INFORMATION TECHNOLOGY AND KNOWLEDGE ENGINEERING CENTRIC KNOWLEDGE MANAGEMENT: A MATURITY MODEL BASED ON KEY MATURITY INDICATORS

By

K.K.KURIAKOSE

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INDIRA GANDHI CENTRE FOR ATOMIC RESEARCH, KALPAKKAM

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Chairman	Prof. M. Sai Baba	**Date:** 02 Dec. 2014
Guide / Convener	Prof. T. Jayakumar	**Date:** 3/12/14
External Examiner		**Date:**
Member 1	Prof. B.P.C. Rao	**Date:** 02/12/14
Member 2	Prof. U. Kamachi Mudali	**Date:**

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Prof. T. Jayakumar

Date: 02 Dec. 2014

Place: Kalpakkam

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K.K. Kuriakose

DECLARATION

I, hereby declare that the investigation presented in the thesis has been carried out by me. The work is original and has not been submitted earlier as a whole or in part for a degree / diploma at this or any other Institution / University.

K.K. Kuriakose

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Conferences

1. "The Role of *Ba* in Knowledge Creation and Innovation in the Context of an R&D Organization", **K.K.Kuriakose**, R. Malathi, V.Parameswaran, and S.A.V. Satya Murty, Proceedings of 8th National Conference on Recent Advances in Information Technology-READIT 2011, 28-29, December 2011, Kalpakkam, 82-89.

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K.K. Kuriakose

DEDICATIONS

This Thesis is dedicated to

The Almighty

My parents

My parents-in-law

My Family

My relatives

My teachers & superiors

My colleagues

My friends

And

To the global knowledge sharing community

Whose combined knowledge and wisdom guided me

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SYNOPSIS

KEYWORDS: Knowledge Management, Maturity Model, Inhibiting Factors, Information Technology, Knowledge Engineering

Knowledge management (KM) aims to create wealth and value by providing organisational entities, the right knowledge, at the right place and at the right time. KM has proven benefits and has been adopted by 80% of the world's biggest companies. Knowledge management maturity model describes the development of KM over time. It provides a roadmap for successful KM implementation. The objective of the thesis is to develop a flexible and adaptable KM maturity model and demonstrate its utility in the context of a government controlled nuclear research and development (R&D) organisation. This model is the core contribution of this thesis to the literature in KM. Vast amount of nuclear knowledge has been created and accumulated through decades of R&D and operational experience. This knowledge is of paramount importance for the continued use of existing nuclear installations and future innovations. Unfortunately the present status of nuclear knowledge and its management still remain in an unsatisfactory condition. It is in this organisational context that the development of a KM maturity model was undertaken.

The thesis presents a detailed review of KM literature covering various facets such as people, process, technology, knowledge, return on investment, critical success factors and evolution of KM. Detailed study of the existing KM maturity models and the morphological analysis carried out is discussed. The context of the nuclear R&D

organisation, where the knowledge management maturity model was demonstrated, is discussed. Also the complexities of nuclear KM and R&D KM are discussed. A new KM maturity model, proposed is discussed. The application and validation of this model through a case study is discussed. The maturity level of the organisation and its ten subunits were assessed, through the case study. The inhibiting factors of the organisation and its subunits were identified through a survey. Flexibility of the proposed model and its adaptability to other organizations have demonstrated and evaluated by expert judgment. The process of knowledge creation in the organisational context in general and one subunit of the organisation in particular was studied. The concept of *ba* which is the context for knowledge creation, and a new framework for *ba* based on SECI model that was developed are discussed. The *ba* structure based on the organisational units and a taxonomy pertaining to the knowledge of the subunit that was developed are described. The conclusions, contributions, recommendations and scope for further work are discussed.

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ABBREVIATIONS

AI	Artificial Intelligence
APQC	American Productivity and Quality Centre
BSC	Balanced Score Card
CKO	Chief Knowledge Officer
CMM	Capability Maturity Model
CMMI	Capability Maturity Model Integration
DSS	Decision Support Systems
EDP	Electronic Data Processing
EIM	Enterprise Information Management
FAQ	Frequently Asked Questions
FBTR	Fast Breeder Test Reactor
FR-KOS	Fast Reactor Knowledge Organisation System
IAEA	International Atomic Energy Agency
ICT	Information and Communication Technology
IEEE	Institution of Electrical and Electronics Engineers
IKMS	Information and Knowledge Management System
IM	Information Management
IMS	Information Management Systems
IT	Information Technology
KA	Key Areas
KBS	Knowledge-Based Systems

KE	Knowledge Engineering
KM	Knowledge Management
KMCA	Knowledge Management Capability Assessment
KMI	Key Maturity Indicators
KMM	Knowledge Management Maturity
KMS	Knowledge Management System
KP	Key Parameters
KPQ	Knowledge Process Quality
KV	Key Values
MIS	Management Information System
NPP	Nuclear Power Plant
RoI	Return on Investment
R&D	Research and Development
SECI	Socialization Externalization Combination Internalization
WWW	World Wide Web

"Knowledge is experience, everything else is just information"

- Albert Einstein

"*Successful companies are those that consistently create new knowledge, disseminate it widely throughout the organization and quickly embody it new technologies and products"*

- Nonaka

"Innovation comes only from readily and seamlessly sharing information rather than hoarding it"

- Tom Peters

CHAPTER 1

INTRODUCTION TO KNOWLEDGE MANAGEMENT

Knowledge is related to information and data. According to Ackoff (1989), data is raw. It simply exists and has no significance beyond its existence. Information is the data that has been given meaning by way of relational connection. In other words information is the processed data. This "meaning" that information gives, may or may not be useful. Knowledge is the appropriate collection of information, such that its intent is to be useful. According to this, data is a pre-requisite for information and information is a pre-requisite for knowledge. Hence information includes data. Also knowledge includes information and data. In other words, data and information are subsets of knowledge.

1.1 CLASSIFICATION OF KNOWLEDGE

According to Davenport and Prusak (1998), when experience and insight are added to information, it becomes knowledge. Knowledge is broader, deeper and richer than data or information. Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insights that provide a framework for evaluating and incorporating new experiences and information. Knowledge originates and is applied in the minds of people. It is embedded in people, tasks, routines and networks. Two different classifications of knowledge are given below.

1.1.1 Explicit and Tacit Knowledge

Knowledge is basically classified into explicit knowledge and tacit knowledge. Explicit knowledge is the knowledge that is easily expressed, captured stored and reused. In contrast, tacit knowledge is highly personal. It is hard to formalize and therefore difficult to communicate to others. Tacit and explicit knowledge are not separate but mutually complimentary entities. These entities interact with each other in the creative activities of human beings. Explicit knowledge is the articulated form of knowledge, knowledge expressed in words, documents, drawings,

paintings, audio, video etc.(Nonaka, 1991). Tacit knowledge is that component of knowledge which resides in living beings, which is implicit, unconscious, personal, subjective, unstructured and inexpressible, but it can be acted upon by indwelling and is the basis for the formation of explicit knowledge. It is connected to values, perceptions and beliefs. The statement 'we know more than what we can tell' of Polanyi highlights the inexpressible nature of tacit knowledge (Polanyi, 1966). However the term 'explicit knowledge' is used where the knowledge is already available explicitly in the form of documents, audio/video recordings etc. in electronic or non-electronic form and the term 'tacit knowledge' where the knowledge still resides in the minds of people in the form of experience, feelings, opinions, intuition etc. It is possible to convert certain percentage of the tacit knowledge into explicit by suitable knowledge elicitation methods.

1.1.2 Core Advanced and Innovative Knowledge

Zack (1999) classified knowledge into core, advanced and innovative based on the strategic nature of the knowledge for an organisation. The core knowledge is the minimum level of knowledge required for survival. Since it is commonly held by members of the industry, it does not provide competitive advantage to the organisation. Advanced knowledge enables an organisation to be competitively viable. The knowledge differentiation is achieved by the knowledge content. Innovative knowledge enables an organisation to lead it and face competitors by innovative methods.

1.2 KNOWLEDGE MANAGEMENT

Knowledge Management (KM) draws concepts from various disciplines like Information and Communication Technology (ICT), Systems Science and Engineering, Information Science, Knowledge Engineering (KE), Collaborative Engineering, Organisational Development, Change Management, Performance Management etc. Successful organisation constantly search for better

ways to improve performance of the organisation. It is reported that frequent disappointment with past management initiatives have motivated managers to gain new understanding into the underlying, but complex mechanism such as knowledge which govern an enterprise's effectiveness (Wiig, 1997). Though the importance of knowledge and its management is accepted by academicians and practitioners, only a few firms have been successful in effectively implementing knowledge management (Gopalakrishnan and Ganesh, 2004).

Knowledge management is the buzzword in any modern organisation, whether it is service, manufacturing or Research and Development (R&D). Knowledge management has proven benefits and has been adopted by 80% of the world's biggest companies (KPMG Consulting, 2000). KM is now being acknowledged not just as a source of wealth but as mechanism to maintain market position, avoid failure and beat the competition (Bhara, 2001).

Knowledge management aims to create wealth and value by providing organisational entities, the right knowledge, at the right place and at the right time. It is a conscious strategy of getting the right knowledge to the right people at the right time and helping people share and put information into action in ways that will improve organisational performance (APQC, 2000). The effective utilization of knowledge by various entities results in improved skills and competencies for decision making, performance improvement and innovations.

The most fundamental processes in KM are knowledge creation, knowledge sharing and knowledge utilization. These processes can happen at various levels, such as, individual, group, department, organisation, nation and global. The increase in levels results in exponentially increasing complexities, challenges and benefits. Based on the boundary of KM processes under consideration, different KM systems evolve viz, personal KM, group KM, departmental KM,

organisational KM, national KM and global KM. In most of the literature 'KM' refers to organisational KM and the same convention is followed in this thesis.

The term 'knowledge management' means different things to different authors and practitioners. Knowledge management is the process of capturing an organisation's collective expertise, wherever, it resides, in databases, in paper or in people's heads and distributing it wherever it can produce maximum benefits (Hibbard, 1997). The essence of this definition is 'make available the collective knowledge to improve performance'. Collective knowledge can be created by combining knowledge from various sources. The sources of knowledge could be various entities of the organisation like employees, teams, departments, polices, procedures etc. In order to make the collective knowledge, individual knowledge needs to be shared. The purpose of making collective knowledge available is to improve performance.

Defining knowledge management is akin to the old fable of the blind men and the elephant where each person touches different part of the elephant's body and arrives at their perception of what the elephant looks like and really is (Bonanno, 2003). Extending the concept of Fahey and Prusak (1998), it can be stated that, not developing a working definition of knowledge management is another deadliest sin of KM.

1.3 EVOLUTION OF KNOWLEDGE MANAGEMENT

Knowledge management in the context of organisations can be traced to various concepts and practices in pursuit of productivity improvement and organisational effectiveness, efficiency and excellence. These concepts can be traced to F.W.Taylor's scientific management principles, and the resultant 'time and motion study' and other industrial engineering practices. According to Taylor(1911), the principal object of management should be to secure the maximum prosperity

for the employer, coupled with the maximum prosperity for each employee. He argues that the greatest prosperity can exist only as the result of the greatest possible productivity of the men and machines of the establishment. Later the concept of 'human relations' emerged out of the famous Hawthrone Experiments of George Elton Mayo(Mayo,1933). Other concepts like 'total quality management', 'systems thinking', 'balanced score card ', 'business process re-engineering', 'management information system' and 'knowledge management' were marketed as 'magic' solutions to productivity improvement and other organisational problems.

According to Wiig (1997) explicit and systematic management of knowledge has emerged naturally as a result of several developments such as changes in socio-economic and business environment that increased the demand for knowledge based products and services, development in ICT and Artificial Intelligence (AI), better understanding of operations research, strategic planning, system thinking, applied cybernetics, cognitive science, and organisational behaviour. Wiig (1997) identified the following 6 eras in the evolution of KM:

i.) Agrarian economics
ii.) Natural resource economics
iii.) Industrial revolution
iv.) Product revolution
v.) Information revolution
vi.) Knowledge revolution.

The ideas and practices of KM are as old as human civilization. For hundreds of years owners of family business have passed their commercial wisdom on to their children, master craftsman have painstakingly taught their trades to apprentices and workers have exchanged ideas and know how on the job (Hanson et al., 1999). Tracing the practice of the concepts of KM, since the early

civilization, four different eras in the history of KM can be identified. The first era is characterized by informal and unsystematic practices of KM, though the term KM was not in existence at that time. The second era is characterized by formal, disciplined and systematic practices of KM, after the introduction of the term KM. The third era is characterized by agile practices and 'wisdom of the crowd'. The fourth era is characterized by adoption of Knowledge Engineering practices with higher thrust on RoI, which is the future KM. It can be observed that the progress from 1st to 2nd era is driven by the realization that, systematic, explicit and deliberate activities are necessary to derive significant benefits from KM and enabled by the availability of information and communication technologies. The progress from 2nd to 3rd era is driven by web2.0 technologies and a realization that organisations need to move from traditional command and control to participatory approach. The progress from 3rd to 4th era is driven by the desire to achieve higher benefits from KM and is enabled by AI and KE technologies. Hence, it is obvious that technology plays the most important role in the advancement of KM.

1.4 ENABLING FACTORS OF KNOWLEDGE MANAGEMENT

Implementation of knowledge management in an organisation involves significant changes in the organisational processes. Several studies have proposed many key variables for successful implementation of knowledge management, which are called enabling factors. Alternatively these factors are also called critical success factors. The absence of these factors are called inhibiting factors.

Rao (2003) identified a KM frame work with '8Cs' viz connectivity, content, community, culture, capacity co-operation, commerce and capital. The study of Chong et al. (2005) identified the following 11 enabling factors for successful implementation of knowledge management:

- Employee training

- Employee involvement
- Spirit of team work
- Employee empowerment
- Top management leadership and commitment
- Information systems infrastructure
- Performance measurement
- Knowledge friendly culture
- Benchmarking
- Knowledge structure
- Elimination of organisational constraints

McCabe (2003) identified the following 10 enabling success factors to establish KM as an enterprise wide discipline:

- Align KM goals to the corporate strategy.
- Build the technology infrastructure to support KM
- Focus on strategic knowledge communities.
- Establish a multi dimensional frame work linking communities to the business.
- Approach KM as a holistic business system.
- Establish community goals that align business and member drivers.
- Integrate KM process to business process.
- Recognize that KM is a process, not a project.
- Establish metrics and a performance management process.
- Institutionalize KM to ensure that it is sustainable.

Holthouse (2003) identified the following 10 enabling success factors of KM:

- Knowledge sharing
- Instilling responsibility for knowledge sharing.
- Capturing and reasoning past experiences.
- Embedding know-how in products, services and processes.
- Developing productive work spaces / places.
- Driving knowledge generation for innovation.
- Building and mapping community expertise.
- Building and mining customer knowledge bases.
- Understanding and measuring the value of intangibles
- Leveraging intellectual assets.

The following research outcomes reported in Rao, (2003), indicate the common mistakes when implementing KM:

- Not developing a solid business case with RoI
- Leading with technology
- Posting KM on standalone initiative and not engaging the people doing the work, also known as the ones with the knowledge
- Not implementing KM to improve a business process.
- Developing a KM initiative without associating it to the way people work as a daily basis.
- Ignoring the need for extensive training and change management
- Not aligning KM with critical business processes.
- Not knowing how to approach the technology infrastructure.
- Inadequate human resource support for KM initiatives

The recommendations reported in Rao, (2003) for organisations evaluating the launch a KM practice are:

- Develop a robust business case that shows how KM solves problems and impacts the organisation strategically.
- Get involvement from thought leaders and influencers, through the development of a cross functional advisory board or Steering Committee.
- Select three different pilot areas to conduct projects that show the value of KM and use a rigorous project management methodology and measurement systems to track the value.
- Evaluate the business need for KM capabilities before focusing on improving specific business processes.
- Use enterprise portal software to provide information access and application access across the enterprise.
- Then integrate with other technologies as needed to provide specific solutions.
- Identify critical intellectual capital; use KM to align it to critical business processes.
- Consider building the KM technology infrastructure upon integrated 'out of the box' suites and adding best of breed where ever justified.
- Professionally develop employees who will be leading KM-related activities and projects.

Fahey and Prusak(1998), identified the following 11 sins of KM:

- Not developing a working definition of knowledge
- Emphasizing knowledge stocks to the detriment of knowledge flow.
- Viewing knowledge as existing predominantly outside the heads of individuals.
- Not understanding that a fundamental intermediate purpose of managing knowledge is to create shared context.
- Paying little heed to the role and importance of tacit knowledge

- Disentangling knowledge from its uses.
- Down playing thinking and reasoning
- Focusing on the past and the present and not on the future
- Failing to recognize the importance of experimentation
- Substituting technological contact for human interface
- Seeking to develop direct measures of knowledge

Fahey and Prusak(1998) also provided the following suggestions:

- Managers need to continually reflect on knowledge as an organisation phenomenon.
- Managers must be obsessive about noting and correcting errors in their stock of knowledge- in what they think they know.
- Managers must be vigilant about detecting and correcting errors in their process of knowing- the generation, moving and leveraging knowledge throughout the organisation.
- Organisation must engage in critical, sustained and honest self reflection about the eleven errors.

After studying 31 KM projects in 24 companies Davenport et al, 1998, identified 8 enabling factors :

i. Link to economic performance or industry value
ii. Technical and organisational infrastructure
iii. Standard flexible knowledge structure
iv. Knowledge friendly culture
v. Clear purpose and language
vi. Change in motivational practices
vii. Multiple channels for knowledge transfer

viii. Senior management support

Szulanski (1994) identified three barriers to knowledge transfer: ignorance of source and recipient, absorptive capacity of recipient and lack of relationship between source and recipient. He found that an average of 27 months is required for transfer of best practice even in the best of the firms. O' Dell and Grayson (1998) identified many hurdles of knowledge sharing, such as organisational silos, culture of promoting individual expertise, lack of integration of KM into work process etc. They also identified the enablers of knowledge transfer as technology, culture, leadership and measurement. Ruggles (1998), through a study of 431 organisations, identified the biggest impediments to knowledge transfer as culture, followed by top management's failure to signal the importance. Further he identified that the biggest difficulties in KM are changing people's behavior and measuring the value and performance of knowledge assets. According to Gupta and Govindarajan (2000), an enterprise's intellectual capital consists of the stock of knowledge held by individuals and corporate units multiplied by the velocity at which such knowledge is shared throughout the organisation

1.5 KEY AREAS OF KNOWLEDGE MANAGEMENT

It can be observed that most of the factors discussed above are related to either people in the organisation, or knowledge management processes in the organisation, or the technology infrastructure used for KM in the organisation or knowledge availability and requirement of the organisation or return on investment of KM in the organisation. These factors are called Key Areas (KA) of KM which are Knowledge, Process, Return on Investment (RoI), People and Technology. These key areas are discussed in the following sections:

1.5.1 Knowledge

Knowledge is critical and it needs to be effectively managed. When other things being equal, the difference between success and failure may turn out to be, how effectively the knowledge is managed (Davenport et al, 1998). Leveraging knowledge is not only important but it may be the most important job management has (Drucker, 1993). Leading management and organisation theorists have popularized the concept of treating organisational knowledge as a valuable strategic asset. For survival, growth and competitive advantage, an organisation must create, locate, capture, share, preserve, and apply the knowledge to solve problems and exploit opportunities (Zack, 1999). Also organisational knowledge is more complex compared to individual knowledge.

1.5.2 Processes

The importance of knowledge creation, knowledge sharing and knowledge utilization processes was highlighted by Nonaka, (1991) as successful *companies are those that consistently create new knowledge, disseminate it widely throughout the organisation and quickly embody it new technologies and products.* These three activities define the knowledge creating company whose sole business is continuous innovation. Other KM processes are knowledge acquisition, knowledge preservation/knowledge storage, knowledge access/ retrieval, knowledge classification, knowledge representation etc.

1.5.2.1 *Knowledge Creation*

Knowledge is created by organisational entities during normal work or through specific activities like R&D, brainstorming, problem solving etc. While the ever popular efforts involving capture, access and transfer of knowledge can lead to increased efficiency, knowledge generation is the key to growth (Ruggles, 1998). Knowledge creation is akin to ‘exploration’, in which individuals

and teams generate new ideas and concepts, by combining existing knowledge (Kogut and Zander, 1992; Nahapiet and Ghoshal, 1999). The creation of knowledge is closely tied to the innovation of products and services (Subramaniam and Youndt, 2005). In the context of an R&D organisation, knowledge creation is the most important KM process.

Nonaka (1994), proposed that knowledge is created through interaction between tacit knowledge and explicit knowledge at various levels of organisational entities such as individuals, teams, organisation and extended organisation through the process of Socialization, Externalization, Combination and Internalization, popularly known as SECI framework. In socialization mode, tacit knowledge gets converted into new tacit knowledge and hence new tacit knowledge is created. It is a process of sharing experiences and thereby, creating new tacit knowledge. Observation, imitation and practice are more important than the use of language in socialization. Examples of knowledge creation through socialization include apprenticeship, on the job training, monthly meetings, conferences, informal meetings etc. In externalization mode, tacit knowledge gets converted into explicit knowledge and thus, new explicit knowledge is created. It is the process of transforming tacit knowledge into explicit form. Tacit knowledge elicitation through interviews is an example of externalization. Externalization also takes place through meetings, brain storming sessions etc. In combination mode, different modules of explicit knowledge get combined into new explicit knowledge. Configuration or reconfiguration of knowledge through adding, sorting, filtering, categorizing of explicit knowledge can result in new explicit knowledge. Data mining and knowledge discovery are also examples of combination. In internalization mode, explicit knowledge gets converted into tacit knowledge and it is related to 'learning'.

It can be observed that though there are four mode of knowledge creation, they are not mutually exclusive. For example in a meeting all the four modes may be taking place. Since tacit

knowledge of different participants is shared, socialization mode of knowledge creation is taking place in a meeting. Since different participants externalize their tacit knowledge through question- answers, comments, criticism etc, externalization mode of knowledge creation is taking place. When the minutes of the meeting are prepared, it is a combination mode of knowledge creation. When different participants understand and learn from what other participants have externalized or from the minutes of the meeting, observations etc., it is the process of knowledge creation, through internalization.

The process of organisational knowledge creation requires a context in terms of who participates, how they participate and when they participate. *Ba* provides such a context. *Ba* literally means 'place' and can be considered as a context in which knowledge is shared, created and utilized. *Ba* is not only a specific space, but also a specific time. It can be physical, virtual or mental space-time combination. *Ba* provides the necessary energy, quality and place for knowledge creation, where information is interpreted to become knowledge (Nonaka et al., 2000). The key concept in *ba* is interaction. Based on type of interaction and medium of interaction, four types of *ba* are originating *ba*, dialoguing *ba*, systemizing *ba* and exercising *ba*, which is depicted in Figure 1.1

Originating *ba* is the primary *ba* from where the knowledge creation process begins. It is characterized by face to face and individual interactions, where individuals share experiences, feelings, emotions etc.(Nonaka and Konno, 1998). From originating *ba* emerge care, love, trust and commitment which form the basis for knowledge sharing among individuals (Nonaka et al., 2000).

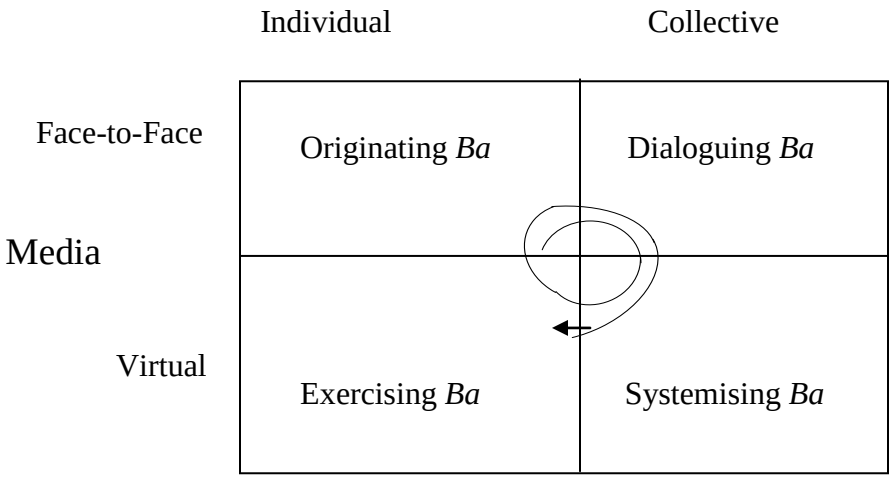


Figure 1.1 Four types of *Ba* (Nonaka et. al, 2000)

Dialoguing *ba* is defined by face to face and collective interactions (Nonaka et al., 2000). It corresponds to the externalization phase of knowledge creation. It is the place where individuals' tacit knowledge in the form of experience, emotions, beliefs etc. are articulated and shared among the participants and converted in to shared concepts. This *ba* is more consciously created by selecting people with the right mix of knowledge, skills and attitude.

Systemizing *ba* is defined by virtual and collective interactions (Nonaka et al., 2000). It corresponds to the combination phase of knowledge creation. Information and communication technology offers a virtual collaborative environment of systemizing *ba* through groupware, online forums etc.

Exercising *ba* is defined by virtual and individual interactions. It corresponds to the internalization, phase of knowledge creation. Here individuals internalize the explicit knowledge that is received through documents, manuals etc.

1.5.2.2 *Knowledge Sharing*

Knowledge sharing is a process of exchange of explicit or tacit knowledge between two agents, during which one agent purposefully receives and uses the knowledge provided by another. The importance of knowledge sharing is conveyed by Nonaka (1991) as making personal knowledge available to others is the central activity of the knowledge creating company. Tobias(2006) observed that knowledge communication and knowledge transfer can be identified as the central task of knowledge management. An organisational culture that encourages open and transparent communication among the employees would lead to increased collaboration and knowledge sharing (Anantatmula and Kanungo, 2007). Knowledge communication is more than communication of information (e.g., facts, figures, events, situations, developments, etc.), or emotions (e.g., fears, hopes, reservations, commitment etc.) because it requires conveying context, background and basic assumptions (Eppler, 2006). From the above discussions, it is clear that knowledge sharing is the focal point in knowledge management and it significantly differs from sharing of data or information.

Depending on the type of knowledge, knowledge sharing methods are classified in to codification approach and personalization approach. The former is centered on explicit knowledge with the strategy of 'people to document' and 'document to people', while the latter is centered on tacit knowledge with the strategy of 'people to people' . In codification approach, knowledge sharing is by the process of externalization, combination and internalization. In personalization approach, knowledge sharing is by the process of socialization. Only by effective knowledge sharing among various organisational entities, new knowledge can be generated and the generated knowledge can be utilized. A holistic approach to knowledge sharing should address both approaches.

The research study conducted by Ribiere (2001), revealed that high solidarity and high trust respectively are essential for knowledge management initiatives based on codification approach and personalization approach to be successful.

1.5.2.3 *Knowledge Utilization*

Knowledge utilization refers to the practices and process that enable effective utilization of available knowledge within the organisation. It represents the 'exploitation' of existing knowledge for the organisation's purposes. Alavi and Leinder (2001) stated that the source of competitive advantage resides in application of knowledge, rather than the knowledge itself. According to Davenport and Probust (2002) the economic value of knowledge does not lie in possessing it, but in using it. When knowledge is utilized, the organisation is benefited, in terms of increased productivity, efficiency, effectiveness and innovation. Knowledge utilization involves identification of knowledge, accessing the knowledge, internalizing the knowledge, recalling the knowledge and applying the knowledge.

1.5.3 Return on Investment

Return on Investment (RoI), on KM is the benefit that the organisation gets. According to Wolford, (1999), knowledge based initiatives must show a return on investment, otherwise they are simply waste Pilot projects for KM must have clearly defined measurable objectives that can be achieved in less than 6 months, even though, change over to an enterprise-wide KM involves a change process that can span several years (Davenport and Probust, 2002). Quantitative and qualitative metrics for actionable understanding should target RoI, barriers to sharing knowledge, employee attitude, level of knowledge standardization, KM system's maturity level and assessment of intellectual capital and knowledge assets (Rao, 2003). Kochikar and Suresh(2003)

discussed many tangible and intangible benefits for the organisation on successful implementation of KM. A few of them are given below:

- ***Raising the quality of performance:*** The primary mechanism for raising the quality of performance is through the institutionalization of 'best practices' residing in organisational pockets, a process which needs the sharing and adoption of these practices across departmental interfaces.
- ***Reducing the cost:*** Achieving greater productivity requires higher level of reuse. The cost of redoing something that has been done earlier and relearning something that has been learnt earlier, anywhere in the organisation, should be less. Successful implementation of KM leads to reduction in the cost of product/service.
- ***Managing risk:*** The de-risking measures in diversifying into new technologies, domains, services and geographical areas, require that the organisation must learn new ways of doing things. Managing risks resulting from attrition and personal movements require that as much knowledge as possible should be documented and effective succession planning process is in place.
- ***Meeting Growth Expectations and Innovation:*** Maintaining a consistently high pace of growth and innovation needs the culture of collaboration, experimentation and dissemination of knowledge. This enables new employees to learn rapidly and become more productive.
- ***Managing Virtual Teams:*** Many organisations that have globalized operations often require teams that are spread across continents to collaborate in delivering single customer solution. Such virtual team work requires a mind set of working with co-workers who may be situated in different time zones and may belong to different cultures, and good technologies to support communication and collaboration.

The intangible benefits include increased customer satisfaction, higher employee satisfaction and cultural change that results in more synergistic organisation. KM has direct and indirect impact on many other organisational performance parameters.

1.5.4 People

According to Nonaka and Takeuchi (1995), everyone in a knowledge creating company is a knowledge creator and all the individuals engaged in knowledge creation are considered as "knowledge creating crew". The knowledge creating crew can be classified into "knowledge practitioners" i.e. front line employees and line managers, "knowledge engineers" i.e. middle managers and "knowledge officers" i.e. top managers. Knowledge practitioners accumulate, generate and update both tacit and explicit knowledge, acting almost as "walking archives" on a day-to-day basis. Knowledge engineers serve as the bridge between knowledge practitioners and knowledge officers. They mediate between "what is" and "what should be". They *engineer* new knowledge according to the organisation's vision. Knowledge officers give an organisation's knowledge creating activities a sense of direction by articulating grand concepts on what the company ought to be; establishing a knowledge vision in the form of a corporate vision or policy statement; and setting the standards for justifying the value of the knowledge that is being created (Nonaka and Takeuchi ,1995). From the above discussions, it is clear that every employee in the organisation plays a significant role in KM. Recognizing the importance of KM roles, many organisations have created roles like Chief Knowledge Officer (CKO) and Knowledge Officers at various levels.

1.5.4.1 *Knowledge sharing culture*

According to Coutu (2003), cultural change in an organisation involves transformational learning. It includes creating an environment of genuine trust and openness, building flat organisations

where people are truly empowered, and creating self managed teams. Turning knowledge into action is easier in organisations that have driven fear and internal competition out of the culture (Pfeffer and Sutton,1999). There is a general agreement that a knowledge friendly organisational culture must be nurtured in order to succeed with a knowledge management initiative.

American Productivity and Quality Centre (APQC) had conducted a study of organisations that were known to have a corporate culture that supports knowledge sharing. The study's central finding is that however strong your commitment and approaches the knowledge management, your culture is stronger. Organisations successful in promoting a strong knowledge sharing culture do not try to change their culture to fit their knowledge management approach. They build their knowledge management approach to fit their culture. As a result, there is not one right way to get people to share, but many different ways depending on the values and style of the organisation (McDermott and O'Dell, 2000). In an organisation, with a knowledge sharing culture, people would share ideas and insights because they see it as natural, rather than something they are forced to do. They would expect it of each other and assume that sharing ideas is the right thing to do (McDermott and O'Dell, 2000).

Davenport and Prusak (1998) identified 4 main factors that encourage employees to share knowledge

1) ***Altruism:*** "It is possible that knowledge sharer may be a nice guy who wants to help whether or not he gets anything but a 'thank you' in return. Or he may be so passionate about his knowledge that he is happy to share it whenever he gets a chance".
2) ***Reciprocity:*** "A knowledge seller will spend the time and effort needed to share knowledge effectively if he expects the buyers to be willing sellers when he is in the

market for their knowledge. Reciprocity may be achieved less directly than by getting knowledge back from others as payment for providing it to them".

3) ***Repute:*** "A knowledge seller usually wants others to know him as a knowledgeable person with valuable expertise that he is willing to share with others in the organisation. Having a reputation of knowledge sharing makes achieving reciprocity more likely and can also lead to tangible benefits of rewards and recognition".
4) ***Trust:*** "Without trust knowledge management will fail regardless of how thoroughly it is supported by technology and rhetoric and even if the survival of the organisation depends on effective knowledge transfer."

Employees who are altruistic will continue to be knowledge shares irrespective of other organisational factors. However, by giving due recognition to altruistic behaviour, more and more employees may tend to exhibit such behaviour. Employees with 'reciprocity' behaviour need to be motivated by monitory and other tangible rewards. Employees with 'reputation' behaviour need to be motivated by suitable recognition scheme for knowledge sharers. Concerted efforts need to be made to improve the level of trust between employees and between employees and management.

1.5.4.2 *Co-opetition*

Co-opetition refers to simultaneous co-operation and competition. Kim (1997) highlighted co-opetition as one of the knowledge strategies. According to Farson and Keyes, (2002), prizes for performance undermine team work because, they place competition above collaborations. Since knowledge is a source of competitive advantage, firms, departments and even individuals will compete based on knowledge they possess. However, the same knowledge can be shared and mutual advantage can be derived, depending on 'how much' is to be shared, when, with whom

and under what conditions. Using a game theoretic frame work Loebecke et al.(1999) reported that knowledge sharing takes place when value added because of monopolistic knowledge is low, synergetical value gained from mutual knowledge sharing is high, value gained from leveragability is high and value lost because of other party's negative reverse impact is low.

1.5.4.3 *Leadership*

For successful KM initiatives, it is necessary to develop leadership capabilities at all levels of functionality (Nonaka, 1994; Holsapple and Joshi, 1999). Leaders create environments, reinforce norms and help set expectations through what they do, through their actions and not just their words (Pfeffer and Sutton,1999). Leaders provide vision, motivation, systems and structures at all levels of the organisation that facilitate conversion of knowledge into competitive advantage (Bryant, 2003). Suri Babu et al. (2008), through a survey of 247 managers in three major public sector undertakings in India, has identified a positive relationship between leadership capability and KM effectiveness.

Successful introduction of KM in to an organisation, requires an expert on KM and top managers who believe in KM. (Davenport and Probust, 2002). Nonaka and Konno (1998) reported that knowledge is manageable only insofar as leaders embrace and foster the dynamism of knowledge creation and the success of knowledge creation depends on management's assumption of responsibility, justification, financial backing and caring. Coutu, (2002) emphasizes that unless leaders become learners themselves, unless they can acknowledge their own vulnerabilities and uncertainties, transformation learning will never take place. Literature discusses mainly two types of leadership, viz, transformational leadership and transactional leadership. While transformational leaders inspire exceptional performance, transactional leaders aspire to achieve solid, consistent performance that meets agreed upon goals. Transformational

leaders create an atmosphere conducive to knowledge creation, sharing and exploitation. Bryant (2003) studied the effect of leadership on KM and concluded that transformational leadership is necessary for knowledge creation and knowledge sharing and transactional leadership is necessary for knowledge exploitation (utilization). APQC has identified leadership behaviors that encourages and that discourages knowledge sharing in an organisation (APQC, 2010a, 2010b).

1.5.4.4 *People Centric KM*

A group of researchers and practitioners believe that knowledge resides in the minds of the people and what is explicitly available is only information. Mostly they have their educational background in psychology, philosophy, sociology or management. To them knowledge is a process, a complex set of dynamic skills which enables them to act in different situations (Sveiby, 1996). This track is as old as the human civilization. However, the progress is slow. The concentration is on tacit knowledge and personalization approach. It is concerned with motivating people and creating conducive environments for knowledge creation, knowledge sharing, knowledge utilization and innovation.

1.5.5 Technology

Technology facilitates KM processes such as knowledge creation, knowledge preservation and knowledge dissemination. The technology architecture should provide all the basic functionality and features associated with robust, scalable and secure enterprise knowledge portal (Kochikar and Suresh, 2003). A typical knowledge portal contains a central KM repository and several satellite repositories which can be accessed by both intranet users and extranet users as shown in the following Figure 1.2 The rationale behind the satellite repository system is to permit the individual departments in the organisation to own the knowledge relevant to their areas. The knowledge portal need to have integration with various corporate databases such as Human

Resource, Finance, Projects etc. The central components of the knowledge portal are the easy to use knowledge navigator utility with contextual and powerful browse / search features, personalization, subscription, user specified knowledge hierarchy, keyword-based search criteria, expert locator, collaboration tools, online learning tools etc. The portal shall also need to include features such as online document submission facility, review, feedback and publication work flow, online chat facility and innovative ways of showcasing new and relevant knowledge. It should have facility for monitoring knowledge usage and knowledge sharing behavior of employees.

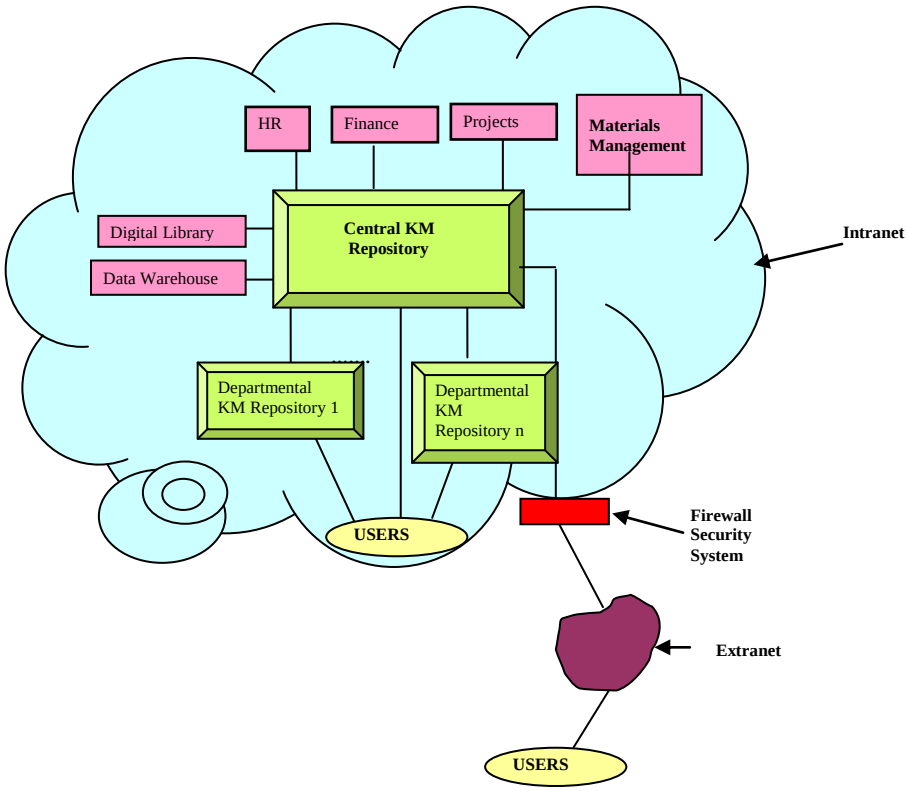


Figure 1.2 Typical KM Portal (Kochikar and Suresh, 2003)

The technologies that are currently being utilized and have great potential are Information Technology and Knowledge Engineering. The emergence of internet and intranet technology has enabled, KM to acquire the kind of formidable possibilities that were previously not possible (Natarajan and Shekhar, 2000). Mobile accessible information puts knowledge to work right at

the demand points. Mobile technologies enhance communication, information and collaboration, the three cornerstones of knowledge building and usage (Keen and Mackintosh, 2001). Information technology certainly plays a central role in KM (Gupta and Govindarajan, 2000).

1.5.5.1 Information Technology and Knowledge Engineering Centric KM

Over the years, organisations have developed and deployed Information Technology (IT) solutions in the pursuit for efficiency, effectiveness and excellence. If the usage of IT for productivity improvement in organisations can be analyzed, it can be seen that the starting point is basic data processing systems. Data processing systems, process transactions and produce reports. It represents the automation of fundamental, routine processing to support operations. For example, it could be the pace of assembly line production, it could be basic accounting operation or it could be the monitoring the progress of projects. For this purpose, Electronic Data Processing (EDP) departments have been set up in many organisations. The idea of using the information captured in transaction processing system for decision making gave birth to Decision Support Systems (DSS), Management Information Systems (MIS), Enterprise Information Management (EIM) etc. The information used in these systems is structured. However knowledge is unstructured and exists in both explicit and tacit form. In a similar way it is argued that 'Knowledge Management' is an extension of 'Information Management' (IM) and 'Knowledge Management Systems'(KMS) are natural extensions of 'Information Management Systems'(IMS) aimed at enhanced efficiency, effectiveness and excellence.

