An Eye Toward the Next-Generation Vision of Knowledge Management Systems

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Abstract

Ubiquitous computing environment accelerates the advent of the IT Ecosystem. In the coming generation, a massive number of ubiquitous devices and services are converged into an ultra-large-scale system. In this context, high degrees of complexity and organization change the paradigm of knowledge and its management levels. The objective of this paper is to explore the Knowledge Management Systems in view of demands in ultra-large-scale systems. We introduce motivation for Next-Generation (NG) usage and their upcoming requirements. The possible applications will be discussed, and summary of different techniques are conducted. The tools and techniques that allow KMS to operate as "Vital Success Enabler" to achieve organizational benefits will be examined. Potential future directions for research are highlighted: these include advances in knowledge capture, storage / retrieval and sharing techniques, in particular with the surrounding role of information technology.

Keywords:

Knowledge Management Systems, Organizational Knowledge, Ultra-Large-Scale Systems, User-Context, Information Technology

1. Introduction

Knowledge is substantially a different notion than data and information; that defined epistemological debate among researchers. And, how to manage the knowledge, has become an important question, since it naturally resides in the minds of people "who know". In the past few years, in KM literatures, several methods and techniques have been proposed to answer that question. The proposed methods, mainly, focused on acquiring, storing/retrieving and sharing of knowledge. In order to review and discuss those proposed solutions, this paper classifies them into two main classes: Information System (IS) and Non-IS (social) perspectives. While it is unnecessary for the purpose of this paper to engage in a debate to probe, question or reframe the Non-IS perspective. However, the detailed discussion about the benefits and limitations of solutions under the IS perspectives is elaborated. This is because such an understanding is useful to consider the manifold views of knowledge as discussed with the potential role of Information Technology. This will also enable us to uncover new aspects to systematize, enhance and expedite large-scale intra- and inter-firms knowledge management. We begin by considering vision of knowledge

2. Vision about Knowledge

Despite numerous attempts at defining the key concepts of 'Data', 'Information' and 'Knowledge', there still seems to be lack of a clear and complete picture of what they are and what the relationship between them is [1], and what it should be. We discuss the known understanding as well as the future vision of knowledge in the literature.

2.1 Existing View of Knowledge

The researchers in IT literature started addressing the question of defining knowledge by distinguishing data, information and knowledge. This orientation in turn reflected in the minds of IT experts for redefining data, information and knowledge. A generally accepted vision which has been developed is that data is raw numbers and facts, information is processed data and knowledge is authenticated information [2] [3] [4]. However, there has been a prolonged confusion in distinguishing knowledge from information in KM literature. The KM experts argue that knowledge is something different from data or information, if not; there is nothing new or interesting about knowledge management [5]. In an article by [6], they describe the view of knowledge as a stat of mind, an object, a process, access to information or probably a capability. In their opinion, knowledge is personalized 'stat of mind'.

2.2 Next-Generation (NG) View of Knowledge

In the business literature, knowledge is considered as power, and knowledge sharing is what enables the business to grow [7]. According to the author [8], knowledge is a fact of modern life and it is a reaction to far-reaching changes taking place in society due to a number of factors and events into a changing world of limitless connection as well as independence of thought. This phenomenon has led the KM workers from a document centric view of information usage to a knowledge centric view, while further moving has preceded the concept toward the user's context centric view that has been described as an important part of Ultra-Large-Scale (ULS) environment for the NG Systems [9]. Such kind of systems are said to adapt complementary approach to analyze the end user's behavior which provides knowledge according to the user's likes and dislikes, preferences or the way they behave. Based on this kind of new perspective of knowledge usage, new changes need to be suggested to generate new models of information structure including ontological techniques that better suited to the knowledge-needs of end users.

2.3 View of Knowledge at Ultra-Large-Scale (ULS) System

In the next few years, the impact of knowledge would be ubiquitous in an Ultra-Large-Scale environment. Knowledge would be managed i.e., captured, stored/retrieve and shared to/from visible as well as invisible devices but with doable context of the user who would be interacting with many systems at a time; while being part of the data, information and knowledge growth cycle (Figure 1.1). To process and analyze the meaningful needs of the user, it would be a complex activity leading the self-growing and self-organizing state of knowledge system. To meet such type of challenge, knowledge may need to be managed as a combination of declarative, procedural, relational and casual way [6].

