Technology Infrastructure for KM Capability

Abdullah Kammani, Hema Date, Nisar Hundewale, and Rahmath Safeena

***Abstract*—Technological Innovation has changed the economic landscape of 21st Century. The effective use of Technology for creating and disseminating knowledge & expertise is a key activity of day to day life. General observations during the literature survey indicate that research on technology for knowledge activity was conducted by academics with respect to case-by-case issues, whereas commercial technology for knowledge activities developed by practitioners, were tailor made and suited for specific Knowledge work or activity. But these developments did little on tracing an overall technology framework required for knowledge activities. To fill this gap, this study adopts systems thinking approach and case study method to formulate a technology framework for knowledge activities. This study gives an appropriate categorization of various technology system used for knowledge activities.**

***Index Terms*–Technology infrastructure, KM capability, knowledge systems, systems thinking.**

I. Introduction

Over the past several years there have been intensive discussions about the importance of managing knowledge within our society. Scholars and observers from disciplines as disparate as sociology, economics, technology and management science agree that knowledge is at centre stage [1] of all developments. The effective use of technology for creating and disseminating Knowledge & expertise is a key activity in all organisations. Effective knowledge activities accelerate learning, optimize operational efficiency, improve decision making, increase innovation, enhance products, and achieve speedy deployment. The introduction of state-of-the-art Technology infrastructure facilities became more pronounced to support the ability to codify and collaborate these activities [2].

II. Problem

This knowledge era has developed considerable uncertainty and risk because of the contradictory nature of its enabling technologies [3]. For Successful application today, we need to understand the various technology available for such knowledge activities, as technology has become one of the critical factors for effective knowledge sharing [4] . New approaches are made possible by advances in IT and applied Artificial Intelligence.

Examples include Intranet, Internet, Groupware, E-groups, E-mail, Text Chat, Voice Chat, Video Chat, Blogs, Wikis, Semantic Web, Search Engine, Portals, mining software. But the major challenge faced by organization in todays environment is the presence of historical data, in the legacy system, which if properly leveraged promises of a wide amount of knowledge critical to enterprises. In attempts to address these challenges, business corporate has come up with various tools like Executive Information System, Digital Dashboards, and techniques viz., Knowledge Discovery at Database (KDD), also known as Business Intelligence (BI) in commercial application standpoint. General observations during the literature survey indicate that research on technology for knowledge activities was conducted by academics with respect to case-by-case issues, whereas commercial technology were developed by practitioners, with tailor made needs suited for specific processes. But these developments did little on retracing an overall technology framework required for knowledge activity. To solve this problem our study uses a systems thinking approach to find out various building blocks of technology framework supporting knowledge activity from a thorough literature survey.

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III. Methodology

First, a literature survey was done from different journals, books, reports to infuse some conceptualization of a systemic prospective of technology Framework adopted for knowledge activity and extract a pattern of relationship as explained in the literature review section below. Second, the authors infer the observation gained through literature review with three cases study. The technique of adopting case study to establish a framework is in accordance with Yin's [33] finding which states that case study is an appropriate tool for gathering research data when a need to focus on contemporary events is expressed. The detailed summary and analysis of these cases is given in a separate section of this paper.

IV. Literature Review

A. Knowledge Activity

Within a literature review of knowledge activity, [5] defines knowledge activity as "any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance in organisations. [6] suggests that knowledge activity addresses the generation, representation, storage, transfer, transformation, application, embedding, and protecting of organisational knowledge. Such definitions, while encompassing many aspects of "process" around knowledge, imply an essentially objectivist view of the subject. Even

more emphasis on technology within knowledge management may be found in writings by technology vendors. Others counter such views arguing knowledge is also concerned with the establishment of an environment and culture in which knowledge can evolve [7]. Often Information Technology (IT) and knowledge activity are thought to be one and the same. Rather, IT acts as a vessel for retaining, retrieving and recycling of Knowledge, while knowledge creation requires a human element to compile, analyze, and forward the Knowledge. Knowledge process in an organisation is enabled with support of Technology Innovation. Hamel & Prahalad [8], posits Technological Innovation (TI) as a useful and inevitable bridge for attaining competitive advantage from knowledge activities.