Gottschalk (2002) analyses the growth of information technology in organisation and classifies in to three eras. During the first era, the concentration was on EDP to achieve efficiency by automation of manual process. During era2, the concentration was on MIS where the focus is on effectiveness by providing the right information to the management. During era3 (current one),

the focus is on strategic information systems to achieve excellence and competitiveness by effective utilization of organisational knowledge.

Knowledge Engineering is the art of bringing the principles and tools of artificial intelligence research to bear on difficult application problems requiring expert knowledge for their solution (Feigenbaum, 1977 cited by Zhongzhi, 2011). R&D in the area of AI, aims to endow computers with human abilities and KE is the practical application of those aspects of AI that are well understood to real problems (Kendal and Creen, 2007). Knowledge-Based Systems (KBS) are computer programs embedded with human knowledge that are designed to emulate the work of human experts. The technical issues of acquiring this knowledge, representing it and using it appropriately to construct and explain lines of reasoning are important problems in the design of knowledge based system (Hendriks and Vriens, 1997). Presently KE based on knowledge and information processing is a remarkable characteristic of AI. In knowledge based systems, knowledge will be stored in the computer in defined structure for KM, problem solving and knowledge sharing (Zhongzhi, 2011). Kendal and Creen (2007) discuss five steps in transferring human knowledge into KBS and seven types of KBS. The 5 steps are:

i. Knowledge Acquisition
ii. Knowledge Validation
iii. Knowledge Representation
iv. Inference and Explanation
v. Justification.

The 7 types of Knowledge-Based Systems discussed in Kendal and Creen (2007) are:

i. Expert Systems,
ii. Neural Networks,
iii. Case-Based Reasoning,

iv. Genetic Algorithms,

v. Intelligent Agents,

vi. Data Mining

vii. Intelligent Tutoring Systems.

According to Prasad and Nadessin (2003) if advances in computing and communications can accelerate the pace at which automated tasks can be performed, we can conceive that KM too may benefit from the kind of growth envisaged by Moore's law. As the application of Moore's law shrinks devices to minuscule levels, wearable computing, coupled with enablers of human communications, such as Instant Messaging will create spontaneous knowledge networks with people as nodes. Advances in digital wireless communications will enable personal area networks of devices and sensors. AI-based natural language processing, text mining, speech recognition and text to speech conversion will increase the access, to knowledge and will make just in time knowledge a reality (Prasad and Nadessin, 2003).

Assuming the validity of the data information and knowledge continuum, it can be concluded that KMS is natural extensions of IMS and KBS, for organisational efficiency, effectiveness, excellence. KMS uses the technologies of IMS and KBS and require tight integration with those systems. KMS is much more complex because of the dynamic and transient nature of tacit knowledge and the unstructured form of explicit knowledge, in addition to the complexities of modern organisation. Most successful organisations have made a transition from Data Processing System to Information Management System and moved to Knowledge Management System. According to Tusi (2003), the objectives of developing a KMS are: capture, create and share knowledge; locate relevant knowledge; provide an environment for knowledge exchange; connect people with relevant interest and skills; facilitate and support intelligent problem solving.

The phenomenal development in IT, that have dramatically expanded the access to knowledge, is the main enabler and even a driver of KM as perceived currently. KE practices that enable better elicitation, representation and retrieval of tacit knowledge will drive KM in to new frontiers. With the technological revolution of internet, World Wide Web (WWW) and fast expanding mobile communication, people are able to get almost all the knowledge they need, at anytime and anywhere. This significant expansion in availability and access of knowledge is not simply limited to digitized explicit knowledge, but even the tacit knowledge residing in the minds of the people, by identifying and connecting the right expert, irrespective of the time or geographical location. Information and Communication Technologies can not only enhance knowledge sharing by lowering temporal and spatial barriers between knowledge workers and improving access to information about knowledge but also motivate knowledge sharing (Hendriks, 1999).

Hence, IT and KE are at the centre stage of KM and the important role played by them will exponentially increase in future as fast developments take place in these technologies. However, significant role need to be played by other Key Areas of KM such as People, Process, Knowledge and RoI. Technology can enable and even shape other Key Areas. Since fast developments are taking place in these technologies, future KM will exploit these developments and may even become drivers to unexplored and uncharted territories of organisational effectiveness.

1.5.6 People and Technology

Technology reshapes human beings and this was advocated by McLuhan, (http://marshallmcluhan.com). The phrase “the medium is the message" coined by McLuhan meaning that the form of a medium embeds itself in the message. In other words, the medium influences how the message is perceived. People and technology exist in a symbiotic relationship.

As people become too much dependent on the technologies created by them, people get transformed to suit the new technologies (Lochhead, 1994).

McLuhan reported that the visual and individualistic print culture would soon be brought to an end by what he called "electronic interdependence" where humankind will move from individualism and fragmentation to a collective identity, with a "tribal base". McLuhan's coinage for this new social organisation is the *global village*. Key to McLuhan's argument is the idea that technology has no *per se* moral bent—it is a tool that profoundly shapes an individual's and, by extension, a society's self-conception and realization.

In the organisational context, it is argued that technology and organisation cannot be separated from each other, because they are mutually constituted. Technology and its users are each constituted by the other- each shape and are shaped in turn by the other. Technology is not simply passive tools, waiting for us to use them(Introna, 2011).

However, it is to be kept in mind that mere adoption of a technology alone is not adequate to realize the organisational benefits. The human action that is facilitated or restricted by technology is simultaneously empowered or restricted by the organisational context. For example “Google” search is allowed in some organisations, while it is prohibited in some other organisations.

1.6 KNOWLEDGE MANAGEMENT MATURITY MODELS

Essentially the motivation for KM implementation should be driven by the organisational needs. KM implementation needs a clear road map that is derived based on goals and resources available. In order to provide a road map for KM implementation, many practitioners and researchers have developed Knowledge Management Maturity (KMM) models. Maturity models

are basically application of life cycle approach. The entity develops through the levels, until the highest level which is the level of perfection.

1.6.1 General Characteristics

Maturity models describe the development of an entity over time. The entity can be anything of interest. It can be a human being, an organisation, a technology, a product, a process etc. A maturity model gives a path to improvement. Maturity model can also be used as a basis for comparison (Klimko, 2001). Maturity models have the following properties (Klimko, 2001, Weerdmeester et al., 2003):

- The development of a single entity is simplified and described with a limited number of maturity levels (usually 4 to 6).
- Levels are characterized by certain requirements which the entity has to achieve on that level.
- Levels are sequentially ordered, from an initial level to an ending level of perfection.
- During the development, the entity progresses forward from one level to the next.
- No levels can be skipped.

A well known maturity model is Maslow's hierarchy of human needs (Maslow 1943). Maslow postulates that there are five levels in human needs. The human needs start with physiological needs and progresses to safety needs, needs of love and belonging, esteem needs and finally to self actualization needs.

Another very popular maturity model is Capability Maturity Model (CMM) and its latest version Capability Maturity Model Integration (CMMI) developed by Software Engineering Institute of

Carnegie Mellon University for process improvement. CMMI supports both a staged representation and a continuous representation. In the staged representation, the model has five stages. Maturity level 1 is called "Initial", which is characterized by ad hoc and chaotic processes. Maturity level 2 is called "Managed", which is characterized by processes that are planned and executed as per the policy. Maturity level 3 is called "Defined" which is characterized by standardized processes that are used to establish consistency across the organisation. Maturity level 4 is called "Quantitatively Managed", which is characterized by managing the process performance through quantitative objectives. Maturity level 5 is called "Optimizing", which is characterized by continual improvement of process performance through continual and innovative process and technological improvements (Chrissis et al., 2007).

In this thesis, the entity of interest is knowledge management and hence only KM maturity(KMM) models are considered. The path to success in KM implementation involves significant changes in process, technology and other infrastructures, mindset of people and systems, process and culture of the organisation. It is extremely difficult to achieve such significant changes that affect the entire organisation through a 'big bang' approach in a single step. It is a worthy decision to implement KM through an evolutionary process with adequate 'absorbing time' for various organisational entities. A clear road map for such an implementation provides the necessary guidance for various stake holders. KMM model provides a framework for organisations to assess their current level of KM maturity. KMM model can be considered as an application of structured approach to knowledge management implementation. KMM model can be defined as the "**application of systematic, disciplined, quantifiable approach- that is, an *engineering* approach to development, implementation and successive progression to attain maturity in knowledge management**".

1.6.2 Existing Models

KMM models are reviewed based on the context of development, number of maturity levels, key areas, assessment methodology, validation methodology etc. The assessment methodology could be subjective or in the sense that the evaluation is purely based on the opinion expressed by various stake holders. It could also be objective in the sense that the evaluation involves collection and analysis of evidences to support the opinion expressed by various stake holders. The model could be validated by survey methods, or by case study method, in the context of one or more organisations.

Various KMM models reviewed are briefly described below. Kochikar (2000) had developed a generic KMM model, in the context of Infosys Technologies Ltd. The model has five maturity levels, viz, default, reactive, aware, convinced and sharing. The assessment methodology is objective. The KAs considered are people, process & technology. The model does not specify anything about validation. The model will be referred as KMM (Kochikar).

Hubert and Lemons (2010) of APQC had developed a generic KMM model for application to APQC's road map to KM results. The model has five maturity levels, viz, initiate, develop, standardize, optimize and innovate. The model specifies the characteristics of different maturity levels in generic terms, without explicitly identifying any specific KA. The model does not specify anything about the methodology of assessment and validation. The model will be referred as KMM (Hubert).

Kulkarni and Freeze (2004) had developed a Knowledge Management Capability Assessment (KMCA) model, for determining the capability levels of an organisation in various knowledge areas. The model identifies six capability levels, viz, difficult, possible, encouraged, enabled,

managed and continuously improved. The model specifies micro capability levels like +, ++ etc. in between two adjacent capability levels. The model classifies the knowledge into four areas, viz, expertise, lessons learned, knowledge documents, and data. These areas are called knowledge capability areas, which are essentially the KAs. The model specifies the subjective assessment methodology with typical questions. The model is validated by survey method. The model will be referred as KMCA (Kulkarni).

Klimko (2001) had developed a generic KMM model. The model has five maturity levels, viz, initial, knowledge discoverer, knowledge creator, knowledge manager and knowledge renewer. The model specifies the characteristics of each stage in terms of focus, key processes, challenge, tool, and pitfall. The model neither specifies the assessment nor validation methodology. The model will be referred as KMM (Klimko).

KPMG Consulting (2000) had proposed a generic KMM model called 'Knowledge Journey'. The model has five maturity levels, viz, knowledge chaotic, knowledge aware, knowledge focused, knowledge managed and knowledge centric. The model specifies the characteristics of different maturity levels in terms of KAs, viz, people, process, content and technology. The model will be referred as Knowledge Journey (KPMG).

Natarajan (2005) developed a KMM model for software industry. The model has four maturity levels. Each maturity levels is called a K-stage. The model is validated by case study approach. The KAs identified are business process readiness, technology infrastructure, human behaviour and leadership. The model does not specify the assessment methodology. The model will be referred as KMM (Natarajan).

Paulzen and Perc (2002) proposed a maturity model for quality improvement in KM. The authors call it 'Knowledge Process Quality' (KPQ) model. The model has five maturity levels, viz, initial, aware, established, quantitatively managed and optimizing. The KAs identified are organisation, people and technology. Though the model discusses the assessment globally, it does not clearly specify the methodology. The validation of the model is discussed as the future work. The model will be referred as KPQ (Paulzen).

Mohanty and Chand (2005) developed a KMM model, keeping the requirements of Tata Consultancy Services in mind. The model has five maturity levels, viz, initial, intent, initiative, intelligent and innovative. The assessment methodology described is objective. The KAs considered are people, process and technology. The authors call the model as 5iKM3 and will be referred by 5iKM3 (Mohanty).

Wisdom Source Technologies developed a KMM model (Wisdom Source, 2004). The model has eight levels of maturity, viz, standardized infrastructure for knowledge sharing, top-down quality assured information flow, top-down retention measurement, organisational learning, organisational knowledgebase, process-driven knowledge sharing, continual process improvement and organisational self-actualization. The model specifies the characteristics of different maturity levels in generic terms, without explicitly identifying any specific KAs. The model is called K3M and will be referred by K3M (Wisdom Source).

Gottschalk (2002) proposed a maturity model for KM technology in Law Firms. The model has four maturity levels, viz, end user tools, who knows what, what they know and what they think. The model discusses the technology characteristics at each level. Also the model discusses the classification of knowledge into core, advanced and innovative. It also classifies the knowledge

into administrative, declarative, procedural and analytical. The model neither specifies the assessment nor validation methodology. The model will be referred as KMM (Gottschalk).

Ehms and Langen (2002), developed a KMM model, keeping the requirements of Siemens in mind. The model has five maturity levels, viz, initial, repeated, defined, managed and optimizing. The model identifies eight KAs, viz, strategy & knowledge goals, environment & partnerships, people & competencies, collaboration & culture, leadership & support, knowledge structures& knowledge forms, technology & infrastructure and processes, roles & organisation. The assessment methodology described is objective. The model will be referred as KMM (Ehms).

Kruger and Snyman (2007) developed a strategic KMM model. It identifies six maturity levels, viz, ICT as an enabler of KM, deciding on KM principles, ability to formulate organisation-wide knowledge policy, building knowledge strategies, formulation of KM strategies and ubiquitous knowledge. The model specifies the characteristics of different maturity levels in generic terms. The model will be referred as Strategic KMM (Kruger).

Gallagher and Hazlett (2004) proposed a generic KMM model. The model has four maturity levels, viz, K-aware, K-Managed, K-enabled, and K-optimized. The KAs identified are knowledge infrastructure, knowledge culture and knowledge technology. The assessment methodology is objective. A case study approach is proposed to validate the model. The model is named as KM3 and will be referred by KM3 (Gallagher).

Pee and Kankanhalli (2009) proposed a generic KMM model. The model has five maturity levels, viz, initial, aware, defined, managed and optimizing. The KAs considered are people, process & technology. The assessment methodology is objective. A case study approach is used

to validate the model. The model is named as G-KMM model and will be referred by G-KMM (Pee).

Boyles et al. (2009), proposed a KM assessment tool, in the context of nuclear industry. The assessment is based on the model with five maturity levels. It identifies seven KAs, viz, policy, human resource, training, documentation, technology, tacit knowledge and KM culture. In the five level model each KA progresses from 'not utilized', 'to a little extent', 'to some extent', 'to a great extent' and 'to a very great extent'. Self –assessment methodology is prescribed. The model will be referred as KMM (Boyles).

1.7 THE CONTEXT OF NUCLEAR R&D ORGANISATION

This thesis proposes a KMM model in the context of a nuclear R&D organisation, which is controlled and funded by Government of India. The complexity of managing knowledge in such an organisation involves the twin complexity of nuclear knowledge management and R&D knowledge management.

1.7.1 Nuclear Knowledge Management

Nuclear organisations can be classified into nuclear R&D organisations and nuclear plants (power plants or reprocessing plants). The knowledge pertaining to nuclear organisations is termed nuclear knowledge. Nuclear technology is a complex one as it involves many disciplines of science and engineering. Knowledge management in the context of Nuclear Power Plant (NPP) acquires much more important role, because of the long time scales involved, high technological excellence required, stringent safety regulations, difficulties in attracting and retaining talented work force etc. Added to this, there is always a challenge to improve the safety and reduce the downtime as well as the unit energy cost. Though nuclear knowledge management has many

things in common with managing any other domain knowledge, managing it requires specific programmes and needs to achieve the objectives. (Yanev, 2009).

There are many stake holders for nuclear knowledge such as designers, consultants, operators, vendors, academic and R&D institutions, governments, regulators, international organisations etc. Nuclear knowledge has been accumulated over a century with specific experience in design, construction, commissioning, operation & maintenance, and R&D. Effective mechanisms need to be developed for preservation of this knowledge and its transfer to successive generations. Effective management of nuclear knowledge should include succession planning for the nuclear work force, the maintenance of the 'nuclear safety case' for operational reactors, and retention of the nuclear knowledge accumulated over the past six decades (IAEA, 2006).

De Grosbois and Kumar (2009), through a study of NPPs have identified 42 common KM practices like KM System, Communities of Practices, Training simulators, Knowledge elicitation, Knowledge codification etc., which highlight the KM options available to the management of NPPs.

The knowledge in an NPP can be broadly classified based on different phases of the power plant viz research and development, conceptual design, detail design, construction, commissioning, operation & maintenance, decommissioning, and refurbishment as depicted in Figure 1.3 (IAEA, 2006). Knowledge transfer takes place from one phase to another in a sequential manner.

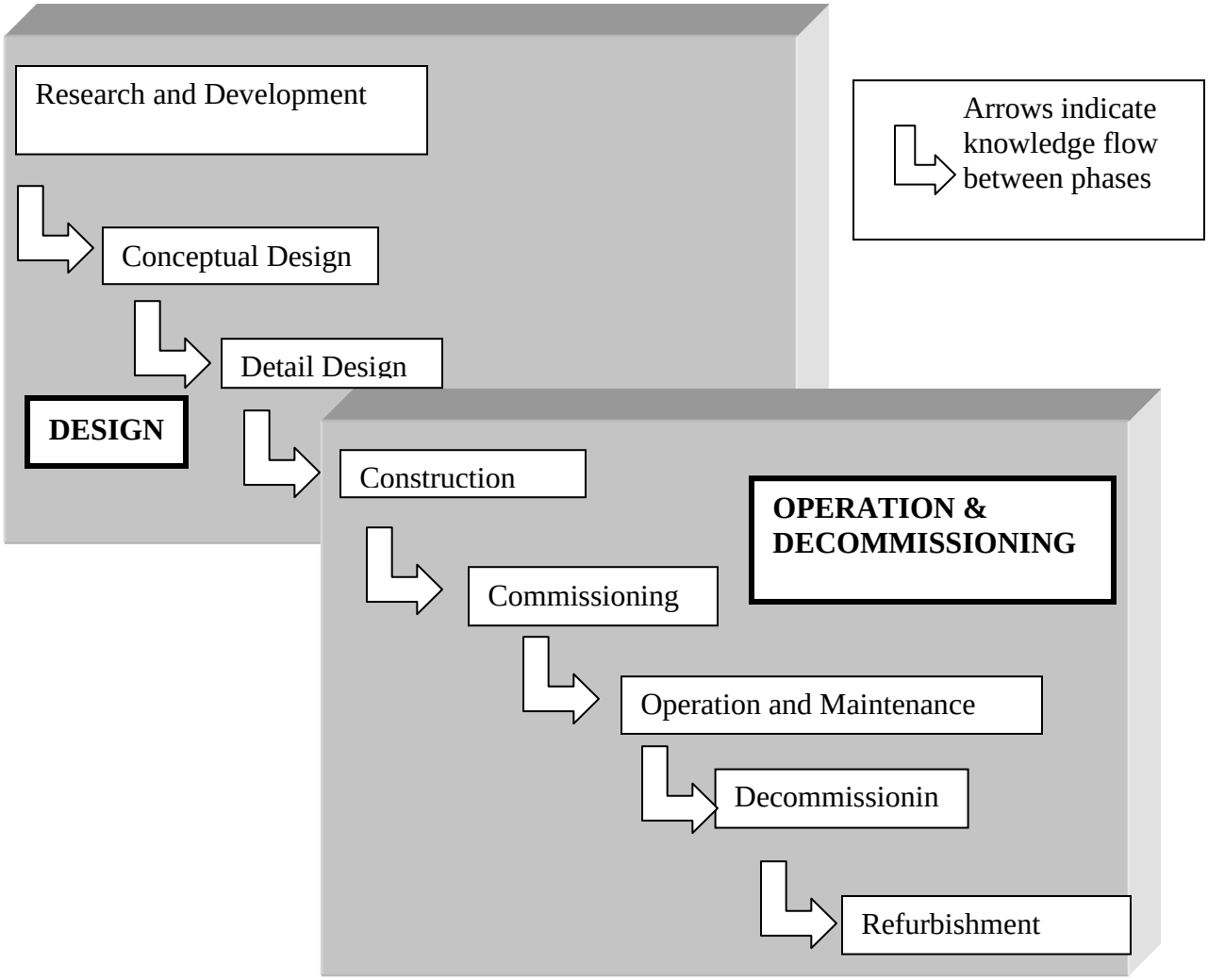


Figure 1.3 Knowledge transfer through the phases of an NPP life cycle (IAEA, 2006)

Nuclear power plants are basically classified into thermal reactors and fast reactors based on the energy of neutron that is used to sustain the chain reaction in the nuclear reactor. Thermal reactors use slowed down neutrons, while fast reactors make use of high energy neutrons without slowing down. IAEA has developed a scheme for classification of knowledge pertaining to Fast Reactors known as Fast Reactor Knowledge Organisation System (FR-KOS). The knowledge in FR-KOS is organised based on the metadata of the original document in a hierarchical structure, as depicted in Figure 1.4 and Table 1.1

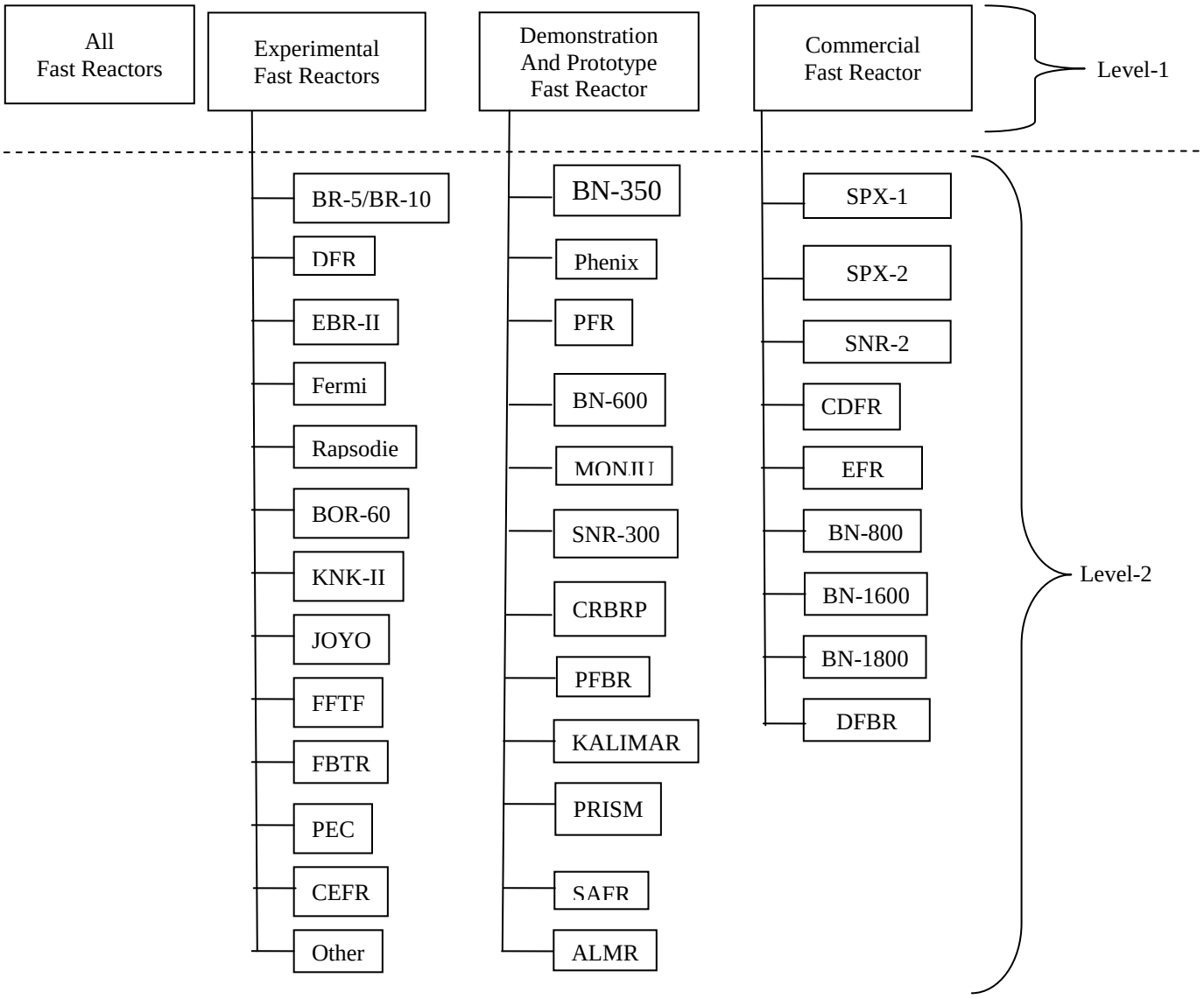


Figure 1.4 The first two levels of Fast Reactor Taxonomy (Pryakhin et al., 2009)

FR-KOS is based on a taxonomy intended to guide experts and will help research and development, educational and industrial organisations to facilitate the process of fast reactor knowledge mining (Pryakhin, et al. 2009). It consists of an electronic repository of fast reactor knowledge and experience from various countries with facilities for effective search and knowledge mining.

Table 1.1 The structure of the two top levels of the topic-stage matrix

(Pryakhin et al., 2009)

Basic Principles	**R&D**	**Design, Analysis, Licensing**	**Manufacturing and Construction**	**Fuel Cycle**	**Operation**	**Decommissioning**
Fast Fission	Reactor Physics	General System Criteria	Site Development	Waste Management	Cold Startup	Planning
Basic Design and Variations	Fuel and Materials	Codes and Standards	Components manufacturing	Trans-port	Low Power Commission-ing.	Experience
Safety Principles and philo-shopy	Heat Transfer and Transport Systems	Core Design	Plant Assembly		Full Power Operation	
	Pipe Integrity	Dynamic Analysis	Balance of plant		Environmental Impact	
	Seismic Analysis	Environmental Impact	Inspection		Maintenance	
	Accident Analysis	System Design Description	Codes and Standards		Off-normal and emergency Operation	
	Sodium Fire	Demonstration of Safety			Failed Fuel Detection	
	BDB events	Project cost analysis (economics)			Fuel Handling	
	Control Materials	Control Systems				
	Shielding	Failed Fuel Detection				
		Shielding				

The first level of FR-KOS classifies reactors into different types like experimental reactor, commercial reactor etc. There is also a general section containing knowledge on all fast reactor facilities, without reference to any particular reactor. The second level lists the reactors under each type. At the third level (Table 1.2), the knowledge acquired in each reactor facility is classified into different stages like basic principles, R&D etc. At the fourth level knowledge in each stage is classified. For example the knowledge in R&D stage is classified into reactor physics, fuels and materials etc. At the fifth level the meta-data pertaining to knowledge documents is placed. At the sixth level the available knowledge documents will be placed. The meta-data, in FR-KOS contains information like, title, authors, type, abstract, key words, reactor facilities, reactor stages etc. which facilitates accurate placement and retrieval of knowledge.

1.7.2 R&D Knowledge Management

The entire activities of an R&D organisation are centered on knowledge creation. R&D organisation is different from other organisations because of its mission, the people working in such organisations, the target work carried out by people, the knowledge that is quested**,** the culture of the organisations, the financial support received, the responsibility to the government and society. Today's R&D organisations are pressed by the demand of efficiency, effectiveness and accountability on the one hand and the requirement of the greater multidisciplinary and multi-site collaboration on the other hand; all of which takes place in an in an environment of increased technological discontinuities, accelerated technological obsolescence and competence erosion and enhanced competition(Osama ,2006).

The main function of R&D organisation is creation of knowledge that is necessary for the current and projected future activities. The knowledge created by R&D acts like insurance against future uncertainties. The challenge for KM is different in organisation whose life blood is knowledge

creation and continuous learning than it is for those for whom better reuse of existing knowledge is primary (Leonard-Barton, 1995, Page-Shipp, 2000).

One of the major challenges faced by R&D organisation is in performance measurement, because most of the outputs are intangible. Austin (1996) asserts that measuring only the easy-to-identity or easy-to-measure areas, especially at the expense of the critical but difficult-to-measure areas, is a flawed practice that creates the possibility that individuals would channel their productive energies towards, those areas that are measured, and fail to do what is critical for the organisation. Current R&D organisations are held responsible for efficiency, effectiveness and accountability in quantitative terms compared to earlier paradigm of assessing R&D performance through qualitative assessments. Measuring the effectiveness of R&D and innovation processes has long been a vexing problem faced by research and corporate managers alike (Osama, 2006). In order to comprehensively focus on R&D productivity, Jain and Triandis, (1990) proposed the concept of organisational effectiveness. They defined organisational effectiveness as a vector that includes quantifiable and non quantifiable outputs and reflects the quality and the relationship of outputs to broad organisational goals and objectives. According to Rouse and Boff (2004) an R&D organisation creates value only if it creates knowledge to meet the future needs. Also the value the organisation creates is the value of the knowledge created, whether that knowledge is utilized or not.

Performance monitoring of R&D organisations need to consider multiple attributes like input, process, output, outcome, in addition to employee satisfaction and customer satisfaction. The problem of performance multidimensionality and hence, measurement complexity is most severe in R&D settings due to the inherent multidimensionality of R&D's output and the long term and intangible nature of the process itself. Osama (2006) found that R&D organisations do a poor

job of linking together the strategy, performance and incentive system. Also he proposed that R&D performance can be influenced by better alignment of individual motivations and organisational goals.

One of the performance measurement approaches that internalizes the inherent multidimensionality of the organisational performance measurement challenge is the Balanced Score Card (BSC) developed by Kaplan ad Norton (1992). The key insight that triggered the idea of BSC was the notion that organisational performance cannot be measured by a single metric but must incorporate a whole series of metrics, across a number of performance dimensions, including input, process and output metrics and metrics measuring intangible aspects of performance (Kaplan and Norton, 1992). Though Balanced Score Card was developed mainly for the corporate world, modified versions were developed for the R&D organisations (Osama, 2006). The above discussions highlight the multidimensionality and complexity of R&D performance measurements and the need for comprehensive R&D KM model that addresses the above complexities.

1.8 RESEARCH MOTIVATION

Despite the availability of many KMM models in literature, a comprehensive framework that can represent different perspectives and provide a holistic picture, is not found in literature. Also it can be seen that each model has certain strengths and interesting features. Some of the models were developed by practitioners, for the use in their own organisation or for use as a consultancy service. Some other models were developed by academicians. In many instances the assessment methodology, validation etc. were not covered. Also the flexibility and adaptability of these models to various organisational environments is neither discussed nor known. Hence, practically adapting the model developed in the context of one organisation to another

organisation with the publically available information has difficulties. Hence, there is adequate motivation to develop a new model which will satisfy the following requirements:

- The model is to be developed in the context of Nuclear R&D organisation
- The model should be modular in structure for ease in design and use
- It should be flexible for continual improvement to suit the various changes in organisational environments
- The model should be practically adaptable to any organisation

1.9 RESEARCH OBJECTIVES

In this context, the following research objectives were arrived at:

- Identify a morphological framework for KM maturity models for holistic representation.
- Develop a flexible KM maturity model in the context of nuclear R&D organisation.
- Validate the model.
- Assess the current level of KM maturity of the context organisation and its sub units using the developed model, thereby demonstrating the applicability of the model.
- Identify the inhibiting factors to attain higher levels of maturity for the context organisation and its sub units.
- Arrive at an appropriate recommendation for the context organisation to achieve higher levels of KM maturity.
- Study the knowledge creation process and the context of knowledge creation *(ba)* in one sub unit of the organisation.
- Develop of a taxonomy of knowledge pertaining to one sub unit of the organisation.

1.10 RESARCH METHODOLOGY

The research methodology used is an exploratory study. A combination of case study and survey was used without triangulation. Case study was used to identify the KM maturity levels of the organisation and its 10 sub units, while survey was used to identify the inhibiting factors to attain higher levels of KM maturity for the organisation and its 10 sub units. According to Yin (2009), case studies are preferred, when how or why questions are posed, the investigator has little control over the events and the focus is on a contemporary phenomenon with in a real-life context. In case studies the richness of the phenomenon and the extensiveness of the real life context require the case study investigators to cope with technically distinctive situations of more variables of interest than data points. Here, an essential tactics is to use multiple sources of evidence, with data needing to coverage in a triangular fashion (Yin, 2009).

Four tests that have been commonly used to establish the quality of any empirical research are construct validity, internal validity, external validity and reliability (Yin, 2009). Construct validity is concerned with identifying correct operational measures for the concepts being studied. Internal validity is concerned with establishing causal relationship in which certain conditions are believed to lead to other conditions. External validity is concerned with generalization of the findings of the study. Reliability is concerned with demonstrating that the operations of the study can be repeated with the same results. The goal of reliability is to minimize the biases in the study.

Through literature survey and morphological analysis of KM maturity models, the attractive features of the existing models were identified. Based on this, a new flexible KM maturity model with the attractive features of the existing models has been developed. The model has been demonstrated and validated through the case study of a nuclear R&D organisation. The current KM maturity levels of the organisation and its 10 subunits has been assessed through the case

study. The inhibiting factors to attain higher level of KM maturity of the target organisation and its subunits were identified through a survey. The knowledge creation process and the context of knowledge creation (*ba*) in the organisational context and in the context of one subunit of the organisation were studied. A taxonomy pertaining to the knowledge of one subunit was developed. The recommendations to attain higher level of KM maturity for the organisation were given.

1.11 OVERVIEW OF THE THESIS

In Chapter 2 morphological analysis of KMM models is described**.** In Chapter 3 the development of a new flexible KMM model, is discussed. In Chapter 4 the demonstration of the model through a case study approach is covered. In Chapter 5 the inhibiting factors to attain higher levels KM maturity for the target organisation through survey methodology are discussed. In Chapter 6 the study of knowledge creation process and the context of knowledge creation (*ba*) in the organisation and in one of the subunits of the organisation is discussed. Development of a taxonomy pertaining to the knowledge of that subunit is also described. In Chapter 7 the conclusions and recommendations are discussed. In Chapter 8 the future directions are explained.

CHAPTER 2

MORPHOLOGICAL ANALYSIS OF KNOWLEDGE MANAGEMENT MATURITY MODELS

In this chapter morphological analysis of KMM models is presented. In order to provide a road map for KM implementation, many practitioners and researchers have developed KMM models. What are the different forms, structure and characteristics of these KMM models? Despite the availability of many models in literature, a comprehensive framework that can represent different perspectives and provide a holistic picture of KMM model is not found in literature. A morphological framework of KMM models addresses this issue and this is discussed in this chapter.

2.1 MORPHOLOGICAL ANALYSIS

The term morphology comes from classical Greek (*morphe*) and means the study of shape or form. It is concerned with the structure and parts of an entity (object) and how these fit together to form a whole. The entity can be physical, social or conceptual (Ritchey, 2006). Morphological analysis is a method of structuring and investigating the total set of relationships, contained in multidimensional, non quantifiable problem complexes (Zwicky, 1969, cited by Ritchey, 2006).

Morphological analysis commences by identifying and defining the dimensions (parameters) and probable options (values) of the entity to be analyzed. A morphological box, also known as Zwicky box, is constructed by setting the dimensions and options in an 'n' dimensional matrix. Each cell of the n dimensional box contains one particular option for each of the dimensions, which indicates a particular configuration of the entity. Each option in a dimension is a row in the

matrix. The rows of same dimension are parallel to each other, and orthogonal to the rows of other dimensions. The rows of different dimensions intersect each other to form cells in the morphological box.

As a simple example, imagine a car with three dimensions size, color and engine type. Let the probable options for size be small, medium & large, for color be white, black, red & green and for engine type be petrol & diesel. Since there are 3 options for size, 4 options for color & 2 options for engine there are 24 (3*4*2) cells in the morphological box, each representing one particular car with one option for each dimension. The 3 dimensional matrix containing all the possible relationships is the complete and systematic morphological field.

2.1.1 Dimensions and Options

The morphological frame work developed for this work has identified six dimensions. Each dimension has two or more options. 15 KMM models from literature discussed in Chapter 1, Section 1.6.2 were used as the basis for the dimensions and options. The dimensions and options are discussed below:

Context: The dimension 'Context' refers to the context in which the maturity model has been developed. The maturity model can be developed in the context of a specific organisation or a specific industry sector like software, manufacturing, R&D etc. Also, it could be developed in a general context without any reference to any organisation or any industry sector. Hence the 3 options considered for the dimension 'Context' are 'General', 'Organisation' and 'Industry Sector'. Certain models clearly specify the context of development. For example the KMM (Kochikar) explicitly mention that the context is organisational. Some other models clearly

specify that, the model has been developed keeping the context of a specific industry sector. Some models explicitly mention that the model is developed in the general context.

Out of the 15 models studied, it was observed that eight (53.4%) models were developed in the general context, four(26.6%) were in the context of specific organisation and three(20%) were in the context of specific industry sector.

Applicability:The dimension 'Applicability' refers to the entity to which the model can be applied. The maturity model may be applicable in general to any organisation, or it may be applicable only for the specific organisation, or to the specific industry sector. Hence the options of the dimension 'Applicability' are 'General', 'Organisation' and 'Industry Sector'. It can be noticed that the options of the dimension 'Context' and 'Applicability' are identical. Does it indicate that the two dimensions are the same? It can be observed from Table 3.2 that, the models developed in the context of 'Organisation' has the 'General' applicability. For example the KMM (Kochikar) , explicitly mention that the context is organisational, while the applicability is general; " while the model has been developed keeping the Infosys context and KM goals in mind, it is sufficiently generic to be used in any organisation which considers knowledge leverage as significant determinant of success" (Kochikar, 2000). Hence, it can be concluded that the dimensions 'Context' and 'Applicability' are different.

Out of the 15 models studied, it was observed that twelve (80%) models have a general applicability three (20%) models have specific industry sector applicability and none (0%) have organisation specific applicability.

Levels: Theoretically the model can progress from a lower level of perfection to a higher level of perfection either in stages or continuously. However all the models reviewed used a staged model of progression. Hence, the continuous model of progression is not considered. The dimension 'Levels' indicates the number of maturity levels from the lowest level of perfection to the highest level of perfection. Ideally, the options for 'Levels' could be any positive number. However, the options considered in this analysis are, the number of levels used in the models reviewed (4, 5, 6&8).

Out of the 15 models analysed, it was observed that nine (60%) models had 5 levels, three (20%) models had 4 levels, two (13.3%) models had 6 levels and one (6.7%) model had 8 levels.

Assessment: The dimension 'Assessment' indicates the methodology suggested or described in the model to assess the knowledge management maturity level of the organisation. It could be subjective in the sense that the evaluation is purely based on the opinion expressed by various stake holders. It could be objective in the sense that the evaluation involves collection and analysis of evidences to support the opinion expressed by various stake holders. Some of the models do not explicitly mention the assessment methodology. Hence, three options considered are 'Subjective', 'Objective' and 'Not known'.

Out of the 15 models studied, it was observed that eight (53.4%) models have not mentioned the assessment methodology, five (33.3%) models have used objective methodology, while two (13.3%) models have used subjective methodology.

Validation : The dimension 'Validation' indicates the methodology used to validate the model. The model could be validated by empirical methods, or by case study method, in the context of

one or more organisations. It could also be possible that the model be validated by more than one method. However, that option was not considered, since none of the models studied, used multiple methods. In majority of the models, the validation is not specified, indicating that the model may not be validated or the validation details cannot be revealed due to confidentiality. Hence the options considered are 'Empirical', 'Case study' and 'Not known'.

Out of the 15 models studied, it was observed that twelve (80%) models have "not known" validation methodology, two (13.3%) models have used case study methodology, while one (6.7%) model had used empirical methodology.

Key Areas: The dimension 'Key Areas' indicates the key areas considered by the model to characterize various maturity stages. Some of the models have used specific key areas like people, process, technology, knowledge, content, culture, leadership, strategy, etc. These models have used a set of Key Areas such as "people, process, technology", "people, process, content, technology" etc. Only the set of "people, process, technology" is used by 4 models [KMM(Kochikar), KPQ(Paulzen), 5iKM3(Mohanty) and G-KMM(Pee)]. Also many models include the Key Area like 'people', 'technology' etc. in their respective set of Key Areas. Hence, for simplicity the options considered are 'General' which indicates, that characteristics are described in general terms, without any specific Key Areas and 'Specific', which indicates that characteristics are described in terms of specific Key Areas.

Out of the 15 models studied, it was observed that eleven (73.3%) models described the characteristics in terms specific Key Areas and four (26.7%) models have described characteristics in general terms. Table 2.1 depicts the overall results of morphological analysis carried out based on the 15 models studied.

