CHAPTER-I
INTRODUCTION AND DESIGN OF THE STUDY

1.1 INTRODUCTION

Software is one of the important parts of individual’s daily life. Each facility of which we are habitual is somewhere controlled by a piece of software. Cars, airplanes, factories, travel agencies, military, banks, games, etc., depend on or are controlled by software. (Schneider, 2009)¹. To make use of all these facilities efficiently, it requires that software, which has control on them, works reliable. Software industries have main goal to produce quality product and for that they need software engineers and other creative employees who will effectively exploit an organization’s knowledge and experience. But much-cited Standish report on software projects (Chaos, 1995)² “Shows a staggering 31.1 per cent of projects that will be cancelled before they ever get completed. Further results indicate 52.7 per cent of projects that will cost 189 per cent of their original estimates. The cost of these failures and overruns is just the tip of the proverbial iceberg. The lost opportunity costs are not measurable, but could easily be in the trillions of dollars…” In the current scenario, demand of the software is increasing while technology changes constantly. Both of these factors make the work process and practices at software industries dynamic in nature. Organizations have to keep track of 3Ws about knowledge: what is knowledge,
where is it, and who has it? Organizations have to give importance to knowledge and their owners and must treat them as assets (Ioana et al., 2001). The information systems literature has emphasized introduction of ‘Knowledge Management Systems’ in order to support organization with-wide knowledge-exchange and learning.

1.2 KNOWLEDGE MANAGEMENT

The first question comes to mind is how we can define knowledge. Data always use raw numbers, out of which information is collected through data processing. Information with context and experiences is called knowledge (Chua and Lam, 2005). According to Agresti, “Knowledge is a mix of framed experience, values, contextual information, and expert insights that provides a framework for evaluating and incorporating new experiences and information.” Knowledge can be classified as tacit or explicit. Tacit knowledge is within the individuals and cannot be recorded or reduced to the digitized form. It is generated by best practices, experience, and wisdom. However, it expresses in the social realm as the responsibility of individuals (productivity, innovation and initiative), and teamwork (communication, co-ordination and collaboration). Explicit knowledge can be recorded digitally in documents, records, patents and other intellectual property artifacts. Explicit knowledge is representational and can exist and be manipulated within the digital domain. Converting data-to-
information and information-to-knowledge describes a value continuum of explicit knowledge. The tools and business processes of Knowledge Management (KM) are intended to enhance this continuum of value (Moffelt et al., 2003). The definitions of tacit and explicit knowledge, as given in (Mikael et al., 2001), are: “Tacit knowledge is internalized, context-specific. Tacit knowledge is the knowledge of the employees” while “Explicit knowledge refers to that type of knowledge which is transmittable in formal, systematic language. Explicit knowledge is easily distributable.” The developers of KM tool Hyperwave present a definition of KM, i.e., it is “the task of developing and exploiting an organization’s tangible and intangible knowledge resources. KM covers organizational and technological issues” (Wiig, 1997).

According to Gartner, KM is an integrated and collaborative approach to the Creation, Capture, Organization, Access and Use of Information Assets. The knowledge cycle is shown in Figure 1.
Knowledge and experience can work as path leader for software industries to increase their market value. As shown in the Figure.1, people create knowledge as per their ability and capture it as reports in any form either in paper or digital. Capturing the knowledge is not enough until it is organized, classified and modified according to needs. Indexing is also done in classification for easy access to the managed knowledge by the employees. At the end, knowledge must be shared, used and modified by the resources that use it. This takes us back to knowledge creation (Mohan, 2005). KM promises to improve the quality, efficiency, and effectiveness of business. So, comprehensive accumulation and adequate proliferation of knowledge is the cornerstone of any business (Torgein and Reidar, 2002). Satish Joshi, Senior VP, Patni Computer Systems Limited says “For us, KM is a set of processes and tools which give us the ability to leverage and combine the collective abilities of our knowledgeable workers”. M.D. Agrawal, GM IS Refinery says that “A KM practice that encompasses end-to-end processes owned by a department can go a long way towards a boosting productivity”.

Experiencing Factory is, the way by which capturing the information makes them reusable, done by delegating these responsibilities to a different cell of the development organization. The experienced factory, as shown in Figure 2, is an infrastructure for reusing life cycle experience, processes and products for
software development. Experiences are collected from software development projects and stored in an experience base as packages. By packing, we mean to generalize, tailor and formalize experiences so that they are easy to reuse. Examples of packages are Product Packages, Process Packages, Relationship Packages, Tool Packages, Management Packages and Data Packages (Dingsoyr, 2000, Basili et.al., 1994). There are two main strategies for managing knowledge i.e. and Personalization. Codification to systematize and store information that represents the knowledge of the company, and make this available for the people in the company and Personalization to support the flow of information in a company by storing information about knowledge sources, like a “yellow pages” of who knows what in a company (Kasvi et. al., 2003).