B. A Systems Thinking Approach to Knowledge Activity

"Systems thinking" is a unique approach to problem-solving that considers problems in their entirety [9]-[11]. Problem-solving in this way involves pattern finding to enhance understanding of, and responsiveness to, the problem. Outcomes from systems thinking depend heavily on how a system is defined because systems thinking examine relationships between the various parts of the system. This interdependence of elements is therefore defines the characteristics of the system, where as the dynamic behavior exhibited by a system depends on the nature, speed and intensity of interactions between the independent system elements [12]. Building a system integrated with databases, search and retrieval engines, collaborative tools, groupware or even with intelligent systems is very common [13]. Our primary focus is on the phenomenon of integrated technological framework for knowledge activity in an Organization, whereby we identifies five major constituents of Technology framework enabling knowledge activity viz., Network Infrastructure, Knowledge Repository, Knowledge Systems, Integration Layer and User Interface See (Figure 2) and establishes relationships between different components. In this approach we try to conceptualize that there is constant knowledge flow (indicated by directional arrows) between components of knowledge Systems and knowledge repository through the network infrastructure. It can be noticed that when the users, usually knowledge workers want to "know" something, they try to collaborate with other users or extract from knowledge repository by providing necessary keyword searches. In the case of learning systems, the users browse through all relevant files and acquire knowledge, where as in expert system the flow of knowledge is two way, in which the knowledge worker share and utilize the experience of each other. In some case the organisation itself publish company wise knowledge using publication system. Details about each constituent are discussed below. Maier, et al., [2] states that Knowledge Infrastructure creates an ICT environment for Knowledge work throughout the organisation.

C. Technology Framework for Knowledge Activtiy

User Interface: To be seamless, the knowledge activity system should embrace a suite of technologies, including intelligent agent software that, if properly integrated, provides a single user interface for access to knowledge resources and business processes - in essence, to act as a universal integration mechanism.

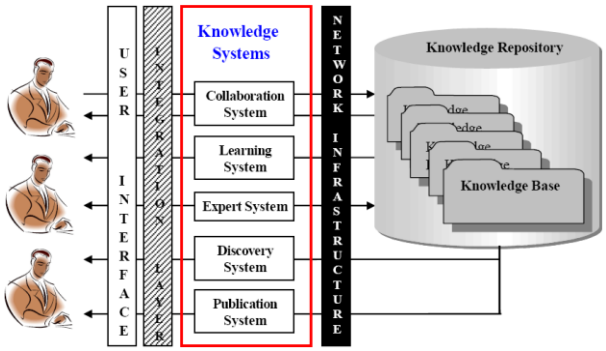

Fig. 1. Technology framework for knowledge activity

This UI provides user interface and necessary help to navigate or deal with three system functions as follows. Network Infrastructure Manager, Knowledge Repository Management (like DBMS, DW and Datamining) and their associated group (community) management for Knowledge services: registration, and authorization, etc.

1) Network Infrastructure: Infrastructure is a term used for variety of things. The most common contexts for the term are everyday life like, road, water, electricity and telecommunication. The foundation for an Enterprise wide knowledge activityinfrastructure is a computer network infrastructure. It is a nervous system or the backbone of a successful KM Practices, forming internets and intranets.

2) Knowledge Repository*:* Some of the technology innovation for that matter, are intended at providing a corporate memory, that is, an explicit, disembodied persistent representation of the knowledge and information in an organisation (a sort of knowledge base) which Carayannis [14] calls with the term Knowledge Repository and adds that it a capability for organisation with activity of storing knowledge with different knowledge schemata in a distributed database or a datawarehouse. Knowledge repositories occupy a central place in any knowledge management system which can be told as an online, computer-based storehouse of organized information, expertise, experience, knowledge and documents about a particular domain of knowledge and support wide range of activities like from business intelligence, customer relationship management to supply chain management, or new strategic initiatives [15].