Table 2 .1 Morphological analysis of 15 KMM models analysed

Sl. No.	Dimension	Options	Models	No. of Models	% of Models
1.	Context	General	KMM(Hubert), KMM(Klimko), Knowledge Journey(KPMG), KPQ(Paulzen), K3M(Wisdom Source), Strategic KMM(Kruger), KM3(Gallagher), G-KMM(Pee)	8	53.4
		Organisation	KMM(Kochikar), KM CA(Kulkarni), 5iKM3(Mohanty), KMM(Ehms),	4	26.7
		Industry Sector	KMM(Natarajan), KMM(Gottschalk), KMM(Boyles)	3	20

2.	Applicability	General	KMM(Kochikar), KMM(Hubert), KM CA(Kulkarni), KMM(Klimko), Knowledge Journey(KPMG), 5iKM3(Mohanty), KMM(Ehms), KPQ(Paulzen), K3M(Wisdom Source), Strategic KMM(Kruger), KM3(Gallagher), G-KMM(Pee)	12	80
		Organisation		0	0
		Industry Sector	KMM(Natarajan), KMM(Gottschalk), KMM(Boyles),	3	20
3.	Levels	4	KMM(Natarajan), KMM(Gottschalk), KM3(Gallagher)	3	20
		5	KMM(Kochikar), KMM(Hubert), KMM(Klimko), Knowledge Journey(KPMG), KPQ(Paulzen), 5iKM3(Mohanty), KMM(Ehms), G-KMM(Pee), KMM(Boyles),	9	60
		6	KMCA(Kulkarni), Strategic KMM(Kruger)	2	13.3
		8	K3M(Wisdom Source)	1	6.7

4.	Assessment	Subjective	KMCA(Kulkarni), KMM(Boyles)	2	13.3
		Objective	KMM(Kochikar), 5iKM3(Mohanty), KMM(Ehms), KM3(Gallagher), G-KMM(Pee)	5	33.3
		Not known	KMM(Hubert), KMM(Klimko), Knowledge Journey(KPMG), KMM(Natarajan), KPQ(Paulzen), K3M(Wisdom Source), KMM(Gottschalk), Strategic KMM(Kruger)	8	53.4
5.	Validation	Case Study	KMM(Natarajan), G-KMM(Pee)	2	13.3
		Empirical	KM CA(Kulkarni)	1	6.7
		Not known	KMM(Kochikar), KMM(Hubert), KMM(Klimko), Knowledge Journey(KPMG), KPQ(Paulzen), 5iKM3(Mohanty), K3M(Wisdom Source) KMM(Gottschalk), KMM(Ehms), Strategic KMM(Kruger), KM3(Gallagher), KMM(Boyles)	12	80

6.	Key Areas	General	KMM(Hubert), KMM(Klimko), K3M(Wisdom Source), Strategic KMM(Kruger)	4	26.7
		Specific	KMM(Kochikar), KPQ(Paulzen), 5iKM3(Mohanty), G-KMM(Pee), KMCA(Kulkarni), Knowledge Journey(KPMG), KMM(Natarajan), KMM(Gottschalk), KMM(Ehms), KM3(Gallagher), KMM(Boyles)	11	73.3

2.1.2 Discussions and Contributions

The morphological analysis described, provides a holistic view of the KM maturity models based on the published literature. Analyzing different KMM models based on different options provide multiple perspectives. It provides an indication of the options of various dimensions, which different models have dealt used. The analysis also provides a quantitative picture of the usage of various options by the models in the literature.

Each model can be described in terms of a specific combination of the options. For example KMM(Kochikar) can be described by the following combination of dimensions. Context: Organisation/ Applicability: General/ Levels: 5/ Assessment: Objective/ Validation: Not known/ Key Areas: Specific/. Other KMM models can also be mapped into the morphological frame work and analyzed in terms of the dimensions and options.

The morphological analysis considered 6 dimensions and constitutes a 6 dimensional matrix. The total number of cells in the morphological box as depicted in Table 2.2 is 648(3*3*4*3*3*2). This indicates 648 KMM models are possible based on the dimensions and options considered.

The morphological analysis of KMM models has implications both for practitioners and researchers. A practitioner can classify certain options as strengths and then evaluate various models based on the morphological framework and select an appropriate framework that has maximum relevance. A researcher interested in developing a flexible model in the context of an organisation can evaluate the available models in the literature based on the morphological framework and design a KMM model. This approach is used in this thesis to develop a flexible and adaptable model.

Table 2.2 Morphological Box

Sl. No.	Dimension	Options	No. of Options
1.	Context	General	3
		Organisation	
		Industry Sector	
2.	Applicability	General	3
		Organisation	
		Industry Sector	
3.	Levels	4	4
		5	
		6	
		8	
4.	Assessment	Subjective	3
		Objective	
		Not known	
5.	Validation	Case Study	3
		Empirical	
		Not known	
6.	Key Areas	General	2
		Specific	

2.2 SUMMARY

In this chapter a morphological framework proposed for developing a flexible KMM model is described. The morphological framework based on the 15 KMM models studied, provided a quantitative analysis of the extent of usage of different options by various models.

CHAPTER 3

DEVELOPMENT OF KMI-KMM MODEL

In this chapter, Key Maturity Indicator (KMI) based KMM model is proposed. The characteristics of 15 relevant models are discussed, the attractive features are identified and KMI-KMM model is presented.

3.1 CHARACTERISTICS OF KNOWLEDGE MANAGEMENT MATURITY MODELS

The characteristics of the 15 KMM models studied along with their strengths are summarized in Table 3.1. In Table 3.1, column 2 lists the model names followed by the authors. The models are named with the name of the first author, wherever available. Column 3 lists the KAs identified in the model. The models which did not identify any KA are represented as 'Generic'. Column 4 lists the number of levels of the models followed by the names of the levels. Column 5 lists the characteristics of the maturity levels in progression from the lowest level to the highest level. Column 6 lists the identified strengths of the KMM model.

Table 3.1 Characteristics of the 15 KMM Models Studied

Sl. No.	Model Name and Author	Key Areas	No of Levels and Names	Characteristics of Levels	Strengths
1	KMM (Kochikar) Kochikar (2000)	• People • Process • Technology	5 • Default • Reactive • Aware • Convinced • Sharing	• Fragmented knowledge • Need based knowledge sharing • Organisation-wide knowledge sharing systems with visible link between KM processes and results • Self-sustaining KM movement • Institutionalization of knowledge sharing culture	Detailed description of general behavioral characteristics and specific characteristics based on KA at each level. An objective assessment methodology
2	KMM (Hubert) Hubert and Lemons (2010)	Generic	5 • Initiate • Develop • Standardize • Optimize • Innovate	• Informal and inconsistent KM processes • Establishment of a KM strategy that is tightly linked to the business strategy • Refining the KM processes into standard replicable methodologies • Expansion of KM strategy throughout the organisation • Continuous improvement, Institutionalization and breakthrough innovation	KM strategy that is linked to business strategy. Individual, departmental and organisational performance assessment aligned with the KM strategy.
3	KMCA(Kulkarni) Kulkarni and Freeze (2004)	Knowledge	6 • Difficult • Possible • Encouraged	• Discouragement for knowledge sharing • Selective knowledge sharing • Recognition and reward for knowledge sharing • KM enabling of normal workflow	Detailed assessment methodology. Validation of the model Use of micro maturity

Sl. No.	Model Name and Author	Key Areas	No of Levels and Names	Characteristics of Levels	Strengths
			• Enabled • Managed • Continuously Improved	• Monitoring and measuring of knowledge sharing • Systematic measurement and improvement of knowledge sharing	levels such as +, ++ etc.
4	KMM(Klimko) Klimko (2001)	Generic	5 • Initial • Knowledge Discoverer • Knowledge Creator • Knowledge Manager • Knowledge Renewer	• Lack of specific attention for KM activities • Recognition of the importance of existing knowledge • Identification and creation of new knowledge required for future activities • Institutionalization of KM function with dedicated KM unit with documented and measurable KM processes • Knowledge sharing with other organisations and exploiting common ways of knowledge creation	Advanced and Innovative knowledge. Documented and measurable KM processes. Inter- organisational knowledge sharing.
5	Knowledge Journey(KPMG) KPMG (2000)	• People • Process • Content • Technology	5 • Knowledge Chaotic • Knowledge Aware • Knowledge Focused • Knowledge	• Lack of visible relationship between KM and achievement of organisational goals • Implementation of KM pilot projects • Organisation-wide usage of KM tools and realization of business benefits • Implementation of integrated framework for KM tools and procedures	Identification of characteristics in terms KAs like people, process, technology and content.

Sl. No.	Model Name and Author	Key Areas	No of Levels and Names	Characteristics of Levels	Strengths
			Managed • Knowledge Centric	• Adoption of KM procedures and tools as integral part of organisational and individual processes	
6	KMM (Natarajan) Natarajan (2005)	• Business Process Readiness • Technology • Infrastructure • Human Behaviour • Leadership	4 K-stages	• Lack of specific KM • Establishment of information sharing mechanism • Establishment of systematic KM processes • Institutionalization of KM as an integral part of business activity	Validation of the model
7	KPQ (Paulzen) Paulzen and Perc(2002)	• Organisation • People • Technology	5 • Initial • Aware • Established • Quantitatively Managed • Optimizing.	• Unplanned knowledge processes • Implementation of the first structure to ensure a higher process quality • Systematic structure and definition of knowledge processes • Enhancement of the process management through tracking the performance measures • Establishment of structures for continuous improvement	Integration of KM processes in to business process.
8	5iKM3 (Mohanty)	• People • Process	5 • Initial	• Lack of formal processes for effective usage of organisational knowledge	Integration of KM processes to business

Sl. No.	Model Name and Author	Key Areas	No of Levels and Names	Characteristics of Levels	Strengths
	Mohanty and Chand (2004)	• Technology	• Intent • Initiative • Intelligent • Innovative.	• Realization of the potential in harnessing organisational knowledge for business benefits • Knowledge enabled business processes and realization of its business impacts • Matured collaboration and collective organisational intelligence • Utilization of organisational knowledge for continuous process optimization and business advantage	process and business benefits An assessment model that includes a proposed solution.
9	K3M Wisdom Source (2004)	Generic.	8 • Infrastructure For Knowledge Sharing • Top-Down Quality Assured Information Flow • Top-Down Retention Measurement • Organisational Learning • Organisational Knowledge Base	• Capturing and delivering of knowledge in repeatable steps • Identification of executive block of knowledge that is critical to lead the organisation as a cohesive unit • Measurement of team understanding of executive knowledge • Culture of knowledge sharing and organisational learning • Culture of continuous improvement and innovation • Result focused process frame work • Culture of knowledge creation • Continuous process development	Good concentration on process improvement.

Sl. No.	Model Name and Author	Key Areas	No of Levels and Names	Characteristics of Levels	Strengths
			• Process-Driven Knowledge Sharing • Continual Process Improvement • Organisational Self-Actualization		
10	KMM(Gottschalk) Gottschalk (2002)	• Technology • Knowledge	4 • End User Tools • Who Knows What • What They Know • What They Think	• Usage of standardized productivity tools by knowledge workers • Creation of knowledge maps • Usage of data mining technology to retrieve relevant knowledge • Availability of AI techniques for solving knowledge problems	Good concentration on technology.
11	KMM(Ehms) Ehms and Langen (2002)	• Strategy & Knowledge Goals • Environment & Partnerships • People & Competencies	5 • Initial • Repeated • Defined • Managed • Optimizing	• Lack of conscious control of knowledge process • Recognition of the importance of KM activities in business • Stable and practiced KM activities that are integrated into day to day work processes with necessary technical systems and KM roles • Measurement of KM efficiency • Organisational ability to adapt to any new KM	Integration of KM processes in to business process. KM Measurements An objective assessment methodology

Sl. No.	Model Name and Author	Key Areas	No of Levels and Names	Characteristics of Levels	Strengths
		• Collaboration & Culture • Leadership & Support • Knowledge Structures & Knowledge Forms • Technology & Infrastructure • Processes • Roles & Organisation		requirements	
12	KMM(Kruger) Kruger and Snyman (2007)	Generic	5 • Initial • Repeated • Defined • Managed • Optimizing	• Lack of awareness on the importance of knowledge as a strategic resource and ineffective management of Information and Communication Technology • Recognition of the importance of KM function and evolution of ICT systems into data and information systems • Formulation of organisation-wide KM policy and implementation of ICT systems to support management decisions and knowledge work	KM policy and strategy. Good concentration on technology KA

Sl. No.	Model Name and Author	Key Areas	No of Levels and Names	Characteristics of Levels	Strengths
				• Encouragement of KM activities and effective ICT and knowledge infrastructure • Strategies for institutionalization of KM practices	
13	KM3(Gallagher) Gallagher and Hazlett(2004)	• Knowledge Infrastructure • Knowledge Culture • Knowledge Technology	4 • K-Aware, • K-Managed • K-Enabled • K-Optimized	From lack of awareness of knowledge management in the first stage to a complete and focused knowledge strategy that is tightly coupled to business strategy and ultimately results in improved business performance in the final stage.	Knowledge strategy that is tightly coupled to the business strategy and business performance An objective assessment methodology.
14	G-KMM (Pee) Pee and Kankanhalli (2009)	• People • Process • Technology	5 • Initial • Aware • Defined • Managed • Optimizing	• Lack of intention to formally manage knowledge • The intention to formally manage the knowledge • Basic infrastructure to support KM activities • Well established KM initiatives • Automatic integration of KM into organisational process and continuous improvement	Integration KM process into organisational process. Validation of the model
15	KMM (Boyles) Boyles et al (2009)	• HR • Training • Documentation • Technology • Tacit Knowledge • KM Culture	5	Each KA progresses from ‘not utilized’ , ‘to a little extent’, ‘to some extent’, ‘to a great extent’ and ‘ to a very great extent’.	Detailed assessment criteria were listed.

3.2 THE PROPOSED KNOWLEDGE MANAGEMENT MATURITY MODEL

From Table 3.1 it is clear that each model has certain strengths. Some of the models were developed by practitioners, for use in their own organisation or for use as consultancy service [KMM(Kochikar), KMM(Ehms) etc.]. For these models the details of assessment methodology, validation etc. are not available in open literature. Some other models are developed by academicians, where the assessment methodology, validation etc. are not done in detail [KMM(Klimko), KPQ(Paulzen) etc.]. Also details concerning flexibility and adaptability of these models to various organisational environments is scarce in open literature. Hence, practically adapting one model to another organisation may pose difficulties.

In view of this, a new KMM model is proposed which will satisfy the following requirements:

- The context of the model is nuclear R&D organisation
- The model should be modular in structure for flexibility
- The Key Areas in KM are People, Process, Technology, Knowledge and RoI
- The model should be capable to assess the current maturity level individually in different Key Areas and the overall KM
- The model should have micro maturity levels like +, ++, similar to the ones used by Kulkarni and Freeze (2004) to motivate the organisation in improving the maturity level as shown in Table 3.1, Sl.No.3
- The model should be adaptable to other general organizations as well as specific industries
- Possibility to consider the extended value chain of the organisation.

The development of the KMM model proceeds with the identification of the specific options for various dimensions identified in the morphological analysis carried out in Chapter 2. The KMM model development process is depicted in Figure 3.1.

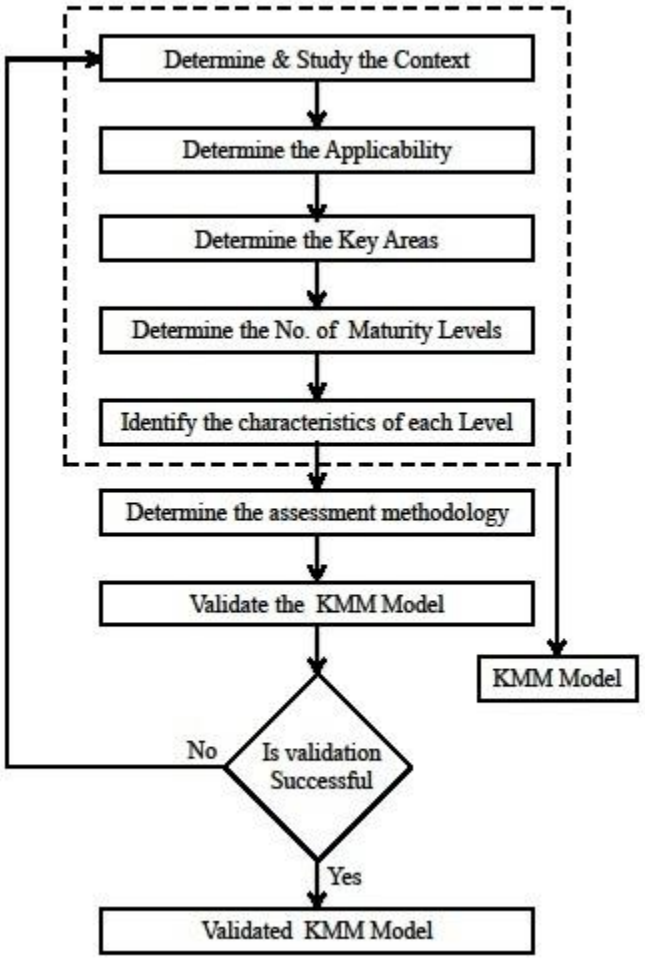


Figure 3.1 KMM model development process

In the context of this research work, the dimensions and options selected are listed below:

- Context - Organisation (Nuclear R&D).
- Applicability - General
- Key Areas – Specific (People, Process, Technology, Knowledge & RoI).
- Number of Levels - 6
- Assessment - Objective
- Validation - Expert Judgment/Case Study

3.2.1 Key Areas

The Key Areas considered are People, Process, Technology, Knowledge and Return on investment (RoI) as represented in Figure 3.2, as they represent almost all organizations ensuring adaptability

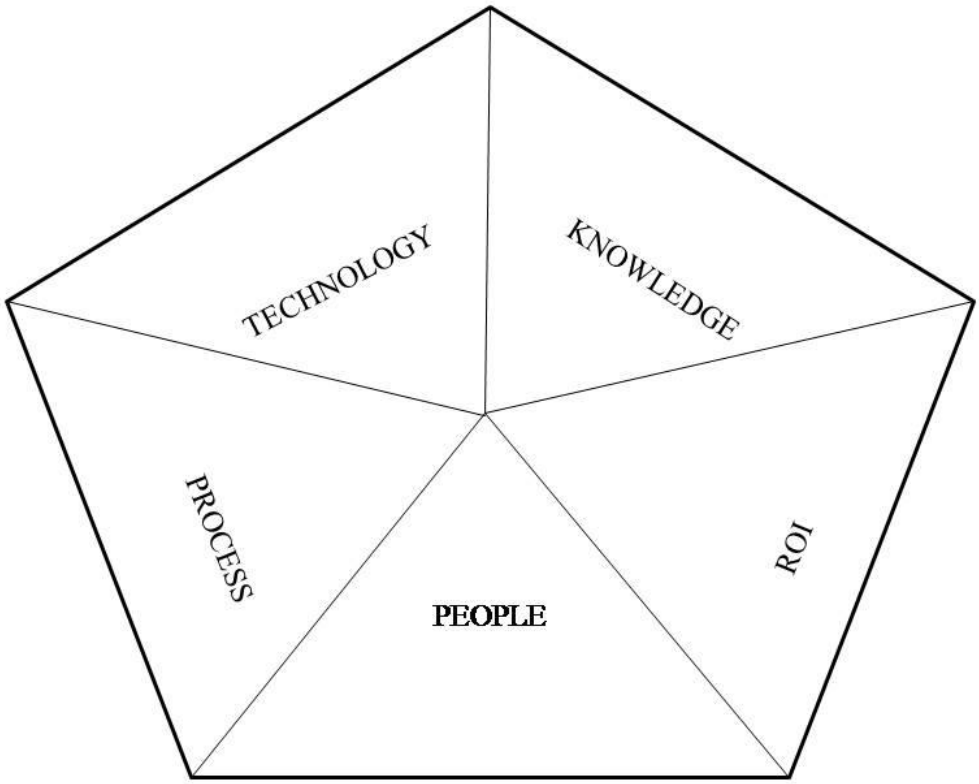


Figure 3.2 Key Areas

Each KA is identified with certain number of parameters called Key Parameters (KP). Each parameter is identified with certain values called Key Values (KV). The Key Parameters identified for different Key Areas and the Key Values are listed below.

3.2.2 Key Parameters

The Key Parameters for different Key Areas are listed below. The Key Parameters under the Key Areas are considered as orthogonal. However some overlap among the Key Parameters is possible because of the overlap among the Key Areas themselves. The classification of parameters into different Key areas was done based on the larger dependence of the parameter on a specific Key Area.

3.2.2.1 'People' Key Parameters

In 'People' Key Area six parameters viz Awareness, Participation, Reward and Recognition Scheme, KM Roles, Communities of Practice, Mentoring and Succession Planning have been considered. Awareness indicates the level of understanding and acceptance of employees the practical meaning of KM as applicable to them in the organisational context. Though awareness indicates the level of understanding, a process is necessary to measure and improve the awareness. However, since it is more concerned with 'People' the parameter is classified under 'People'. The parameter 'Participation' indicates the level of participation of employees in formal KM activities. Again though this parameter also indicates a level, a process is necessary to measure and improve the participation. However since it is more concerned with 'People' the parameter is classified under 'People'. The parameter 'Reward and Recognition Scheme' indicates the effectiveness of reward and recognition schemes to motivate employees for voluntary participation in formal KM activities. Though introduction of 'Reward and Recognition Scheme', measuring its effectiveness etc. requires a process, since the parameter indicates the effectiveness, which is a people dependent level resulting from the scheme, the parameter is classified under 'People'. The parameter 'KM roles' indicates the effectiveness of KM roles like Chief Knowledge Officer, Departmental Knowledge Officers etc. A process is necessary to create KM roles and assess the effectiveness etc. Since the parameter indicates the effectiveness of the

roles which is more 'People' dependent, it is classified under 'People'. The parameter 'Communities of Practice' indicates the effectiveness of knowledge sharing communities. Though a process is necessary to create 'Communities of Practice' and assess its effectiveness etc., since the parameter indicates the effectiveness of knowledge sharing communities, which is more 'People' dependent, it is classified under 'People'. The parameter 'Mentoring and Succession Planning' indicates the effectiveness of mentoring and succession planning. Though a process is necessary to implement 'Mentoring and Succession Planning' scheme and assess its effectiveness, since the parameter indicates the effectiveness of the scheme, which is more 'People' dependent, it is classified under 'People'.

3.2.2.2 'Process' Key Parameters

In the Key Area 'Process' four parameters viz KM Policy, KM Strategy, KM Processes and Process Integration have been chosen. The parameter 'KM Policy' indicates the effectiveness of KM Policy which is a statement of intent of what one wants to achieve with KM. This parameter sets the goals of KM for the organisation. The effectiveness of KM policy depends on the policy and its implementation. Since this parameter is more related to 'Process', it is classified under 'Process'. The parameter 'KM Strategy' indicates the effectiveness of KM strategy which is a statement of how one wants to achieve KM. It is the effectiveness of the methods used by the organisation to achieve its KM goals. Since this parameter is more related to 'Process', it is classified under 'Process'. The parameter 'KM Processes' indicates the overall effectiveness of different KM processes viz. Knowledge identification, knowledge creation, knowledge acquisition, knowledge preservation, knowledge quality rating, knowledge sharing, knowledge utilization and KM RoI measurement. This parameter is classified under 'Process'. The parameter 'Process integration' indicates level of integration and the effectiveness of integration of KM processes (which are listed under KM Process) with normal work processes. This

parameter is classified under ‘Process’. All these processes have some element of ‘People’, because these are implemented by people. However since these parameters are more process related than people related, these have been considered under ‘Process’.

3.2.2.3 ‘Technology’ Key Parameters

In the Key Area ‘Technology’ six parameters viz. Network, Data and Information Management, Explicit Knowledge Management, Tacit Knowledge Management, KE Techniques and Technology Integration have been considered. The parameter ‘Network’ indicates the effectiveness of organisation-wide connectivity of computer systems and other related resources. The parameter ‘Data and Information Management’ indicates the effectiveness of organisation-wide data and information system. The parameter ‘Explicit Knowledge Management’ indicates the effectiveness of technology for content management. The parameter ‘Tacit Knowledge Management’ indicates the effectiveness of technology for collaboration and management of tacit knowledge. The parameter ‘KE Techniques’ indicates the effectiveness of AI and KE techniques for knowledge elicitation, knowledge representation, knowledge retrieval, inference etc. The parameter ‘Technology Integration’ indicates the level of integration and its overall effectiveness of various technology enabled systems of the organisation like Data Management Systems, Information Management Systems, Content Management Systems, Collaboration Systems, AI and KE Systems etc. All the above parameters also have some relation to ‘People’ because technology infrastructure is used by people and some relation to ‘Process’ because some processes are required to implement the technology infrastructure and monitor its effectiveness. However, since these are more technology related than people or process, these parameters are classified under ‘Technology’

3.2.2.4 'Knowledge' Key Parameters

In the Key Area 'Knowledge' four parameters viz Knowledge Classification, Knowledge Capability Areas, Knowledge Organisation and Knowledge Value have been considered. The parameter 'Knowledge Classification' indicates the combined effectiveness of core, advanced and innovative knowledge. The parameter 'Knowledge Capability Areas' indicates the combined effectiveness of data, knowledge documents, lessons learned, expertise, knowledge in the form of Frequently Asked Questions (FAQ), blogs, wikis etc. The parameter 'Knowledge Organisation' indicates the combined effectiveness of the organisation of the knowledge, based on knowledge map, meta knowledge, taxonomy etc. The parameter 'Knowledge Value' indicates the combined value of the knowledge available in the organisational repository, as perceived by the organisation. Although the above parameters have some relation to 'People' and 'Process', since these are more related to 'Knowledge' these are classified under 'Knowledge'.

3.2.2.5 'RoI' Key Parameters

In the Key Area 'RoI' three parameters viz Employee Satisfaction, Productivity and Organisational Reputation have been considered. The parameter 'Employee Satisfaction ' indicates the level of satisfaction of employees on KM activities. The parameter 'Productivity' indicates productivity improvement due to KM activities. The parameter 'Organisational Reputation' indicates Improvement in organisational reputation due to KM activities. Though the above parameters also have some relation to 'People' and 'Process', since these are more related to 'RoI' these are classified under 'RoI'.

Key Parameters of different Key Areas in the proposed KMM model are summarized listed in the Table 3.2.

Table 3.2 Key Parameters

Sl. No KA	Key Area	Sl. No KP	Key Parameters	Description
1	People	1	Awareness	The level of understanding and acceptance of employees the practical meaning of KM as applicable to them in the organisational context.
		2	Participation	The level of participation of employees in formal KM activities.
		3	Reward and Recognition Scheme	The effectiveness of reward and recognition schemes to motivate employees for voluntary participation in formal KM activities.
		4	KM roles	The effectiveness of KM roles which can be full time or part time.
		5	Communities of Practice	The effectiveness of knowledge sharing communities.
		6	Mentoring and Succession Planning	The effectiveness of mentoring and succession planning.
2	Process	1	KM Policy	The effectiveness of KM Policy which is a statement of intent of what one wants to achieve with KM.
		2	KM Strategy	The effectiveness of KM Strategy which is a statement of how one wants to achieve KM.
		3	KM Processes	The KM processes considered are knowledge identification, knowledge creation, knowledge acquisition, knowledge preservation, knowledge quality, knowledge sharing, knowledge utilization and KM RoI measurement. The parameter indicates the overall effectiveness of KM processes.
		4	Process Integration	Process integration refers to the integration of KM processes with normal work processes. The parameter indicates the level of integration and its effectiveness.
3	Technology	1	Network	Network refers to organisation-wide connectivity of computer systems and other related resources. The parameter indicates the effectiveness of the network.
		2	Data and Information Management	The effectiveness of organisation-wide data and information system.

Sl. No KA	Key Area	Sl. No KP	Key Parameters	Description
3	Technology	3	Explicit Knowledge Management	The effectiveness of technology for content management.
		4	Tacit Knowledge Management	The effectiveness of technology for collaboration and management of tacit knowledge.
		5	KE Techniques	The effectiveness of AI and KE for knowledge elicitation, knowledge representation, knowledge retrieval, inference etc.
		6	Technology Integration	The integration of various technology enabled systems of the organisation like Data Management Systems, Information Management Systems, Content Management Systems, Collaboration Systems, AI and KE Systems etc. The parameter indicates the level of integration and its overall effectiveness.
4	Knowledge	1	Knowledge Classification	Knowledge is classified into core, advanced and innovative. The parameter indicates the combined effectiveness of core, advanced and innovative knowledge.
		2	Knowledge Capability Areas	The knowledge capability areas identified in the literature, viz, data, knowledge documents,lessons learned, expertise and knowledge in the form of Frequently Asked Questions (FAQ). Also it includes unapproved and un solicited knowledge in the form of blogs, wikis etc. The combined effectiveness is indicated by the parameter.
		3	Knowledge Organisation	Knowledge organisation refers to the organisation of the knowledge based on knowledge map, meta knowledge, taxonomy etc. and its combined effectiveness is indicated by the parameter.
		4	Knowledge Value	The combined value of the knowledge available in the organisational repository, as perceived by the organisation.
5	RoI	1	Employee Satisfaction	The level of satisfaction of employees on KM activities.
		2	Productivity	Productivity improvement due to KM activities.
		3	Organisational Reputation	Improvement in organisational reputation due to KM activities.

3.2.3 Key Values

The 'Key Values' identified for the Key Parameters are:

- Nil
- Low
- Medium
- High
- 0 – 100

The value 'Nil' indicates that the key parameter is either not applicable or not assessed or does not exist. The values 'Low', 'Medium' and 'High' indicate that the key parameter is assessed qualitatively. The value 0-100 indicates that the key parameter is assessed quantitatively and it is expressed as percentage.

3.2.4 Maturity Levels and Maturity Indicators

The proposed KMI-KMM model has six maturity levels (level 0 to level 5). The maturity levels are named as:

- Default (0)
- Initial (1)
- Qualitative Development (2)
- Quantitative Development (3)
- Maturity (4)
- Extended-Organisational Maturity (5)

The uniqueness of the proposed proposed model is the use of extended organisational maturity as level 5. The proposed KMI-KMM model identifies different maturity levels by a specific combination of Key Maturity Indicators (KMI). Each KMI is identified by a specific combination of KA, KP and KV. For an organisation to be in a specific maturity level, all the KMIs pertaining

to that level and all preceding levels need to be satisfied. No level can be skipped. Micro maturity levels such as + and ++ similar the ones proposed in Kulkarni and Freeze (2004), are proposed in this KMM model to motivate organisations to improve the maturity levels.

If an organisation satisfies all the KMIs pertaining to one level, say level 1, and at least one KMI pertaining to the next level (level2) for each KA, or KV exceeds the requirements of the particular level (level 1) for at least one KP for each KA, then that organisation is considered to be in a level 1+. Similarly, if the organisation satisfies at least 50% of the KMIs pertaining to level 2 for each KA, or KV exceeds the requirements of the particular level (level 1) for 50% of KPs for each KA, then that organisation is considered to be in a level of 1++. Also if the organisation satisfies all KMIs of level 1 and satisfies at least one KMI of level 2 or KV exceeds the requirements of the particular level(level 1) for at least one KP for a specific KA, then that organisation is considered to be in level 1 in the overall maturity and 1+ in that specific KA alone. Similarly if the organisation satisfies all KMIs of level 1 and satisfies at least 50 % of the KMIs of level 2 or KV exceeds requirement of the particular level(level 1) for at least 50% of the KPs for one or more specific KAs alone, then that organisation is considered to be in level 1 in the overall maturity and 1++ in the specific KAs alone. The maturity levels, their general characteristics, characteristics in terms of Key Areas and Key maturity Indicators of different levels are described below.

3.2.4.1 *Level 0: Default*

Level 0 is the basic level. By default all organisations will be at a minimum of level 0. It is characterized by the absence of any formal KM activity. The organisation recognizes and rewards only individual expertise and capabilities. Organisation is in a level of 'unconscious incompetence' in KM. The characteristics of Level 0 are as follows:

People: Awareness of KM may not exist. People work in isolation and compete with each other. The thinking is "we do not know anything about KM".

Process: The only KM processes are mandatory reports, formal training and informal socialization.

Technology: Generally individual productivity tools are being used.

Knowledge: Only routine knowledge required for survival is created and shared through training and informal socialization.

RoI: This Key Area is not applicable at this level, since formal KM does not exist.

Since this is the default level the Key Values of Key Parameters are not assessed.

3.2.4.2 *Level 1 : Initial*

It is characterized by the intention of the management to start formal knowledge management activity. Though organisation does not have the clarity on how to proceed, it initiates KM activities. Organisation generally works as silos and the knowledge sharing takes place only within the silos. Though islands of excellence exist, pool of excellence is lacking. Organisation is in a level of 'conscious incompetence' in KM. The characteristics of Level 1 are as follows:

People : A low level of awareness of formal knowledge management and the need for knowledge management exists among the employees. Participation in KM activities is low. Only part-time KM roles exist. Mentoring and succession planning is prevalent in an adhoc way. The thinking is "we need KM, but it is too difficult and time consuming"

Process: A documented KM policy and KM strategy exists. Organisation-wide procedure for documenting and selective sharing of routine and procedural knowledge exists. Procedure for formal knowledge sharing sessions exists.

Technology: Organisation wide network exists. Isolated/networked systems for data, information and explicit knowledge like publication, progress report, project reports etc., exist. Also technology infrastructure for tacit knowledge sharing exists in a primitive level.

Knowledge: The quantity of routine and procedural knowledge shared has improved.

RoI: Since formal KM activities are only initiated RoI may be negligible.

3.2.4.3 *Level 2: Qualitative Development*

This stage is characterized by qualitative assessment of KM activities and its impact on the performance of individuals, department and organisation. Based on the qualitative assessment, the performance of KM activities and its impact on the organisational performance is good.

People: Organisation wide awareness and participation of KM activities is monitored qualitatively and is good. Dedicated full time KM roles were created in addition to part time roles with clear mandate and review mechanism. A committee of senior management reviews the progress and takes appropriate corrective actions. Reward and recognition schemes are introduced. Knowledge sharing communities are encouraged. Mentoring and succession planning is practiced with appropriate knowledge transfer. The thinking is "we are doing KM"

Process: The effectiveness of KM policy and KM strategy is improved in a qualitative way. Formal processes for knowledge identification, creation, acquisition, approval, quality rating, preservation, sharing, utilization and impact assessment on performance of individuals, department and organisation exists. All the formal processes are documented, the effectiveness is measured qualitatively and corrective mechanisms are incorporated. The effectiveness of the formal processes is good.

Technology: A user friendly knowledge portal with necessary content management and collaboration technologies, and necessary security features is operational. Integration of

organisational data and information system with knowledge portal is being explored. Knowledge engineering techniques are being explored for knowledge acquisition, knowledge representation, knowledge retrieval and inference. The portal of the organization is so configured in such a way that employees can do the information/knowledge oriented work from the portal itself. All the necessary links to other internal and external websites and utilities are provided. The effectiveness of the portal is monitored qualitatively and is good.

Knowledge*:* In addition to routine knowledge, advanced knowledge required for performance improvement and future activities is created/ acquired and shared. Tacit knowledge is elicited and shared across the organisation, in addition to sharing in communities. Knowledge is organized with Knowledge Map, Meta Knowledge structure and taxonomy. Knowledge in the form of Lessons Learned, Frequently Asked Questions (FAQ), Expertise, Data etc. are documented, preserved and shared. Also unapproved and unsolicited knowledge is being shared. The quality of knowledge and its organisation is measured qualitatively and is good.

RoI*:* Since formal KM activities are improved qualitatively the RoI should be good. Employees are satisfied with the KM activities. Improvement in productivity and organizational reputation due to KM initiatives are visible.

The Key Maturity Indicators for level0, level1 and level2 are given in Table 3.3

Table 3.3 KMI for Level 0,1 and 2

Key Area	Key Parameters	Key values (Level 0)	Key values (Level 1)	Key values (Level 2)
People	Awareness	Nil	Low	Medium
	Participation	Nil	Low	Medium
	KM roles	Nil	Low	Medium
	Mentoring and Succession Planning	Nil	Low	Medium
	Communities of Practice	Nil	Nil	Low
	Reward and Recognition Scheme	Nil	Nil	Low
Process	KM Policy	Nil	Low	Medium
	KM Strategy	Nil	Low	Medium
	KM Processes	Nil	Low	Medium
	Process Integration	Nil	Nil	Low
Technology	Network	Nil	Medium	High
	Data and IM	Nil	Medium	High
	Explicit KM	Nil	Low	Medium
	Tacit KM	Nil	Low	Medium
	KE techniques	Nil	Nil	Low
	Technology Integration	Nil	Nil	Low
Knowledge	Knowledge Classification	Nil	Low	Medium
	Knowledge Capability Areas	Nil	Nil	Medium
	Knowledge Organisation	Nil	Nil	Medium
	Knowledge Value	Nil	Nil	Medium
RoI	Employee Satisfaction	Nil	Nil	Medium
	Productivity	Nil	Nil	Medium
	Organisational Reputation	Nil	Nil	Medium

3.2.4.4 *Level 3: Quantitative Development*

This stage is characterized by quantitative assessment of KM activities and its impact on the organisational performance. The organisation is able to quantitatively link the KM activities and

the organisational effectiveness in terms of various performance indicators. The effectiveness of the measured parameters reaches more than 50% of the targeted value. Organisation reaches the level of 'conscious competence' in KM.

People: Awareness and acceptance of KM activities is improved significantly. More than 50% of the employees are active participants in KM activities. Knowledge sharing communities exist irrespective of departmental boundaries and more than 50% of the employees are members in one or more knowledge sharing communities. People have started recognizing that knowledge management is a part of the normal work. Dedicated KM roles, reward & recognition scheme and mentoring and succession planning continues with quantitatively measurable RoI. The thinking is "we are doing KM very well".

Process: The effectiveness of KM policy and KM strategy is improved and is more than 50% of the targeted value. Organisation wide KM processes get integrated with normal work processes with quantitative measurements and corrective mechanisms. More than 50% of the normal work processes have integrated KM processes.

Technology: Integration of organisational data and information system with knowledge portal is successful in locating the relevant knowledge. Isolated applications using KE techniques used for knowledge acquisition, knowledge representation, knowledge retrieval and inference like natural language processing, speech recognition, ontology, knowledge discovery through data mining / text mining, case based reasoning, rule based reasoning etc are successful and is being integrated with the knowledge portal. The portal is configured in such a way that more than 50% of the employees do the information/knowledge oriented work from the portal itself. The effectiveness of the knowledge portal is measured quantitatively and is more than 50%.

Knowledge: In addition to routine and advanced knowledge, innovative knowledge required for innovations and leadership positions is created/ acquired and shared. The quality of knowledge in

Knowledge Capability Areas and its organisation is measured quantitatively in addition to qualitative measurements. The overall quality of the knowledge shared is more than 50% of the targeted value.

***RoI**:* Employee satisfaction, productivity improvement and improvement in organisational reputation due to KM initiatives are quantitatively monitored. These parameters are more than 50% of the targeted value indicating significant improvement in RoI.

3.2.4.5 *Level 4: Maturity*

Knowledge management has become an integral part of every activity and got embedded into the organisational culture. The level is characterized by continual improvement and institutionalization of the knowledge management practices. The effectiveness of the measured parameters reaches more than 90%. Organisation reaches the level of "unconscious competence" in KM.

***People**:* Everyone recognizes knowledge management as an integral part of their work. They are able to see the visible link which is backed by qualitative and quantitative measurements between KM activities and performance & growth of individuals, department and organisation. People have become insensitive to organisational hierarchies and affiliations as far as KM activities are concerned. Collaborative activities and knowledge sharing communities are widespread throughout the organisation. The effectiveness of KM roles has reached a level where dedicated senior level KM roles like Chief Knowledge officer may get replaced with part-time roles, though lower level roles for technology enhancement/maintenance may continue. The effectiveness of reward & recognition scheme and mentoring and succession planning have reached a level where exclusive schemes may get vanished and may become a part of the normal work culture. Continual improvement in effectiveness of various parameters, performance, growth and RoI is

monitored and is moiré than 90%. The thinking is "we have achieved in making KM a way of our life".

Process: The effectiveness of KM policy, KM strategy, KM processes and process integration is continually improved and is moiré than 90% of the targeted value. Process integration has reached a level, where KM processes have become an integral part of every organisational activity including organisational performance measurements.

Technology: The data and information system of the organisation get seamlessly integrated with the knowledge management portal. KE techniques used for knowledge acquisition, knowledge representation, knowledge retrieval and inference like natural language processing, speech recognition, ontology, knowledge discovery through data mining / text mining, case based reasoning, rule based reasoning etc are matured and get seamlessly integrated with the knowledge management portal. The portal is configured in such a way that all the employees can do all the information/knowledge oriented work from the portal itself. All the employees have made the KM portal as their preferred home page. The security, reliability, availability, user friendliness and effectiveness of the KM portal is continually improved and is more than 90%.