Knowledge Management a Support in Software Engineering

There is always a discussion in software engineering about management of knowledge and foster learning software organizations. Feldmann and Althoff have defined “Learning software organization” as an organization that has to “create a culture that promotes continuous learning and fosters the exchange of experience” (Bjornson and Dingsoyr, 2008). Software Development Life Cycle (SDLC) initiates from requirement collection in coordination with customers followup by all remaining phases like designing, coding, testing, deployment and maintenance and replacement. Work Product (artifacts) developed during all these phases will
be managed and stored in baseline. Ultimately these artifacts from baselines are used with individual experience as a knowledge source for effective product development. The quality of the knowledge is applied in business processes by organizations is a critical factor to achieve great success. Main challenges which organizations have to face to take advantages from the knowledge are the faster growth of innovations through fast evolution of knowledge and generation of an environment to accommodate those, that need to implement formal methods in accordance to informal knowledge, reduction in knowledge workforce, and it requires time to adopt knowledge in process while team members have less time in schedule tight projects (O’Leary, 1998\textsuperscript{14}). In response to these needs, KM has been used. KM combines tools and technologies to provide support to the capture, access, reuse and dissemination of knowledge, generating benefits for the organization and their members.

The use of KM to SE would allow sharing experiences of individual or groups, create a baseline from it, and establish a common procedure for use at organizational level and facilitate the adoption and transfer of new methodologies, techniques and technologies between different departments or even partners. A successful KM project is associated with three key aspects. The first aspect highlights on establishing an organizational culture for sharing and collaborating. The second aspect highlights the exchange of knowledge among the employees.
The third and last aspect suggests the use of a corporate memory to describe the knowledge and interchange of relevant knowledge (Andrade et al., 2006)\textsuperscript{15}.

1.3 REVIEW OF LITERATURE

Knowledge Management In Software Industries

In software industries, KM is one of the effective processes to capture knowledge of different areas and use it like discussion about common problems associated with technologies and information as query solution of different situation on industries that can help solve common problems. This, in turn, boosts productivity. A survey by Reuters her found that 90 per cent of companies that deploy a Knowledge Management (KM) solution benefits from better decision-making, while 81 per cent say that they notice increased productivity.

Patni Computer System has created a knowledge centre, which has led to a reduction in training time and a boost I productivity due to better sharing of knowledge among its employees. Some of the features of the knowledge centre are information about the quality management system, searchable repository of reusable software components, discussion forum, helpdesk for facilitating process consulting to projects and marketing centre which holds frequently asked questions by customers (Chatters, 1999)\textsuperscript{16}.
NASA Software Engineering Laboratory has implemented first Experience Factory in forms of cost data, process data and product data. Process data is the data of information, tools and technology used while product data is the data of change and error information and results in static analysis on delivered code. All these collected data are used to develop predictive models and to enhance the software processes. The result of this activity is reported as defect rates that has dramatically been down (75% from 1987-91, and 37% from 1991-95); the cost of producing software gone down by 55 per cent from 1987-91 and 42 per cent from 1991-95. Reuse has been improved by 300 per cent from 1987-91 and 8 per cent from 1991-95. Finally, functionality has been increased five-fold from 1976-92.

Ericsson Software Technology in Sweden has also experimented by transferring the experience on site to establish a corporate culture for communicating experiences easier. To identify the type of knowledge, people can have benefits from communication, that they use the expertise of “Experienced brokers” (Johansson, 1999).17

Australian Telecommunications Company in cooperation with the Center for Advanced Empirical Software Research at the University of New South Wales, Australia uses its experience in the factory to effectively use time to deliver the product with good quality, and to enhance experience sharing between projects
with the help of documentation done in the development (Koennecker et al., 1999)\textsuperscript{18}.

“Engineering Process Improvement Framework” developed by ICL High Performance Systems in the UK includes a repository for knowledge sharing. The framework is an implementation of an experience factory. The approach defined by a project is assessed and calibrated against an evolving definition of best practices prior to implementation, leading to the identification of risks and actions to be managed by the project. The main objective for introducing this improvement program is to “improve the predictability of costs and delivery dates of systems and solutions” (Hatters et al., 2000)\textsuperscript{19}.

