowledge on a consistent basis. The availability of these resources was key to enabling knowledge workers to internalise and create new knowledge at a faster pace. A conscious effort should be made by the managers to develop knowledge resources – both explicit and tacit, which were of good quality and reliable.

Human resource management took the third position, which implied that the training of KM system, incentives provided, and motivation factors were good in the software sector. Training could enhance an individual's willingness to collaborate, propagate knowledge and be innovative (Marczewska and Kostrzewski, 2018). The KM leadership in position four in perception also has a high KMI value of 78.69%, which indicated the importance given by management of software companies for KM activities. Leadership commitment was crucial for any initiative in an organisation to be successful. The case of KM was not different either. Leaders should encourage knowledge sharing activities and exhibit the same so that employees follow suit.

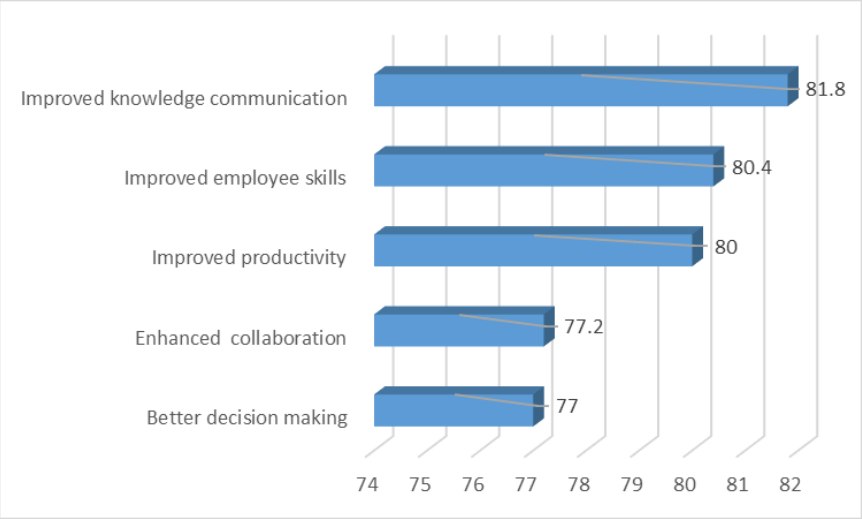
KM organisation, technology and strategy had almost similar scores of 77.8, 77.46 and 77.3, respectively, which were high as per the scale. A factor which is marginally lower than the other factors and had been ranked the lowest was the knowledge management measurement. Although the score was above average, there was scope for improvement for this factor. Hence, it is recommended that software organisations should focus more on the measurement of KM activities. On microanalysis of this factor, it could be observed that linking of KM measurement to financial performance needed improvement. Clear KM indicators should be developed for measuring KM performance of employees, departments, and organisation. This could also be linked to incentives for employees for knowledge contribution and sharing.

Figure 3 KM process capability dimensions (see online version for colours)



The second significant parameter considered for this research was the KM process capability dimension. The overall KMI for this factor was 77.92%, which indicated a good level of performance. On analysing the KMP on a sub-factor level (Figure 3), the perception about knowledge generation (80.52%) was the highest, which was an indicator that KM performance in the organisation was on the right track because the ultimate aim of KM should be to generate new knowledge. The KM processes such as knowledge application (79.43%), knowledge distribution (78.77%) also showed favourable performance levels. However, factors such as benchmarking (76.55%) and knowledge auditing (74.33%) could be improved further for strengthening the process capability dimension.

Figure 4 KM effectiveness measures (see online version for colours)



This research concluded with a focus on the outcome of a knowledge management program in software organisations. The outcome measures revolve around five primary sub-parameters such as improved knowledge communication, improved employees' skills, better decision-making, enhanced collaboration and improved productivity. Overall, the KMI for the KM effectiveness was 78.81%, which is a high value. Observing the trend of CSFs and KM process capability scores the KME was also expected to be high. This indicated that if the input and process were proper, then the KM outcomes would be achieved. Here, the success factors and process capability were perceived to be good in the software sector, which had impacted the effectiveness of KM in these organisations, which again is also high. On close observation of the KME dimension (Figure 4), the highest ranked sub-parameter was knowledge communication (81.8%), which was followed by improved employee skills (80.4%) and improved productivity (80%). Although perception about enhanced collaboration (77.2%) and better decision-making (77%) was good, their KMI was comparatively less. Hence this area required focus and improvement.

Overall, it could be inferred that the KM implementation in the software sector was in the right direction. The importance given for CSFs of KM indicated that the strategic managers were serious about KM implementation. The processes which were in place to

support KM activities were well-established and functional. Software organisations should look beyond themselves to identify the best practices of KM and implement them in their organisations. Knowledge auditing could be enhanced by consistent checking of knowledge to keep it relevant and useful. Because of this holistic approach to KM, the software organisations were very well reaping the benefits. It is high time that the industry takes a right strategic decision to scale up the KM activities to the next level. Currently, the KM technology and tools which were primarily limited to collaboration and content management needed to be upgraded. Software sector should move towards adopting technologies such as artificial intelligence and machine learning for broadening the scope and impact of KM.

6 Conclusions, limitations and future scope

This research employed a holistic approach to analysing KM in software organisations from three different perspectives. The first objective was to see how knowledge workers perceive the drivers of KM or the CSFs of KM. The second objective was to understand the KMP of Indian software organisations. Finally, how effective KM implementation had been in these organisations were assessed based on the outcome measures.

This research had some limitations which needed to be addressed in future studies. The present study was based on a quantitative approach and was descriptive in nature. The empirical validation of the proposed conceptual model needed to be conducted with a larger sample size for analysing the effect of each factor on the KME. It is recommended to conduct the observational studies and interviews in the software sector to explain in detail the impact of KM. This could also give rise to new factors which may have to be added to the list of theoretically proposed parameters. The KMP dimensions considered in this research were limited to knowledge generation, application, distribution, auditing and benchmarking. However, the KM literature described several other KM processes such as knowledge dissimilation, knowledge synthesis, etc. which are not analysed as part of this research. The present study was based on the perception of knowledge workers. However, for KM which impacted a broader stakeholder group, it is essential to gather a broader perspective for understanding its intricacies. Therefore, it is recommended as a future scope to gather the perceptions of other stakeholders such as top managers, customers, shareholders, etc. to analyse KM from different viewpoints. KME dimension can be expanded further to include variables such as the performance of customer relationship management (CRM) and business process management (BPM) as an indicator of firm performance. Further, the analysis presented in this research is specific to large IT organisations. Hence, future studies could study the impact of different control groups such as age, location, team-size, sales, etc. on the CSFs and KME.

Withstanding these limitations, this research still provides a significant contribution to the KM literature. The results discussed in this research can be used as a benchmark for evaluating KM implementations across individual software firms. The holistic KM model presented in this paper can act as a guideline for those organisations that are new to KM implementation. Further, this research also paved the way for organisations that have been unsuccessful in their KM practices to retrospect and re-strategise their KM program for leading it in the right way.

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