Knowledge: The quality and quantity of knowledge shared is continually improved and is more than 90% of the targeted value. The knowledge necessary to carry out the current and future activities of the organisation is guaranteed as an integrated package of explicit and tacit knowledge.

RoI: Employee satisfaction, productivity improvement and improvement in organisational reputation due to KM initiatives are than 90% of the targeted value, indicating a high level of RoI. The organization is getting significant tangible and intangible benefits due to its investments in KM initiatives.

The Key Maturity Indicators for level 3 and level 4 are given in Table 3.4

3.2.4.6 *Level 5: Extended - Organisational Maturity*

Level 5 is characterized by achieving maturity with respect to partnering organisations like, suppliers, customers and other alliance organisations and seamless integration with these organisations. Essentially, organisational boundaries with respect to knowledge management breaks down and the target organisation along with the partnering organisations together as a single entity reach the KMIs of level 4 maturity. However to achieve level 5 maturity, the extended organisation may have to assess the current level and gradually progress from that level, however low it is.

The Key Maturity Indicators for various maturity levels are summarized in Table 3.5 and they are pictorially represented in Figure 3.3.

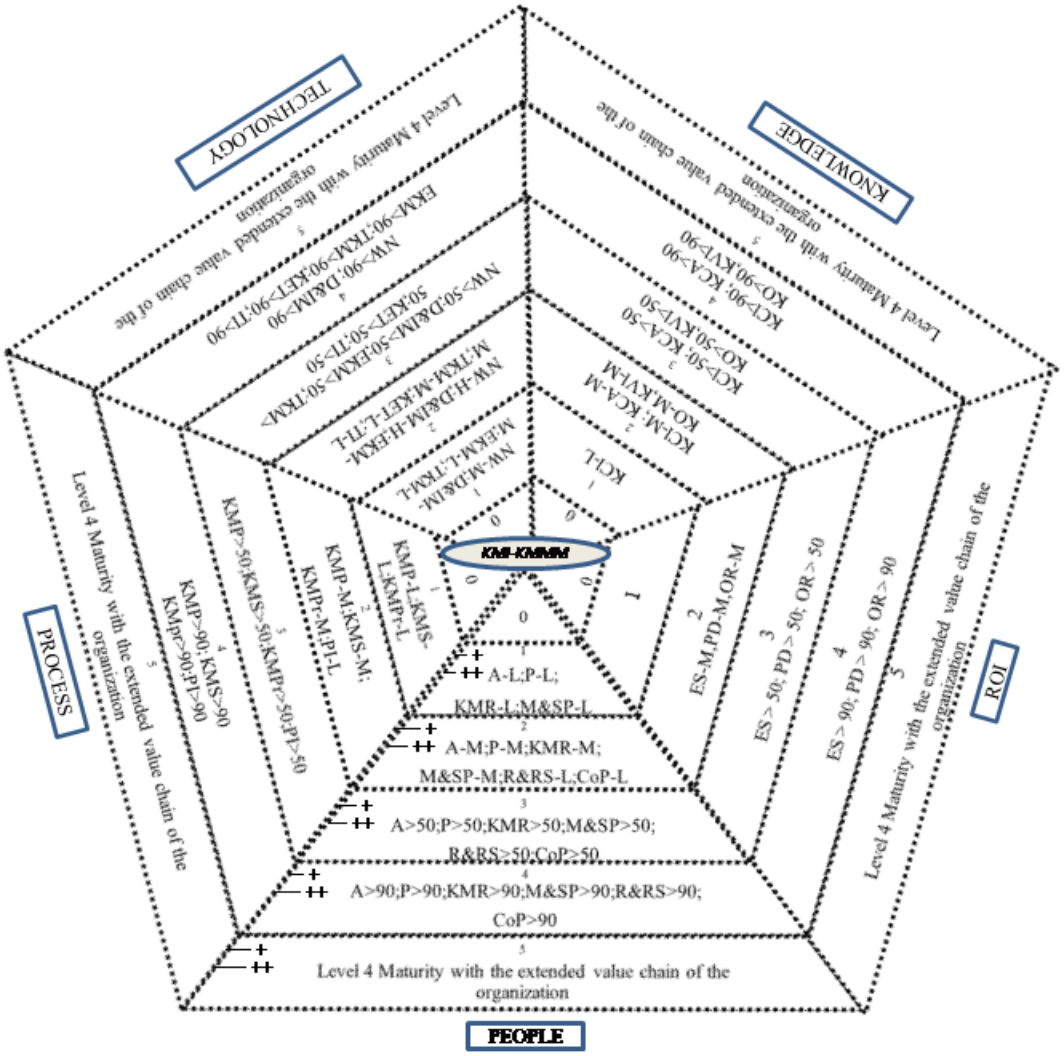
In Figure 3.3 each triangle in the pentagon represents a Key Area. The maturity levels (0-5) in each KA are represented by the outer lines of each box within the triangle. The Key Parameters and the corresponding Key Values for various Maturity Levels are represented in the respective boxes in abbreviated form. The abbreviations are expanded and represented below the pentagon.

Table 3.4 KMI for Level 3 & 4

Key Area	Key Parameters	Key values % (Level 3)	Key values % (Level 4)
People	Awareness	>50	>90
	Participation	>50	>90
	KM roles	>50	>90
	Mentoring and Succession Planning	>50	>90
	Communities of Practice	>50	>90
	Reward and Recognition Scheme	>50	>90
Process	KM Policy	>50	>90
	KM Strategy	>50	>90
	KM Processes	>50	>90
	Process Integration	>50	>90
Technology	Network	>50	>90
	Data and Information Management	>50	>90
	Explicit KM	>50	>90
	Tacit KM	>50	>90
	KE techniques	>50	>90
	Technology Integration	>50	>90
Knowledge	Knowledge Classification	>50	>90
	Knowledge Capability Areas	>50	>90
	Knowledge Organisation	>50	>90
	Knowledge Value	>50	>90
RoI	Employee Satisfaction	>50	>90
	Productivity	>50	>90
	Organisational Reputation	>50	>90

Table 3.5 Maturity Levels and Key Maturity Indicators

Maturity Level	Key Parameters & Key Values (People)	Key Parameters & Key Values (Process)	Key Parameters & Key Values (Technology)	Key Parameters & Key Values (Knowledge)	Key Parameters & Key Values (ROI)
0 Default	Nil	Nil	Nil	Nil	Nil
1 Initial	▪ Awareness- Low ▪ Participation -Low ▪ KM roles –Low ▪ Mentoring and Succession Planning-Low ▪ Communities of Practice-Nil ▪ Reward and Recognition Scheme- Nil	▪ KM Policy-Low ▪ KM Strategy-Low ▪ KM Processes-Low ▪ Process Integration-Nil	▪ Network-Medium ▪ Data and IM-Medium ▪ Explicit KM-Low ▪ Tacit KM-Low ▪ KE techniques-Nil ▪ Technology Integration- Nil	▪ Knowledge Classification-Low ▪ Knowledge Capability Areas-Nil ▪ Knowledge Organisation-Nil ▪ Knowledge Value-Nil	▪ Employee Satisfaction-Nil ▪ Productivity-Nil ▪ Organisational Reputation- Nil
2 Qualitative Development	▪ Awareness- Medium ▪ Participation -Medium ▪ KM roles -Medium ▪ Mentoring and Succession Planning-Medium ▪ Communities of Practice-Low ▪ Reward and Recognition Scheme- Low	▪ KM Policy-Medium ▪ KM Strategy-Medium ▪ KM Processes-Medium ▪ Process Integration-Low	▪ Network-High ▪ Data and IM-High ▪ Explicit KM-Medium ▪ Tacit KM-Medium ▪ KE Techniques-Low ▪ Technology Integration-Low	▪ Knowledge Classification-Medium ▪ Knowledge Capability Areas-Medium ▪ Knowledge Organisation-Medium ▪ Knowledge Value-Medium	▪ Employee Satisfaction-Medium ▪ Productivity- Medium ▪ Organisational Reputation-Medium
3 Quantitative Development	▪ Awareness->50 ▪ Participation ->50 ▪ KM roles ->50 ▪ Mentoring and Succession Planning->50 ▪ Communities of Practice->50 ▪ Reward and Recognition Scheme- >50	▪ KM Policy->50 ▪ KM Strategy->50 ▪ KM Processes->50 ▪ Process Integration->50	▪ Network->50 ▪ Data and IM->50 ▪ Explicit KM->50 ▪ Tacit KM->50 ▪ KE techniques->50 ▪ Technology Integration->50	▪ Knowledge Classification->50 ▪ KnowledgeCapability Areas->50 ▪ Knowledge Organisation->50 ▪ Knowledge Value->50	▪ Employee Satisfaction->50% ▪ Productivity->50% ▪ OrganisationalReputation->50%
4 Maturity	▪ Awareness->90 ▪ Participation ->90 ▪ KM roles ->90 ▪ Mentoring and Succession Planning->90 ▪ Communities of Practice->90 ▪ Reward and Recognition Scheme- >90	▪ KM Policy->90 ▪ KM Strategy->90 ▪ KM Processes->90 ▪ Process Integration->90	▪ Network->90 ▪ Data and IM->90 ▪ Explicit KM->90 ▪ Tacit KM->90 ▪ KE techniques->90 ▪ Technology Integration->90	▪ Knowledge Classification- >90 ▪ Knowledge Capability Areas- >90 ▪ Knowledge Organisation- >90 ▪ Knowledge Value->90	▪ Employee Satisfaction->90% ▪ Productivity- >90% ▪ Organisational Reputation- ->90%
5 Extended-organisational maturity.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.



A-Awareness	**EKM-Explicit Knowledge Management**
P-Participation	**TKM-Tacit Knowledge Management**
KMR-Knowledge Management Roles	**KET-Knowledge Engineering Techniques**
M&SP-Mentoring & Succession Planning	**TI-Technology Integration**
R&RS-Reward & Recognition Scheme	**KCl-Knowledge Classification**
CoP-Communities of Practice	**KCA-Knowledge Capability Areas**
KMP-Knowledge Management Policy	**KO-Knowledge Organisation**
KMS-Knowledge Management Strategy	**KVl-Knowledge Value**
KMPr-Knowledge Management Process	**ES-Employee Satisfaction**
PI-Process Integration	**PD-Productivity**
NW-Network	**OR-Organizational Reputation**
D&IM-Data & Information Management	**L-Low; M-Medium; H-High**

Fig. 3.3 Maturity Levels and Key Maturity Indicators

3.3 FLEXIBILITY OF THE MODEL

Flexibility of KMI-KMM model is demonstrated by modifying the model and creating 2 modified KMI-KMM models viz KMIX-KMM model and KMIY-KMM model as discussed below:

KMIX-KMM model is a subset of KMI-KMM model. It has only in 3 Key Areas viz People, Technology and Knowledge. In 'People' Key Area it has only in 3 Key Parameters viz: Awareness, Participation and KM Roles. In 'Technology' Key Area it has only in 2 Key Parameters viz: Network and , Explicit Knowledge Management. In 'Knowledge' Key Area, it has only one Key Parameter viz Knowledge Classification. The Key Areas and Key Parameters of the KMIX-KMM model are listed in Table 3.6.

Table 3.6 Key Ares and Key Parameters of KMIX-KMM Model

Sl.No.	Key Areas	Key Parameters
1	People	Awareness
2		Participation
3		KM Roles
4	Technology	Network
5		Explicit Knowledge Management
6	Knowledge	Knowledge Classification

The Key Areas and maturity levels are pictorially represented in Figure 3.4. Since the Key Areas are only 3, the figure is a triangle. The Key Values for different maturity levels are assumed to be the same as that of KMI-KMM Model. However, that also can be modified, if required. The Key Values for different maturity levels KMIX-KMM model are given in Table 3.7

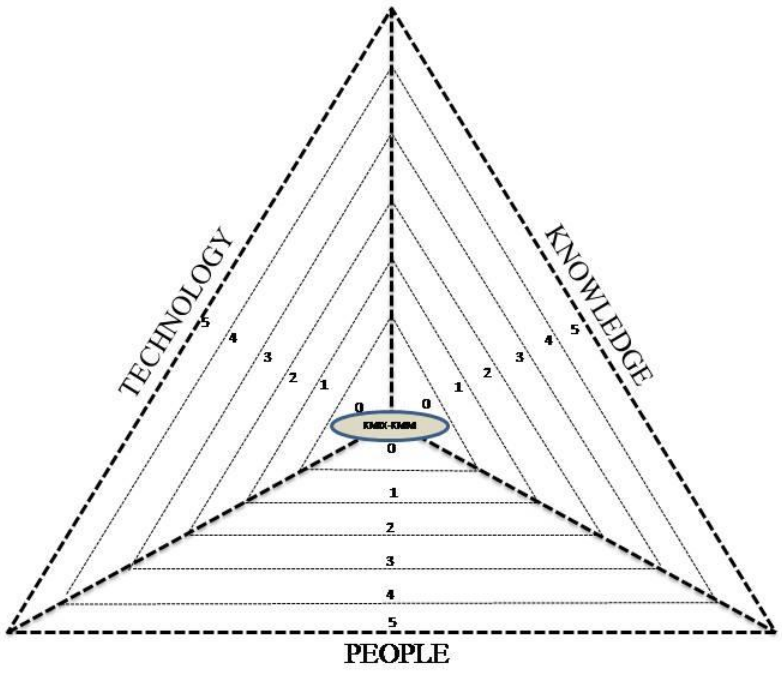


Figure 3.4 Key Areas and Maturity Levels of KMIX-KMM Model

KMIY-KMM model is a superset of the KMI-KMM model. It has the same Key Areas and Key Parameters as that of KMI-KMM-model. However, it has one additional Key Parameter in the Key Area 'RoI' viz. 'Innovation' which indicates improvement in innovation due to KM activities. The Key Parameters of KMIY-KMM model is listed in Table 3.8. The additional Key Parameter introduced is shown in bold characters.

Table 3.7 Maturity Levels and Key Maturity Indicators of KMIX-KMM Model

Maturity Level	**Key Parameters & Key Values (People)**	**Key Parameters & Key Values (Technology)**	**Key Parameters & Key Values (Knowledge)**
0 Default	Nil	Nil	Nil
1 Initial	▪ Awareness- Low ▪ Participation -Low ▪ KM roles –Low	▪ Network-Medium ▪ Explicit KM-Low	▪ Knowledge Classification-Low
2 Qualitative Development	▪ Awareness- Medium ▪ Participation -Medium ▪ KM roles -Medium	▪ Network-High ▪ Explicit KM-Medium	▪ Knowledge Classification-Medium
3 Quantitative Development	▪ Awareness->50 ▪ Participation ->50 ▪ KM roles ->50	▪ Network->50 ▪ Explicit KM->50	▪ Knowledge Classification->50
4 Maturity	▪ Awareness->90 ▪ Participation ->90 ▪ KM roles ->90	▪ Network->90 ▪ Explicit KM->90	▪ Knowledge Classification- >90
5 Extended-organisational maturity.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.

Table 3.8 Key Parameters of KMIY-KMM Model

Sl.No.	Key Areas	Key Parameters
1	People	Awareness
2		Participation
3		KM Roles
4		Mentoring & Succession Planning
5		Reward & Recognition Scheme
6		Communities of Practice
7	Technology	Network
8		Data & Information Management
9		Explicit Knowledge Management
10		Tacit Knowledge Management
11		KE Techniques
12		Technology Integration
13	Process	K M Policy
14		K M Strategy
15		K M Processes
16		Process Integration
17	Knowledge	Knowledge Classification
18		Knowledge Capability Area
19		Knowledge Organisation
20		Knowledge Value
21	RoI	Employee Satisfaction
22		Productivity
23		Organisational Reputation
24		**Innovation**

Maturity Levels and Key Maturity Indicators of KMIY-KMM model is shown in Table 3.9 and in Figure 3.5, assuming the Key Values of the additional Key Parameter introduced are similar to the other Key parameters. The additional Key Parameter and its Key Value are shown in bold characters.

Also, it is possible to simultaneously remove some Key Areas or Key Parameters and add some other Key Areas or Key Parameters. It is also possible to alter the Key Values. This demonstrates the flexibility of the model.

Table 3.9 Maturity Levels and Maturity Indicators of KMIY-KMM Model

Maturity Level	**Key Parameters & Key Values (People)**	**Key Parameters & Key Values (Process)**	**Key Parameters & Key Values (Technology)**	**Key Parameters & Key Values (Knowledge)**	**Key Parameters & Key Values (ROI)**
0 Default	Nil	Nil	Nil	Nil	Nil
1 Initial	▪ Awareness- Low ▪ Participation -Low ▪ KM roles –Low ▪ Mentoring and Succession Planning-Low ▪ Communities of Practice-Nil ▪ Reward and Recognition Scheme- Nil	▪ KM Policy-Low ▪ KM Strategy-Low ▪ KM Processes-Low ▪ Process Integration-Nil	▪ Network-Medium ▪ Data and IM-Medium ▪ Explicit KM-Low ▪ Tacit KM-Low ▪ KE techniques-Nil ▪ Technology Integration- Nil	▪ Knowledge Classification-Low ▪ Knowledge Capability Areas-Nil ▪ Knowledge Organisation-Nil ▪ Knowledge Value-Nil	▪ Employee Satisfaction-Nil ▪ Productivity-Nil ▪ Organisational Reputation- Nil ▪ **Innovation-Nil**
2 Qualitative Development	▪ Awareness- Medium ▪ Participation -Medium ▪ KM roles -Medium ▪ Mentoring and Succession Planning-Medium ▪ Communities of Practice-Low ▪ Reward and Recognition Scheme- Low	▪ KM Policy-Medium ▪ KM Strategy-Medium ▪ KM Processes-Medium ▪ Process Integration-Low	▪ Network-High ▪ Data and IM-High ▪ Explicit KM-Medium ▪ Tacit KM-Medium ▪ KE Techniques-Low ▪ Technology Integration-Low	▪ Knowledge Classification-Medium ▪ Knowledge Capability Areas-Medium ▪ Knowledge Organisation-Medium ▪ Knowledge Value-Medium	▪ Employee Satisfaction-Medium ▪ Productivity- Medium ▪ Organisational Reputation- Medium ▪ **Innovation-Medium**
3 Quantitative Development	▪ Awareness->50 ▪ Participation ->50 ▪ KM roles ->50 ▪ Mentoring and Succession Planning->50 ▪ Communities of Practice->50 ▪ Reward and Recognition Scheme- >50	▪ KM Policy->50 ▪ KM Strategy->50 ▪ KM Processes->50 ▪ Process Integration->50	▪ Network->50 ▪ Data and IM->50 ▪ Explicit KM->50 ▪ Tacit KM->50 ▪ KE techniques->50 ▪ Technology Integration->50	▪ Knowledge Classification->50 ▪ Knowledge Capability Areas->50 ▪ Knowledge Organisation->50 ▪ Knowledge Value->50	▪ Employee Satisfaction->50% ▪ Productivity->50% ▪ Organisational Reputation- ->50% ▪ **Innovation->50%**
4 Maturity	▪ Awareness->90 ▪ Participation ->90 ▪ KM roles ->90 ▪ Mentoring and Succession Planning->90 ▪ Communities of Practice->90 ▪ Reward and Recognition Scheme- >90	▪ KM Policy->90 ▪ KM Strategy->90 ▪ KM Processes->90 ▪ Process Integration->90	▪ Network->90 ▪ Data and IM->90 ▪ Explicit KM->90 ▪ Tacit KM->90 ▪ KE techniques->90 ▪ Technology Integration->90	▪ Knowledge Classification- >90 ▪ Knowledge Capability Areas- >90 ▪ Knowledge Organisation- >90 ▪ Knowledge Value->90	▪ Employee Satisfaction->90% ▪ Productivity- >90% ▪ Organisational Reputation- ->90% ▪ **Innovation->90%**
5 Extended-organisational maturity.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.	Same as level 4 with extended value chain of the organisation.

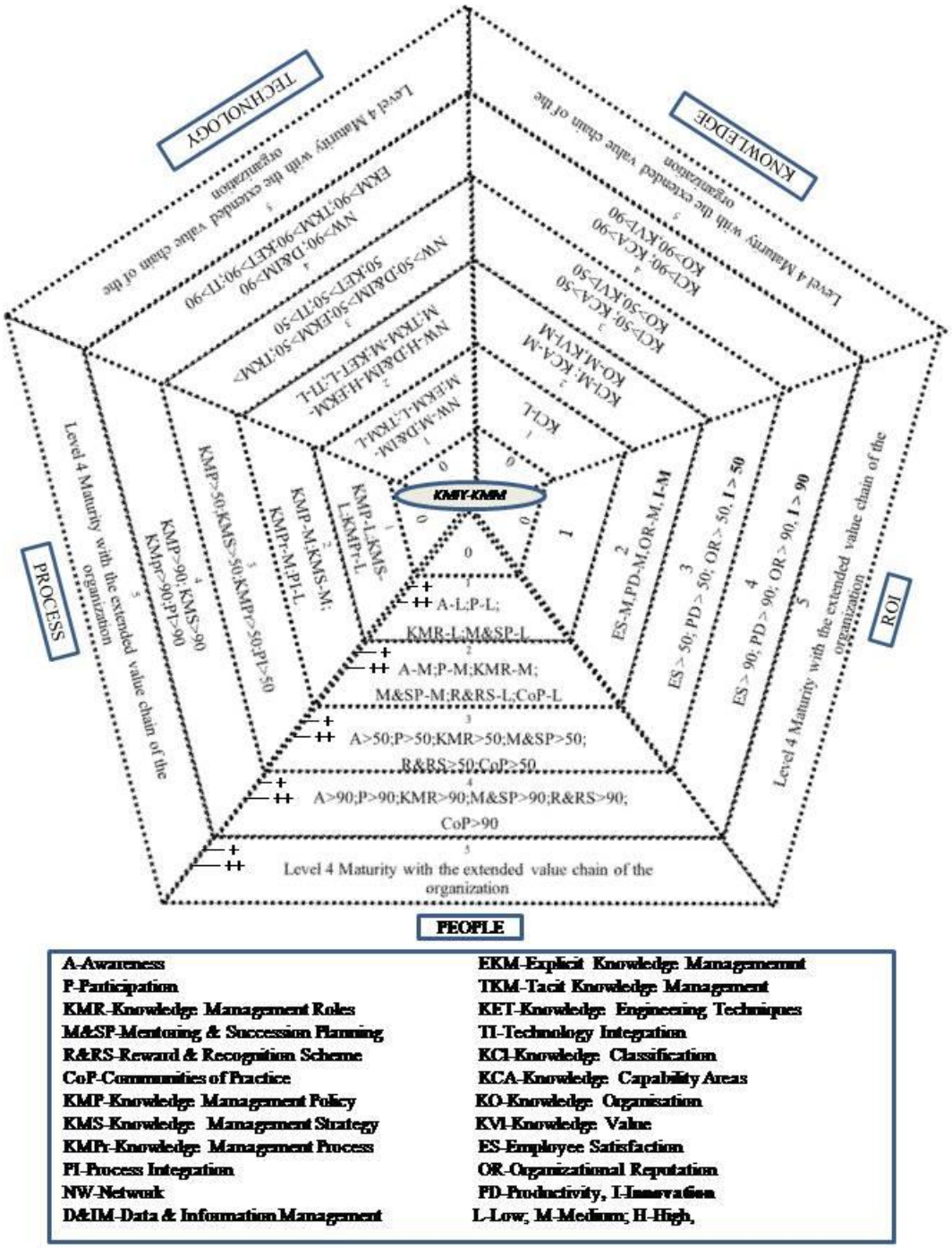


Figure 3.5 Maturity Levels and Maturity Indicators of KMIY-KMM Model

3.4 ASSESSMENT METHODOLOGY

The methodology describes the assessment of current level of maturity of the target organisation. An objective assessment methodology consisting of verification of records, in depth interview and focus group discussion is proposed. Any organisation that is to be assessed has to start with level 1. If an organisation is assessed to be in level 1, it can further be assessed for level 1+, 1++, 2 etc. The current maturity level of the organisation has to be arrived at in consultation with various stake holders of the organisation. The assessment methodology is demonstrated in Chapter 4.

3.5 UNIQUE FEATURES OF THE MODEL

The approach based on the unique concept of KMI makes the model more flexible and adaptable. Since KMI is a combination of KA, KP and KV, the flexibility in selecting the KMI indicates, the flexibility in selecting KA, KP and KV as well. This concept also makes the model amenable for continual improvement of the model itself, by introducing additional KMIs, removing the unwanted KMIs or modifying the KMIs to adapt to the changes in the organisational environments. The adaptability of the model is demonstrated in Chapter 4. This being the first model that has used the unique concept of KMI, the model is named as KMI-KMM (Key Maturity Indicator-Knowledge Management Maturity) model.

To the best of the knowledge of the researcher, this is the first model that used a balanced approach with adequate concentration on 5 Key Areas viz. People, Process, Technology, Knowledge and RoI. Most of the models use only 3 KM process, viz. knowledge creation, knowledge sharing and knowledge utilization. This model uses additional processes viz. knowledge identification, knowledge acquisition, knowledge preservation, knowledge quality and KM RoI measurement. Knowledge preservation is very important in the context of nuclear organisation. Also this model uses succession planning as a Key Parameter which is very

important for nuclear organisation. Essentially, RoI is an outcome of KM maturity. This is the first model which has used RoI as a Key Area and argues that without achieving the targeted RoI, the maturity is incomplete.

This model considers application of Knowledge Engineering techniques as mandatory for higher levels of KM maturity. Though maximum number of models (60%) in literature have used 5 levels of maturity, this model has used 6 levels of maturity. In this model also the highest level of maturity for the organisation is achieved in 5 levels. The 6^{th} level of maturity is proposed for the extended organisation. The final maturity level (6^{th} level) considers the target organisation along with other partnering organisations like suppliers, customers and collaborators as a single entity. By considering the 6^{th} level for extended organisation, the model extends the traditional boundary of the organisation, and a step forward in the direction of 'National' and 'Global' knowledge management.

The proposed KMI-KMM model has the strengths of the models as detailed in Table 3.10. In comparison the developed model KMI-KMM model is more robust with distinct Key Maturity Indicators and clear objective evaluation criteria.

Table 3.10 Features of the KMI-KMM Model as Strengths of Other Models

Sl.No	Features of KMI-KMM Model	Strengths of other models
1	Parameters of maturity level	KMM(Kochikar)
2	KM strategy	KMM(Hubert), KM3(Gallaghar), Strategic KMM(Kruger)
3	KM policy	Strategic KMM(Kruger)
4	KM RoI	KMM(Hubert)
5	Four key areas(People, Process, Technology and Knowledge)	Knowledge journey(KPMG)
6	Knowledge classification(core, advanced and innovative)	KMM(Klimko), KMM(Gottschalk)
7	Documented and measurable KM process	KMM(Klimko), KMM(Ehms)
8	Extended organisational maturity	KMM(Klimko),StrategicKMM(Kruger)
9	Process integration	KPQ(Paulzen),G-KMM(Pee), 5iKM3(Mohanty),KMM(Ehms)
10	Concentration on technology including AI and KE	KMM(Gottschalk)
11	Objective assessment methodology	KMM(Kochikar),5iKM3(Mohanty), KMM(Ehms), KM3(Gallaghar)
12	Validation	KMCA(Kulkarni), KMM(Natarajan), G-KMM(Pee)

3.6 VALIDATION METHODOLOGY

The KMM model needs to be validated by one or more methods. As a first step, the proposed KMI-KMM model is validated by 'expert opinion'. This validation process is detailed in Section 3.7. As a second step, the model is demonstrated and validated based on the study of a government controlled nuclear R&D organisation with 10 major departments and more than 2000 employees, through case study approach as detailed in Chapter 4.

3.7 FEEDBACK AND EXPERT OPINION

The model development had gone through many iterations and review. At each stage of the development process, the model was presented to experts within and outside the organisation. The feedbacks given were incorporated. The feedbacks were in the form of characteristics at different stages, parameters and values at different maturity levels, the representation of the model in the form of pentagon, name of the model etc.

In order to validate the KMI-KMM model, expert opinions on the model were obtained. The experts were selected based on their experience, position, publications, academic qualifications etc. Expert opinions were obtained from the following academic institutes/ industry through an assessment Questionnaire:

1) T.A. Pai Management Institute, Manipal
2) Indian Institute of Management, Kozhikode
3) Anna University, Chennai
4) Cognizant Technology Solutions, Chennai

The expert opinions received are given in Appendix A and tabulated in Table 3.11.

Table 3.11 Comparison of Expert Opinions on KMI-KMM Model

Sl.No	Parameters	Expert 1	Expert 2	Expert 3	Expert 4
1	The proposed model conforms with the theory and practices in the KM literature	Agree	Agree	Agree	Agree
2	The proposed Key Areas, Key Parameters and Key Maturity Indicators are relevant	Relevant	Relevant	Relevant	Relevant
3	The Key Area, Return of Investment (RoI) proposed in the model is useful and good	Agree	Agree	Agree	Agree
4	The proposal of a maturity level for extended organisation is acceptable	Acceptable	Acceptable	Acceptable	Acceptable
5	The approach followed in the model development process is very arbitrary	Non-Arbitrary	Non-Arbitrary	Non-Arbitrary	Not-Arbitrary
6	The proposed model is flexible concerning addition / removal of key parameters	Agree	Agree	Agree	Agree
7	The proposed model can be adopted to other organisations as well	Agree	Agree	Agree	Agree
8	Comments	I think this work is very unique in its outcomes and is a fruit of systematic effort. The researcher has combined multiple inputs from different sources to develop a model that captures different parameters very well. Highly commended and recommended for a doctorate degree.		Number of key parameters varies for each key area. Quantitative assessment is also carried out.	A thorough analysis has been done by the researcher. The indicators are very appropriate to the context chosen. The researcher has done sufficient research benchmarking. Can be adopted with some context specific changes.

The experts feel that the KMI-KMM model conforms to the theory and practice in KM literature; the proposed Key Areas, Key Parameters & Key Maturity indicators are relevant; the Key Area Return on Investment (RoI) proposed in the model is useful & good; the proposal of a maturity level for extended organisation is acceptable; the approach followed in the model development process is non-arbitrary; the proposed model is flexible and adaptable.

3.8 SUMMARY

In this chapter a knowledge management maturity model called KMI-KMM is developed. The model is flexible with its unique KMI concept and can be adapted to any organisational environment. The model uses a balanced approach with adequate concentration on various key areas, viz, People, Process, Technology, Knowledge and RoI. The model has been validated by experts from three academic institutes and one expert from industry.

CHAPTER 4

DEMONSTRATION OF THE KMI-KMM MODEL IN THE CONTEXT OF A NUCLEAR R&D ORGANISATION

This Chapter describes the work carried out to evaluate the knowledge management maturity of an organisation and its subunits based on the KMI-KMM model described in Chapter 3 through an embedded case study. The study also validates the KMI-KMM model.

4.1 ORGANISATIONAL CONTEXT

The KMI-KMM model has been proposed in the context of a nuclear R&D organisation, which is controlled and financed by Government. The complexity of managing knowledge in such an organisation involves the twin complexity of nuclear knowledge management and R&D knowledge management as highlighted in Section 1.7. The organisation had initiated formal KM practices a few years back. It had developed and documented a formal KM policy for the organisation. It had implemented an interconnected technology infrastructure for knowledge preservation and sharing, with freedom for individual subunits to organize its own knowledge repository, which is the knowledge management portal of the organisation. The subunits are called 'groups' in the organisation and the same name will be used in subsequent discussions. The organisation had also created part time KM roles like Chief Knowledge Officer and Group Knowledge Officers, with a task force constituted by the Director, who is the Chief Executive Officer of the organisation. In the next section the activities of the organisation and its groups are briefly discussed.

4.1.1 Groups and Activities

The main organisational activities are R&D with respect to Nuclear Reactors. The organisation has 11 major technical groups and two non technical groups. Only 10 technical groups are considered for the study. Though the organisation is predominantly R&D oriented, it has groups which are carrying out technical services, operation and maintenance and project execution. Brief description of the activities of the groups are listed in Table 4.1 (IGCAR, 2011).

Table 4.1 Groups and Activities

Group	**Activities**
G1	Carrying out R&D and analytic support with respect to all the Chemistry aspects of the organisation.
G2	Developing Electronics and Instrumentation Systems, providing Computational and Data Communication services to the organisation.
G3	Providing Engineering Services to the organisation.
G4	Design and Project Execution.
G5	Development and testing of models and prototype components.
G6	Carrying out basic research and applied research.
G7	Carrying out basic research.
G8	Carrying out Design and R&D.
G9	Plant Operation and Maintenance.
G10	Technology Development, R&D activities and Project execution.

The following are the broad characteristics of the organisation and its groups (*www.igcar.gov*):

- The organisation has established comprehensive R&D facilities covering the entire spectrum of Fast Breeder Reactor Technology related to Sodium Technology, Reactor Engineering, Reactor Physics, Metallurgy and Materials, Chemistry of Fuels and its materials, Fuel Reprocessing, Reactor Safety, Control and Instrumentation, Computer

Application etc. and has developed a strong base in a variety of disciplines related to this advanced technology. Apart from thrust areas related to nuclear technology, the organisation has credentials as a leader of basic research in various frontier and topical areas.

- The organisation has staff strength of 2816 including 1274 Engineers and Scientists. The annual outlay of the organisation is 670 million rupees towards R&D activities and plan schemes.
- The organisation extends its expertise and facilities to other R&D Sectors and industries. It also has collaborations with other R&D organisation and educational institutions. It also has identified the knowledge gap areas, where expertise needs to be developed.
- The organisation in its journey of excellence has achieved several scientific and technological milestones, with international benchmarks and high impact on its mission program. Enhancing Quality and Commitment of Human Resources is the key to the strategy of achieving and sustaining excellence. The organisation facilitates innovations in management of Science and Technology for enhancing the focus, creativity and productivity (IGCAR, 2007).

Group G1: This group is responsible for carrying out R&D, to provide input to all the chemistry aspect of reactor and associated fuel cycles. The group also provides analytical support to various activities of the organisation. It also develops instrumentation and facilities in support of R&D activities.The knowledge management portal shows the list of publications and selected publications. Quarterly progress reports and electronic articles are made available. Future planed activities are also documented. Profile and contact details of people are also made available

Group G2: This group is responsible for the development of electronics and instrumentation system for the fast reactor and associated fuel cycles. The group uses various design tools and case tools to carry out its work. It also develops training simulators and various application software. The group provides computational and data communication services to various units of the organisation. It is also responsible for knowledge management activities of the organisation. The knowledge management portal shows the publications, design reports, progress reports and presentations. Knowledge documents are classified based on a taxonomy. A secured server with restricted access is also made available. Profile and contact details of people are also made available

Group G3*:* This group is responsible for providing various engineering services pertaining to Civil Engineering, Electrical Engineering and Mechanical Engineering and Telecommunication services to the organisation.The group had a knowledge management portal showing activities, publications, presentations etc. However currently the server is not active due to technical problem

Group G4: This group is responsible for the design, construction and commissioning of facilities to close the fuel cycle of Fast Breeder Reactor.The knowledge management portal shows the activities in general.

Group G5: This group is responsible for development and testing of scaled model and proto type components. The group has sodium and water test facilities, steam generator test facility and boron enrichment plant.The knowledge management portal shows the publications, design reports, progress reports and presentations. A secured database server with restricted access is also made available, which contains various events and internal reports. Advanced and innovative

knowledge in the form of mega challenges and identified gap areas are documented. Profile and contact details of people are also made available

Group G6: This group is responsible for carrying out research on both basic and applied aspects of materials. The activities include development of special materials and welding consumables, optimization of thermo mechanical treatments and other fabrication processes, characterization of micro structuring and mechanical properties and their inter relationships, modeling of micro structural stability and phase evolution corrosion and bio-foulding studies, development and application of specialized non destructive evaluation techniques, advanced mechanical property measurement like impression creep testing , irradiation experiments, development of technologies for robotic and remote handling.The group had a knowledge management portal showing activities, publications, presentations etc. However currently the server is not active due to technical problem

Group G7: This group is responsible for conducting basic research on topical problems in material science including super conductivity and nano materials.The knowledge management portal shows the publications and presentations. In addition discussion forum and wiki is also implemented. Profile and contact details of people are also made available.

Group G8: This group is responsible for the design and development of Reactor assembly components and executes R&D in the domain of structural mechanics, thermal hydraulics and safety engineering.The group had a knowledge management portal showing activities, publications, presentations etc. However currently the server is not active due to technical problem

Group G9: The group is responsible for the operation and maintenance of Fast Breeder Test Reactor. The group also provides training to the operation and maintenance staff of the reactor.The knowledge management portal shows the publications, progress reports, milestones and frequently asked questions. The group also has a secured server with restricted access for internal use.

Group G10: This group is responsible for the development of fast reactor fuel reprocessing technology as well as design, construction and operation of the reprocessing plants. The group also carries out various R&D activities. The knowledge management portal shows the publications, presentations and collaborative projects.

The above discussion highlights the activities of the organisation in general and KM related activities in particular. It can be observed that the activities of different groups are highly diversified in nature. Hence the study of the organisation and its 10 groups reflects a representative study of multiple organisations. KM practices of one of the groups will be discussed in detail in Chapter 6.

4.2 ORGANISATIONAL STUDY

In order to assess KM maturity of various groups, the proposed KMI-KMM model was used. A case study approach was found to be appropriate and employed for the maturity assessment, since many of the questions were pertaining to ‘how’ and ‘why’ and an in-depth description of the phenomenon was required.

4.2.1 Research Methodology

The main research questions are:

- Why the organisation had initiated the formal KM practices?
- How can the KM maturity level of the organisation be identified?

In order to answer the above questions, it is necessary to have a structured methodology to implement the KM practices and to measure the progress of the KM implementation for the organisation under consideration. A KM maturity model is an accepted methodology for systematic implementation of KM practices. Hence, the proposed KMI-KMM model is used as the basis, to find the probable answers to the main research questions and to evaluate the current maturity of the organisation and its major groups.The main focus of the study is identification of the current KM maturity level of the organisation and its groups. The unit of analysis is the KM practices of the organisation and subunits of analysis are the KM practices of the groups of the organisation.

4.2.2 Pilot Study

Pilot study was conducted using semi-structured interview with selected representatives of the organisation. The guiding questionnaire used for this interview is given in the Appendix B. The pilot study revealed that the KM awareness needs significant improvement. Also it revealed some of the prevailing inhibiting factors for attaining higher levels of KM maturity.

4.2.3 Detailed Study

Since there are sub-units of analysis, an embedded case study is found to be appropriate. Based on the experience gained through pilot study, the following strategy was adopted to conduct the study.

- Conduct an awareness seminar in each group
- Conduct a focus group discussion with the participants on their current practices and expectations.
- Verify various records

4.2.3.1 Maturity Level Assessment

The participants for the awareness seminar and focus group discussion were selected randomly from each group. The guiding questionnaire used for the focus group discussion is given in Appendix C. The seminar and the focus group discussion were audio recorded. The records verified include the web site of the organisation, annual report of the organisation, the knowledge management portal of the organisation, and various Data and Information Management Systems of the organisation.

Based on the study, the current maturity levels of individual groups were arrived at by the researcher. The Key Maturity Indicators for each group that are arrived at and their respective maturity levels are depicted in the Table 4.2 and 4.3 respectively. Because of the practical difficulties in arriving at Key Values for 'Productivity' and 'Organisational Reputation' only 'Employee Satisfaction' was considered as the Key Parameter for RoI in the study. Also 'Knowledge Value' is not evaluated.

In Table 4.2 the columns Key Areas and Key Parameters are the same described in Section 3.2.2 and Table 3.2 in Chapter 3. The column KV G1 refers to the Key Value of group G1 for respective Key Area and Key Parameter. In Table 4.3 ML(People) represents maturity level of People Key Area for the respective group. Similarly, maturity level of other Key Areas like Process, Technology etc. are represented by ML(Process), ML(Technology) respectively.