3) Integration Layer*:* An integration layer coordinates a variety of knowledge Systems, with Knowledge Repository and User Interface on a Network Infrastructure platform. Here taxonomy or ontology is used to meaningfully organize and link knowledge elements that come from a variety of sources and are used to analyze the semantics of the organisational knowledge base [2]. As pointed out earlier Knowledge Systems work on the basis of integration services, e.g. a knowledge Repository which handles the organisations meta knowledge describing knowledge elements that comes from a variety of sources with the help of meta-data for a number of dimensions, e.g., person, time, topic, location, process, type. Therefore taxonomy, knowledge structure or ontology helps to meaningfully organize and link the knowledge elements are used to analyze the semantics of the organizational knowledge base.

Integration layer are needed to manage meta- knowledge elements and the users that work with the systems.

4) Knoweldge Systems*:* Advanced Technology innovations offers various system to support knowledge process and activities, which Maier, et al.*[2]* coined as knowledge Systems. For our purpose of study we have classified Knowledge System in to five systems which support knowledge process in terms of different stages of knowledge. Collaboration system target joint development of knowledge in teams, communities and knowledge networks. Learning system primarily helps to internalize knowledge and also foster learning circles and networks. Both of the above system deals with supporting the tacit dimension of knowledge, where as expert system deals with the conversion of tacit knowledge in to explicit form, thus forming knowledge based systems which to a certain extent help any novice user to have an expert intervention on decision making. Then is the discovery system which allows extracting nuggets of knowledge from the repository. These systems support the search, visualization and exploration of knowledge. Finally the publication system which deals with documentation, dissemination and reporting of bundled knowledge from the knowledge repository. All of these systems mentioned are integrated through integration layer.

a) Collaboration System: In an organisation that practice knowledge activityconsist of members from different locations, organisations, and firms. For that constellation, a virtual space (the „cyber ba‟) *[16]* by combining the word „cyber‟ with the term „ba‟ which aroused from the Japanese experiment of Knowledge Creating Company *[17]* is necessary to facilitate knowledge transfer within the team and between teams. The benefit of collaborative system is to manage, collaborate, communicate which includes convey and capture process of Knowledge from and to the teams in an organization. It integrates knowledge activitysolutions with a high-level framework, methodologies, systems and tools to optimize working with knowledge at all levels. One such application is groupware, which is a collection of computer software and work processes *[18]*.

b) Learning System: Schein, [19] argues that in a world of turbulent change, organisations have to learn ever faster, which cal.ls for a learning culture that functions as a perpetual learning system. That implies that there is continuous learning taking place in the organisation to ensure that, it can achieve customer satisfaction with their product or services. [20] says that a learning system exhibit sustainability by being easily adaptable to changing environmental conditions. Chen & Hsiang, [21] says that the e-learning systems in the virtual communities is associated with knowledge transfer are usually aimed at reducing costs and increasing efficiency (e.g., an effective use of long-distance education can reduce travel and other expenses) and to transform individual professional capabilities and to enhance overall the competitive advantage of the organization. Zander & Kogut, [22] are of the opinion that the learning capacity of a company‟ s members determines its organizational competitiveness in this age influenced by a growing knowledge-based economy.

c) Expert System: In a knowledge activityenvironment the emphasis is on developing a right circumstance to stimulate the development of knowledge. Skaates & Seppänen [23] says this era was strongly affected by interest in knowledge engineering techniques, as the use of knowledge engineering and so-called expert system technologies was widely anticipated to become dominant in computing. Here, the aim is to represent part of the knowledge, reasoning and decision making of an expert within a well-defined domain to use it as a decision support system [24]. These authors adds that such an expert system decides on certain problems; partly replaces the human expert and supports a (less experienced) person in doing an expert job. For Instance Hendriks [25] says that when Knowledge-based systems (KBS) are related to KM, a certain tendency exists to regard them as failed attempts to replicate human expertise [26]. Consequently, Hendriks [25] adds that these systems are treated as not inherently different from popular technologies used in KM, such as collaborative and publication system for disclosing knowledge sources [27]. Hendriks [25] also points out that introducing an Expert system (ES) in an organization has therefore certain implications for how the organization explicates structures and codifies its knowledge.