In the late 1990s, Tata Steel introduced Knowledge Management in the form of “Knowledge Repository” by involving small group of people from the organization. Through this repository, employees shared their experiences and knowledge. Then after one year company formed “Knowledge Communities” where like-minded people met and shared their experiences. In 2001 “KM index” was used by the company to evaluate the performance of an employee in the KM initiative. Later, it linked performance evaluation to KM and used a balanced scorecard to monitor the performance of employees, divisions, as well as the organization as a whole, in KM. All these initiatives of Tata Steel seem to have paid off; in early 2003, Tata Steel was recognized as one of Asia’s Most Admired
Knowledge Enterprises (Yeh et al., 2006). Many other organizations like Accenture, Cap Gemini Ernst and Young, Deloitte and Touche, Ernst and Young, KPMG Consulting, Mckinsey and Company etc. are successfully using KM.

**Implementation of Knowledge Management**

To implement KM, an excellent Implementation Plan is required to design by reusing the lessons from successful (and less successful) Implementations in other companies, and tailored to your own context. Implementation of KM varies from company to company and country to country. It should give benefits to individual to collect effective knowledge as per their needs. The plan will be based on the results of assessment and benchmarking, the Knowledge Management strategy, the proposed and agreed Knowledge Management framework, the communications plan, a staged, change management approach, and a full analysis of the risks to Knowledge Management delivery.

Team which has responsibilities of managing KM must have required support from management. They initiate from small scale with monitoring the growth of KM and resolving the problems arising in it. After getting the base line status that is stable status it can be implemented at organization level. Someone should expect the return from the day of implementation of it but actually it will take time to deliver effective knowledge and must be revised regularly. It may
take several iterations of real input and measurable output and subsequent updates before a good KM system is in place.

Some of the key features required to successful implementation of KM are:

- Business success history defined in the form of business cases and budget allocation
- Communities of practices which required elements like sponsorship, membership, role of responsibilities, accountability and measurement, supporting tools
- Identify the hurdles in the environment as well as in culture and resolve the issues responsible for those hurdles to create KM
- Information technology impact
- Measurement

Implementation of KM into an organization with existing methodologies of KM is connected with problems like low level of complexity, lack of information, technological orientation, etc. To overcome these obstacles, FIM UHK has developed a new methodology of KM implementation called KM-Beat-It. This methodology has started to analyse both the strength and the weaknesses of existing KM methodologies. It works in different phases which are assembly of realization team to get support from higher management or owners of the organization, analysis of initial state to create integrated view on the current state
of organization, creation of knowledge strategy to support business strategy and indentify knowledge activities, realization of KM activities to conduct projects or plans leading to KM (Ures, 2005)\textsuperscript{21}.

6. Tools Support for Knowledge Management

Commercial tools as well as academic tools are available for Knowledge Management. KM facilitates features such as search and database maintenance, internet features, security, FAQ lists, logged chat features, find-an-expert features, personalization, etc., which aid in knowledge-sharing within an organization. Some of the tools used for KM are Experience Management System, Case-Based Reasoning (CBR) for retaining and retrieving experience.

One more tool named BORE has been developed by the University of Nebraska-Lincoln. This tool comprises of case studies related to real time problem solving experiences, and descriptions of resources like tools, projects, people and development methods. All these solution information are used to solve new problems faced by software developers during future projects. CODE-a general-purpose Knowledge Management system is also supportive system developed to serve as a medium for knowledge capture and transfer, as well as editing or “packaging” knowledge to make it easily available.

Mostly IT based tools are categorized into Groupware Systems, Data Warehousing, Data Mining, & OLAP, Decision Support Systems, Content
Management Systems, Document Management Systems etc. (adapted from Gupta and Sharma 2005, in Bali et al., 2009). All the tools belong to any group can support KM if they are designed and implemented properly. Groupware tools such as publishing and communication tools, collaborative management tools, video conferencing and informal communication tools provide facilities to create, share explicit knowledge as well to find the sources of the knowledge. One of the best examples of Groupware tool is Lotus Notes. Data mining tools and techniques can be used to search stored data for patterns that might lead to new insights. In Decision Support Systems KM is involved to enhance the manger’s knowledge through knowledge discovery and supply of relevant information. Kiku (2006) has emphasized that a decision support system must be designed in light of KM. Content Management Systems are very relevant to Knowledge Management (KM), since they are responsible for the creation, management, and distribution of content on the intranet, extranet, or a website. Document Management Systems aid in the publishing, storage, indexing, and retrieval of documents. Although such systems deal almost exclusively with explicit knowledge, the sheer volume of documents that an organization has to deal with makes them useful and in some cases even mandatory (Alavi and Leiduer, 1999).
1.4 SCOPE OF THE RESEARCH