Table 4.2 Key Maturity Indicators for Groups

Sl.No.	Key Areas	Key Parameters	KV G1	KV G2	KV G3	KV G4	KV G5	KV G6	KV G7	KV G8	KV G9	KV G10
1	People	Awareness	L	M	L	L	M	L	M	M	M	L
2		Participation	L	M	L	L	M	L	M	M	M	L
3		KM Roles	L	M	L	L	M	L	M	M	M	L
4		Mentoring & Succession Planning	L	L	L	L	L	L	L	L	L	L
5		Reward & Recognition Scheme	L	L	L	L	L	L	L	L	L	L
6		Communities of Practice	L	L	L	L	L	L	L	L	L	L
7	Technology	Network	H	H	H	H	H	H	H	H	H	H
8		Data & Information Management	M	M	M	M	M	M	M	M	M	M
9		Explicit Knowledge Management	L	M	L	L	M	L	M	L	M	L
10		Tacit Knowledge Management	L	L	L	L	L	L	M	L	L	L
11		KE Techniques	N	L	N	N	N	N	N	N	N	N
12		Technology Integration	N	N	N	N	N	N	N	N	N	N
13	Process	K M Policy	L	L	L	L	L	L	L	L	L	L
14		K M Strategy	L	L	L	L	L	L	L	L	L	L
15		K M Processes	L	L	L	L	L	L	L	L	L	L
16		Process Integration	N	N	N	N	N	N	N	N	N	N
17	Knowledge	Knowledge Classification	L	L	L	L	M	L	M	L	L	L
18		Knowledge Capability Area	L	L	L	L	L	L	M	L	L	L
19		Knowledge Organisation	N	N	N	N	N	N	N	N	N	N
20	RoI	Employee Satisfaction	L	L	L	L	L	L	L	L	L	L

N - Nil ; L - Low; M - Medium; H - High

Table 4.3 Maturity Levels of Groups and Organisation

Sl.No.	Group	ML (People)	ML (Process)	ML (Technology)	ML (Knowledge)	ML (RoI)
1.	G1	1+	1	1+	1	1
2.	G2	1++	1	1++	1	1
3.	G3	1+	1	1+	1	1
4.	G4	1+	1	1+	1	1
5.	G5	1++	1	1+	1+	1
6.	G6	1+	1	1+	1	1
7.	G7	1++	1	1++	1++	1
8.	G8	1++	1	1+	1	1
9.	G9	1++	1	1+	1	1
10.	G10	1+	1	1+	1	1
11.	Organisation	1+	1	1+	1	1

ML-Maturity Level

4.3 ANALYSIS

The analysis was carried out based on various groups of the organisation to identify the maturity levels of individual groups and that of the organisation as a whole.

4.3.1 Groups

The knowledge management maturity of various groups is discussed in the following sections.

Group G1: The group has achieved a maturity of Level1+, in 'People' Key Area, since it has achieved 'Low' performance in 'Communities of Practice' and 'Reward and Recognition Scheme', which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1+, in 'Technology' Key Area, since it has achieved 'High' in 'Network'. It is in Level 1 maturity in 'Knowledge' Key Area. The group has achieved an overall KM maturity of Level 1 as shown in Figure 4.1. The solid line in red colour represents the maturity in the respective Key Areas.

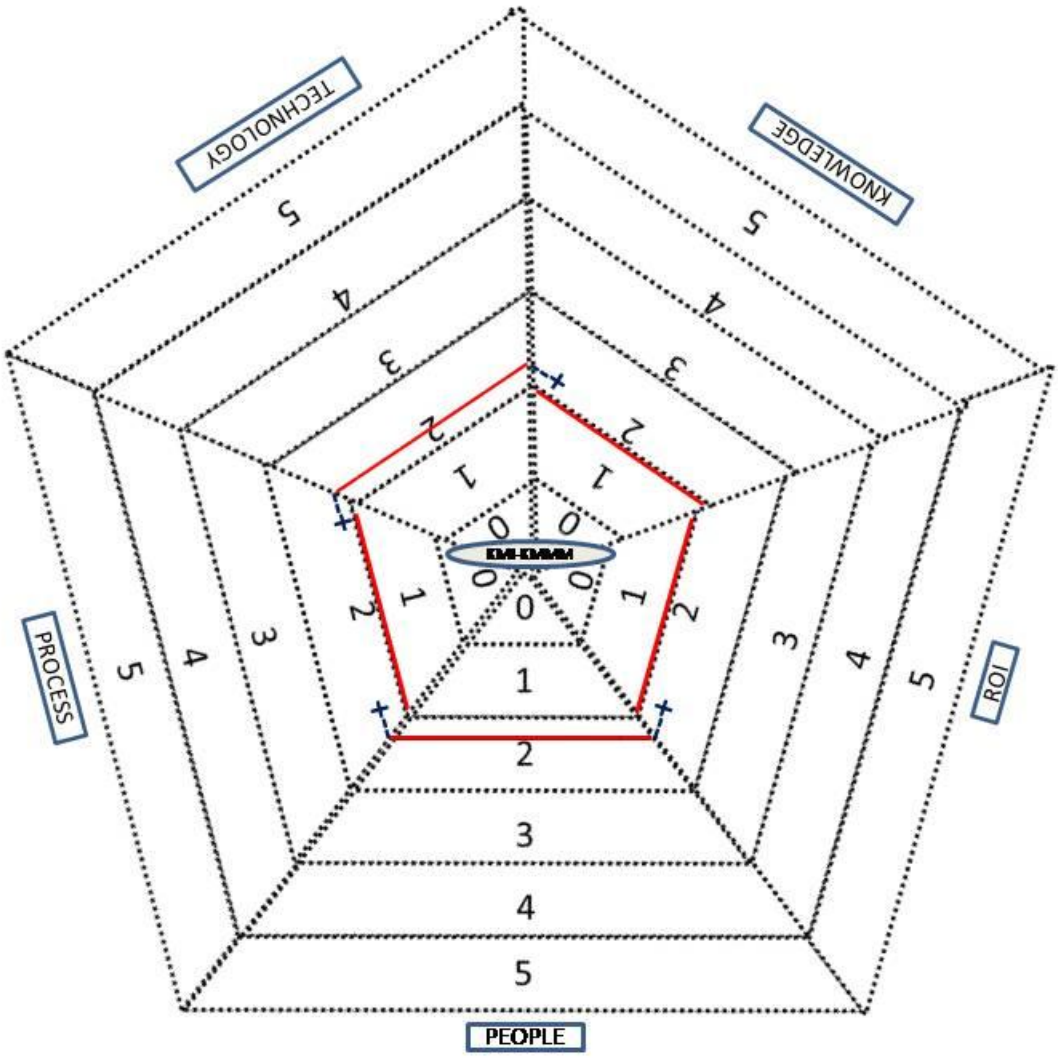


Figure 4.1 KM Maturity of Group G1

Group G2: The group has achieved a maturity of Level1++, in 'People' Key Area, since it has achieved a 'Medium' performance in 'Awareness', 'Participation' & 'KM roles' and 'Low' performance in 'Communities of Practice' and 'Reward and Recognition Scheme' , which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1++, in 'Technology' Key Area, since it has achieved 'High' in ' Network', 'Medium' in 'Explicit KM' and 'Low' in 'KE Techniques'. It is in Level 1 maturity in 'Knowledge' Key Area. The group has achieved an overall KM maturity of Level 1, as shown in Figure 4.2

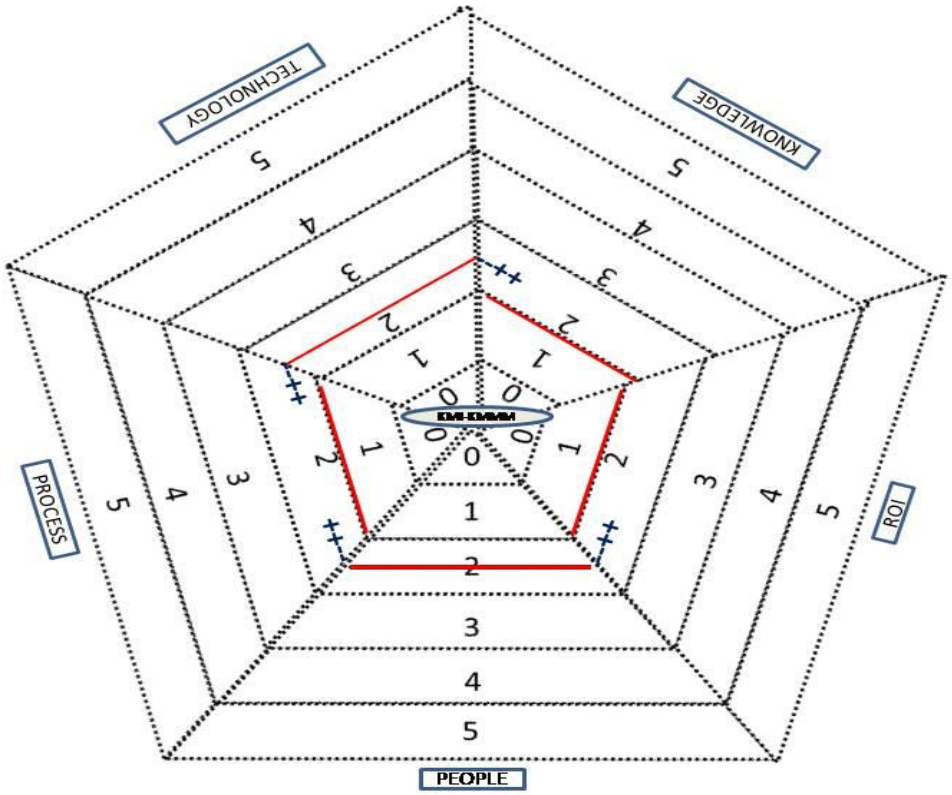


Figure.4.2 KM Maturity of Group G2

Group G3: The group has achieved a maturity of Level1+, in 'People' Key Area, since it has achieved a 'Low' performance in 'Communities of Practice', and 'Reward and Recognition Scheme' which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1+, in 'Technology' Key Area, since it has achieved 'High' in 'Network'. It is in Level 1 maturity in 'Knowledge' Key Area. The group has achieved an overall KM maturity of Level 1, as shown in Figure 4.3

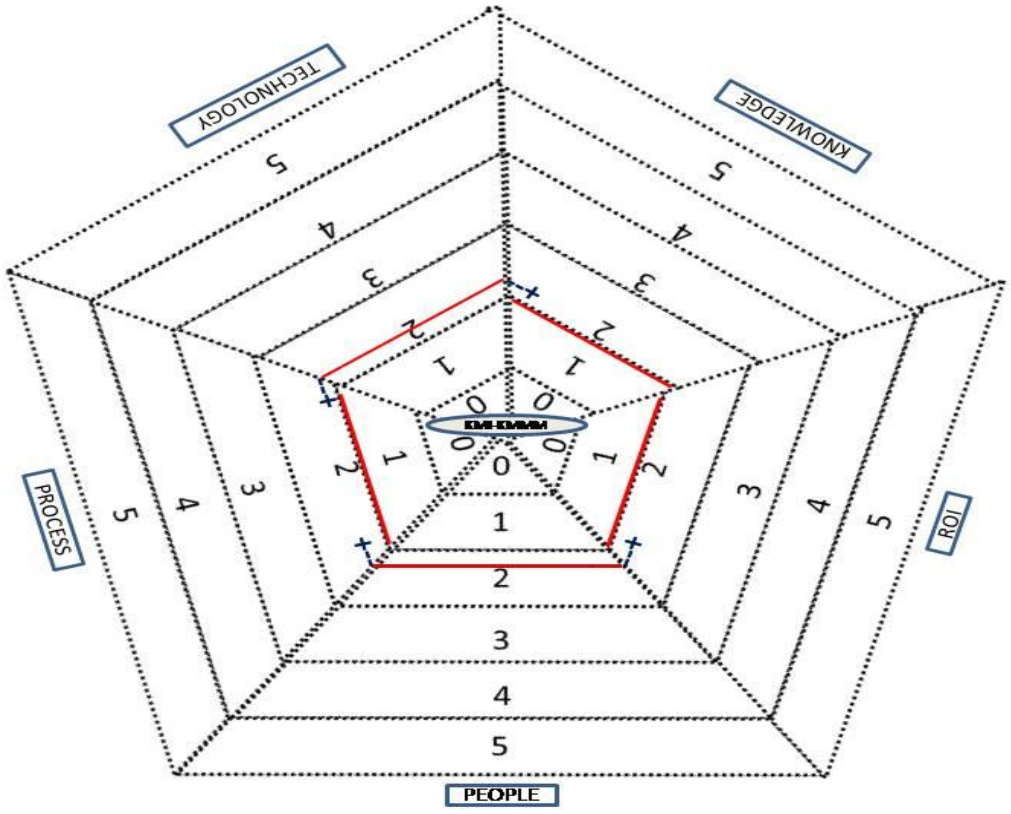


Figure.4.3 KM Maturity of Group G3

The ***Group G4:*** The group has achieved a maturity of Level1+, in 'People' Key Area, since it has achieved a 'Low' performance in 'Reward & Recognition Scheme' and 'Communities of Practice', which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1+, in 'Technology' Key Area, since it has achieved 'High' in 'Network'. It is in Level 1 maturity in 'Knowledge' Key Area. The group has achieved an overall KM maturity of Level 1, as shown in Figure 4.4

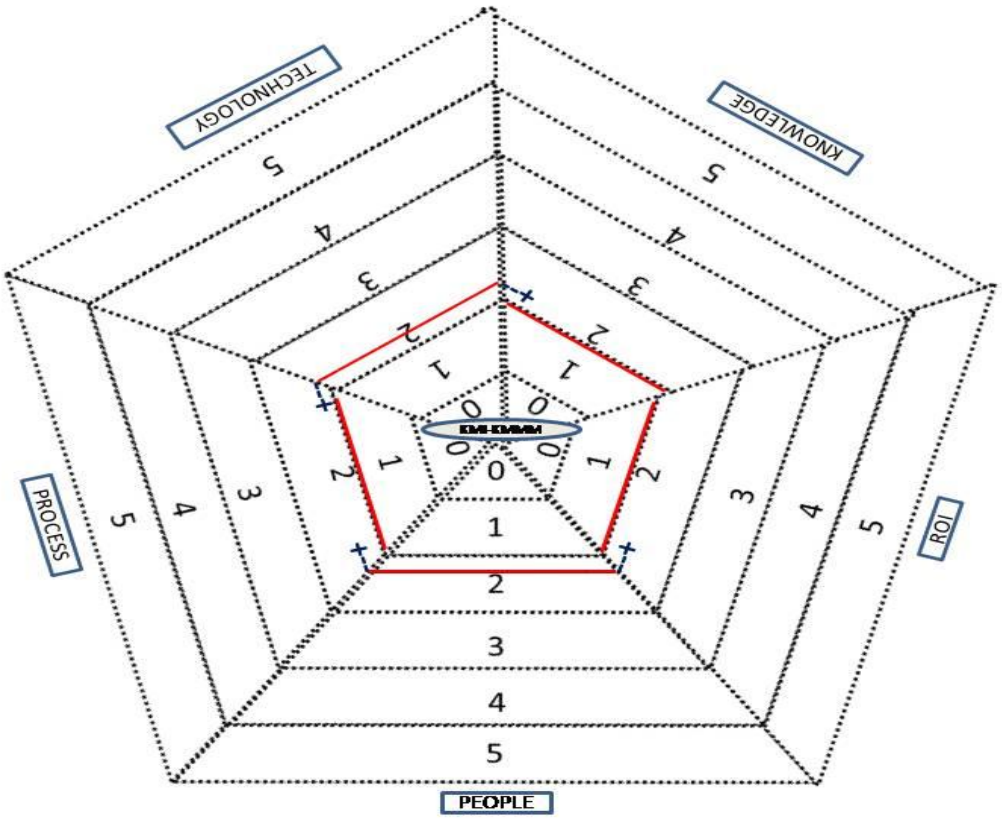


Figure 4.4 KM Maturity of Group G4

Group G5: The group has achieved a maturity of Level1++, in 'People' Key Area, since it has achieved a 'Medium' performance in 'Awareness', 'Participation' & 'KM roles' and 'Low' performance in 'Communities of Practice' and 'Reward & Recognition Scheme', which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1+, in 'Technology' Key Area, since it has achieved 'High' in 'Network' and 'Medium' in 'Explicit KM'. It is in Level 1+ maturity in 'Knowledge' Key Area, since it has achieved, 'Medium' performance in 'Knowledge Classification'. The group has achieved an overall KM maturity of Level 1, as shown in Figure 4.5.

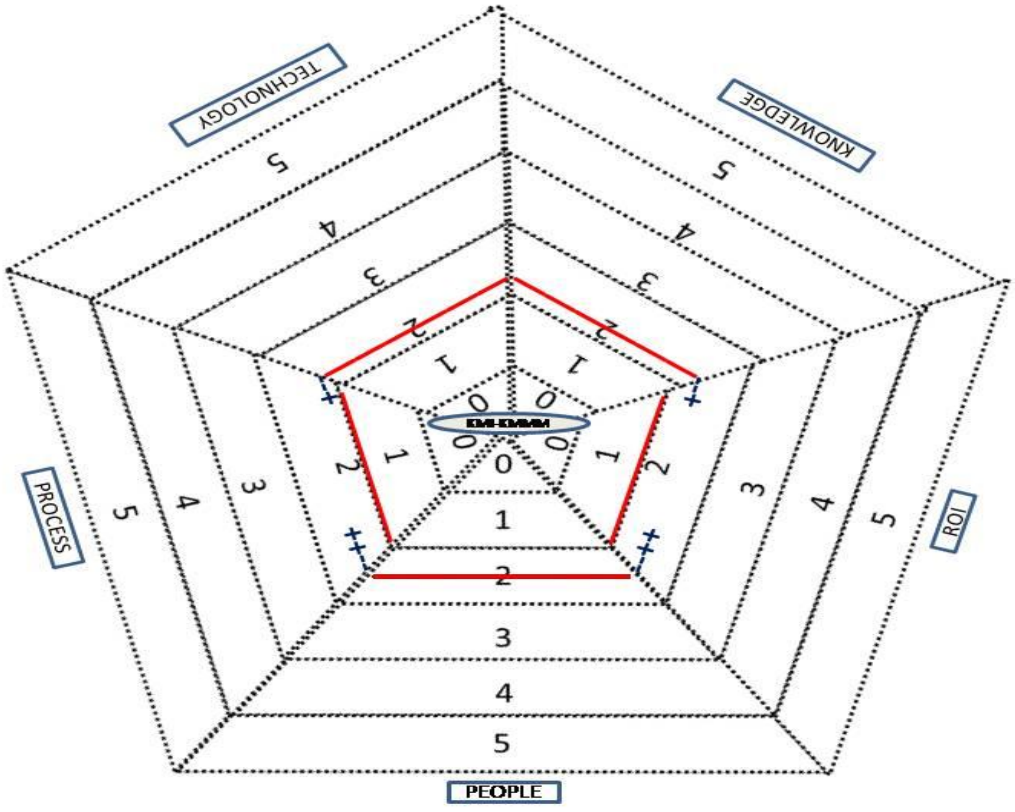


Figure 4.5 KM Maturity of Group G5

Group G6: The group has achieved a maturity of Level1+ in 'People' Key Area, since it has achieved a 'Low' performance in 'Reward& Recognition scheme' and 'Communities of Practice' which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1+ in 'Technology' Key Area, since it has achieved 'High' in 'Network'. It is in Level 1 maturity in 'Knowledge' Key Area. The group has achieved an overall KM maturity of Level 1. The KM maturity of the Group G6 pictorially represented in Figure 4.6

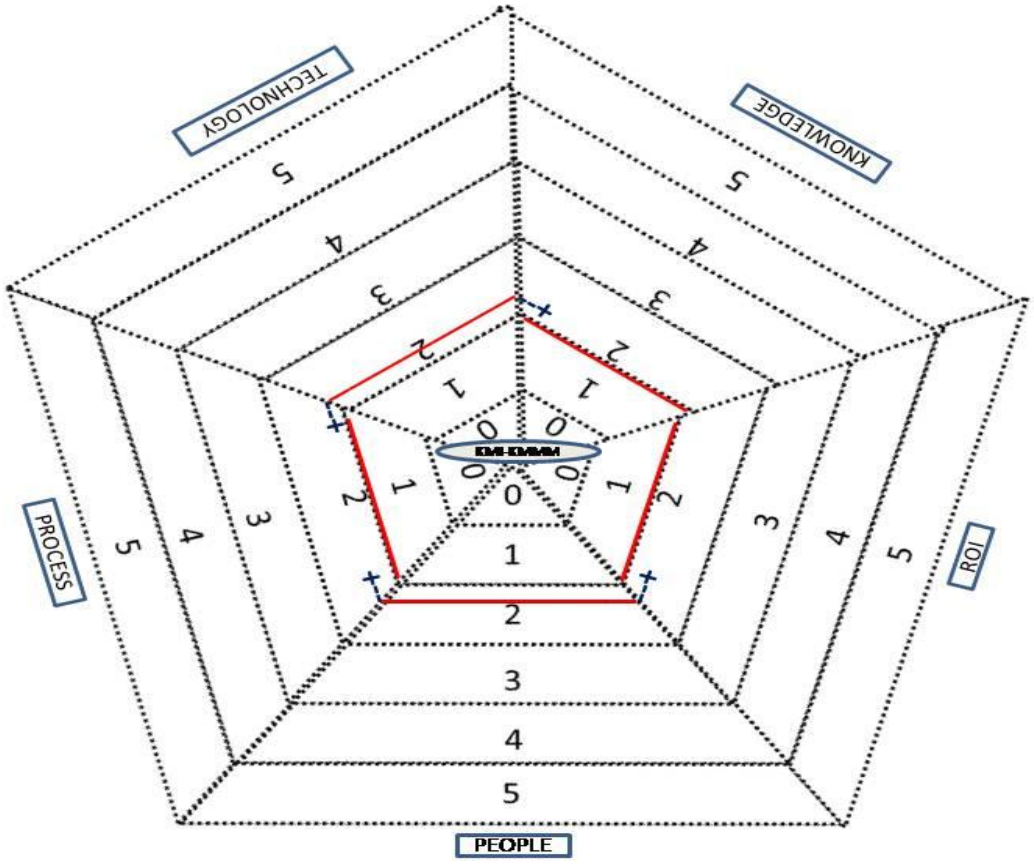


Figure 4.6 KM Maturity of Group G6

Group G7: : The group has achieved a maturity of Level1++, in 'People' Key Area, since it has achieved a 'Medium' performance in 'Awareness', 'Participation' & 'KM roles' and 'Low' performance in 'Reward& Recognition scheme' and 'Communities of Practice', which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1++, in 'Technology' Key Area, since it has achieved 'High' in 'Network', 'Medium' in 'Explicit KM', and 'Tacit KM'. It is in Level 1++ maturity in 'Knowledge' Key Area, since it has achieved, 'Medium' performance in 'Knowledge Classification' and 'Knowledge Capability Area'. The group has achieved an overall KM maturity of Level 1, as shown in Figure 4.7.

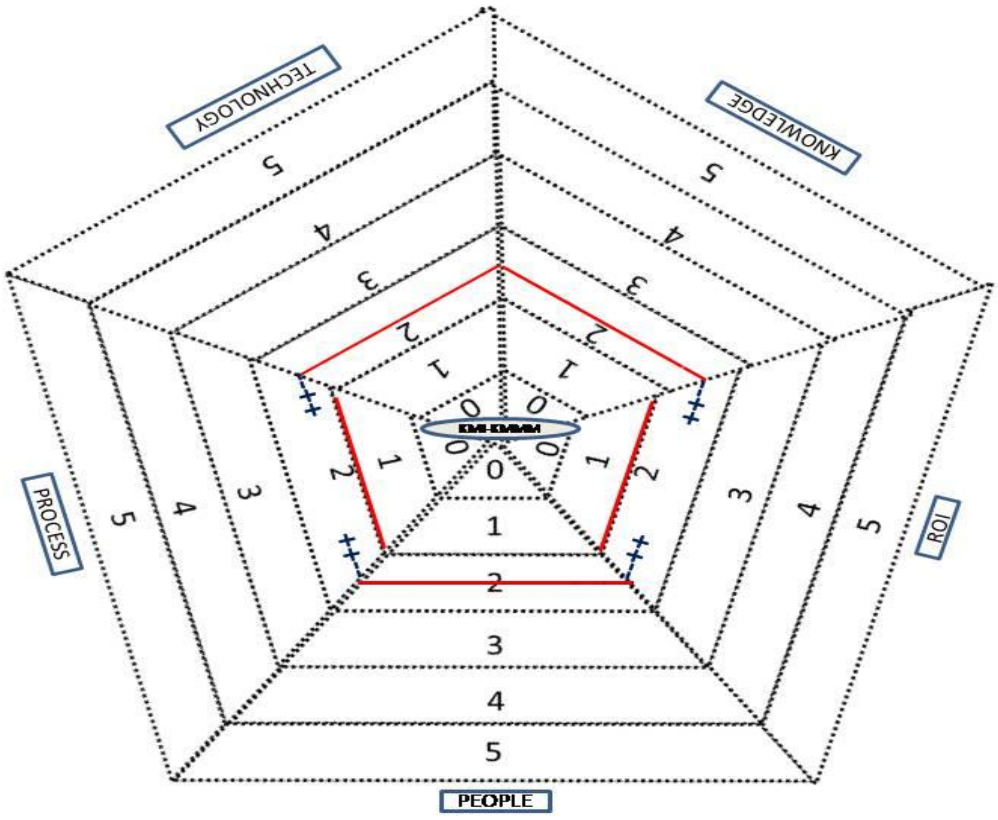


Figure 4.7 KM Maturity of Group G7

Group G8: The group has achieved a maturity of Level1++, in 'People' Key Area, since it has achieved a 'Medium' performance in 'Awareness', 'Participation' & 'KM roles' and 'Low' performance in 'Reward& Recognition scheme' and 'Communities of Practice', which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1+, in 'Technology' Key Area, since it has achieved 'High' in 'Network'. It is in Level 1 maturity in 'Knowledge' Key Area. The group has achieved an overall KM maturity of Level 1, as shown in Figure 4.8.

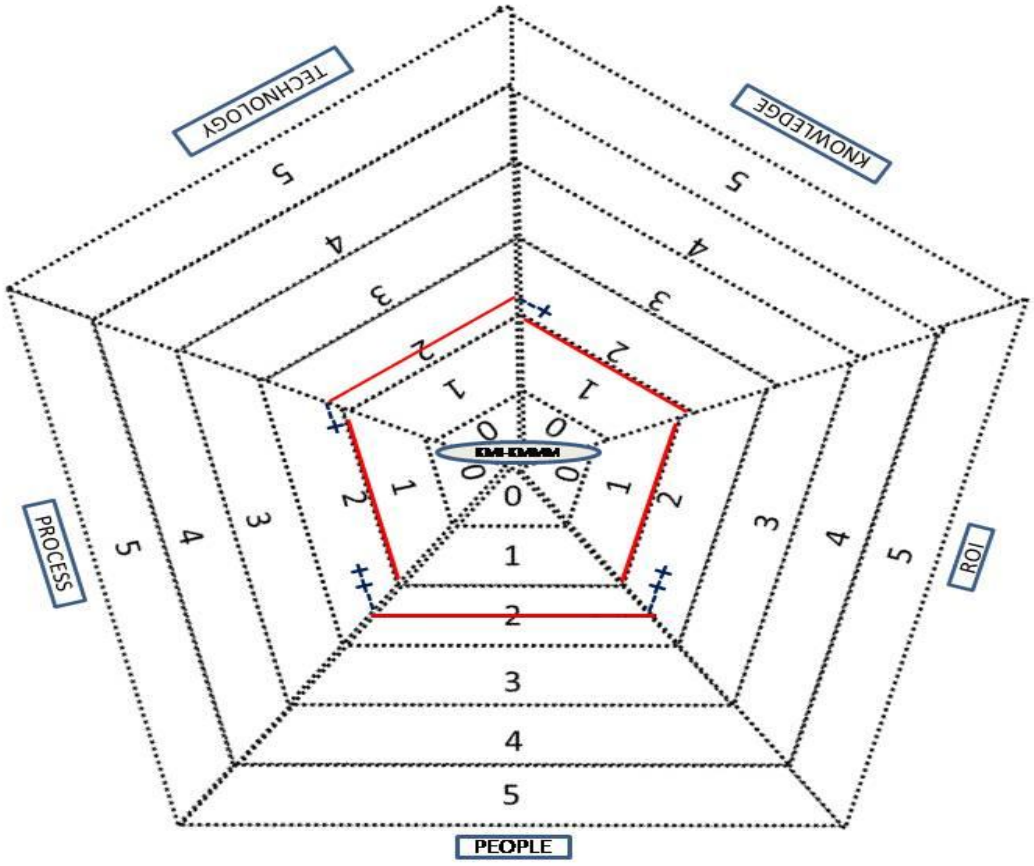


Figure 4.8 KM Maturity of Group G8

Group G9: The group has achieved a maturity of Level1++, in 'People' Key Area, since it has achieved a 'Medium' performance in 'Awareness', 'Participation' and 'KM roles' and 'Low' performance in 'Reward & Recognition Scheme' and 'Communities of Practice', which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1+, in 'Technology' Key Area, since it has achieved 'High' in 'Network', 'Medium' in 'Explicit KM'. It is in Level 1 maturity in 'Knowledge' Key Area. The group has achieved an overall KM maturity of Level 1, as shown in Figure 4.9.

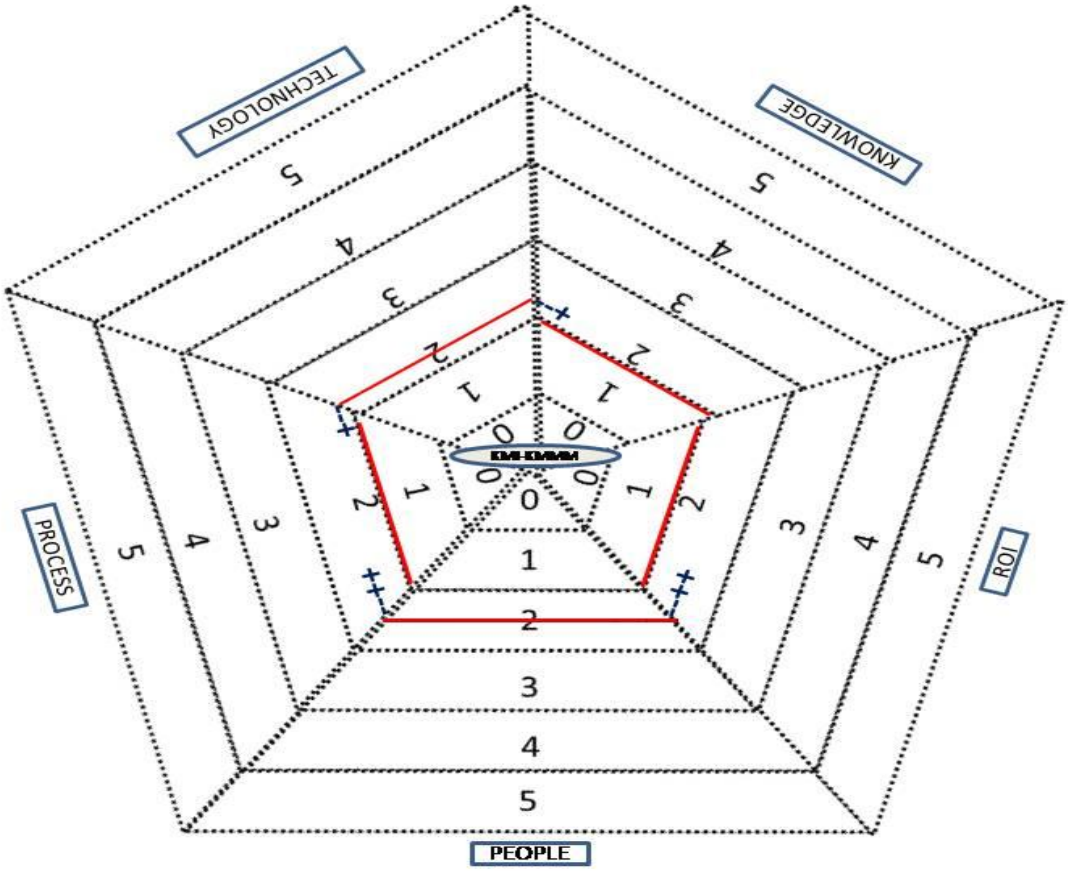


Figure 4.9 KM Maturity of Group G9

Group G10: The group has achieved a maturity of Level1+, in 'People' Key Area, since it has achieved a 'Low' performance in 'Reward & Recognition Scheme' and 'Communities of Practice', which pertains to level 2 performance. It is in Level 1 maturity in 'Process' Key Area. The group is in Level 1+, in 'Technology' Key Area, since it has achieved 'High' in 'Network'. It is in Level 1 maturity in 'Knowledge' Key Area. The group has achieved an overall KM maturity of Level 1, as shown in Figure 4.10

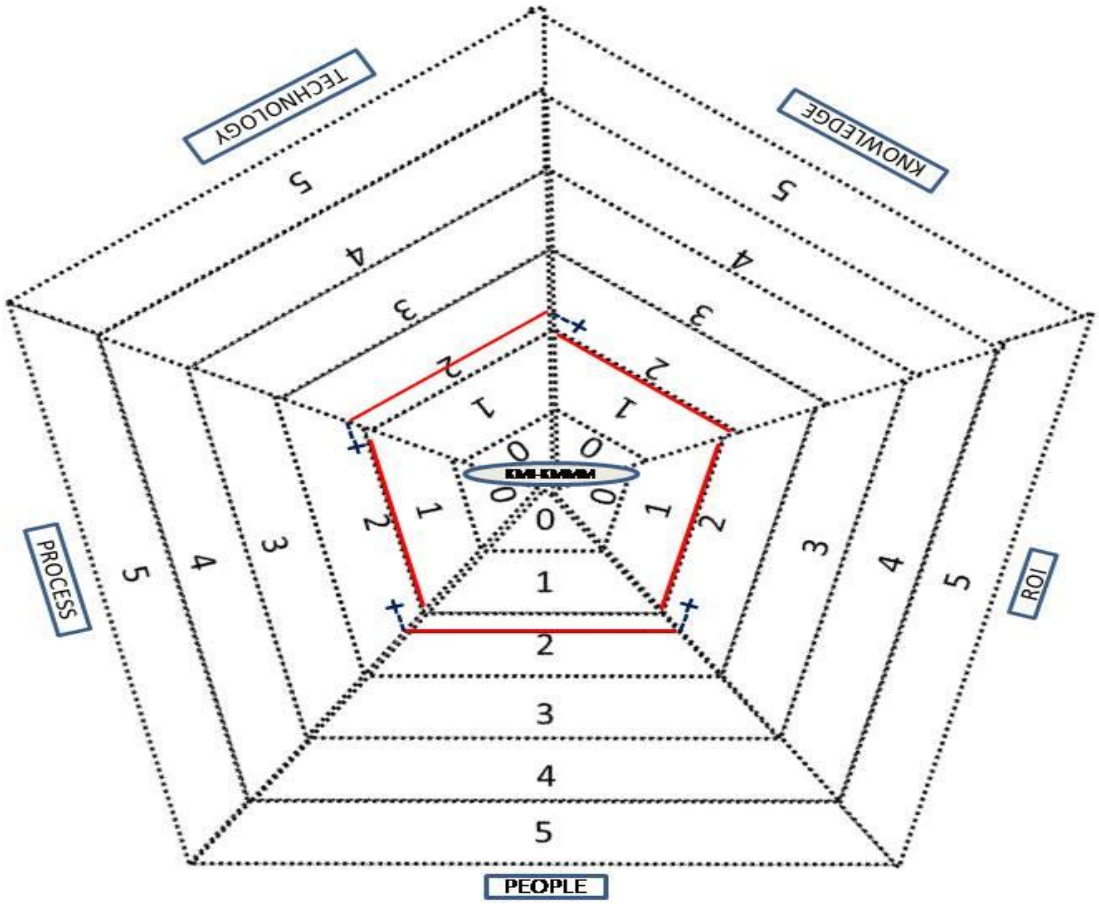


Figure 4.10 KM Maturity of Group G10

4.3.2 Organisation

The overall organisational KM maturity is determined by the lowest level achieved by any of the groups. Hence the KM maturity of the organisation is Level1+, in 'People' Key Area, Level 1 in 'Process' Key Area, Level 1+, in 'Technology' Key Area and Level 1 in 'Knowledge' Key Area. The organisation has achieved an 'Employee Satisfaction' of 'Low' in KM activities. However as per the model, RoI is not evaluated for Level 1 maturity. The organisation has achieved an overall KM maturity of Level 1. The KM maturity of the organisation is depicted in Figure 4.11

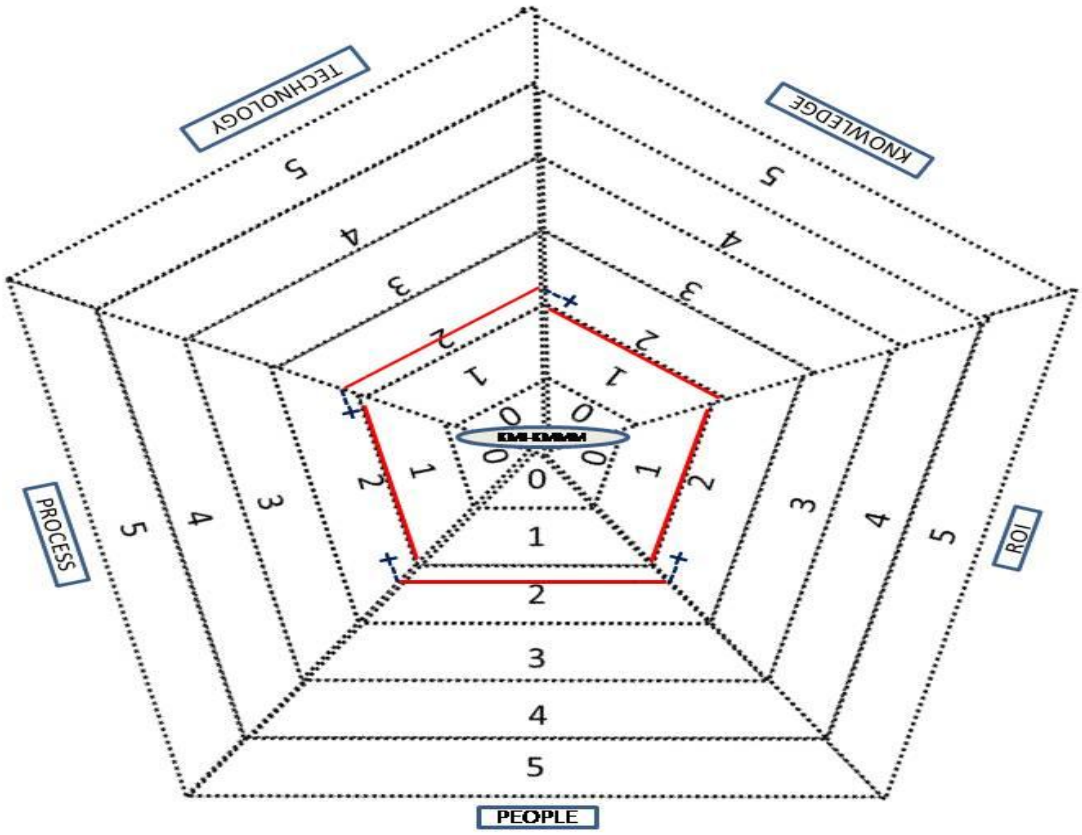


Figure 4.11 KM Maturity of Organization

The organisation need to focus more on 'Process' and 'Knowledge' Key Areas to move to Level 1+. For the organisation to progress to Level 1++, it needs to qualitatively improve on the various parameters identified in the model. Also it needs to have a mechanism to monitor and take corrective actions on the qualitative progress on the parameters.

4.4 ADAPTABILITY OF THE MODEL

Adaptability of KMI-KMM model is demonstrated by applying the modified model KMIX-KMM model discussed in Chapter 3, to 2 hypothetical organisations viz organisation A denoted by ORGA and organisation B denoted by ORGB.

4.4.1 Organisation A

It may be recalled that KMIX-KMM model is a subset of KMI-KMM model and ORGA is interested only in the Key Areas and Key Parameters of KMIX-KMM model.

Assuming that ORGA has the same number of groups as that of the target organisation and the data obtained was the same as that of the target organisation while ORGA has adapted the KMIX-KMM model, the results are shown in Table 4.4 and 4.5

Comparing the results in Table 4.4 and 4.5 of ORGA with that in 4.2 and 4.3 of the target organisation, it can be seen that the KM maturity levels of many groups ORGA are higher. It can be observed from Table 4.5 that KM maturity of level 2 has been achieved by G2, G5, G7, G8 & G9 in 'People' Key Area, by G2, G5, G7 & G9 in 'Technology' Key Area and by G5 & G7 in 'Knowledge' Key Area respectively. However, since the organisational KM maturity is decided by the lowest level maturity achieved by any of the groups, the organisational KM maturity is in level 1, 1+ and 1 in 'People', 'Technology' and 'Knowledge' Key Areas respectively. The KM maturity ORGA is depicted in Figure 4.12.