d) Discovery System: The Internet and the World Wide Web have made the process of collecting data easier, adding to the huge volume of data available to businesses, sometimes referred as avalanche of data [14] or mountains of data [28]. This process is known as “Knowledge Discovery system”. Apply knowledge discovery techniques (e.g. data/ text mining, neural networks, etc.) for mining knowledge bases/repositories and Improve query capabilities through natural language understanding techniques [29]. Raghu & Vinze, [30] posits that, the process of knowledge discovery was noticeably improved by placing the ontological structure on the information. Heinrichs & Lim, [31] states that web-based data mining tools provide the ability to extract knowledge, moreover they provide knowledge worker with the ability to focus.

e) Publication System: Knowledge needs to be distributed and shared throughout the organization, before it can be exploited at the organizational level [17]. To what extent a firm succeeds in distributing knowledge depends on organizational culture and the amount of explicit knowledge available in the firm. For many of them it has become data” [7] . The main two function of a publishing system can be pointed out as 1) disseminate and deliver explicit knowledge by abstracting, designing analyzing, editing, writing and reporting. 2) Publish explicit knowledge through document management, and KM portals which in turn includes content management, archives management, bibliometrics, cataloguing, codification, indexing, metadata, records management, taxonomies, text analysis and thesauri [32] . Oppong et al., [3] also says organization and storage of Knowledge techniques contribute to the effectiveness of knowledge publication and distribution. Till here we formalized and discussed in details about a Systemic Knowledge Infrastructure Framework which calls forth to adopt a case study technique to gain wider insights and establish the framework that has developed from real time settings. Thus we will discuss about the case study done for this study in the next section.

V. Case Analysis and Discusssion

As mentioned in the research methodology section, this

study involves observations from three companies, named as Case A, Case B, and Case C. The detailed summary and analysis of these cases is given in the following subsections. Documents related to the details of each case were also collected, reviewed with the intention to tease out three salient details. The first was the conceptualization of Knowledge and the rationale for which the KM is conceived. The second was to deliberate about the outcome of knowledge activity implementation. Below we try illustrating a brief summary of each case. From the review illustrated in the previous sections we conceptualized various components of an integrated technological framework for knowledge activity. Based on this conceptualization we did an in-depth interview with respondents of the above three cases and fetched out the following findings which would be helpful in bridging the missing links of earlier studies. During the case study the data was collected, categorized and analyzed. It was found that the extracted systemic framework (See Fig. 2.) from literature survey matches more or less with the Knowledge Infrastructure supporting knowledge activity in real time scenario (See Table I & II).

TABLE I: COMPONENTS OF KNOWLEDGE INFRASTRUCTURE FOR KM

Componenets	**Case A**	**Case B**	**Case C**
User Interface	√	√	√
Integration Layer	√	√	√
Knowledge Systems	√	√	√
Network Infrastructure	√	√	√
Knowledge Repository	√	√	√

TABLE II: KNOWLEDGE SYSTEMS AND EXMAPLES

Knowledge Systems	**Case E.g.**
Collaborative System	Lotus Notes Engine
Learning System	E-Vidyalaya
Expert System	Workflow templates
Discovery System	Search Facility, Ask- Experts
Publication System	Domino.doc

A. Case A

It is one of the largest and most respected companies in Indias private sector having a diversified line of business like technology, engineering, construction and manufacturing. It has an international presence, with a global spread of offices. It gives a definition for KM "as an art of creating value from an organization's intangible assets. It involves an integrated approach to the creation, capture, retention, accessing, sharing and leveraging of an enterprise's information assets for business gain. It encompasses a very massive task of integrating the vast resources of explicit knowledge and the tacit knowledge in the E&C Division. The integrated Knowledge Management system of E&C Division is called KnowNet and is used for harnessing the tacit knowledge and experience of E&C personnel.