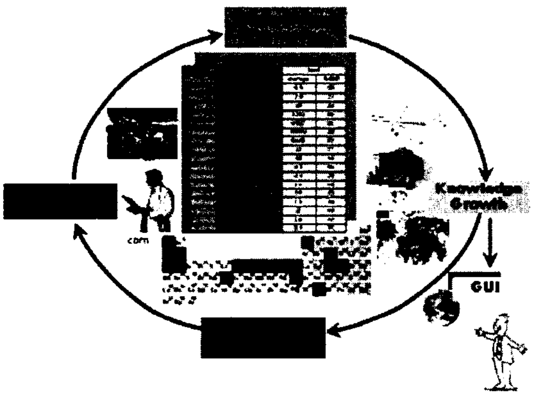

Figure 1 - Multi-system interaction with data, information and knowledge growth cycle

The system in Figure 1 that is capable of self-growing would essentially pose several challenges while managing knowledge on a large scale. We will discuss these potential issues later in Section 6. Before that, it is feasible to elaborate the hierarchical structure of knowledge growth and related issues at a bit lower scale i.e., organizational level, extensively discussed in the KM literature.

3. Hierarchical Structure of Knowledge at Organizational Level

A most widely cited view of knowledge is to deal it as organizational level, known as "Organizational Knowledge-Asset". To focus on this view, a practical definition of knowledge management by [7] describes that KM is the practice of treating knowledge like any other business asset as something to be used, maintained, and expanded to the benefit of the organization. The term asset is normally referred to the tacit knowledge (that resides in the individual's mind) and explicit knowledge (that is articulated in digital or hard-copy format). Indeed, the fundamental challenge is to manage both types of 'knowledge-asset'. By managing knowledge-asset means, to acquire knowledge from the individuals store/retrieve to/from knowledge-base (software or non-software) and share it among the users (knowledge workers in teams, departments) that may help organization to achieve its objectives. In general, knowledge exists at individual, team, department and organization level. Naturally, the knowledge-contents that reside in a group or team would be more than an individual's knowledge-contents (quantitatively). And, the knowledge-contents that reside at department or organizational level would be more than a team or an individual's knowledge-contents. The Figure 2 illustrates the quantitative view of tacit and explicit knowledge of a firm.

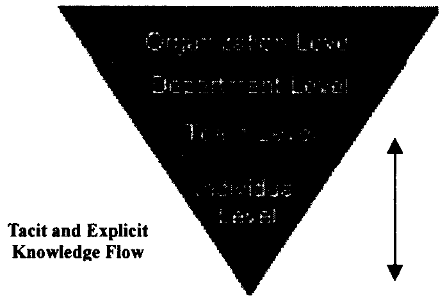

Figure 2 - Hierarchical Structure of Knowledge Flow

A typical knowledge management system should be able to manage the knowledge at each individual, team, department level as well as manage its flow across the levels that could add value to the organization. Here, by a typical knowledge management system, we mean a system that can help increase organizational overall capabilities in terms of human capital, physical capital, intellectual capital and financial capital (business benefits). More importantly, a good KMS should itself have dynamic behavior and be able in coping with the changing behavior of organization overtime.

4. Knowledge Flow at Cross-Organizational Level

While the preponderance of knowledge management theory stems from strategy and organizational theory research, the majority of knowledge management initiatives involve the role of Information Technology to significant degree [10]. IS-based solutions focus on cross-organizational flow of knowledge with the main KM processes of capturing, storing/retrieval and sharing knowledge using information technology in Ultra-Large-Scale environment. The following Figure 3 explains the horizontal flow of knowledge at cross-organizational. The knowledge assets at cross-organizational can be exploited in a variety of ways. By sharing and reusing best practices, for instance, Firm x can learn from other Firm y or Firm z and improve business process while eliminating duplication of effort. New collaborative business opportunities can be generated by collective intelligence and knowledge sharing on automatic need-driven basis [11].