Table 4.4 Key Maturity Indicators for Groups of ORGA

Sl.No.	Key Areas	Key Parameters	KV G1	KV G2	KV G3	KV G4	KV G5	KV G6	KV G7	KV G8	KV G9	KV G10
1	People	Awareness	L	M	L	L	M	L	M	M	M	L
2		Participation	L	M	L	L	M	L	M	M	M	L
3		KM Roles	L	M	L	L	M	L	M	M	M	L
4	Technology	Network	H	H	H	H	H	H	H	H	H	H
5		Explicit Knowledge Management	L	M	L	L	M	L	M	L	M	L
6	Knowledge	Knowledge Classification	L	L	L	L	M	L	M	L	L	L

Table 4.5 Maturity Levels for Groups and ORGA

Sl.No.	Group	ML(People)	ML(Technology)	ML(Knowledge)
1.	G1	1	1+	1
2.	G2	2	2	1
3.	G3	1	1+	1
4.	G4	1	1+	1
5.	G5	2	2	2
6.	G6	1	1+	1
7.	G7	2	2	2
8.	G8	2	1+	1
9.	G9	2	2	1
10.	G10	1	1+	1
11.	Organisation	1	1+	1

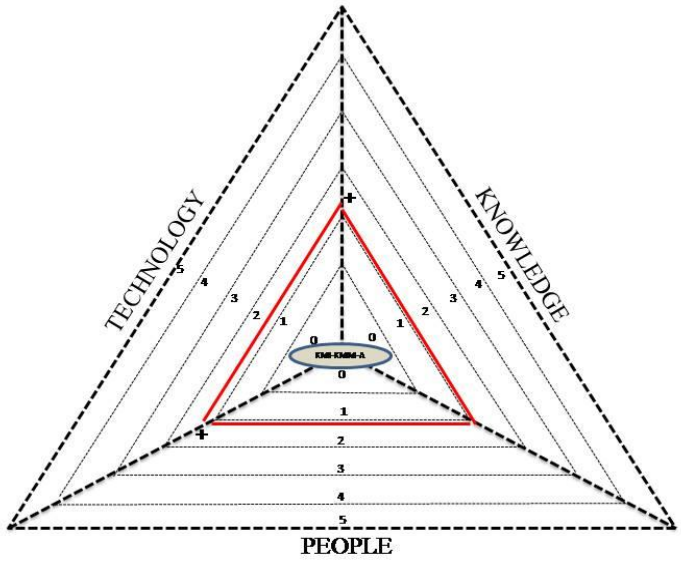


Figure 4.12 KM maturity of ORGA

4.4.2 Organisation B

It is assumed that organisation B is also interested in the same Key Areas and Key Parameters as that of ORGA and hence, decided to adapt KMIX-KMM model. However ORGB has only two groups whose data is identical to that of G5 and G7 of the target organisation. The results are depicted in Table 4.6 and 4.7. It can be seen that ORGB has achieved level 2 maturity in all the Key Areas, since all the groups of ORGB have achieved level 2 maturity in all the Key Areas. The KM maturity ORGB is depicted in Figure 4.13

Table 4.6 Key Maturity Indicators for Groups of ORGB

Sl.No.	Key Areas	Key Parameters	KV G5	KV G7
1	People	Awareness	M	M
2		Participation	M	M
3		KM Roles	M	M
4	Technology	Network	H	H
5		Explicit Knowledge Management	M	M
6	Knowledge	Knowledge Classification	M	M

Table 4.7 Maturity Levels for Groups of ORGB

Sl.No.	Group	ML(People)	ML(Technology)	ML(Knowledge)
1	G5	2	2	2
2	G7	2	2	2
3	Organisation	2	2	2

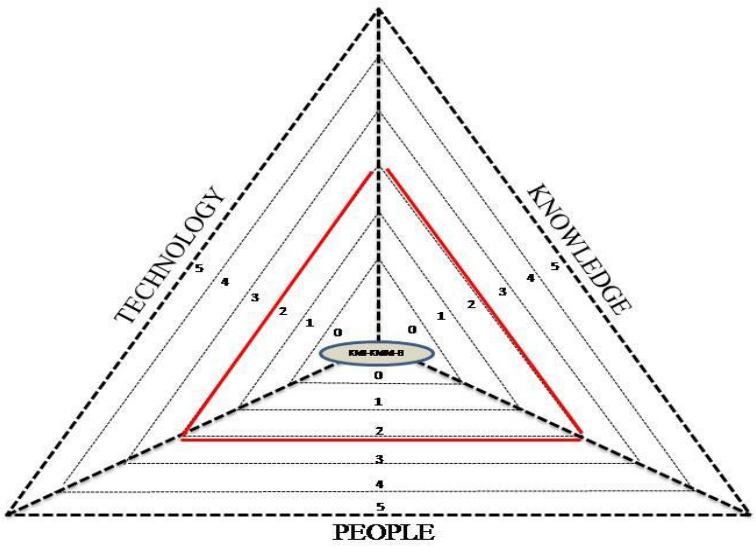


Figure 4.13 KM maturity of ORGB

4.4.3 Discussion

It can be observed that ORGA and ORGB were able to easily adapt the modified KMIX-KMM model to suit their requirements. It can also be observed that since these organisations have adapted the modified KMIX-KMM model, the KM maturity levels of the groups and that of the organisation are different than that of the target organisation, even though the data is identical. Similarly, it is also possible for another organisation to adapt super-set model similar to KMIY-KMM model by adding additional Key Areas or Key Parameters. This demonstrates the flexibility and adaptability inbuilt into the KMMI-KMM model.

4.5 VALIDATION

Different tests that are used to validate the study are described in the following sections.

4.5.1 Construct Validity

A pilot study was conducted across the cross section of the organisation and the feed backs received were implemented in the case study. This case study used multiple sources of evidences like focus group discussion, semi-structured interview, organisational web site, organisational annual report etc. The key informants of the organisation have reviewed the draft case study report. Hence it can be concluded that operational measures of the concepts are correct and thus the study satisfies the construct validity.

4.5.2 External Validity

Since the case study has embedded sub units of analysis, the findings of the study can be analytically generalized across similar organisations. Also the extension of the study to hypothetical organisations, further generalizes the study.

4.5.3 Reliability

Since the study has used multiple sources of evidences, objective data and random participants, the reliability can be ensured.

In addition to the above 4 tests, the study also satisfies discriminant validity (Trochim,2000). Different groups of the organisation are at different levels of maturity with reference to different Key Areas. This indicates that Key Areas are distinct and not correlated, providing evidence of discriminant validity. Also the 'absolute test' specified by Kulkarni and Freeze(2004) is satisfied as detailed below. For every Key Areas, achieving a lower level maturity is a prerequisite for achieving next level maturity. The results indicate that none of the higher levels can be satisfied without satisfying the lower levels. Hence the study validates the knowledge management maturity model developed in Chapter 3.

4.6 OBJECTIVITY OF DATA

The case study pertains to one organisation and its 10 groups. Through the case study, KM maturity levels of the groups and that of the organisation were assessed. Depending on the values obtained for the Key Parameters through the case study, the KM maturity level of the groups of the organisation was determined. KM maturity level of the organisation was determined by the lowest level achieved by any of the groups of the organisation. Analysis was done for each individual group and for the organisation as a whole.

Since the different groups of the organisation are involved in diversified activities like basic research, applied research, design, project execution, technical service, operation and maintenance, accademics etc. the organisation is highly diversified. Also different groups of the organisation are at different maturity levels. For the data collection and interpretation individual

groups of the organisation were taken as different entities. For the case study, data was collected through various sources such as focus group discussion, semi-structured interview, annual report of the organisation, organisational web site, KM portal of the organisation, various Information Management Systems of the organisation. For the focus group discussion, the participants from each group were selected randomly. Since most of the data were objective and obtained from multiple sources, objectivity was maintained. Also the analysis and the draft report were presented to the key officials of the organisation. Hence, though the organisation was selected based on accessibility to data, objectivity was maintained in the data collection and interpretation.

The maturity levels of various groups and that of the organisation given in Table 4.3 are reproduced in Table 4.8 with highlighted G2 data. The researcher belongs to group G2. The maturity level of G2 is shown in bold italics. The maturity levels of various groups and that of the organisation after removing G2 is given in Table 4.8A.

Table 4.8 Maturity Levels of Groups and Organisation with G2 highlighted

Sl.No.	**Groups**	**ML (People)**	**ML (Process)**	**ML (Technology)**	**ML (Knowledge)**	**ML (RoI)**
1.	G1	1+	1	1+	1	1
2.	***G2***	***1++***	***1***	***1++***	***1***	***1***
3.	G3	1+	1	1+	1	1
4.	G4	1+	1	1+	1	1
5.	G5	1++	1	1+	1+	1
6.	G6	1+	1	1+	1	1
7.	G7	1++	1	1++	1++	1
8.	G8	1++	1	1+	1	1
9.	G9	1++	1	1+	1	1
10.	G10	1+	1	1+	1	1
11.	Organisation	1+	1	1+	1	1

ML-Maturity Level

Table 4.8A Maturity Levels of Groups and Organisation without G2

Sl.No.	Groups	ML (People)	ML (Process)	ML (Technology)	ML (Knowledge)	ML (RoI)
1.	G1	1+	1	1+	1	1
2.	G3	1+	1	1+	1	1
3.	G4	1+	1	1+	1	1
4.	G5	1++	1	1+	1+	1
5.	G6	1+	1	1+	1	1
6.	G7	1++	1	1++	1++	1
7.	G8	1++	1	1+	1	1
8.	G9	1++	1	1+	1	1
9.	G10	1+	1	1+	1	1
10.	Organisation	1+	1	1+	1	1

It can be observed that, the elimination of group G2 from the study does not affect the maturity level of the organisation, since maturity level of the organisation is determined by the lowest level achieved by any of the groups. Also the maturity level of G2 (People-1++; Process-1; Technology-1++; Knowledge-1; RoI-1) is comparable to the maturity level of other groups like G5, G7, G8 etc. Hence, it can be stated that, the familiarity of the researcher with the organisation did not influence the findings of the study.

4.7 SUMMARY

In this Chapter, the KMI-KMM model developed in the Chapter 3 was applied in an organisational context, to demonstrate its applicability. The KM maturity of a nuclear R&D organisation and its groups were assessed. Adaptability of the model was demonstrated by applying the modified model to 2 hypothetical organisations. Also the model was validated by the case study approach.

CHAPTER 5

IDENTIFICATION OF INHIBITING FACTORS FOR KM MATURITY IN THE CONTEXT OF A NUCLEAR R&D ORGANISATION

In this chapter the inhibiting factors to attain higher levels of KM maturity of the target organisation whose KM maturity was assessed in Chapter 4 was identified through survey methodology. The study also suggests methods to improve KM maturity of the target organisation.

5.1 Inhibiting Factors

In order to identify the inhibiting factors which prevent the organisation attaining higher levels of KM maturity, a questionnaire was developed and this is given in Appendix D. It contained 21 factors that can influence the KM maturity. It was developed based on the e literature survey in Chapter 1 and the study of the organisation. The presence of those factors can act as enablers and the absence can act as inhibitors. Detailed discussion on these factors is covered in Section 1.4

Inhibiting factors of various groups and the organization were identified through a survey. A questionnaire was used based on a five point Likert scale (strongly agree, agree, neither agree/nor disagree, disagree, strongly disagree) to collect the response from the participants. The questionnaire was pre-tested, with a few senior, middle and junior level employees, for the understanding of the questions and the concepts that is represented. Based on the feedback received, the structure was modified to make the inhibiting factors more explicit by adding the 'if'

to all the inhibiting factors. For example for the inhibiting factor "lack of adequate time" the initial question was '*I am willing to share more of my work, experiences, ideas, expertise, etc. with other members of the organisation as my contribution to the organisational knowledge repository, if: I have more time'.* The question was modified as '*I am willing to share more of my work, experiences, ideas, expertise, etc. with other members of the organisation as my contribution to the organisational knowledge repository: if I have more time'.* Also since the questionnaire was personally administered by the researcher after an awareness seminar in each group, the necessary clarifications could be provided. However, the clarifications required were minimum.

If the answer to the question is 'strongly agree', it indicates that the factor say 'lack of time' is a strong inhibiting factor. If the answer is 'strongly agree' or 'agree' it is considered as a positively answered question. The mean, standard deviation and percentage of positive responses for each group are summarized in the Table 5.1.

The strongest inhibiting factor based on the mean, for each group is highlighted. Detailed analysis is presented in Section 5.3.

Table 5.1 Inhibiting Factors of Groups

S.No	Inhibiting Factors	G1			G2			G3			G4			G5			G6			G7			G8			G9			G10		
		M	SD	PR	M	SD	PR	M	SD	PR	M	SD	PR	M	SD	PR	M	SD	PR	M	SD	PR	M	SD	PR	M	SD	PR	M	SD	PR
1	Lack of time	3.33	1.12	56	3.43	1.01	54	3.86	0.92	78	4.13	0.81	87	3.82	0.97	74	3.93	0.96	78	3.67	0.69	55	3.68	1.12	61	3.29	1.07	50	3.83	0.92	77
2	Lack of awareness of knowledge requirements	3.67	1.12	75	3.94	0.73	77	3.95	1.00	81	4.31	0.48	100	4.13	1.00	82	3.86	0.99	71	4.28	0.67	88	4.29	0.66	96	3.57	1.09	14	4.00	0.77	77
3	Lack of expertise in organizing the available Knowledge	4.33	1.12	78	3.40	1.01	51	3.70	0.91	70	3.88	0.62	75	3.97	0.90	77	2.86	0.91	28	3.44	0.62	39	3.82	0.77	68	3.43	0.85	50	4.00	0.84	82
4	Lack of awareness of the process of contribution	4.11	0.33	100	3.66	0.84	60	4.08	0.72	84	4.00	0.52	87	4.03	0.81	79	3.36	1.11	50	3.89	0.83	61	3.86	0.89	68	4.14	0.53	93	3.76	0.77	67
5	Lack of assistance in contribution	3.22	1.39	44	3.20	1.21	43	3.43	1.12	54	3.56	0.89	56	3.38	1.16	59	2.21	1.37	14	2.83	0.79	16	3.36	0.87	46	3.36	1.08	50	3.71	0.96	68
6	Lack of user friendly technology infrastructure	3.67	1.32	67	4.06	0.76	80	4.00	0.78	75	4.31	0.70	87	4.28	0.69	92	3.93	0.96	64	3.72	1.02	44	4.25	0.84	75	4.00	0.88	78	4.23	0.60	91
7	Lack of integration of the process of contribution with day-today work	3.11	1.45	56	4.09	0.70	86	3.92	0.89	67	4.44	0.73	87	4.38	0.63	82	4.00	0.85	78	3.83	0.92	50	4.29	0.76	82	4.00	0.68	78	4.00	0.87	80
8	Lack of awareness of the utility of the contributions	4.22	0.67	89	3.40	1.03	54	3.57	1.01	57	3.44	1.03	62	3.77	0.81	69	3.86	0.83	71	3.39	1.09	44	4.00	0.77	79	3.36	0.84	43	3.89	0.99	77
9	Lack of tangible reward	3.78	1.09	56	3.00	1.08	34	3.03	1.21	32	2.94	1.06	31	3.38	1.09	43	3.00	0.93	21	3.00	1.08	22	3.43	1.23	54	2.64	1.01	14	3.03	1.25	40
10	Lack of recognition	4.22	1.20	67	3.29	0.99	48	3.14	1.13	38	3.06	1.29	50	3.59	1.23	66	3.21	1.15	43	3.00	1.03	17	3.39	1.10	46	2.86	1.10	21	3.66	0.91	65
11	Lack of gratefulness	4.44	1.13	78	3.03	0.89	28	3.22	1.20	40	3.13	1.20	37	3.44	1.25	54	2.57	1.12	14	2.83	0.86	17	3.07	1.12	25	2.57	0.51	0	3.37	0.88	57
12	Lack of feedback	4.56	0.53	100	3.77	1.06	74	3.89	0.97	70	3.88	0.96	81	4.10	0.75	77	2.00	0.65	78	3.94	0.73	72	4.14	0.59	89	3.79	0.89	64	4.11	0.83	82
13	Lack of weightage for contribution in performance appraisal	2.89	1.36	33	3.31	1.11	46	3.35	1.14	46	3.31	1.45	62	3.64	1.04	66	3.71	0.80	78	3.00	0.97	22	3.50	1.29	57	3.14	1.08	28	3.14	1.46	54

S.No	Inhibiting Factors	G1			G2			G3			G4			G5			G6			G7			G8			G9			G10		
14	Lack of protection of intellectual property	4.11	1.27	78	3.40	3.80	48	3.41	1.01	48	2.75	1.34	31	3.54	1.27	56	4.14	0.83	86	3.44	0.86	33	3.50	1.32	57	3.79	0.89	64	3.49	1.27	57
15	Lack of assurance against negative reverse impact	3.89	0.78	67	3.80	0.93	71	3.84	0.90	67	3.31	1.14	50	3.56	1.17	64	4.36	0.81	93	3.39	0.92	17	3.64	1.03	57	3.71	0.91	57	3.77	1.11	71
16	Lack of assurance against belittling by colleagues	3.22	0.97	33	2.80	1.13	28	3.27	0.90	38	2.69	1.08	18	2.90	1.02	25	3.21	0.77	43	2.61	0.70	6	2.75	1.17	25	2.71	1.07	14	3.57	1.07	57
17	Lack of awareness on the significance of the contribution to the organisation	4.11	1.05	78	3.77	1.03	66	3.73	1.07	62	3.88	1.15	75	4.18	0.91	84	4.43	0.49	100	4.00	0.91	72	4.32	0.98	82	4.07	0.83	71	3.94	1.06	74
18	Lack of directive from the reporting officer	3.11	0.93	33	3.06	1.00	31	3.05	0.97	38	3.50	1.15	50	3.36	0.84	38	3.57	1.05	50	2.83	0.62	6	3.61	1.17	54	3.36	1.01	43	3.37	0.91	51
19	Lack of contributions from colleagues	3.67	0.87	67	3.00	1.06	34	2.97	1.07	27	3.00	1.26	31	3.31	1.06	43	3.64	0.89	50	2.83	0.71	11	3.11	1.34	43	2.57	0.94	7	3.09	1.01	37
20	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	4.00	0.76	78	3.43	1.09	46	3.54	0.96	57	3.50	0.86	75	3.87	0.86	66	3.54	0.93	61	3.11	1.08	39	3.89	0.88	71	2.79	0.97	21	3.69	0.90	77
21	Lack of mandatory organisational policy on contributions	4.00	0.7	78	3.26	1.07	74	3.14	1.25	43	3.00	1.41	31	3.31	1.17	46	3.07	0.88	21	2.67	1.03	11	2.89	1.26	48	2.93	1.00	21	2.91	1.20	48

M-Mean, SD – Standard Deviation, PR – Positive Response

5.2 PARTICIPANT PROFILE

In this Section the participant profile is analyzed in terms of the percentage of participation and demographic variables.

5.2.1 Participation

The participation is analyzed in terms of the percentage of participation from each group with respect to the total number of participants and with respect to the total number of employees in that group. Table 5.2 depicts the number of participants from each group and the percentage with respect to the total number of participants, ordered in the descending order of the percentage. The highest percentage is from G5 followed by G3.

Table 5.2 Participants from Groups

Group	Participants	Percentage
G5	39	15.91
G3	37	15.10
G2	35	14.28
G10	35	14.28
G8	28	11.42
G7	18	7.34
G4	16	6.53
G6	14	5.71
G9	14	5.71
G1	9	3.60
Total	**245**	**100**

Table 5.3 depicts the number of employees, participants and the percentage of participants with respect to the number of employees from different groups and the organisation(ORG), in the

descending order of the percentage of the groups. The participation from all groups, except three groups (G6,G9,G1), are higher than the percentage of participants for the organisation (11.7).

Table 5.3 Employees and participants

Group	Employees	Participants	Percentage
G4	43	16	37.20
G2	127	35	27.55
G8	108	28	25.92
G5	252	39	15.47
G7	135	18	13.33
G3	297	37	12.45
G10	296	35	11.82
G6	278	14	5.03
G9	339	14	4.13
G1	219	9	4.11
ORG	2094	245	11.70

5.2.2 Demographic Variables

The demographic variables of the participants are analyzed in this Section. The overall profile of participants from the organisation and that from various groups vary significantly. Figure 5.1a depicts the profile of organisation-wide participants based on type of work. Though the organisation is predominantly carrying out Research & Development, the highest number of participants were carrying out development work (31%), followed by research (27%). Figure 5.1b depicts the group-wise profile based on type of work. The group G1 mostly carries out research work(75%), followed by project. The group G2 mainly carries out development work(50%) followed by research(35%). The group G3 mainly carries out development work(50%) followed by research(35%). The group G4 carries out development work(47%) followed by research(40%).

The group G5 carries out mostly development work(54%) followed by research(25%). The group G6 carries out mostly project work(46%) followed by design(39%). The group G7 carries out project work and technical services equally(50%). The group G8 carries out mostly development work(82%) followed by technical services (12%). The group G9 carries out mostly development work(71%) followed by project (22%). The group G10 carries out development work and research almost equally(39% and 31%).

Type of Work	%
Research	29
Development	29
Project	21
Technical Services	21

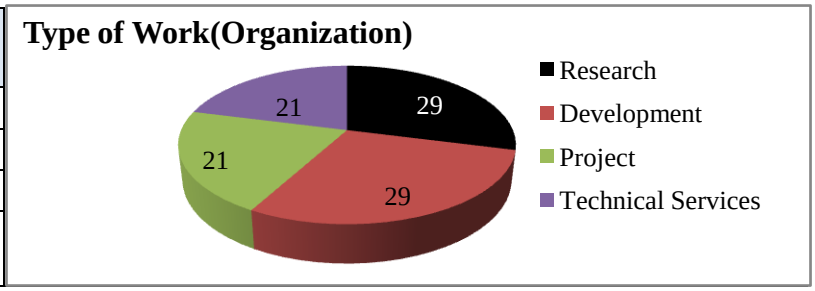
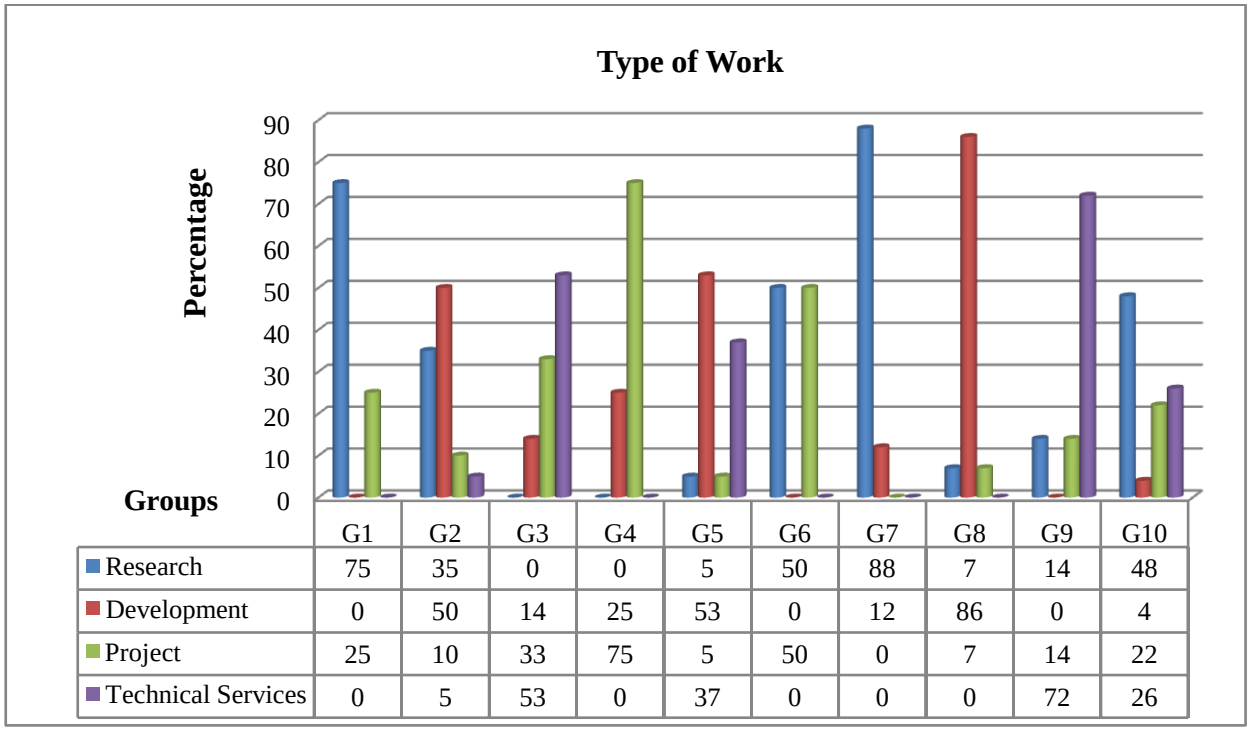


Figure 5.1a Type of Work (Organisation**)**



	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Research	75	35	0	0	5	50	88	7	14	48
Development	0	50	14	25	53	0	12	86	0	4
Project	25	10	33	75	5	50	0	7	14	22
Technical Services	0	5	53	0	37	0	0	0	72	26

Figure 5.1b Type of Work (Groups)

Figure 5.2a and 5.2b depicts the qualification of participants organisation-wide and group-wise respectively. The overall participants of the organisation were mostly graduates (44%), followed by postgraduates (29%). The maximum participants for G1(72%), G2(52%), G4(47%), G6(46%) were post graduates. For G5(54%), G8(82%), G9(71%), G10(39%), the maximum participants were graduates. For G7 the participants were equally distributed between post graduates and Ph.D holders. For G3 alone the maximum(56%) participants were diploma holders.

Qualification	%
Diploma	18
Graduate	44
Post Graduate	29
Ph.D.	9

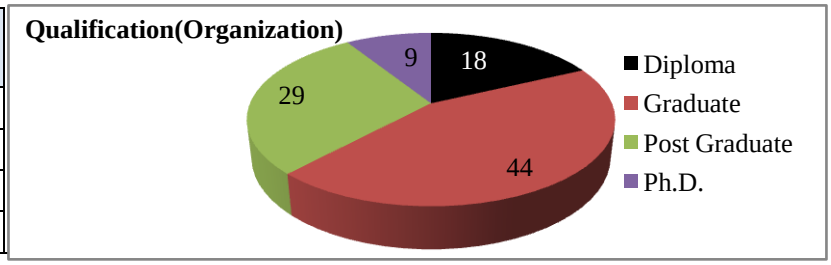
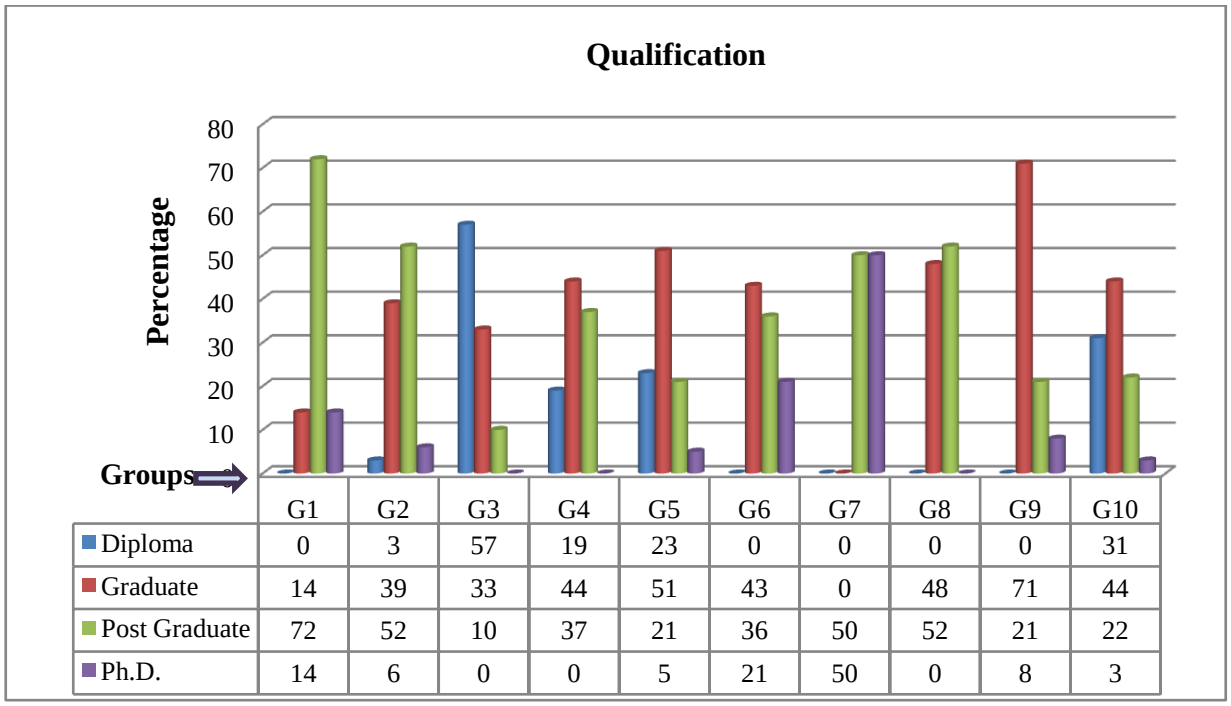


Figure 5.2a Qualification (Organisation)



	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Diploma	0	3	57	19	23	0	0	0	0	31
Graduate	14	39	33	44	51	43	0	48	71	44
Post Graduate	72	52	10	37	21	36	50	52	21	22
Ph.D.	14	6	0	0	5	21	50	0	8	3

Figure 5.2b Qualification (Groups)

The discipline of the participants of the organisation and groups is depicted in Figure 5.3a and 5.3b respectively. Organisation-wide the discipline of engineering was more predominant (73%), compared to science (27%). Also all groups except G1, G7 and G10, the engineering discipline was more predominant.

Discipline	%
Science	27
Engineering	73

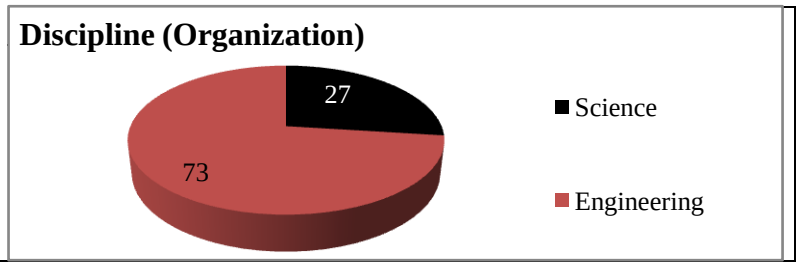
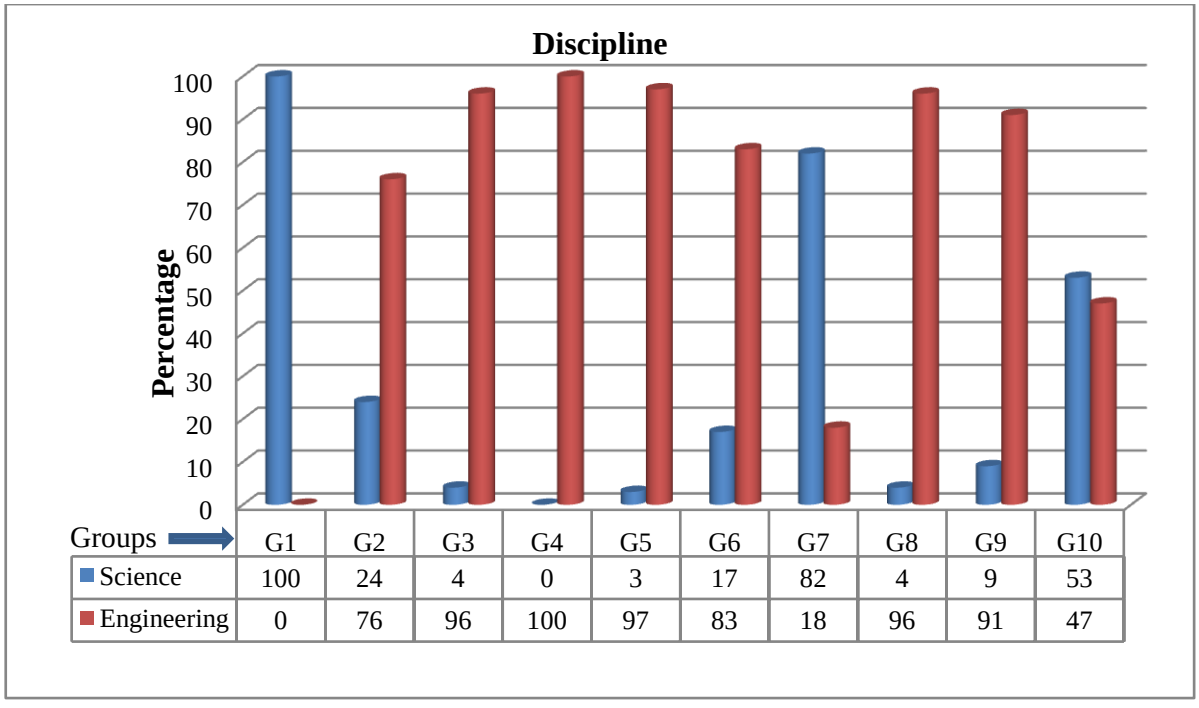


Figure 5.3a Discipline (Organisation)



Groups	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Science	100	24	4	0	3	17	82	4	9	53
Engineering	0	76	96	100	97	83	18	96	91	47

Figure 5.3b Discipline (Groups)

The grade of the participants of the organisation and groups is depicted in Figure 5.4a and 5.4b respectively. The organisation-wide participants were mostly middle level employees (65%). The same trend was observed in all the groups except G9, where only senior officers participated.

Grade	%
Upto SO/B	14
SO/C-E	65
SO/F-G	16
SO/H & Above	5

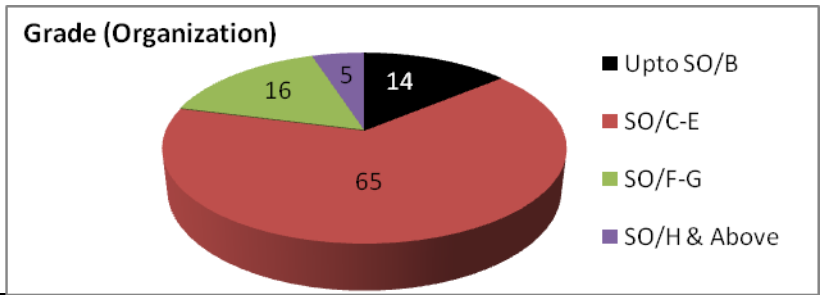
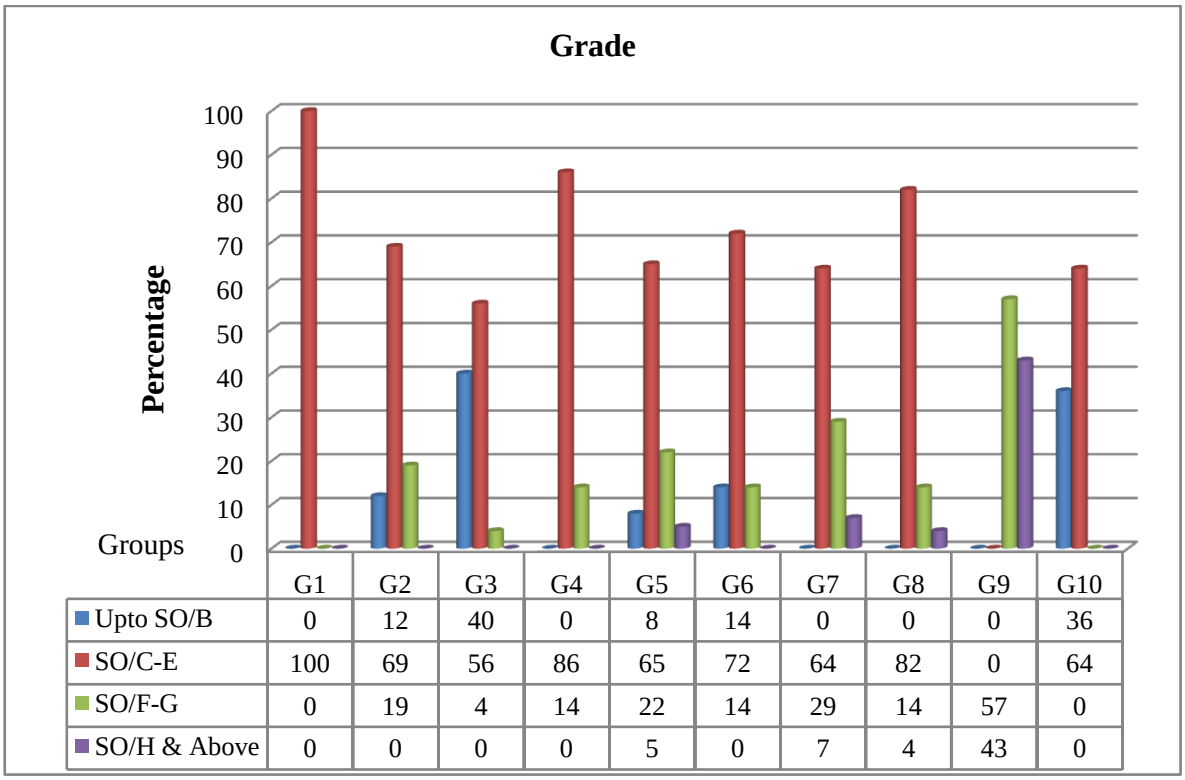


Figure 5.4a Grade (Organisation)



Groups	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Upto SO/B	0	12	40	0	8	14	0	0	0	36
SO/C-E	100	69	56	86	65	72	64	82	0	64
SO/F-G	0	19	4	14	22	14	29	14	57	0
SO/H & Above	0	0	0	0	5	0	7	4	43	0

Figure 5.4b Grade (Groups)

The service of the participants of the organisation and groups is depicted in Figure 5.5a and 5.5b respectively. Organisation-wide participants were predominantly 'low' (less than 10 years) experienced (44%). In all the groups except G5, G9 and G10 the same trend was observed. In G5 and G10 the participants were predominantly 'medium' (10-19 years) experienced. In G9 the participants were predominantly 'high' (more than 20 years) experienced.

Service	%
< 10	44
10 – 19	23
20 – 30	22
> 30	11

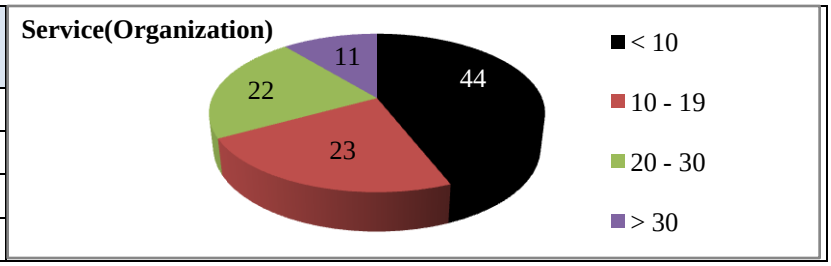
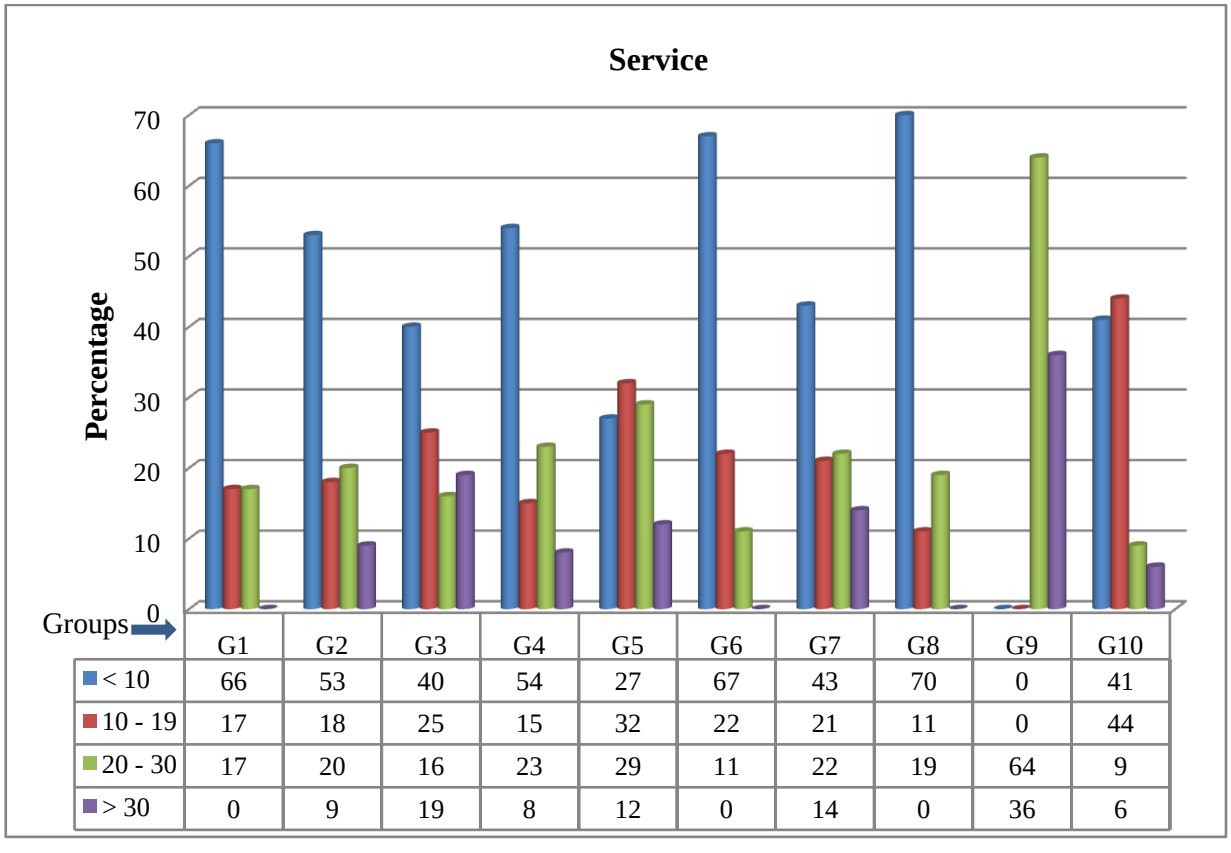


Figure 5.5a Service (Organisation)



	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
< 10	66	53	40	54	27	67	43	70	0	41
10 - 19	17	18	25	15	32	22	21	11	0	44
20 - 30	17	20	16	23	29	11	22	19	64	9
> 30	0	9	19	8	12	0	14	0	36	6

Figure 5.5b Service (Groups)

The age of the participants of the organisation and groups is depicted in Figure 5.6a and 5.6b respectively. Organisation-wide participants were predominantly young (less than 30 years) (31%). In groups G2, G6 and G8 the same trend was observed. In G1 and G10 the participants were equally distributed between 'less than 30' and '30 to 39' years of age. In G3 and G4 '30 to 39' age group was predominant. In G5 and G7 '40 to 50' age group was predominant. In G9 alone the participants were predominantly old(greater than 50).