Software Engineering (SE) is a discipline that is yet to reach maturity, despite the tremendous amount of research it has engendered. In 1990s, increased consideration was given to the process used for software development and its potential to improve software quality. The popularity of the Capability Maturity Model (CMM), ISO 9000 series of standards and the Software Process Improvement and capability determination (SPICE) model are testament to the importance associated with a process – orientation for software engineering. The need to, further, develop software practices within organizations adds to the demand for systematic knowledge and skill management at all stages of a software cycle. The increased complexity of project work has also led to a greater reliance upon knowledge processes to solve problems. Therefore, software developers are required to develop knowledge of emerging technologies, while ensuring that they adhere to organisational processes and methodology. Knowledge Management in a software organization is seen as an opportunity to create a common language of understanding among software developers, so that they can interact, negotiate and share knowledge and experiences. Furthermore, the KM system supports the ability to systematically manage innovative knowledge in Software Engineering. Hence, the present study has made an attempt to measure the effectiveness of
implementation of KM in the enrichment of Software Engineering in the software companies.

1.5 PROBLEM FORMULATION

In the recent years, the importance of Knowledge Management has been burning as a basis of competitive success. Knowledge Management caters to the critical issues of organisational adaption, survival and competence in the face of increasingly discontinuous environmental change. Essentially, it embodies organisational process that seeks the synergistic combination of the data–and information–processing capacity of information technologies, and the creative and innovative capacity of human beings. There is a strategic view of Knowledge Management that considers the synergy between technological and behavioural issues as necessary for survival in wicked environments. The Software Engineering consists of software development, maintenance and enrichment. The software development has its own phases of requirement-analysis, design, code generation and testing. The content in the phases depends upon the requirements of the clients. Hence, the Software Engineering should be a customer centric engineering. Since, the needs and requirements of the customers are frequently changed, the software engineers should know a wider knowledge on the needs of their customers and also to manage the customers’ needs. Hence, the knowledge in all the phases of software development and its, maintenance and enrichment is
highly essential. Otherwise, their software will be obsolete. This is the hectic problem in Software Engineering.

**Related Reviews**

Rituraj (2011)\textsuperscript{23} has revealed that the Knowledge Management is seen as a process of converting information into value for the corporation to reduce cost, increase employee’s productivity and improve quality of product and services.

Ajila and Sun (2004)\textsuperscript{24} have investigated push and pull approaches to delivering knowledge to software development projects. The push means using tools to identify and pride knowledge to potential users whereas pull means that users themselves have to use repositories and other tools to identify relevant knowledge. They have found that pulling leads to more effective software development.

Ravichandran and Rai (2003)\textsuperscript{25} have studied the influence of embedding and creation of knowledge on software process capability. They have found support for a model where knowledge creation has an effect on process capability when the knowledge is embedded after its creation.

Ward and Aurum (2004)\textsuperscript{26} have found leadership to be the most significant positive factor for the management of knowledge but that the tools, the techniques
and the methodologies that the companies have are not adequate for managing knowledge effectively.

Manish et al., (2005)\textsuperscript{27} have found that Indian Software Companies are aware of the capabilities of Knowledge Management Systems and are using it to improve productivity, reduce defects, facilitate reuse of software components, and share lessons learnt in execution of projects.

Conradi (2000)\textsuperscript{28} have revealed that Knowledge Management is particularly important for software consulting companies that can apply knowledge acquired in prior projects in the execution of subsequent projects. Software Development Companies can organize and exploit prior experience to facilitate learning at individual and organization levels.

Ramasubramanian Jagadeesan (2002)\textsuperscript{29} has discussed the challenge of managing knowledge at Infosys, a leading software company in India that provider “consultancy and software services world wide to future 500 companies."

Rus and Lindvall (2002)\textsuperscript{30} have found that the Software Companies rely on Knowledge Management activities such as document management, competence management, and software reuse to sustain the level of competence.

Perlow (1999)\textsuperscript{31} has revealed that Knowledge Management is one of the hallmarks distinguishing the higher levels of capability maturity.
Rosenberg (2003)\textsuperscript{32} has explained why manufacturing based total quality approaches have not worked well in Software Engineering. Such approaches do not deal well enough with the nature of a software product.

Hoyle (2001)\textsuperscript{33} relates the ISO 9000 services standards and Quality Management Systems of all kinds in organizations, but some parts of Software Engineering Industry have been attracted by the ideas of systems designed to deliver products that meet customer needs.