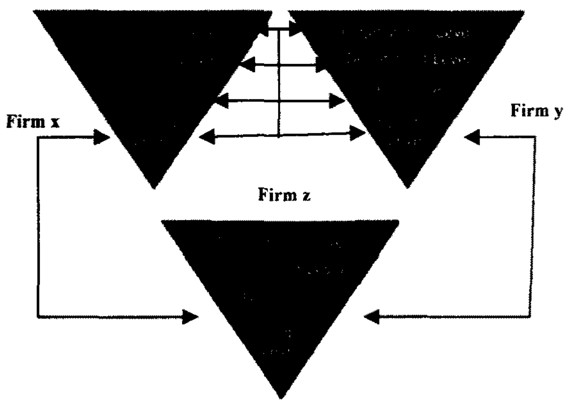

Figure 3 - Cross-Organization Knowledge Flow

However, automatic, need-driven, proactive and context-based knowledge sharing, in particular, at cross-organizational for self-growing-system, is the sparkling challenge. This issue has been discussed in Sections 6 and 7.

The following sub-section explains the implementation purpose of processes and modes for different types of knowledge described in literature.

5. Knowledge Types, Modes, Processes and IT Applications

Designers of knowledge management systems have attempted to implement different types of knowledge i.e., tacit and explicit to employ different modes of knowledge i.e., externalization, internalization and combination [21], to put into operation of the processes of knowledge i.e., capturing, storage/retrieval and sharing [6]. Through the implementation of IT application, process of coding for externalization, internalization and combination mode is performed. The process of coding, under externalization mode, requires successful delivery of "know how" (acquiring knowledge) from an individual's mind into the structured (SQL Knowledge-based form) or un-structured (XML, MS Word, audios, videos, reports, etc) database. Data warehousing, document repositories, software agents and expert forums are being used to create and acquire knowledge with a great value in IS design based solutions. Academic Sharing Knowledge (ASK) at NASA [11] and *Air Force's Knowledge Now (AFKN) in United States Air* Force [12] are the working practical applications. The process of coding, under internalization mode, requires successful delivery of "know how" (acquired knowledge) from structured or un- structured source to the tacit knowledge (minds of individuals). Data mining, search engines, semantic indexing, ontology, interfaces and knowledge ecosystem are some of the examples. Computerized Provider Order Entry (CPOE) by Partners is a promising healthcare system to help physicians for real-time decision making [13] is a practical example of IT application. The process of coding, under combination mode, requires successful delivery of "know how" (acquired knowledge) from structured or un- structured source into the explicit knowledge (again into structured or *un- structured source). Integrated solutions and content* management systems are the examples to achieve combinational mode that can later be used for knowledge reference. IBM Lotus Notes [16], Sun's Virtual Workplace [17], Autonomy [18] and Google Online Document Manager [19] are some of the working examples. Much of these applications use the concept of ontology and semantic web to search and extract information. Recently, however, much ontology creation has been a manual process. In the CYC [14], for example, commonsense knowledge was extracted manually from different sources and expressed using ontologies. A similar approach is used by Yahoo and Google Directory. However, semantic knowledge beyond static form of information will facilitate demands on process automation.

6. Research Issues in Knowledge Management Systems

Although, using ontology and semantic techniques, there have been several new and exciting developments in KM technologies and applications for different problem domains, however, like other technologies, KM technologies and its applications are evolving and broadening their horizon facing several research issues. We present some of the challenging issues faced or raised by KM researchers. In [12], while working on a knowledge management project for US Air Force, one of the most important and common issues he found was that existing IT infrastructure was originally designed to aggregate and synthesize data and information, but not to manage or share knowledge. Another issue raised is about 'Understanding users and their context' that has been described as a big challenge in a proposal report regarding Ultra-Large-Scale Systems by Depart of Defense (DoD) published in 2006 [9]. The Apple's concept of knowledge navigator [20] also projected several research questions, yet to be answered. One of them is the "relationship" between a knowledge management system and its user. It also suggests about "connecting knowledge to people" rather than "connecting people to knowledge" so that knowledge should be automatic, proactive and intelligent as the meaningful needs of the user. In fact, the existing KMS provides capability to individuals or a group of users, whereas the needs for organization, enterprise or ULS seek for the dynamic solutions for knowledge automation. That is why the existing solutions affect the demands of today's KM for agile globalization. The future expectation for Next-Generation KMS is about this "relationship" between systems and its users including context-based, need-driven solutions that are collaborative, proactive and responsive.