Age	%
< 30	31
30 – 39	29
40 – 50	25
> 50	15

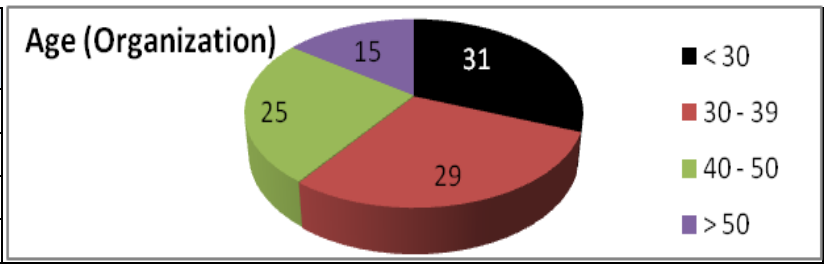
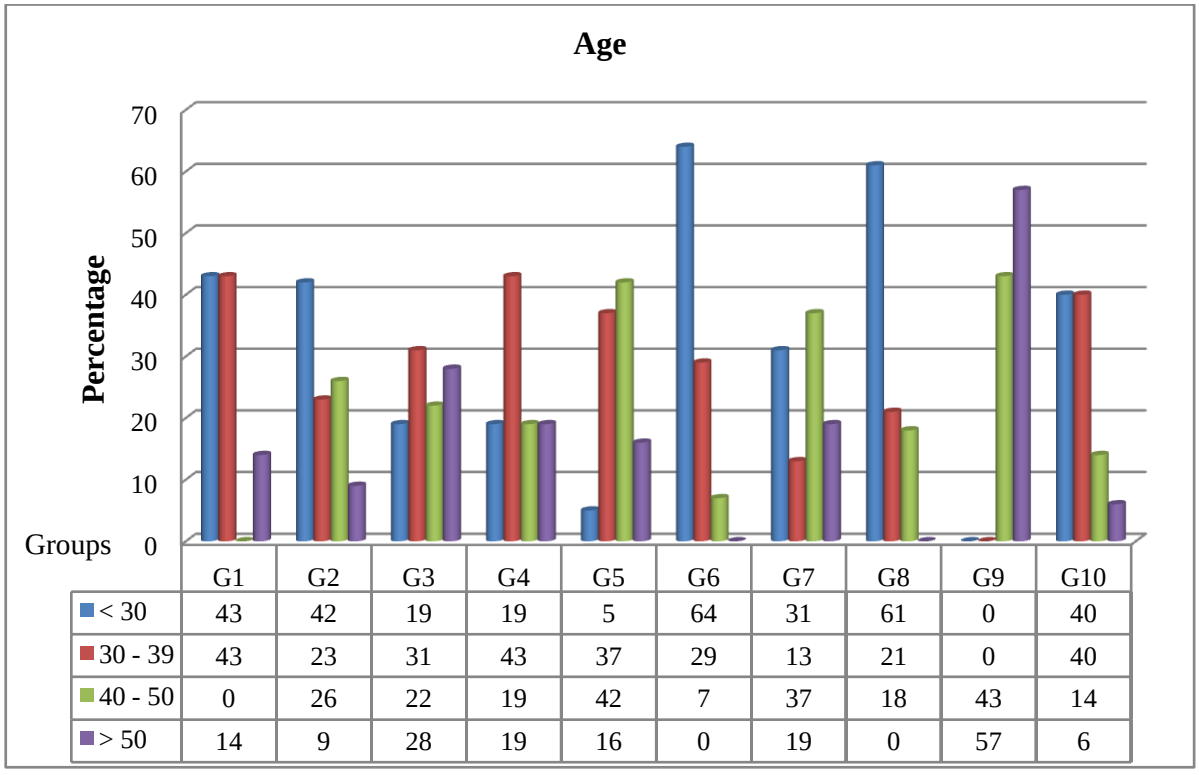


Figure 5.6a Age (Organisation)



Groups	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
< 30	43	42	19	19	5	64	31	61	0	40
30 - 39	43	23	31	43	37	29	13	21	0	40
40 - 50	0	26	22	19	42	7	37	18	43	14
> 50	14	9	28	19	16	0	19	0	57	6

Figure 5.6b Age (Groups)

The gender distribution of the participants of the organisation and groups is depicted in Figure 5.7a and 5.7b respectively. Organisation-wide participants were predominantly male (83%) In almost all the groups the same trend was observed, except G2 and G6, where the female participants were comparable.

Gender	%
Male	83
Female	17

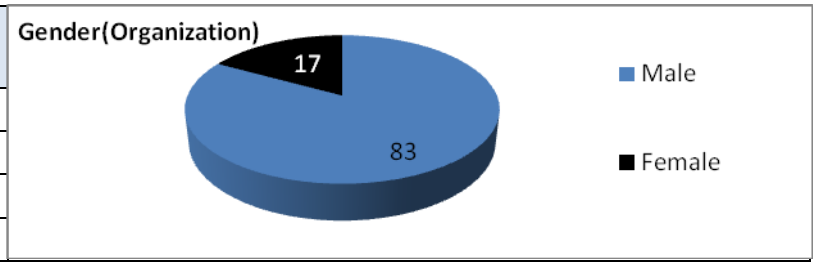
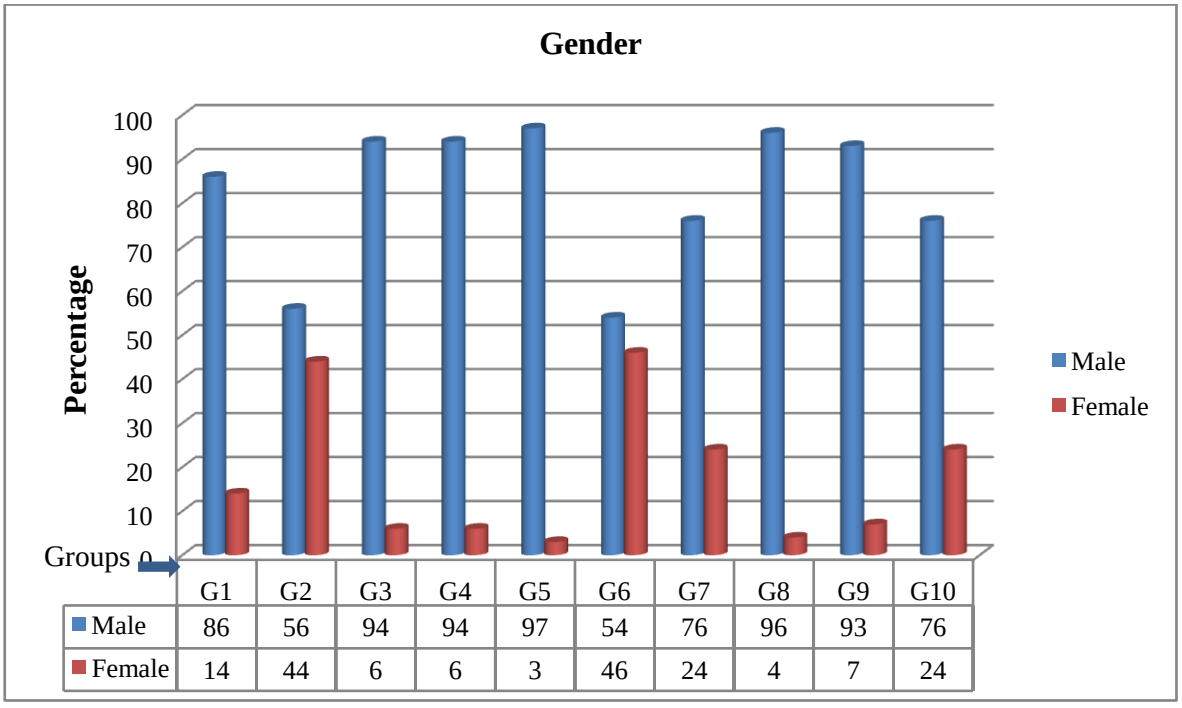


Figure 5.7a Gender (Organisation)



	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Male	86	56	94	94	97	54	76	96	93	76
Female	14	44	6	6	3	46	24	4	7	24

Figure 5.7b Gender (Groups)

The analysis could not find any relationship of demographic variables with predominant inhibiting factors. Two demographic variables namely Grade and Gender in the population obtained from the organisational web site is depicted in Table 5.4. It indicates that sample represents the population. Also the sample size (245) is more than the minimum requirement given in literature (sample size of 239 for a population of 2000).

Table 5.4 Demographic variables of the population

DV(Grade)	E	DV(Gender)	E
Upto B	24	Male	86
C-E	51	Female	14
F-G	19		
H& above	6		

DV-Demographic Variable; E- No of Employees

5.3 ANALYSIS

The analysis was carried out based on various groups of the organisation and organisation wide, to identify the prominent inhibiting factors.

5.3.1 Groups

The inhibiting factors of various groups are discussed in the following sections. The inhibiting factors are depicted in descending order of the mean. The standard deviation and percentage of positive responses are also listed. It can be observed that stronger inhibiting factors based on mean vary for different groups. Also it can be observed that the standard deviation and percentage of positive response for different inhibiting factors vary for different groups. These variations reflects the diverse perceptions of KM in different groups.

Group G1: The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.5. It can be seen that the strongest inhibiting factor is 'lack of feedback', with a mean of 4.56, standard deviation of 0.53 and 100% positive responses.

Table 5.5 Inhibiting Factors of Group G1

Sl.No	Inhibiting Factors (G1)	M	SD	PR
1	Lack of feedback	4.56	0.53	100
2	Lack of gratefulness	4.44	1.13	78
3	Lack of expertise in organizing the available knowledge	4.33	1.12	78
4	Lack of recognition	4.22	1.20	67
5	Lack of awareness of the utility of the contributions	4.22	0.67	89
6	Lack of protection of intellectual property	4.11	1.27	78
7	Lack of awareness on the significance of the contribution to the organisation	4.11	1.05	78
8	Lack of awareness of the process of contribution	4.11	0.33	100
9	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	4.00	0.76	78
10	Lack of mandatory organisational policy on contributions	4.00	0.70	78
11	Lack of assurance against negative reverse impact	3.89	0.78	67
12	Lack of tangible reward	3.78	1.09	56
13	Lack of user friendly technology infrastructure	3.67	1.32	67
14	Lack of awareness of knowledge requirements	3.67	1.12	75
15	Lack of contributions from colleagues	3.67	0.87	67
16	Lack of time	3.33	1.12	56
17	Lack of assistance in contribution	3.22	1.39	44
18	Lack of assurance against belittling by colleagues	3.22	0.97	33
19	Lack of integration of the process of contribution with day to day work	3.11	1.45	56
20	Lack of directive from the reporting officer	3.11	0.93	33
21	Lack of weightage for contribution in performance appraisal	2.89	1.36	33

Group G2*:* The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.6. The strongest inhibiting factor is 'lack of integration of the process of contribution with day to day work', with a mean of 4.09, standard deviation of 0.70 and 86% positive responses.

Table 5.6 Inhibiting Factors of Group G2

Sl.No	Inhibiting Factors (G2)	M	SD	PR
1	Lack of integration of the process of contribution with day to day work	4.09	0.70	86
2	Lack of user friendly technology infrastructure	4.06	0.76	80
3	Lack of awareness of knowledge requirements	3.94	0.73	77
4	Lack of assurance against negative reverse impact	3.80	0.93	71
5	Lack of feedback	3.77	1.06	74
6	Lack of awareness on the significance of the contribution to the organisation	3.77	1.03	66
7	Lack of awareness of the process of contribution	3.66	0.84	60
8	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	3.43	1.09	46
9	Lack of time	3.43	1.01	54
10	Lack of protection of intellectual property	3.40	3.80	48
11	Lack of awareness of the utility of the contributions	3.40	1.03	54
12	Lack of expertise in organizing the available knowledge	3.40	1.01	51
13	Lack of weightage for contribution in performance appraisal	3.31	1.11	46
14	Lack of recognition	3.29	0.99	48
15	Lack of mandatory organisational policy on contributions	3.26	1.07	74
16	Lack of assistance in contribution	3.20	1.21	43
17	Lack of directive from the reporting officer	3.06	1.00	31
18	Lack of gratefulness	3.03	0.89	28
19	Lack of tangible reward	3.00	1.08	34
20	Lack of contributions from colleagues	3.00	1.06	34
21	Lack of assurance against belittling by colleagues	2.80	1.13	28

***Group G3**:* The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.7. The strongest inhibiting factor is 'lack of awareness of the process of contribution' with a mean of 4.08, standard deviation of 0.72 and 84% positive responses.

Table 5.7 Inhibiting Factors of G3

Sl.No	Inhibiting Factors (G3)	Mean	SD	PR
1	Lack of awareness of the process of contribution	4.08	0.72	84
2	Lack of user friendly technology infrastructure	4.00	0.78	75
3	Lack of awareness of knowledge requirements	3.95	1.00	81
4	Lack of integration of the process of contribution with day to day work	3.92	0.89	67
5	Lack of feedback	3.89	0.97	70
6	Lack of time	3.86	0.92	78
7	Lack of assurance against negative reverse impact	3.84	0.90	67
8	Lack of awareness on the significance of the contribution to the organisation	3.73	1.07	62
9	Lack of expertise in organizing the available knowledge	3.70	0.91	70
10	Lack of awareness of the utility of the contributions	3.57	1.01	57
11	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	3.54	0.96	57
12	Lack of assistance in contribution	3.43	1.12	54
13	Lack of protection of intellectual property	3.41	1.01	48
14	Lack of weightage for contribution in performance appraisal	3.35	1.14	46
15	Lack of assurance against belittling by colleagues	3.27	0.90	38
16	Lack of gratefulness	3.22	1.20	40
17	Lack of recognition	3.14	1.25	43
18	Lack of mandatory organisational policy on contributions	3.14	1.13	38
19	Lack of directive from the reporting officer	3.05	0.97	38
20	Lack of tangible reward	3.03	1.21	32
21	Lack of contributions from colleagues	2.97	1.07	27

Group G4: The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.8. The strongest inhibiting factor is 'lack of integration of the process of contribution with day to day work', with a mean of 4.44, standard deviation of 0.73 and 87% positive responses.

Table 5.8 Inhibiting Factors of Group G4

Sl.No	Inhibiting Factors (G4)	Mean	SD	PR
1	Lack of integration of the process of contribution with day to day work	4.44	0.73	87
2	Lack of user friendly technology infrastructure	4.31	0.70	87
3	Lack of awareness of knowledge requirements	4.31	0.48	100
4	Lack of time	4.13	0.81	87
5	Lack of awareness of the process of contribution	4.00	0.52	87
6	Lack of awareness on the significance of the contribution to the organisation	3.88	1.15	75
7	Lack of feedback	3.88	0.96	81
8	Lack of expertise in organizing the available knowledge	3.88	0.62	75
9	Lack of assistance in contribution	3.56	0.89	56
10	Lack of directive from the reporting officer	3.50	1.15	50
11	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	3.50	0.86	75
12	Lack of awareness of the utility of the contributions	3.44	1.03	62
13	Lack of weightage for contribution in performance appraisal	3.31	1.45	62
14	Lack of assurance against negative reverse impact	3.31	1.14	50
15	Lack of gratefulness	3.13	1.20	37
16	Lack of recognition	3.06	1.29	50
17	Lack of mandatory organisational policy on contributions	3.00	1.41	31
18	Lack of contributions from colleagues	3.00	1.26	31
19	Lack of tangible reward	2.94	1.06	31
20	Lack of protection of intellectual property	2.75	1.34	31
21	Lack of assurance against belittling by colleagues	2.69	1.08	18

Group G5: The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.9. The strongest inhibiting factor is 'lack of integration of the process of contribution with day to day work', with a mean of 4.38, standard deviation of 0.63 and 82% positive responses.

Table 5.9 Inhibiting Factors of Group G5

Sl.No	Inhibiting Factors (G5)	Mean	SD	PR
1	Lack of integration of the process of contribution with day to day work	4.38	0.63	82
2	Lack of user friendly technology infrastructure	4.28	0.69	92
3	Lack of awareness on the significance of the contribution to the organisation	4.18	0.91	84
4	Lack of awareness of knowledge requirements	4.13	1.00	82
5	Lack of feedback	4.10	0.75	77
6	Lack of awareness of the process of contribution	4.03	0.81	79
7	Lack of expertise in organizing the available knowledge	3.97	0.90	77
8	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	3.87	0.86	66
9	Lack of time	3.82	0.97	74
10	Lack of awareness of the utility of the contributions	3.77	0.81	69
11	Lack of weightage for contribution in performance appraisal	3.64	1.04	66
12	Lack of recognition	3.59	1.23	66
13	Lack of assurance against negative reverse impact	3.56	1.17	64
14	Lack of protection of intellectual property	3.54	1.27	56
15	Lack of gratefulness	3.44	1.25	54
16	Lack of assistance in contribution	3.38	1.16	59
17	Lack of tangible reward	3.38	1.09	43
18	Lack of directive from the reporting officer	3.36	0.84	38
19	Lack of mandatory organisational policy on contributions	3.31	1.17	46
20	Lack of contributions from colleagues	3.31	1.06	43
21	Lack of assurance against belittling by colleagues	2.90	1.02	25

Group G6: The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.10. The strongest inhibiting factor is 'lack of awareness on the significance of contribution to the organisation', with a mean of 4.43, standard deviation of 0.49 and 100% positive responses.

Table 5.10 Inhibiting Factors of Group G6

Sl.No	Inhibiting Factors (G6)	Mean	SD	PR
1	Lack of awareness on the significance of the contribution to the organisation	4.43	0.49	100
2	Lack of assurance against negative reverse impact	4.36	0.81	93
3	Lack of protection of intellectual property	4.14	0.83	86
4	Lack of integration of the process of contribution with day to day work	4.00	0.85	78
5	Lack of time	3.93	0.96	78
6	Lack of user friendly technology infrastructure	3.93	0.96	64
7	Lack of awareness of knowledge requirements	3.86	0.99	71
8	Lack of awareness of the utility of the contributions	3.86	0.83	71
9	Lack of weightage for contribution in performance appraisal	3.71	0.80	78
10	Lack of contributions from colleagues	3.64	0.89	50
11	Lack of directive from the reporting officer	3.57	1.05	50
12	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	3.54	0.93	61
13	Lack of awareness of the process of contribution	3.36	1.11	50
14	Lack of recognition	3.21	1.15	43
15	Lack of assurance against belittling by colleagues	3.21	0.77	43
16	Lack of mandatory organisational policy on contributions	3.07	0.88	21
17	Lack of tangible reward	3.00	0.93	21
18	Lack of expertise in organizing the available knowledge	2.86	0.91	28
19	Lack of gratefulness	2.57	1.12	14
20	Lack of assistance in contribution	2.21	1.37	14
21	Lack of feedback	2.00	0.65	78

Group G7: The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.11. The strongest inhibiting factor is 'lack of awareness of knowledge requirements', with a mean of 4.28, standard deviation of 0.67 and 88% positive responses.

Table 5.11 Inhibiting Factors of Group G7

Sl.No	Inhibiting Factors (G7)	Mean	SD	PR
1	Lack of awareness of knowledge requirements	4.28	0.67	88
2	Lack of awareness on the significance of the contribution to the organisation	4.00	0.91	72
3	Lack of feedback	3.94	0.73	72
4	Lack of awareness of the process of contribution	3.89	0.83	61
5	Lack of integration of the process of contribution with day to day work	3.83	0.92	50
6	Lack of user friendly technology infrastructure	3.72	1.02	44
7	Lack of time	3.67	0.69	55
8	Lack of protection of intellectual property	3.44	0.86	33
9	Lack of expertise in organizing the available knowledge	3.44	0.62	39
10	Lack of awareness of the utility of the contributions	3.39	1.09	44
11	Lack of assurance against negative reverse impact	3.39	0.92	17
12	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	3.11	1.08	39
13	Lack of tangible reward	3.00	1.08	22
14	Lack of recognition	3.00	1.03	17
15	Lack of weightage for contribution in performance appraisal	3.00	0.97	22
16	Lack of gratefulness	2.83	0.86	17
17	Lack of assistance in contribution	2.83	0.79	16
18	Lack of contributions from colleagues	2.83	0.71	11
19	Lack of directive from the reporting officer	2.83	0.62	6
20	Lack of mandatory organisational policy on contributions	2.67	1.03	11
21	Lack of assurance against belittling by colleagues	2.61	0.70	6

Group G8: The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.12. The strongest inhibiting factor is 'lack of awareness on the significance of contribution to the organisation', with a mean of 4.32, standard deviation of 0.98 and 82% positive responses.

Table 5.12 Inhibiting Factors of Group G8

Sl.No	Inhibiting Factors (G8)	Mean	SD	PR
1	Lack of awareness on the significance of the contribution to the organisation	4.32	0.98	82
2	Lack of integration of the process of contribution with day to day work	4.29	0.76	82
3	Lack of awareness of knowledge requirements	4.29	0.66	96
4	Lack of user friendly technology infrastructure	4.25	0.84	75
5	Lack of feedback	4.14	0.59	89
6	Lack of awareness of the utility of the contributions	4.00	0.77	79
7	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	3.89	0.88	71
8	Lack of awareness of the process of contribution	3.86	0.89	68
9	Lack of expertise in organizing the available knowledge	3.82	0.77	68
10	Lack of time	3.68	1.12	61
11	Lack of assurance against negative reverse impact	3.64	1.03	57
12	Lack of directive from the reporting officer	3.61	1.17	54
13	Lack of protection of intellectual property	3.50	1.32	57
14	Lack of weightage for contribution in performance appraisal	3.50	1.29	57
15	Lack of tangible reward	3.43	1.23	54
16	Lack of recognition	3.39	1.10	46
17	Lack of assistance in contribution	3.36	0.87	46
18	Lack of contributions from colleagues	3.11	1.34	43
19	Lack of gratefulness	3.07	1.12	25
20	Lack of mandatory organisational policy on contributions	2.89	1.26	48
21	Lack of assurance against belittling by colleagues	2.75	1.17	25

Group G9: The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.13. The strongest inhibiting factor is 'lack of awareness of the process of contribution', with a mean of 4.14, standard deviation of 0.53 and 93% positive responses.

Table 5.13 Inhibiting Factors of Group G9

Sl.No	Inhibiting Factors (G9)	Mean	SD	PR
1	Lack of awareness of the process of contribution	4.14	0.53	93
2	Lack of awareness on the significance of the contribution to the organisation	4.07	0.83	71
3	Lack of user friendly technology infrastructure	4.00	0.88	78
4	Lack of integration of the process of contribution with day to day work	4.00	0.68	78
5	Lack of feedback	3.79	0.89	64
6	Lack of protection of intellectual property	3.79	0.89	64
7	Lack of assurance against negative reverse impact	3.71	0.91	57
8	Lack of awareness of knowledge requirements	3.57	1.09	14
9	Lack of expertise in organizing the available knowledge	3.43	0.85	50
10	Lack of time	3.29	1.07	50
11	Lack of assistance in contribution	3.36	1.08	50
12	Lack of directive from the reporting officer	3.36	1.01	43
13	Lack of awareness of the utility of the contributions	3.36	0.84	43
14	Lack of weightage for contribution in performance appraisal	3.14	1.08	28
15	Lack of mandatory organisational policy on contributions	2.93	1.00	21
16	Lack of recognition	2.86	1.10	21
17	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	2.79	0.97	21
18	Lack of assurance against belittling by colleagues	2.71	1.07	14
19	Lack of tangible reward	2.64	1.01	14
20	Lack of contributions from colleagues	2.57	0.94	7
21	Lack of gratefulness	2.57	0.51	10

Group G10: The inhibiting factors of the group in the descending order of the mean are depicted in Table 5.14. The strongest inhibiting factor is 'lack of user friendly technology infrastructure', with a mean of 4.23, standard deviation of 0.60 and 91% positive responses.

Table 5.14 Inhibiting Factors of Group G10

Sl.No	Inhibiting Factors (G10)	Mean	SD	PR
1	Lack of user friendly technology infrastructure	4.23	0.60	91
2	Lack of feedback	4.11	0.83	82
3	Lack of integration of the process of contribution with day- to-day work	4.00	0.87	80
4	Lack of expertise in organizing the available knowledge	4.00	0.84	82
5	Lack of awareness of knowledge requirements	4.00	0.77	77
6	Lack of awareness on the significance of the contribution to the organisation	3.94	1.06	74
7	Lack of awareness of the utility of the contributions	3.89	0.99	77
8	Lack of time	3.83	0.92	77
9	Lack of assurance against negative reverse impact	3.77	1.11	71
10	Lack of awareness of the process of contribution	3.76	0.77	67
11	Lack of assistance in contribution	3.71	0.96	68
12	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	3.69	0.90	77
13	Lack of recognition	3.66	0.91	65
14	Lack of assurance against belittling by colleagues	3.57	1.07	57
15	Lack of protection of intellectual property	3.49	1.27	57
16	Lack of directive from the reporting officer	3.37	0.91	51
17	Lack of gratefulness	3.37	0.88	57
18	Lack of weightage for contribution in performance appraisal	3.14	1.46	54
19	Lack of contributions from colleagues	3.09	1.01	37
20	Lack of tangible reward	3.03	1.25	40
21	Lack of mandatory organisational policy on contributions	2.91	1.20	48

5.3.2 Organisation

The inhibiting factors of the organisation in the descending order of the mean are depicted in Table 5.15.

Table 5.15 Inhibiting Factors of the Organisation

Sl.No.	Inhibiting Factors	Mean	SD	PR
1	Lack of user friendly technology infrastructure	4.10	0.81	77.55
2	Lack of integration of the process of contribution with day-to-day work	4.08	0.85	78.36
3	Lack of awareness of knowledge requirements	4.03	0.87	82.04
4	Lack of awareness on the significance of the contribution to the organisation	4.01	0.99	75.10
5	Lack of feedback	4.00	0.85	77.95
6	Lack of awareness of the process of contribution	3.89	0.80	73.77
7	Lack of time	3.72	1.00	68.16
8	Lack of assurance against negative reverse impact	3.71	1.02	64.08
9	Lack of expertise in organizing the available Knowledge	3.71	0.92	64.89
10	Lack of awareness of the utility of the contributions	3.68	0.95	64.48
11	Lack of assurance on meeting the knowledge requirements by the organisational knowledge repository	3.58	0.98	56.79
12	Lack of protection of intellectual property	3.50	1.17	53.87
13	Lack of recognition	3.35	1.12	48.57
14	Lack of weightage for contribution in performance appraisal	3.34	1.19	51.42
15	Lack of assistance in contribution	3.31	1.12	48.97
16	Lack of directive from the reporting officer	3.27	0.98	40.00
17	Lack of gratefulness	3.17	1.10	37.14
18	Lack of tangible reward	3.12	1.14	36.32
19	Lack of mandatory organisational policy on contributions	3.09	1.16	37.55
20	Lack of contributions from colleagues	3.09	1.07	34.69
21	Lack of assurance against belittling by colleagues	3.00	1.05	31.02

The most predominant inhibiting factors based on mean (mean >=4.0) are 'lack of user friendly technology infrastructure' (mean=4.10), 'lack of integration of the process of contribution with day to day work' (mean=4.08), 'lack of awareness of knowledge requirements' (mean=4.03), 'lack of awareness on the significance of the contribution to the organisation' (mean=4.01), and 'lack of feedback' (mean=4.00). The organisation need to formulate and implement an action plan to eliminate or at least minimize the inhibiting factors, to achieve higher levels of KM maturity.

The frequency distribution of most predominant 5 inhibiting factors (based on mean) for the groups and the organisation in descending order is depicted in Table 5.16.

Table 5.16 Frequency distribution of Most Predominant Inhibiting Factors

Sl.No.	Inhibiting Factors	Frequency	Percentage
1	Lack of integration of the process of contribution with day-to-day work	10	18.2
2	Lack of feedback	9	16.4
3	Lack of awareness of knowledge requirements	8	14.5
4	Lack of user friendly technology infrastructure	8	14.5
5	Lack of awareness on the significance of the contribution to the organisation	6	10.9
6	Lack of awareness of the process of contribution	4	7.3
7	Lack of time	2	3.6
8	Lack of expertise in organizing the available Knowledge	2	3.6
9	Lack of assurance against negative reverse impact	2	3.6
10	Lack of gratefulness	1	1.8
11	Lack of recognition	1	1.8
12	Lack of awareness of the utility of the contributions	1	1.8
13	Lack of protection of intellectual property	1	1.8

It can be observed that, based on the frequency distribution the top 5 inhibiting factors are:

- Lack of integration of the process of contribution with day-today work
- Lack of feedback
- Lack of awareness of knowledge requirements
- Lack of user friendly technology infrastructure
- Lack of awareness on the significance of the contribution to the organization

5.4 DISCUSSION

The survey used a questionnaire which was pre-tested and modified based on the feedbacks received during the pre-test. Also the survey used stratification by taking each group as a separate entity. Also participants from each group were randomly selected. Hence, it can be considered as stratified random sampling. Also the responses were anonymous and voluntary. The analysis and the draft report were presented to the key officials of the organisation. Hence, though the organisation was selected based on accessibility to data, objectivity was maintained in the study.

Following are some of the suggestions made by the participants that indicate the areas that need to be improved.

- Some persons from each section should be made responsible to collect and make the information available
- All organisational publications should be made available in the portal
- Provision for marks for documents and contributors should be available
- Discussion forums should be made available
- In addition to approved knowledge documents, unapproved knowledge documents, blogs are also to be made available

- Search capability may be made more versatile
- More credit should be given to the knowledge sharer
- Submission of knowledge documents should be made mandatory
- Record of important discussions and talks should be made available

It can be observed that the most predominant inhibiting factor is the lack of integration of KM processes with day-to-day work. As highlighted in Section 1.5.2.1, the most important KM process in the context of an R&D organization is knowledge creation. Improvements in the effectiveness of knowledge creation will help an R&D organization to achieve higher levels of KM maturity. Hence, the process of knowledge creation and its context pertaining to one group are studied in Chapter 6.

5.5 SUMMARY

In this Chapter, the inhibiting factors which prevent various groups in the organisation as well as the organisation from attaining higher levels of maturity are identified through a survey. The profile of participants in terms of participation and demographic variables were analysed. The frequency distribution of most predominant 5 inhibiting factors for the groups and the organization were tabulated. The study revealed that the most predominant inhibiting factors are lack of integration of KM processes with day-to-day work, lack of feedback, lack of awareness and lack of user friendly technology infrastructure.

CHAPTER 6

KNOWLEDGE CREATION AND *BA*: A STUDY

In this chapter the process of knowledge creation and the concept of *ba* are discussed. A new framework of *ba* based on the mode of knowledge creation and the type of interaction is proposed. Also the design of *ba* in the organisational context is illustrated. Subsequently the current practice of knowledge creation, in one of the groups (G9) of the organisation discussed in Chapter 4 is studied. Also taxonomy for knowledge pertaining to the group is developed.

6.1. INTRODUCTION

Knowledge creation is the most important KM process in the context of an R&D organisation and it takes place in *ba*. Improvements in the effectiveness of knowledge creation will help an R&D organization to achieve higher levels of KM maturity. This thesis proposes a new *ba*, viz, SECI *ba*, based on literature survey and organisational study and illustrates in the organisational context. The illustration is in the general context of the organisation and specific context of one of the groups (G9) of the organisation discussed in Chapter 4. This study of knowledge creation was conducted based on the published literature, the information available on the knowledge management portal and a semi structured interview conducted with a few knowledge officers of the group.

The group G9 is responsible for the operation and maintenance of a Fast Breeder Test Reactor(FBTR). This reactor was designed and constructed based on an agreement that was signed with French Atomic Energy Commission for transfer of the design of the Rapsodie Reactor, training of personnel in Rapsodie and transfer of manufacturing technology for critical components. It is a 40 MWt/13.2 MWe sodium cooled loop type mixed carbide fuelled reactor

and it is operational since 1985(Srinivasan, et al., 2006). It is a research reactor intended to gain knowledge in design, construction, commissioning, training, operation, maintenance and decommissioning of fast reactors. It also serves as a test bed for various R&D related to fuel development and structural materials.

Vast amount of knowledge was created during the reactor design, construction, operation, maintenance and experiments carried out in the reactor. This knowledge is preserved, shared and utilized for the design of new fast breeder reactors, which are being constructed. The knowledge in reactor is classified based on phase of the reactor like R&D, design, construction, commissioning, operation, etc. and further based on reactor subsystems like neutronics, sodium system, steam water system, electrical system, central data processing system, fuel handling system and auxiliary systems. The knowledge is further classified based on different forms like experiences, incidents, lessons learned, improvements and recommendations and further based on the form of knowledge like publications, internal reports, design document etc.

This being the first operational fast reactor in India, the initial knowledge transfer from the collaborators was very effective. The subsequent knowledge creation, knowledge sharing and knowledge preservation resulted not only in the improved performance of the reactor, but also in the design of new fast reactors. Every technical challenge in the reactor has been unique in its own way. Every problem has been identified, right solutions found and the journey continued. Every problem was a challenge which brought different diagnostic techniques and troubleshooting aids as its spin off. This made the reactor operation and maintenance an exciting journey towards continuous learning for perfection and mastery of a nascent technology (IGCAR, 2010).

6.2 SECI *Ba*

The four types of *ba* described in Section 1.5.2.1 correspond to four modes of knowledge creation and based on type of interaction, viz., individual or collective and media of interaction, viz, face to face or virtual.

This thesis proposes four types of *ba* (SECI *Ba*) in line with four modes of knowledge creation viz., socializing *ba*, externalizing *ba*, combining *ba* and internalizing *ba*. These four modes of knowledge creation can take place by real interactions or virtual interactions through the use of ICT. Hence, these result in eight types of *ba*, namely, *real socializing ba*, *real externalizing ba*, *real combining ba*, *real internalizing ba* and *virtual socializing ba*, *virtual externalizing ba*, *virtual combining ba*, *virtual internalizing ba*. as depicted in Figure 6.1.

Real Socializing Ba	Real Externalizing Ba	Virtual Socializing Ba	Virtual Externalizing Ba
Real Internalizing Ba	Real Combining Ba	Virtual Internalizing Ba	Virtual Combining Ba

Figure 6.1 SECI *Ba*

Also since the interactions can take place at different levels of the organisational unit, the 8 types of *ba* specific to the organisational unit can be evolved resulting in nx8 independent *ba*, where 'n' is the number of organisational units.

6.3 TYPES OF *BA* IN THE ORGANISATIONAL CONTEXT

The organisation considered is the one discussed in chapter 4. It is divided into various Groups which are divided into Divisions and further divided into Sections. In this context, the following *ba* are possible:

- Sectional *ba*
- Divisional *ba*
- Group *ba*
- Organisational *ba*
- Inter-organisational *ba*

Different *ba* based on organisational units is depicted in Figure 6.2. In all the above organisational unit based *ba*, the 8 types of *ba* described earlier are possible.

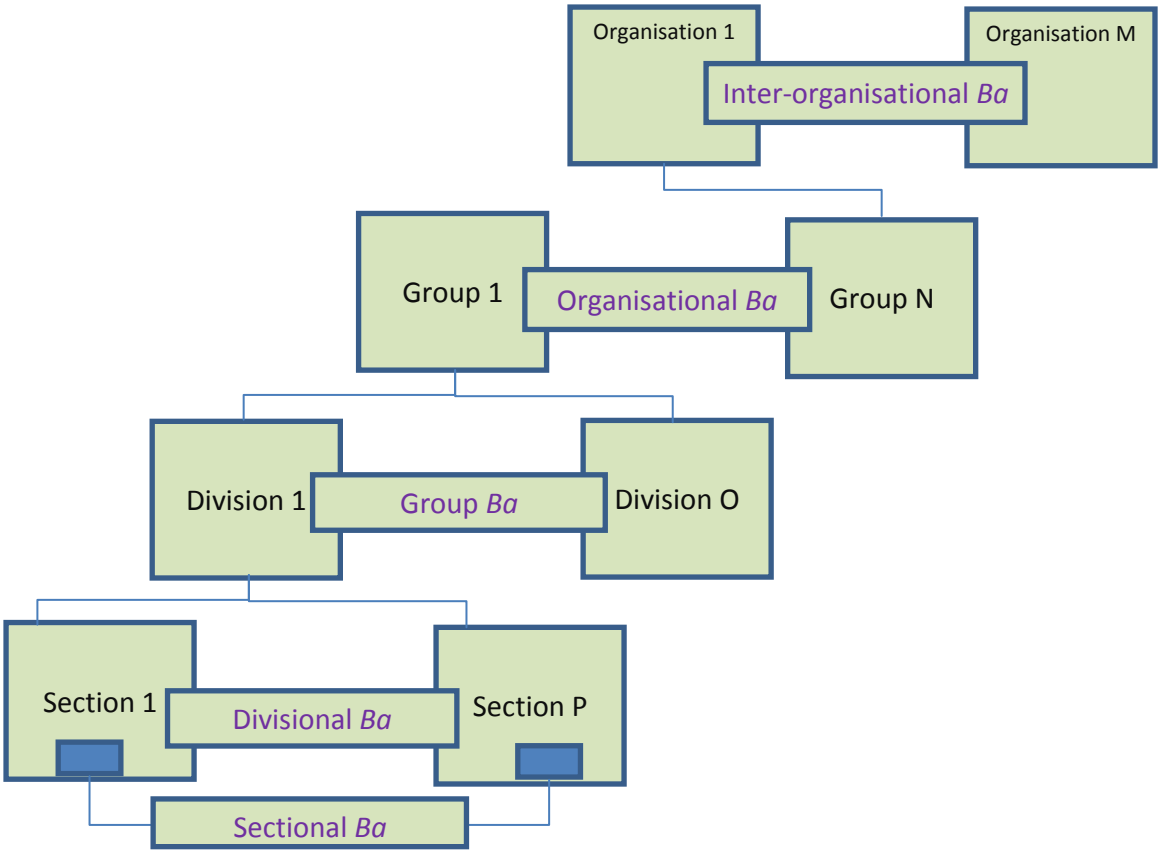


Figure 6.2 Types of *Ba* based on organisational units

In sectional *ba* the participants are limited to the members of the section. Formal and informal meetings organized within the section, where different modes of knowledge creation takes place are examples of sectional *ba.* In Divisional *ba* the participants are limited to the members of the Division, but they transcend sectional boundaries. Formal and informal meetings organized within the Division, like task force meetings, project review meetings, divisional meetings, where different modes of knowledge creation takes place are examples of Divisional *ba*.

In Group *ba* the participants are limited to the members of the Group but they transcend the Divisional and Sectional boundaries. Formal and informal meetings are arranged within the Group, like Task Force meeting, Group meetings and Technical meetings, where different modes of knowledge creation takes place are examples of Group *ba*.