Rus and Lindvall (2002)\textsuperscript{34} have identified the motivations of implementing Knowledge Management System in Software Engineering that acquire knowledge about new technologies, decrease twice and increase quality, access domain knowledge, quickly adopt the organization culture and skill identification.

Kess and Haapasalo (2002)\textsuperscript{35} have argued that software processed are essentially knowledge process, structured within a Knowledge Management Frame Work.

Aurum et. al., (2003)\textsuperscript{36} have pointed out that Software Development can be improved by recognizing related knowledge content and structured as well as appropriate knowledge and engaging in planning activities.

Basili et. al., (2001)\textsuperscript{37} acknowledge that implement the ‘Experience Factory (EF)’ approach for Knowledge Management urbanization in organisation, a
number of potential barriers to success must be overcome. They argued that while the EF is aimed at instituting a learning organization, it requires a significant investment of time and effort.

Johnson et. al., (1999)\(^{38}\) list problems identified with the experience Factory approach, as such as its experimental nature, the organisational restructuring it prompts as well as its reliance upon an experience base containing a vast amount of written documentation.

Tamanna et al., (2011)\(^{39}\) evaluate the Knowledge Management, in Software Engineering with the help of four important measures namely requirements, development team, involvement of users and project type and risk. They concluded that the using of Knowledge Management in Software Engineering is highly beneficial to the companies.

Kuan and Elaine (2006)\(^{40}\) have found that the implemented Knowledge Management initiative and system will be beneficial to the organization by enhanced division support, efficiency and innovation.

Civi (2000)\(^{41}\) and Gupta et al., (2000) have mentioned that the completed advantage of the software companies will be realized when they properly managed and leverage knowledge to become more adaptive, innovative, intelligent and sustainable.
Jarrar (2002)\textsuperscript{42} listed the benefits of adopting Knowledge Management in software companies. The enhance decision making through just – in – time intelligence, improve work efficiently and productively, increase innovation, improve competency and competitiveness, enable rapid generation of technical solutions and increase responsiveness to customers.

Desouza (2004)\textsuperscript{43} has revealed that industrial engineers are the best candidates to optimize and systemize KM programmers in organization. This is attributable to the fact that they are well trained in dealing with layout, transportation, maintenance, and human factor problems.

For Cadell and Guadamillas (2002)\textsuperscript{44} have mentioned eight important areas in order to make the Knowledge Management initiatives in an effective way. These are customer, soft systems methodologies, operational analysis, requirements elicitation, software and tools, data management and analysis, domain and mood.

Ravichandran and Rai (2003)\textsuperscript{45} have provided strong support to the mediated impact model suggesting that the extent to which knowledge is embedded in the process has a significant positive effect on software process capability. The process is influenced by the extent to which knowledge is created in the context of the development process.
Harter et al., (2001)\textsuperscript{46} have examined the effects of process maturity on software quality and software development cycle time. They have found that while process maturity improvements have a positive impact on software quality, they have also increased the development cycle time.

Alavi and Leidner (2001)\textsuperscript{47} have noted that Information Technology enables the acquisition of greater amount of information, by expanding the availability of data associated with horizontal and vertical organisational processes. This expands availability of information, complied with the deployment of fact based learning and represents an opportunity to rapidly create process knowledge by empirically investigating process behaviour.

Iom and Hars (1998)\textsuperscript{48} have revealed that in the context of software development, declaration knowledge could be knowledgeable about the business in data structures, metadata, and business logic in the form of programs that are once validated, these forms of declarative knowledge can be reused in subsequent projects.

Purvis et al., (2000)\textsuperscript{49} have mentioned that software process technologies such as CASE tools provide a certain degree of structure to the development process. They also embedded procedural knowledge and facilitate their deployment in a consistent manner.
Purvis et al., (2001)\textsuperscript{50} reveal that case tools have been considered important knowledge platforms that prided codified knowledge, act as organisational memory, facilitate the development of routines that coordinate system development tasks, and incorporate refined knowledge requited for task sequencing.

Nonaka and Konno (1998)\textsuperscript{51} have identified socialization, externalization, combination, and internalization as four inter related mechanisms for knowledge creation included two of these mechanisms namely fact–based learning and knowledge codification for reuse.

Hansen et al., (1999)\textsuperscript{52} have suggested a personalization strategy involving operation and maintenance of effective knowledge networks within the organization that can be effectively tapped into. Future research should go beyond codification and include a broader set of strategies for tapping into and deploying relevant software development knowledge.