B. Case B

This company revolutionized the Indian market by introducing products like Vacuum Cleaners in 1982, Water Purifiers in 1984, and Air Purifiers in 1994. New concepts to Indian homes at the time of introduction, today they have become almost a necessity in most urban middle-class homes. It pioneered the concept of Direct Sales in health and hygiene products, starting from a single office with ten field representatives in 1982, today operates from 200 offices covering 100 cities with over 7,000 sales representatives. For them knowledge activity promises to help companies to be faster, more efficient and innovative than their competitors and helps in considerably fulfilling the knowledge gaps formed due to the attrition of employees. It deals with the interactions between the organization and the environment and the ability of the organization to act and react.

C. Case C

It is a leading consulting and software services firm based in India, partnering with clients for technology based business convergence and transformation. The company is SEI-CMM level 5 certified and listed in major stock exchanges. It is an organisation demonstrating leadership in the implementation of knowledge management practices and processes by realizing measurable business benefits. It has started offering its knowledge management solutions and expertise to global corporate enterprises by providing a unique blend of domain knowledge.

VI. CONCLUSION

Knowledge Infrastructure for knowledge activity leads to systematic process of organizing, storing, enquiring, disseminating, thus increase in knowledge creation, sharing, utilization and retention. However an integrated view of Kn0owledge Infrastructure framework for knowledge activity would help in formulating two major issues; firstly, for practitioners, this will aid in optimizing technological architecture from the existing legacy infrastructure of the organisation, secondly for academics, it provides a common language to discuss and study the components of a Knowledge Infrastructure framework for KM. This study has tried compiled and categorized different systems that support Knowledge management. The fact that it is a conceptual model based on literature survey and a multi case study restricts the scope of the study to the main components of tools involved in Knowledge work is the limitation of the study. At the same time this study can be base for understanding and doing further research or implementation of technology framework required for KM.

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REFERENCES

[1] T. Davenport, D. D. Long, and M. Beers, "Successful Knowledge Management Projects," *Sloan Management Review*, vol. Winter, 1998, pp. 43-57.
[2] R. Maier, T. Hadrich, and R. Peinl, *Enterprise Knowledge Infrastructure*, Germany: Springer, 2005.
[3] S. Oppong, D. Yen, and J. Merhout, "A new strategy for harnessing knowledge management in e-commerce," *Technology in Society*, vol. 27, 2005, pp. 413-435.
[4] Y. Choi, "An empirical study of factors affecting successful implementation of knowledge management," *Doctoral Dissertation*, University of Nebraska, 2000.
[5] H. Scarbrough, J. Swan, and J. Preston, "Knowledge Management: A Literature Review," 1999.