In Organisational *ba* the participants are limited the organisation, but they transcend the Group, Divisional and Sectional boundaries. Formal and informal meetings, that are organized within the organization, like Task Force meetings, various Committee meetings where different modes of knowledge creation takes place are examples of organisational *ba.*

In Inter-organisational *ba*, the participants transcend the organisational boundaries. Formal and informal meetings organized with participants from various organisations where different modes of knowledge creation takes place are examples of Inter-organisational *ba*.

Ba that exist in different organisational units can be connected to form a greater *ba*, in a similar way as that of a modular system. However the coherence among the *ba* has to achieved based on shared knowledge vision, trust and care. Also knowledge flow takes place in both directions when different *ba* are integrated as depicted in Figure 6.3.

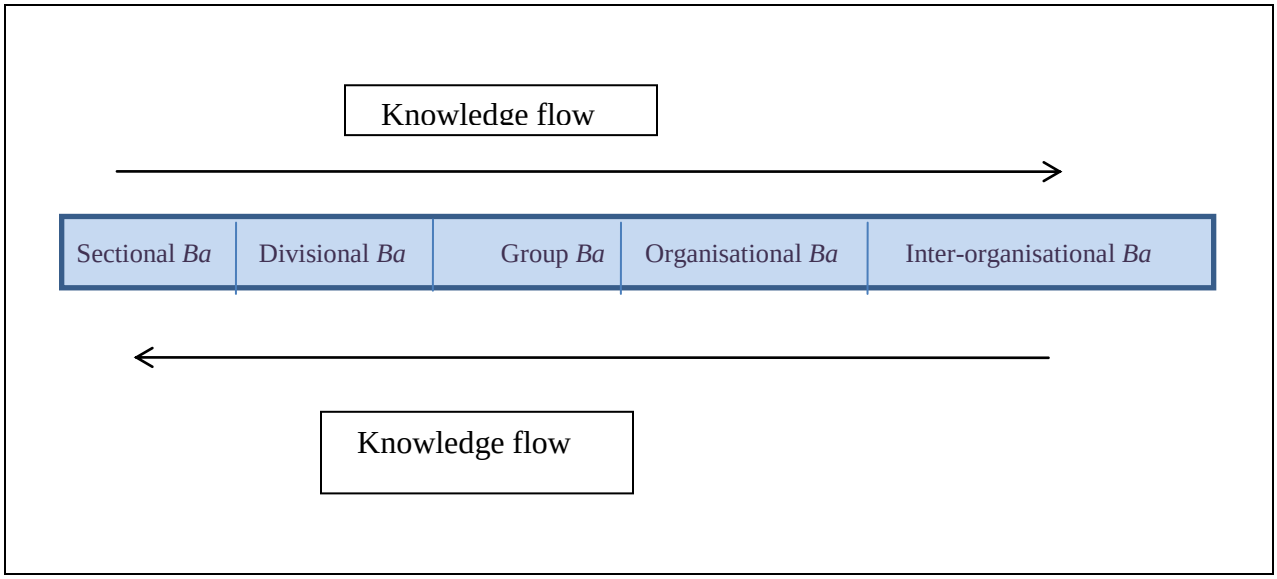


Figure 6.3 Integration of *Ba*

6.4 KNOWLEDGE CREATION IN GROUP G9

Knowledge creation in Group G9 was studied based on semi-structured interview with key officials of the group. The guiding Questionnaire is given in Appendix E. In the context of the Group G9 all the 4 modes of knowledge creation takes place regularly. Since this group is mainly located in a single building almost all the knowledge creation takes place in real mode. When socialization mode is considered, the initial project team was given on the job training in Rapsodie. At present new operators are given on the job training followed by different levels of assessment in the form of qualification tests. Also the operators meant for new reactors are given on the job training. Daily morning knowledge sharing sessions are held, where the experience of the previous day and the work plan for the current day are discussed. These knowledge sharing sessions are attended by knowledge engineers and selected knowledge practitioners. In addition, there are regular weekly knowledge sharing sessions conducted for knowledge engineers,

knowledge officers and selected knowledge practitioners. In addition, there are periodic knowledge sharing sessions attended by knowledge officers, selected knowledge engineers and external experts. All these knowledge creation processes take place in 'Real Socializing *Ba*'.

Considering the externalization mode, regular tacit knowledge elicitation programmes are held, and the elicited knowledge in the form of audio/video recordings and documents are made available in the knowledge portal. Also regular weekly meetings of knowledge engineers with knowledge officers and knowledge engineers with knowledge practitioners are conducted, where discussions and brainstorming sessions are held. These knowledge creation processes take place in 'Real Externalizing *Ba'*.

Also minutes of meetings of important knowledge sharing sessions are prepared and shared. Daily operation logs are prepared and shared. Operation document for each system is prepared and shared. An 'event reporting system' is in practice where normal plant events and significant events are documented and shared. System manuals and flow sheets are prepared and shared. Operation manuals and emergency operating procedures are documented and shared. Monthly schedule and monthly reports are prepared and shared. This reactor has recently completed 25 years of successful operation. A knowledge module in the form of a book was brought out combining various knowledge modules from the various phases of the project like design, construction, commissioning, operation, maintenance, R&D, retrofitting etc. This is another classic example of combination mode of knowledge creation that had taken place in 'Real Combining *Ba*'.

Class room and on the job training are given to the operators, maintenance personnel, station chemists and reactor physicists. Whenever a modification in any of the systems are required, the proposal for the modification is discussed and an engineering change notification is prepared and circulated among the relevant stake holders and concurrence is obtained before the modification is being carried out. The initial project team of the reactor had internalized the fast reactor design knowledge from the design documents provided by the Rapsodie engineers. Similarly, the operators of the reactor internalize the knowledge of fast reactor operation from operation manuals. These are examples of 'Real Internalizing *Ba*'.

6.5 KNOWLEDGE CLASSIFICATION IN GROUP G9

Within each phase of FBTR, the knowledge is classified based systems, subsystems and sub-subsystems. This classification based on systems, subsystems and sub-subsystems for the Group G9 is detailed in Table 6.1. The reactor is divided into 9 systems viz Reactor Block Pile, Sodium System, Steam Water System, Auxiliary System, Fuel Handling, Station Power Supply, Turbine & Alternator, Central Data Processing System and Reactor Protection System. Each system is divided further into subsystems and sub-subsystems.

Table 6.1 Reactor systems and subsystems

System	Subsystem	Sub-subsystem
Reactor Block Pile	Reactor Assembly	
	Rotation Plug Cooling System(RPC)	
	Reactor Core	
	Interseal Argon system	Core Cover Plate Mechanism (CCPM)

System	Subsystem	Sub-subsystem
		Core Thermocouple Couple (CTC)
		Control Rod Drive Mechanism (CRDM)
		Inflatable Seals
	Biological Shield Cooling	Emergency Storage Tank
	Control Rod Drive Mechanism	
	Clad Rupture Detection circuit (CRD)	CRD in Argon
		CRD in Sodium(DND)
	Displacement Measurement Device(DMD)	
	Preheating and Emergency cooling	
	Primary cover gas	Helium Injection Circuit
Sodium System	Primary Sodium System	Primary Sodium Main Circuit
		Primary Fill & Drain Circuit
		Primary Cold Trap Cooling Circuit
		Primary Sodium Purification Circuit
		Primary Sodium Pumps and Drives
	Secondary Sodium System	Secondary Sodium Main Circuit
		Secondary Sodium Purification Circuit
		Secondary Cold Trap Cooling Circuit
		Hydrogen in Argon Detection
		Secondary Cover Gas
		Sodium in Argon Detection (SAD)

System	Subsystem	Sub-subsystem
		Secondary Sodium Pumps and Drives
		Steam Generator Leak Detection System
Steam Water System	Condensate System	Chemical Dosing Units
	Steam water system	Condensate Polishing Unit
		Auxiliary Steam Circuit
	Feed water system	Package Boiler
Auxiliary System	Raw water system	
		Service Water System
	Fire Fighting	Domestic Water System
		Fire Water System
		CO2 Fire Fighting System
	Compressed Air System	Mulsyfyre System
	Service Argon System	
	Active Liquid Effluent System	
	Condenser Cooling Water Circuit	
	Service Water System	
	Reaction product discharge & recovery circuit	
	Dimineralised water plant	Demineralised Water Storage and Distribution System
	Flooding System	
	Air condition and Ventilation	Active Building Air Conditioning and Ventilation
		Inactive area Air conditioning and Ventilation

System	Subsystem	Sub-subsystem
Fuel Handling	Fresh Element charging and transfer	
	Fresh Element storage and transportation	
	Irradiated element transport and storage	
	Irradiated element discharging	
Station Power Supply	Main power Supply	6.6KV power supply Bus
		415V power supply Bus
	Emergency power supply	Diesel Generators
	Control power supply	24V DC power supply/Battery Bank
		48V DC power supply/Battery Bank
		220V DC power supply/Battery Bank
		Uninterrupted power supply(UPS)
Turbine & Alternator	Alternator and its auxiliaries	Generator air cooling
	Centrifuge	
	Turbine and its auxiliaries	Gland sealing
		Vaccum system
		Turbovisory parameters
Central Data Processing System	Main system	
	Stand alone system	
Reactor Protection System	Neutronic Instruments	
	LOR circuit	
	SCRAM circuit	

It can be observed that some of the subsystems may not have sub-subsystems. For instance the subsystem 'Reactor Assembly' has no sub-subsystem. Within each system/ subsystem/ sub-subsystem, the knowledge is further classified based on type of knowledge like "Lessons Learned", "Experiences", "Precautions", "Guidelines", "Recommendations", "Improvements", "Incidents" and "Repeated Incidents". The causes of the incidents were categorized as "Design Deficiency", "Operator Error", "Equipment Failure" etc. Also the remedial measures are documented.

The knowledge is also categorized based on the form of knowledge like publications, presentations, internal reports, design reports, manuals, drawings, operating documents, minutes of meetings, elicited knowledge etc.

The taxonomy starts with the phase of the reactor like R&D, Design, Consruction etc. Within each phase, system/ subsystem/ sub-subsystem is considered. Within each system/ subsystem/ sub-subsystem, the type of knowledge and further the form of knowledge are considered. The developed taxonomy is depicted in Figure 6.4

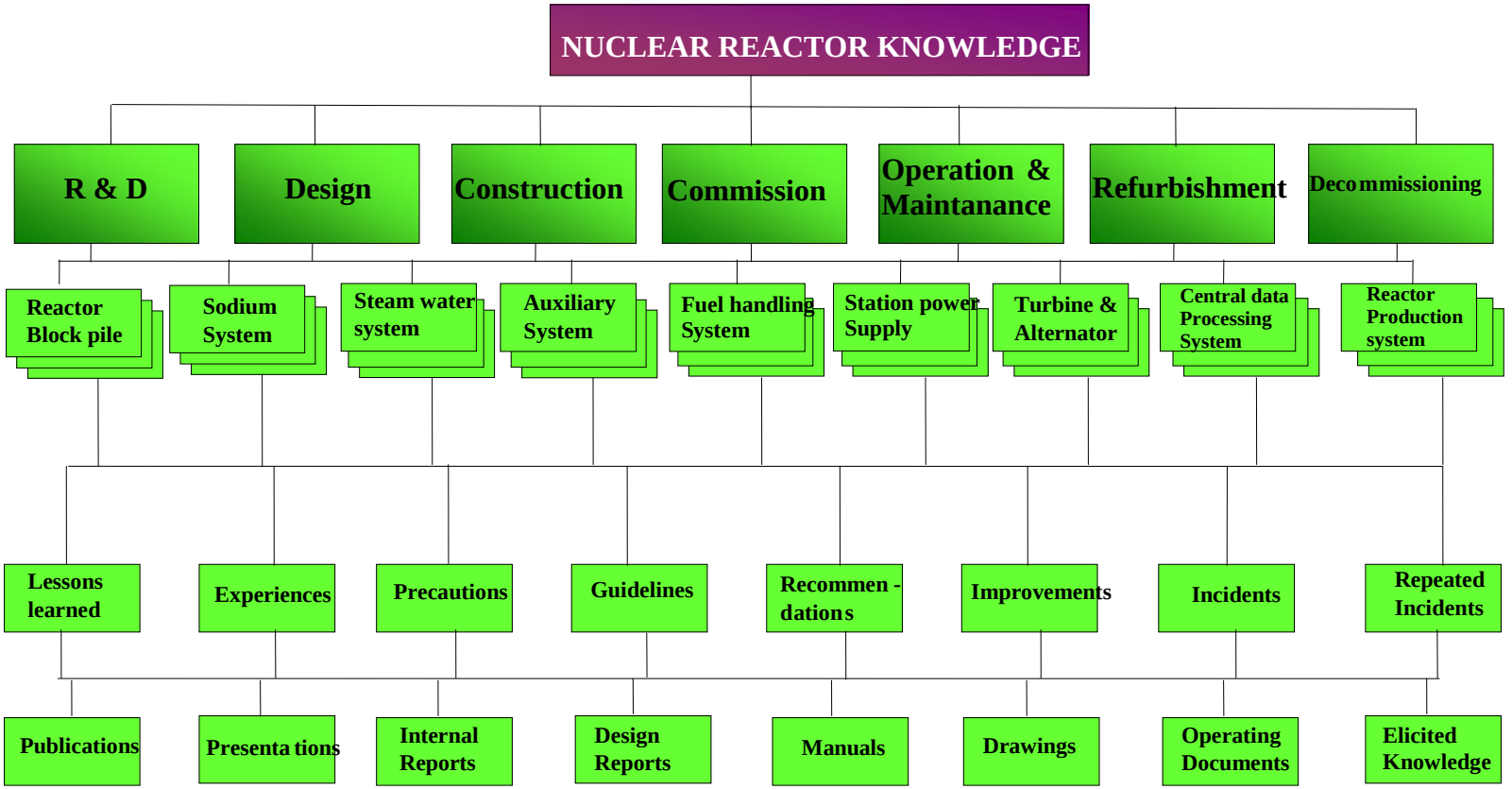


Figure 6.4 Taxonomy of Reactor knowledge

The following typical examples illustrate the structure of knowledge base. It starts with the phase of the reactor, followed by reactor subsystem, followed by type of knowledge, followed by the form of knowledge followed by the actual documents

Examples:

- Construction → Sodium System → Precautions → Internal Report →Cleanliness
- Commissioning → Sodium System → Primary Sodium → Guidelines → Internal Note→ Leak Tightness
- Commissioning → Sodium System → Secondary Sodium System → Incident → Internal Report → Sodium Leak from Cold Trap → Causes → High Heat Flux → Remedial Measures →Provide Surface Thermocouples
- Commissioning → Sodium System → Lessons Learned→ Presentation→ Stringent Quality Assurance Procedures
- Commissioning → Sodium System → Recommendations → Publication→ Transfer of Sodium from a Storage Tank → Usage of Electro Magnetic Pump rather than Pressurizing the Tank
- Operation → Reactor Protection System → Control Rod Drive Mechanism →Incident → Internal Note → Uncontrolled Withdrawal of one Control Rod → Causes → Sluggishness of Raise Contactor → Remedial Measures→ Control Rods Level Discordance as Lowering of Rod Input

Each knowledge module has meta knowledge structure with Title, Author, Journal/Conference/ Technical Meeting/Others, Date, Summary, Keywords, Utility, and Target Users. Also tacit knowledge has a structure with Name, Designation, Qualification, Date of Birth, Date of joining

Service, Contact Details, Expertise, Interest, Domains of work, Projects Carried out, Knowledge Artifacts and Remarks.

6. 6 SUMMARY

In this chapter the process of knowledge creation, which is the most important KM process in the context of an R&D organisation was discussed. A framework of *ba* based on the SECI mode of knowledge creation and the type of interaction was proposed (SECI *ba*). Also the design of *ba* in the organisational context was illustrated. The current practice of knowledge creation, in the group based on SECI *ba* was discussed. A taxonomy for the knowledge pertaining to the group was developed. The developments were discussed with the key officials of the group. Improvements in knowledge creation can significantly improve the KM maturity level of the group.

CHAPTER 7

SUMMARY AND RECOMMENDATIONS

In this chapter the thesis is summarized in terms of objectives, research methodology, analysis, findings, contributions, recommendations and limitations.

7.1 RESEARCH OBJECTIVES

The core objective of the research was to develop a flexible and adaptable KM maturity model combining the attractive features of the existing models. Demonstration and validation of the model were part of the core objectives. Assessing the current level of KM maturity of the organisation and its sub units also were objectives. Identifying the inhibiting factors to attain higher levels of maturity for the organisation and its sub units was also an objective. Knowledge creation being the most important KM process in the context of R&D organisation, a detailed study of this process was another objective. Development of a taxonomy pertaining to the knowledge of one of the sub-units of the organisation was another objective. Arriving at an appropriate recommendation for the context organisation to achieve higher levels of KM maturity was the final objective.

7.2 RESARCH METHODOLOGY

A combination of case study and survey was used without triangulation. Case study was used to identify the KM maturity levels of the organisation and its 10 sub units, while survey was used to identify the inhibiting factors to attain higher levels of KM maturity for the organisation and its 10 sub units. Through study of existing KM maturity models and morphological analysis, the strengths of the existing models were identified. Based on the above studies a new flexible and

adaptable KM maturity model which combines the attractive features of the existing models was developed. The model was validated by expert judgment. Also application of the model was demonstrated and validated through a case study of a nuclear R&D organisation. The current KM maturity levels of the organisation and its 10 sub-units were assessed through case study approach. The inhibiting factors to attain higher levels of KM maturity for the target organisation and its 10 sub-units were identified through survey methodology. The recommendations to attain higher levels of KM maturity for the organisation were given. Also the process of knowledge creation and *ba* in the general context of the organisation and specific context of one sub unit of the organisation were studied. SECI *ba*, based SECI model of knowledge creation was proposed in the organisational context. A taxonomy pertaining to the knowledge of the sub unit also was proposed.

7.3 ANALYSIS AND FINDINGS

The study revealed that, the organisation had initiated formal KM practices, a few years back, with a KM policy, technology infrastructure, and KM roles. It had attained a KM maturity of Level1+, in 'People' Key Area, Level 1 in 'Process' Key Area, Level 1+, in 'Technology' Key Area and Level 1 in 'Knowledge' Key Area. The organisation has achieved an 'Employee Satisfaction' of 'Low' in KM activities. However as per the model, RoI is not evaluated for Level 1 maturity. The organisation has achieved an overall KM maturity of Level 1. The study had identified many inhibiting factors, which prevented the organisation from attaining higher levels of maturity. The study had also assessed the KM maturity of the individual sub units of the organisation and identified the respective inhibiting factors.

7.4 RECOMMENDATIONS

Currently the context organisation has attained an overall KM maturity of Level 1. However, many groups are in Level 1+ and 1++ with respect to 'People', 'Technology' and 'Knowledge' Key Areas. The organisation needs to focus more on 'Process' and 'Knowledge' Key Areas to move to Level 1+ and 1++. For the organisation to progress to Level 2, it needs to qualitatively improve up on the various parameters identified in the model. Also it needs to have a mechanism to monitor and take corrective actions on the qualitative progress on the parameters. To progress to Level 3 the organisation needs to introduce quantitative monitoring in addition to qualitative monitoring. The recommendations for improving the maturity are proposed in the following sections based on key areas and enabling factors.

7.4.1 People

Currently the awareness of KM among the employees is low. A working definition of 'knowledge' and 'knowledge management' needs to be developed. A typical definition is given in Section 7.6 of this thesis.

Awareness can be improved by seminars, discussions, brainstorming sessions, knowledge cafes etc. The awareness need to be periodically monitored, qualitatively and corrective actions need to be taken.

The participation of employees in KM activities is currently low. This level of participation need to be improved by assigning higher level of priority to KM activities. Recognition of the benefits of KM, to employees and to the organisation in practical terms can enhance the participation. Participation can be monitored by No. of documents submitted, No. of documents downloaded, No. of knowledge sharing sessions, over all knowledge sharing quality index etc.

Though there are formal KM roles, the effectiveness is low. Assigning higher priority and proper training for KM roles can enhance the effectiveness. Introduction of qualitative and quantitative monitoring of the effectiveness can improve it further.

The effectiveness of mentoring and succession planning is low. In general the reporting officer acts as the mentor and hence knowledge transfer takes place. However the busy schedule of the reporting officers and probable negative reverse impact can adversely affect the effectiveness of knowledge transfer. The succession planning generally follows the seniority. However if the successor can be identified at least two years ahead of superannuation, the effectiveness of knowledge transfer can be further improved. All the critical tasks need to have knowledge preservation schemes by proper documentation and tacit knowledge transfer to probable successors to guard against unplanned attrition.

Formal communities, in the form of 'Quality Circles' and 'Technical Colloquiums' are existing. Also informal communities are existing. However more and more communities need to be created and nurtured to make it more effective in knowledge sharing, problem solving and innovation. Adequate support by the reporting officers and qualitative and quantitative monitoring can improve further the effectiveness of communities of practice.

7.4.2 Process

The current KM processes are centered around mandatory documentation like publications, design reports, presentations etc. and formal knowledge sharing sessions like colloquiums, seminars etc. The effectiveness need to be monitored, qualitatively and quantitatively and corrective actions need to be taken. The effectiveness of the KM policy and KM strategy need to be improved through brain storming sessions and feedback. Lack of process integration was one

of the major inhibitors. Hence KM should get integrated with more and more normal work process.

7.4.3 Technology

Currently an intranet based knowledge portal is available. About 800 users are accessing the portal every month. Also another system is operational for management of data. Integration of both systems will bring more benefits. Also introducing features for document submission, rating, approval, feedback, publishing, collaboration, keeping track the usage etc. will enhance the utility. AI and KE techniques for knowledge representation, knowledge elicitation, knowledge discovery etc. can be introduced after a critical level of participation and utility has been established.

7.4.4 Knowledge

A knowledge organisation scheme based on a flexible taxonomy applicable for the organisation and individual sub-units is to be developed. A typical taxonomy applicable for one of the sub units was developed in Chapter 6. It is necessary to identify core, advanced and innovative knowledge applicable to the organisation and individual sub-units. Documenting experiences like 'lessons learned', 'best practices', FAQ etc. need to be made mandatory. The quantity and quality of knowledge available in the repository and its utilization need to be monitored qualitatively & quantitatively and corrective actions need to be taken periodically.

7.4.5 Return on Investment

Benefits of KM efforts need to monitored periodically and corrective actions need to be taken. Though the study has been conducted based on employee satisfaction alone, other factors of organisational performance as per the model also need to be considered.

7.4.6 Enabling Factors

Many enabling factors were discussed in Chapter 1. These factors are enabling conditions for successful KM. Also the study identified the present inhibiting factors that prevent the organisation and various sub units from achieving higher levels of KM maturity. Removing the inhibiting factors will enhance the effectiveness of KM activities. A knowledge sharing culture, need to be nurtured with a strong commitment and involvement from the leadership. The impact of various enabling factors, on improving the maturity need to be studied. The presence of these enabling factors need to ensured to achieve higher levels of maturity.

7.4.7 Procedure for KM Activities

A typical procedure for implementation of KM activities is given below. The activity considered is 'KM Awareness Creation'. Similar procedure need to be developed for all other KM activities.

KM Activity : KM Awareness Creation

Goal: The goal of awareness creation is to ensure that all the employees understand the practical meaning of KM, its importance, the benefits to individuals and to the organisation, the method of practicing and monitoring.

Policy: The management is committed to improve the awareness of KM among all the employees and create a shared vision with respect to KM for the organisation.

Action Plan: The awareness about KM can be improved by different methods like training, group discussion, soliciting suggestions, ideas, feedback from employees etc. It is felt that each Division can be one entity targeted for improving the awareness.

Resources Required: Skilled manpower, financial resources and infrastructural resources

Stake Holders: All the employees

Responsibility: The responsibility of improving awareness should be entrusted to employees who are motivated to carry out the work.

Training: The necessary training to the people to whom the responsibility of improving the awareness has been entrusted may be given.

Monitoring: Monitor the progress in awareness and shared vision at Divisional level through survey, focus group, semi structured interview etc.

Review and Correction: Review the progress with appropriate level of management and take the corrective actions.

7.5 CONTRIBUTIONS

The major contributions of this thesis are:

1. Development of a morphological frame work of KM maturity models (Chapter 2)
2. Development of a flexible and adaptable KM maturity model (KMI-KMM) based on the unique concept of 'Key Maturity Indicators' (Chapter 3)
3. Application of the proposed KMI-KMM model for assessment of the level of maturity in the context of a nuclear R&D organisation and its groups (Chapter 4)
4. Identification of the inhibiting factors of the context organisation and its groups to attain higher level of KM maturity and recommendation for improving the KM maturity (Chapter 5 & 7)
5. Study of knowledge creation process, the context of knowledge creation and classification of knowledge in one group of the organization (Chapter 6)

7.6 CONCLUSION

Formal knowledge management is in the fore front of the business strategy of many organisations. Deriving business benefits from KM depends on many factors. A guiding KM maturity model is essential for any organisation, embarking on formal KM, to bench mark its activities. The major contributions of this research to the body of knowledge in the discipline of KM is given in Section

7.5. As a spin off to this study, KM awareness programmes were conducted in all the groups of the organisation, and hence, the target organisation is benefited, by improved KM awareness and a better understanding of the KM path ahead. As a working definition, an organisation can consider knowledge as ***that data, information and experience when shared and utilized by the organisational entities, has the potential to improve the organisational performance***.

This thesis redefines KM as one ***that creates and nurtures the technology and people centric organisational environment of trust, solidarity and co-opetition where liberal knowledge creation, knowledge sharing and knowledge utilization takes place as an integral part of every role, on a continuous basis, thereby improving the dynamic capacity of the employees to act effectively, in various situations resulting in improved organisational performance and thus improved quality of life and happiness to all the stakeholders.*** Knowledge management creates synergy and long term sustainable growth, prosperity and happiness to individuals, teams, organisations, society, nations and to the entire world.

CHAPTER 8

FUTURE WORK

The core contribution of this research is the flexible and adaptable KM maturity model based on the unique concept of Key Maturity Indicators. In this chapter, the possible extensions to this research are discussed.

This model has been developed based on the study of 15 KM maturity models and the context study of one organisation. Detailed study of more number of maturity models will provide insights into more number of attractive features and the model can be improved by incorporating those features which are relevant. In-depth study of more number of organisations where maturity models are applied can provide additional insights to improve the model further. The model can be tuned to the requirements of the organisation by tuning the Key Maturity Indicators and introducing additional Key Maturity Indicators that are relevant to the organisation and removing the ones that are irrelevant to the organisation, thus developing organisation specific models.

In addition to the validation by expert judgment, the model has been demonstrated and validated in the context of only one organisation and its 10 subunits. More number of organisational studies can be carried out to further validate the model. The model can be validated across multiple industry sectors by conducting organisational study across those industry sectors. Also a longitudinal study of the same organisation using the model can demonstrate the improvements in the KM maturity of the organisation and also aid in further validation of the model.

Detailed study of one of the KM processes namely knowledge creation was carried out in one of the organisational subunits. As an extension to this research knowledge creation process in other

subunits of the organisation can be studied. Also other KM process like knowledge sharing, knowledge utilization, knowledge preservation etc. can be studied in one or more number of organisational subunits. These studies can provide valuable insights to further improve the model.

Development of a maturity model is only a beginning. It needs to undergo many improvements until the model itself attains the 'maturity'. The following remarks are worth pondering about, for any organisation embarking on KM initiatives.

Continually improved and well applied knowledge will be the fuel to improve quality of life for the world at large (Wiig 1997)

Only when we have made up our minds that sharing knowledge is important, not only for efficiency's sake, but also to increase the humanization of the business and social environments, in which we work, we will be prepared for the task confronting us. When established procedures are not conducive to the sharing of knowledge, the company must be ready to re-structure itself in to an organisation, more amenable to knowledge sharing (Davenport and Probst 2002).

Though the initial battle to win the first converts to the practice of knowledge sharing is a hugely uphill one, with a judicious mix of motivation, facilitation and awareness mechanisms, steady progress can be made on the road towards achieving greater sharing and the pace of adoption accelerates with time. Once a 'critical mass' of users has been reached, the movement reaches a take-off point, beyond which it becomes self sustaining without significant effort being devoted to motivation. KM becomes part of the organisational fabric and sharing becomes an integral part of every role across the organisation, thus reducing considerably the effort required of dedicated KM roles. (Kochikar and Suresh, 2003).

APPENDIX – A

EXPERT OPINION ON KMI-KMM MODEL

Assessment of the KMI-KMM Model proposed by
Mr. K Kuriakose as part of the Doctoral Thesis on
"INFORMATION TECHNOLOGY AND KNOWLEDGE ENGINEERING CENTRIC KNOWLEDGE MANAGEMENT: A MATURITY MODEL BASED ON KEY MATURITY INDICATORS", based on the request of Dr. T. Jayakumar, HBNI

Sl. No	Parameter for assessment of the KMI-KMM model	Assessment options	My assessment	Comments, if any*
1	The proposed model confirms with the theory and practices in the KM literature	(Agree) / Disagree / Not known	Agree	I think this work is very unique in its outcomes and is a fruit of systematic effort. These researcher has combined multiple inputs from different sources to develop a model that captures different parameters very well. Highly commended and recommended for a doctorate degree.
2	The proposed Key Areas, Key Parameters and Key Maturity Indicators are relevant	(Relevant) / Irrelevant / Not known	Relevant	
3	The Key Area, Return of Investment (RoI) proposed in the model is useful and good	(Agree) / Disagree / Not known	Agree	
4	The proposal of a maturity level for extended organization is acceptable	(Acceptable) / Not acceptable / Not known	Acceptable	
5	The approach followed in the model development process is very arbitrary	Arbitrary / (Non-arbitrary) / Not known	Non arbitrary	
6	The proposed model is flexible concerning addition / removal of key parameters	(Agree) / Disagree / Not known	Agree	
7	The proposed model can be adoptable to other organisations as well	(Agree) / Disagree / Not known	Agree	

* *Additional pages may please be used, if required*

Signature: J. Ajithkumar

Name: J. AJITH KUMAR

Contact details: Associate Dean and Professor, (Research) T. A. PAI MANAGEMENT INSTITUTE, MANIPAL, KARNATAKA – 576104

Tel: 0820-270-1028

T. A. PAI MANAGEMENT INSTITUTE * MANIPAL *

Assessment of the KMI-KMM Model proposed by
Mr. K Kuriakose as part of the Doctoral Thesis on
"INFORMATION TECHNOLOGY AND KNOWLEDGE ENGINEERING CENTRIC KNOWLEDGE MANAGEMENT: A MATURITY MODEL BASED ON KEY MATURITY INDICATORS", based on the request of Dr. T. Jayakumar, HBNI

Sl. No	Parameter for assessment of the KMI-KMM model	Assessment options	My assessment	Comments, if any*
1	The proposed model confirms with the theory and practices in the KM literature	Agree / Disagree / Not known	Agree	
2	The proposed Key Areas, Key Parameters and Key Maturity Indicators are relevant	Relevant / Irrelevant / Not known	Relevant	
3	The Key Area, Return of Investment (RoI) proposed in the model is useful and good	Agree / Disagree / Not known	Agree	
4	The proposal of a maturity level for extended organization is acceptable	Acceptable / Not acceptable/ Not known	Acceptable	
5	The approach followed in the model development process is very arbitrary	Arbitrary / Non-arbitrary/ Not known	Non-arbitrary	
6	The proposed model is flexible concerning addition / removal of key parameters	Agree / Disagree / Not known	Agree	
7	The proposed model can be adoptable to other organisations as well	Agree / Disagree / Not known	Agree	

* *Additional pages may please be used, if required*

Signature:

Name: Dr. M. G. SREEKUMAR

Contact details:

Dr. M.G. SREEKUMAR
Chief Librarian & Information Officer
Indian Institute of Management Kozhikode
IIMK Campus P.O
Kozhikode-673 570

Dr. M.G. SREEKUMAR
Adjunct Professor
Indian Institute of Management Kozhikode
IIMK Campus P.O
Kozhikode-673 570

Ph: 09447654066

Email: mgsree@iimk.ac.in

Assessment of the KMI-KMM Model proposed by
Mr. K Kuriakose as part of the Doctoral Thesis on
"INFORMATION TECHNOLOGY AND KNOWLEDGE ENGINEERING CENTRIC KNOWLEDGE MANAGEMENT: A MATURITY MODEL BASED ON KEY MATURITY INDICATORS", based on the request of Dr. T. Jayakumar, HBNI

Sl. No	Parameter for assessment of the KMI-KMM model	Assessment options	My assessment	Comments, if any*
1	The proposed model confirms with the theory and practices in the KM literature	Agree / Disagree / Not known	Agree	
2	The proposed Key Areas, Key Parameters and Key Maturity Indicators are relevant	Relevant / Irrelevant / Not known	Relevant	Number of key Parameters varies for each key area.
3	The Key Area, Return of Investment (RoI) proposed in the model is useful and good	Agree / Disagree / Not known	Agree	
4	The proposal of a maturity level for extended organization is acceptable	Acceptable / Not acceptable/ Not known	Acceptable	
5	The approach followed in the model development process is very arbitrary	Arbitrary / Non-arbitrary/ Not known	Non Arbitrary	Quantitative assessment is also carried out.
6	The proposed model is flexible concerning addition / removal of key parameters	Agree / Disagree / Not known	Agree	
7	The proposed model can be adoptable to other organisations as well	Agree / Disagree / Not known	Agree	

* *Additional pages may please be used, if required*

Signature: 4/7/14

Name: Dr. G.V. UMA
Professor
Department of Information Science & Technology
CEG Campus, Anna University, Chennai - 25.

Contact details:

Assessment of the KMI-KMM Model proposed by
Mr. K Kuriakose as part of the Doctoral Thesis on
"INFORMATION TECHNOLOGY AND KNOWLEDGE ENGINEERING CENTRIC KNOWLEDGE MANAGEMENT: A MATURITY MODEL BASED ON KEY MATURITY INDICATORS", based on the request of Dr. T. Jayakumar, HBNI

Sl. No	Parameter for assessment of the KMI-KMM model	Assessment options	My assessment	Comments, if any*
1	The proposed model confirms with the theory and practices in the KM literature	Agree✓ Disagree / Not known	Agree	A thorough analysis has been done by the researcher
2	The proposed Key Areas, Key Parameters and Key Maturity Indicators are relevant	Relevant✓ Irrelevant / Not known	Relevant	The indicators are very appropriate to the context chosen.
3	The Key Area, Return of Investment (RoI) proposed in the model is useful and good	Agree✓ Disagree / Not known	Agree	
4	The proposal of a maturity level for extended organization is acceptable	Acceptable✓ Not acceptable/ Not known	Acceptable	
5	The approach followed in the model development process is very arbitrary	Arbitrary / Non-arbitrary✓ Not known	Not Arbitrary	The researcher has done sufficient research benchmarking.
6	The proposed model is flexible concerning addition / removal of key parameters	Agree✓ Disagree / Not known	Agree	
7	The proposed model can be adoptable to other organisations as well	Agree✓ Disagree / Not known	Agree	Can be adopted with some context-specific changes

* *Additional pages may please be used, if required*

Signature: Gopa (09-July-2014), Chennai

Name: K. GOPALAKRISHNAN, Ph.D.

Contact details: Manager, Knowledge management Department,
Cognizant Technology Solutions
No.1, Veeranam Road, Perungudi
Chennai – 600 096
Phone (mobile): +91 9840192031
4263 1273

APPENDIX - B

QUESTIONNAIRE - SEMI STRUCTURED INTERVIEW(Pilot Study)

1. Percentage of activities of this Division in the following categories

   Basic Research 0, 25%, 50%, 75%, 100%

   Applied Research 0, 25%, 50%, 75%, 100%

   Design 0, 25%, 50%, 75%, 100%

   Development 0, 25%, 50%, 75%, 100%

   Project Execution 0, 25%, 50%, 75%, 100%

   Services 0, 25%, 50%, 75%, 100%

   Any other 0, 25%, 50%, 75%, 100%

2. Percentage of activities of the Division in the following modes

   individual oriented 0, 25%, 50%, 75%, 100%

   team oriented 0, 25%, 50%, 75%, 100%

3. What are the processes/ practices in your Division for Explicit & Tacit knowledge(with examples)(Explicit knowledge is that which is available in the form of documents, audio/ video recordings etc.; Tacit knowledge is the one that resides in the minds of the people in the form of experiences, intuitions, beliefs etc.)

   a. New knowledge creation/generation
   b. knowledge sharing
   c. knowledge utilization
   d. knowledge preservation

4. How can the practices be improved?
5. How can we integrate KM practices in day- to–day work practices?
6. Will you please give some examples of current & required knowledge pertaining to the Division
7. How can the knowledge pertaining to the Division be classified?
8. How can the knowledge management portal IGCIMS be improved?
9. What are effects of KM practices on performance in the level of Individual/ Division / Group / Centre ?
10. What are the parameters on which performance of Individual/Division is evaluated?
11. How do you motivate scientists for better performance including higher participation in KM activities?
12. Do you believe that an effective strategy and actions for organisation-wide management of Data, Information & Knowledge can foster collaboration, considerably save the productive time of scientists, and thus improve the overall organisational performance?

APPENDIX - C

QUESTIONNAIRE - FOCUS GROUP DISCUSSION

1. How often you use the knowledge management portal?
2. What is your total contribution in terms of knowledge documents to the portal?
3. How often you document your experiences and make it available to other members of the organisation?
4. How often you share your experiences in formal/informal knowledge sharing communities?
5. How far you are satisfied with the reward & recognition scheme for knowledge sharing?
6. How often you seek/ you get help from knowledge officers of your group?
7. How often you mentor your colleagues/ you are mentored by your colleagues?
8. How far you are satisfied with KM policy & strategy of the organisation?
9. How the various activities related to knowledge preservation, knowledge creation, knowledge sharing etc. can be improved?
10. How far you are satisfied with the knowledge management portal and KM activities of the organisation?

APPENDIX – D

QUESTIONNAIRE – INHIBITING FACTORS

Dear Colleagues**,**

The following questionnaire is to identify the areas of improvement in knowledge management practices at IGCAR.

I request you to fill up the details in an unbiased way and hand over the same to me.

Thank you very much for your time and effort.

K.K.Kuriakose, CD/EIG, 22906, kuriakose@igcar.gov.in

Knowledge Management (KM) Questionnaire

I. Complete the following sentence and **TICK (✓)** the appropriate column, indicating the extent to which the phrases hold true for you,

'I am willing to share more of my work, experiences, ideas, expertise, etc. with other members of the organisation as my contribution to the organisational knowledge repository:

SA-Strongly agree; **A**-Agree; **NA/DA**-Neither Agree Nor Disagree; **D**-Disagree; **SD**-Strongly Disagree

No		SA	A	NA/ DA	D	SD
1	If I have more time					
2	If I know what knowledge other people are interested in					
3	If someone helps me to get my contributions organized					
4	If I know where to put or send my contributions					
5	If someone else takes care of the details of submitting my contributions					
6	If the submitting system was more streamlined and user friendly					
7	If the process of contributing was more integrated with the work already I do					
8	If I know how people will use my contributions					
9	If I get some tangible reward for my contributions					
10	If I get more credit for my contributions					
11	If more people thank me for my contributions					
12	If I get feedback on my contributions					
13	If I know that my contributions are considered in my CR grading					
14	If I am assured that no one else is going to take credit for my work					
15	If I am assured that my contributions will not affect me negatively					
16	If I feel that my colleagues will not laugh at me					
17	If I feel that my contributions will make a difference to the organisation					
18	If my boss explicitly tells me to contribute					
19	If other people also contribute					
20	If I get the required knowledge whenever I need from the total contributions made by everyone to the organisational knowledge repository					
21	If the contribution is made compulsory as an organisational policy					

II . Suggestions for improving KM Practices of your GROUP/CENTRE :

III. Personal Data: Please TICK (✓) the blank column near to the option

1	Type of work	Research		Design/ Development		Project		Technical Services/ O&M	
2	Qualification	Diploma		Graduate		Post-Graduate		Ph.D	
3	Discipline	Science		Engineering					
4	Grade	Upto So/B		SO/C-E		SO/F-G		SO/H & Above	
5	Gender	Male		Female					
6	Age (Years)	< 30		30 - 39		40 - 50		> 50	
7	Service (Years)	< 10		10- 19		20 - 30		> 30	

APPENDIX –E

QUESTIONNAIRE - SEMI-STRUCTURED INTERVIEW AT GROUP G9

1. What are the current practices of socialization in your group?

    Weekly / Monthly meetings

    Informal meetings

    Others

2. Do you have specific place and time for meetings?

3. Do you record the discussions of the meeting or prepare the minutes of meeting

4. What are the current practices of externalization?

    Creation of documents

    Giving talks

    Interview

    Others

5. What are the current practices of combination?

    Monthly/Annual reports

    Publications

    Book

    Others

6. What are the current practices of internalization?

    Attending lectures

    Discussion

    On the job training

    Others

7. Can you give some examples of knowledge assets, skills, know-how etc?

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THANK YOU