Teece (1998)\textsuperscript{53} has identified eight basic Knowledge Management processes; generating new knowledge; accessing valuable knowledge from outside sources; using accessible knowledge in decision making; embedding knowledge in processes; products and/or services; representing knowledge in documents, databases and software; facilitating knowledge growth through culture and incentives; transferring existing knowledge into other plants of the organization; and measuring the value of knowledge assets and/or impact of Knowledge Management.
Shu-mei (2008)\textsuperscript{54} has found that the financial and own-financial performance increases when the Knowledge Management System in software companies is continuously improved. The quality of Knowledge Management System will increase the performance of the companies.

Lee et al., (2005)\textsuperscript{55} has used five components to measure the Knowledge Management performance. These are knowledge creation, knowledge accumulation, knowledge sharing, knowledge utilization, and knowledge internalization.

Riliere and Sitar (2003)\textsuperscript{56} have revealed that corporate performance is significantly influenced by the Knowledge Management activities.

Lin et al., (2005)\textsuperscript{57} have revealed the positive significant influence of the adoption of Knowledge Management on the financial and own-financial factors. The financial factor represents the sales of the recent years whereas the own-financial factor represents competitiveness and innovativeness.

Kim et al., (2003)\textsuperscript{58} have mentioned the importance of Top Management support to lever the capability of the knowledge for the organization. They should ensure the consistency between the enterprise mission and knowledge strategy by clearly defining knowledge goals that are connected with functional strategies.

F. Liaster (2004)\textsuperscript{59} has suggested that firms must train employees to have good skill to apply and use the Information Technology for implementing the Knowledge Management and provide abundant resume support to Knowledge Management.
Chang et al., (2004)\textsuperscript{60} has found that the success to implement the Knowledge Management systems should firstly obtain all employees commitments and then appropriate measure system to evaluate the Knowledge Management performance.

Chen et al., (2006)\textsuperscript{61} have given emphasis on importance of external knowledge, knowledge transfer, knowledge transfer activities, social and electronic network that have found out all related to business performance.

Beijerse (2000)\textsuperscript{62} found out that there was no explicit policy that was targeted at strategic Knowledge Management. Most of the SMCS have treated Knowledge Management on an operational level at the level of systems and instruments.

Matlay (2000)\textsuperscript{63} has concluded that strategic learning and knowledge orientation leading to survival and solid growth in the long run, although there might be other ways of obtaining short term gains.

Alam et al., (2009)\textsuperscript{64} have shown that reward system, culture trust and technology are the key factors influence the knowledge sharing behaviour in SMES.

Almahamid et al., (2010)\textsuperscript{65} have found there is significant relationship between organisational knowledge sharing practices, employees learning commitments, employee adaptability, and employees job satisfaction.

**CONFORMATION OF PROBLEM FOUNDATION**

Even through there are so many studies related to the implementation, issues and consequences of the KM in Software Engineering, there is only a limited study in Indian
Software Industry especially situated in Tamilnadu. The present study has made an attempt to fill up the research gap with the help of proposed research model.

**PROPOSED RESEARCH MODEL**

The proposed research model is given below.

![Diagram]

**1.6 OBJECTIVES OF THE STUDY**

Based on the proposed research model, the objectives of the study are confined:

1. to measure the rate of implementation of KM in Software Engineering at the companies;

2. to examine the motivators and the issues in the implementation of KM in Software Engineering at the companies;

3. to analyse the various enrichment due to the implementation of KM in Software Engineering;
4. to identify the important discriminant aspects of KM, it’s implementation, motivators, issues and outcomes among the lesser and the higher experienced companies;

5. to evaluate the impact of implementation of KM on the enrichment of software engineering, software system quality and software quality.

RESEARCH METHODOLOGY

Research Methodology enlightens the methods to be followed in research works starting from the problem identification of research to the identification of the solutions to those problems. The research methodology focuses on the methods to be adopted at the various steps in the research process. It includes research design, population of the study, sampling procedure, sources of data, collection of data, analysis of data limitations of the study.

RESEARCH DESIGN

Since the present study has made an attempt to explain the implementation of Knowledge Management in Software Engineering as per the view of the Software Engineers in the company, it is descriptive in nature. Apart from this, the present study has its own objectives and pre-planned methodologies. The present study also examines the impact of implementation of KM in Software Engineering for the enrichment of Software Engineering, it is also in diagnostic nature. Hence, the applied research design of the study is descriptive and diagnostic research.
Sampling Frame Work of the Study

The applied sampling frame work of the study is census method. The study included all registered software companies in the Chamber of Software Companies (CSS) in Chennai. In total, there are 423 software companies have registered their names at CSS. All are included for the study. In order to represent each company, Software Engineer/Project Manager is included for the present study as the sample of the study.