[6] G. Hedlund, "A Model of Knowledge Management and the N-form Corporation," *Strategic Management Journal*, vol. 15, 1994, pp. 73-90.
[7] T. Davenport and L. Prusak, *Working Knowledge: How Organizations Manage What They Know*, Boston: HBS Press, 1998.
[8] G. Hamel and C. Prahalad, *Competing for the Future*, Boston: Harvard Business School Press, 1994.
[9] M. Hall, "Systems Thinking and Human Values: Towards Understanding Performance in Organizations," *The Performance of Social Systems: Perspectives and* Problems, F. Parra-Luna, Ed., New York: Springer, 2000, pp. 15-24.
[10] B. Montano, J. Liebowitz, J. Buchwalter, D. McCaw, B. Newman, and K. Rebeck, "A systems thinking framework for knowledge management," *Decision Support Systems*, vol. 31, 2001, pp. 5–16.
[11] P. Senge, *The Fifth Discipline:The Art and Practice of the learingi organisation*, New York: Doubleday, 1990.
[12] J. Morecroft, R. Sanchez, and A. Heene, "Integrating systems thinking and competence concepts in a new view of Resources, Capabilities, and Management Processes," *Systems Perspectives on Resource, Capabilities and Management Process*, J. Morrisson, R. Sanchez, and A. Heene, Eds., Oxford: Elsevier Science, 2002, pp. 3-16.
[13] K. Wong and E. Aspinwall, "Development of a knowledge management initiative and system: A case study," *Expert Systems with Applications*, vol. 30, 2006, pp. 633-641.
[14] E. Carayannis, "Fostering synergies between information technology and managerial and organizational cognition: the role of knowledge management," *Technovation*, vol. 19, 1999, pp. 219-231.
[15] P. Rastogi, "Knowledge management and intellectual capital - the new virtuous reality of competitiveness," *Human Systems Management*, vol. 19, 2000, pp. 39-48.
[16] M. Eppler and O. Sukowski, "Managing Team Knowledge: Core Processes, Tools And Enabling Factors," *European Management Journal*, vol. 18, 2000, pp. 334-341.
[17] I. Nonaka and H. Takeuchi, *The Knowledge Creating Company*, Boston: Harvard Business Press, 1995.
[18] J. Gunnlaugsdottir, "Seek and you will find share and you will benefit: organizing knowledge using groupware systems," *International* Journal *of Information Management*, vol. 23, 2003, pp. 363–380.
[19] E. Schein, *Organisational Culture and Leadership*, San Francisco, CA: Jossey-Bass, 1992.
[20] S. Richardson, J. Courtney, and J. Haynes, "Theoretical principles for knowledge management system design: Application to pediatric bipolar disorder," *Decision Support Systems*, vol. 42, 2006, pp. 1321-1337.
[21] R. Chen and C. Hsiang, "A study on the critical success factors for corporations embarking on knowledge community-based e-learning.," *Information Sciences*, vol. 177, 2007, pp. 570–586.
[22] U. Zander and B. Kogut, "Knowledge and the speed of the transfer and imitation of organizational capabilities; An empirical test.," *Organization Science*, vol. 6, 1995, pp. 76-92.
[23] M. Skaates and V. Seppänen, "Managing Relationship Driven Competence Dynamics In Professional Service Organisations," *European Management Journal*, vol. 20, 2002, pp. 430-437.
[24] D. Van donk and R. Jan, "Exploring the knowledge inventory in project-based organisations: a case study," *International Journal of Project Management*, vol. 23, 2005, pp. 75-83.
[25] P. Hendriks, "Do smarter systems make for smarter organizations?" *Decision Support Systems*, vol. 27, 1999, pp. 197-211.
[26] D. Skyrme, "Knowledge management solutions — the IT contribution," *SIGGROUP Bulletin*, vol. 19, 1998, pp. 34-39.
[27] S. Dutta, "Strategies for implementing knowledge-based systems," *IEEE Transactions on Engineering Management*, vol. 44, 1997, pp. 79–90.
[28] J. Fürnkranz, "A Brief Introduction to Knowledge Discovery in Databases," *ÖGAI-Journal*, vol. 14, 1995, pp. 14-17.
[29] J. Liebowitz and I. Megbolugbe, "A set of frameworks to aid the project manager in conceptualizing and implementing knowledge management initiatives," *International Journal of Project Management*, vol. 21, 2003, pp. 189-198.
[30] T. Raghu and A. Vinze, "A business process context for Knowledge Management," *Decision Support Systems*, vol. 43, 2007, pp. 1062-1079.
[31] J. Heinrichs and J. Lim, "Integrating web-based data mining tools with business models for knowledge management," *Decision Support Systems*, vol. 35, 2003, pp. 103-112.
[32] A. Abell and N. Oxbrow, Competing with knowledge: The information professional in the knowledge management age, London: TFPL, 2001.
[33] R. K. Yin, Case study research: design and methods, 2nd ed. California: Thousand Oaks, 1994.

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