6.1 More Challenging Issue

From software development point of view, as mentioned earlier, most of the KMS research focuses and appreciates the use of ontology based solutions. However, the new focal point of the research is the continual adaptation of the ontology to the user's needs. By analyzing the usage data with respect to ontology, more meaningful changes can be discovered. Moreover, ever changing contents and dynamic context both are inevitable in future [15]. Hence, the contents and the structure of ontology-based application utilize the underlying ontology, by changing the ontology according to the user's context. The system itself should be tailored to the user's need. This would help a system to self-grow (Figure 4) and help its user to navigate in the system and acquire as well as share knowledge from the environment.

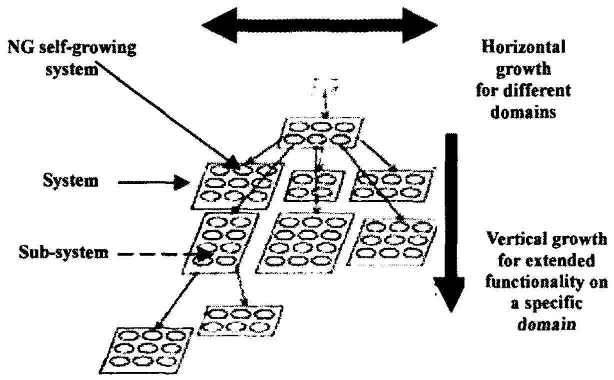

Figure 4 – NG Self-Growing View of System

Figure 4 is one way to understand the continuous and rapid expansion of self-growing ULS which contains many systems and each system contains a group of many sub-systems. Since it is a complex activity to design and build such a ULS, managing knowledge in such an environment would require extensive research.

7. Future Directions for Knowledge Management

Based on our literature review, we identify three significant areas of research that would potentially engage the interest of KM researchers in the next few years.

7.1 Context-Based Behavior Adaptation

Accurately understanding and capturing the user's context is a difficult task while in the ULS environment. The ever-changing and ever-growing nature of the system, its users, and its environment make this a far greater challenge [9]. The continuous modeling of user, their expectation and intention is the potential research area for KM in ULS space. In addition, drawing upon our discussion in the research issues section, a new dimension in KMS research is "Behavior Adaptation" where system should adapt their behaviors to the need of users and circumstances. A KMS need to serve diverse users with different needs at different times and with different fundamental relations to the system. To develop sophisticated insights into how to work on techniques that could help several thousands of group of users, application developers, architects, policy makers and infrastructure makers, wherein each of whom will have their own expectations to conceptualize the view of their domain in a natural way, leads to the new research dimension in KMS.

7.2 Ubiquitous Access of Knowledge

Wireless networks, mobile devices, ubiquitous information handling capabilities (embedded into everyday environments) and their dynamic reconfiguration is representing many challenges. Moreover, the expanding possibilities for distributed information storage and processing will guarantee that technological issues in KM remain important. In the increasingly self-growing "knowledganized society", the next generation knowledge management seems stay focused on the research area of distributed information storage and ubiquitous access of knowledge.

7.3 Knowledge Visualization

It is necessary to work on the use of semantics for better display. Since visualizing knowledge is an interesting research area. It could combine both semantic technologies and the psychology of human-computer interaction. Knowledge representation considering semantics is also crucial to present text and visual information in the manner of agility and pervasiveness.

8. Conclusion

The insight of this paper is based on a literature review on Knowledge Management Systems, its technologies and applications on the next-generation perspective. We have studied a number of issues for the complexity and multi-faceted nature of KM technologies tend toward context-based, need-driven, collaborative and responsiveness of KM applications. There are contradictory considerations in effective usage of users and complex integrated knowledge for expanding areas. The KMS technologies have the potential to become effective tool for the next-generation systems. It is our understanding that context-based, need-driven proactive, collaborative and responsive KMS will be the system for the Next-Generation Ultra-Large-Scale systems.

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