COLLECTION OF DATA

Since the present study is completely based on the primary data, a special care has been to frame the questionnaire. The questionnaire has been divided into four important parts. The first part includes the profile of the software companies and respondents. The second part includes the rate of implementation of KM in Software Engineering at the companies whereas the third part of the questionnaire focuses on the issues and motivators to implement KM in the Software Engineering. The fourth part includes various enrichment of Software Engineering in the implementation of KM. The relevant variables are drawn from the review of previous studies and view of expects. A pilot study has been conducted among 50 Software Engineers at various Software Companies in Chennai. Based on their advice, certain modifications, additions, deletions and simplifications have been carried out in order to prepare the final draft of the questionnaire.
FRAME WORK OF ANALYSIS

For analysing the collected data, the following statistical tools have been used. The selection of statistical tools is based on the nature of scale of data and the objective for which the analysis has been implemented. They are given below.

1) ‘T’ test

The ‘t’ test is used to find out the significant difference among the means in two group of samples. The ‘t’ statistics is calculated by

\[
t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1 - 1)\sigma_{s1}^2 + (n_2 - 1)\sigma_{s2}^2}{n_1 + n_2 - 2} \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}}
\]

which is compared with the degree of freedom of \((n_1 + n_2 - 2)\).

Whereas
- \(t\) = ‘t’ statistics
- \(\bar{X}_1\) = mean of the first sample group
- \(\bar{X}_2\) = mean of the second sample group
- \(n_1\) = number of samples in the first group
- \(n_2\) = number of samples in the second group
- \(\sigma_{s1}^2\) = variance in the first sample
- \(\sigma_{s2}^2\) = variance in the second sample

The ‘t’ test has been applied to test the significant differences among the lesser and higher experienced companies regarding their views on the various aspects and outcomes related to the implementation of KM in Software Engineering.
2. One Way Analysis of Variance (ANOVA)

The One Way Analysis of Variance is applied when the criterion variable is in interval scale and the number of group of samples included for the study is more than two. The ‘F’ statistics is calculated by

\[
F = \frac{\text{Trss}/dF}{\text{Ess}/dF} = \frac{\text{Greater Variance}}{\text{Smaller Variance}}
\]

Compared with the F(K-1;N-k) degree of freedom

Whereas \( F \) = ‘F’ statistics

\( N \) = Number of sample size

\( K \) = Number of groups included

Trss/df = Variance between groups and

Ess/df = Variance within groups.

The One Way ANOVA has been applied to examine the association between the profile of the companies, Software Engineers and their views on the various aspects related to the implementation of KM in Software Engineering, its motivators, critical success factors, issues and impacts to MSMEs.

3. Exploratory Factors Analysis (EFA)

The Exploratory Factor Analysis is used when the researcher wants to narrate the variable into handsome factors and also find the relationship between the variables and narrated factors. It is also called narration analysis. Whenever the variables related to a
particular event are unmanageable or plenty and also in interval scale, the factor analysis has to be executed to narrate these variables into factors. Before applying the factor analysis, the validity of data for factor analysis has to be executed with the help of the Kaiser-Mayer-Olhin (KMO) Measure of Sampling Adequacy and Bartletts Test of Sphericity. The acceptable KMO measure of sampling adequacy is 0.5, whereas the acceptable level of significance of Chi-Square value is upto 0.05 per cent. In the present study, the factor analysis has been executed to identify the important critical factors and issues in the implementation of KM in Software Engineering.

4. Confirmatory Factor Analysis (CFA)

The Confirmatory Factor Analysis has been executed with the help of LISREL 8 software package. It is applied to test the reliability and validity of the variables included in each construct. In the current study, the CFA has been applied to test the reliability and validity of variables in each concepts generated for the fulfillment of the objectives of the study. These are components of KM, motivators, critical success factors leading to implementation of KM, issues in implementation of KM and the various enrichment of Software Engineering due to implementation of KM.

5. Discriminate Analysis (Two Group Model)

The Discriminate Analysis is used when the dependent variable is in nominal scale and the independent variable is in interval scale. It is used to identify the important discriminate variables among the two groups formulated in the study. The unstandardized cannon discriminate function has been estimated by
\[ Z = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \ldots + b_nx_n \]

whereas

\[ Z \] = Discriminant Criterion

\[ X_1, X_2, \ldots, X_n \] = Discriminant Variables

\[ b_1, b_2, \ldots, b_n \] = Discriminant Co-efficients

The Wilks Lambda has been calculated as a multi-variant measure of group difference over discriminating variables. The relative discriminating power of the variables was calculated by

\[ I_j = K_j \left( \frac{\bar{X}_{j1} - \bar{X}_{j2}}{\sigma_{x_j}} \right) \]

Whereas

\[ I_j \] = the important value of \( j^{th} \) variable

\[ K_j \] = unstandardized discriminant co-efficient for the \( j^{th} \) variable

\[ X_{jk} \] = mean of the \( j^{th} \) variable for \( j^{th} \) group

The relative importance of a variable \( R_j \) is given by

\[ R_j = \frac{I_j}{\sum_{j=1}^{n} I_j} \]

In the present study, the two group discriminant analysis has been administered to identify the important discriminant components of KM, critical success factors and various enrichment of Software Engineering among the lesser and the higher experienced software companies.
6. Multiple Regression Analysis

The Multiple Regression Analysis is applied to analyse the impact of independent variables on dependent variable when both the variables are in interval scale. The linear regression model is fitted by

\[ Y = a + b_1x_1 + b_2x_2 + \ldots + b_nx_n + e \]

whereas

- \( Y \) = Dependent variables
- \( X_1, X_2, \ldots, X_n \) = Independent variables
- \( b_1, b_2, \ldots, b_n \) = Regression coefficient of independent variables
- \( a \) = intercept and
- \( e \) = error term

In the present study, the multiple regression analysis has been administered to find out the impact of implementation of KM in Software Engineering on the various enrichment of Software Engineering due to implementation of Software Engineering and the impact of various factors leading to implementations of Software Engineering on the rate of implementation of Software Engineering.

LIMITATION OF THE STUDY

The present study is satisfied with the following limitations:

1. The variables related to the concepts developed in the present study are drawn from the review of previous studies and the view of experts.

2. The scope of the study is confined to only registered software companies in the Chamber of Software Companies (CSS) in Chennai.
3. The Software Companies are purposively classified into lesser and higher experienced companies.

4. The measurement of variables in each concept generated for the present study is completely based on the view of the Software Engineers in the company. Hence, it may be subjected to personal bias.

5. The linear relationship between dependent and independent variables are assumed;

6. The measurement of all concepts is based on Likert five point scale.

THESIS ORGANISATION

The present study is designed into a chapter for a clear and neat presentation.

Chapter-I, ‘Introduction and Design of the Study’; explains the introduction, need for the study, statement of the problem, review of previous studies, research gap, proposed research model, objectives, methodology and limitation of the study.

Chapter-II, ‘Conceptual Frame Work’ exhibits the definitions, measuring, measurements and variables in all concepts generated for the fulfillment of the objectives of the study.

Chapter-III, ‘Profile of the Companies and Implementation of Knowledge Management’ discusses the profile of the companies, Software Engineers and the rate of implementation of various components of KM in the Software Companies.
Chapter-IV, ‘Issues and Motivators in the Implementation of KM in Software Engineering’, deals with the motivators, critical success factors and issues in the implementation of KM in Software Engineering and also its association among with the profiles of the companies.

Chapter-V ‘Evaluation of Implementation of KM in the Enrichment of Software Engineers’ explains various enrichment of Software Engineering due to the implementation of KM, impact of implementation of KM on the various enrichment of Software Engineering, the association between the profile of the companies and the view on various enrichment in Software Engineering and the discriminant enrichment among the lesser and higher experienced companies.

Chapter-VI Summary of Finding, Conclusions and Suggestions, includes the summary of findings of the present study, suggestions, and also the scope for future study.
REFERENCES


CHAPTER-II
CONCEPTUAL FRAMEWORK OF THE STUDY

The development of concepts is inevitable in order to fulfill the objectives of the research. In the present study, there are some concepts generated to fulfill the objectives of the study. These are Knowledge Management (KM) Process, Knowledge Management Activities, Knowledge Management Tools, Knowledge Management Initiatives, enablers of successful KM initiatives, training factors for KM initiatives, KM systems, critical success factors of KM in software engineering, motivating factors, issues in implementation of KM in software engineering, KM perspectives, software engineering, software system quality and software quality.

The meaning, definition, variables and methods to measure the above said concepts in the present study are discussed in the present chapter.

Knowledge Management (KM)

Knowledge management is an organisation intellectual capital consists of tangible and intangible assets (Rus et al., 2007\(^1\)). Tangible assets, which correspond to documented, explicit knowledge, can vary for different industries and applications but usually include manuals, directories, correspondence with clients, vendors; and sub-contractors, competitor intelligence; patents; licenses; and knowledge derived from work process (Lawton, 2001\(^2\)). Intangible assets