SOFTWARE REQUIREMENTS FOR KNOWLEDGE MANAGEMENT IN CONSTRUCTION ORGANIZATIONS

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Software vendors are continuously introducing different tools claiming that their products are the complete and ultimate solutions to Knowledge Management (KM) problems. This research investigates the vendors' claims, identifies the weaknesses in existing KM software, and explores the requirements for better KM software for construction organizations. The literature on KM software is first reviewed. Major vendors and users of KM software are then interrogated for a closer investigation of what current KM software can offer. It is found that existing software address only some elements of the KM sub-processes. In addition, they do not address the majority of the requirements of construction organizations. The research concludes that construction organizations need KM software to be more oriented towards the industry by addressing its specific needs. Some of these needs are discussed, in brief, at the end of the paper.

Keywords: knowledge management, knowledge management software.

INTRODUCTION

Knowledge is important to organizational survival in competitive markets and needs to be managed effectively in order to improve organizational performance. A KM process consists of several sub-processes (e.g. gathering, storing, and sharing knowledge) where the relationship between these sub-processes is not necessarily a linear relationship (Laudon and Laudon, 1998; Webb, 1998). These sub-processes need to be properly addressed and fully integrated in a KM system. Provided that the organizational culture is open, promotes trust, and there is willingness to share knowledge, the KM sub-processes can be successfully managed with the aid of appropriate tools and technologies.

IT (Information Technology) tools, non-IT tools, or a mixture can be used to support KM. The non-IT tools can be as simple as pen and paper, videotape, telephone, etc. Although these non-IT tools are important for managing knowledge, IT remains a key enabler for the implementation of KM (Anumba *et al.*, 2000; Egbu, 2000). IT can support the different sub-processes of KM for the use of a geographically dispersed team. IT tools and technologies form one third of the time, effort, and money that is required to develop and use a KM system (Davenport and Prusak, 1998; Tiwana,

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2000) and it is believed that "…it would be impossible for many companies to pursue their existing approaches to KM if existing IT capabilities were not available" (Manasco, 1996). IT supports KM by means of hardware and software systems with a continuously increasing number of KM software products. Software vendors claim that their products provide the complete and ultimate solution to KM problems. The claim of these vendors and what their products can do have been investigated, taking account of the organizational requirements of the construction industry. This paper presents the findings of the investigation conducted and outlines the software requirements for KM in construction organizations. First, a few key terms are defined and a review of the KM software market is presented.

DEFINITIONS

The term 'KM' is relatively new to construction organizations (Carrillo *et al.*, 2000) and there is no specific definition for it. From a construction context, KM can be defined as the process of capturing/gathering, storing and retrieving, transferring and sharing, modifying/updating, and using the different types of project knowledge that are mainly gained during a project's lifecycle. The principal aim of KM, from a construction perspective, is to make this knowledge easily accessible, modifiable, and usable so that time is saved, performance is improved, and innovation is enabled in future projects. This knowledge should cover all types of construction project and may be tacit or explicit, or in the form of best practices, lessons learned, etc.

The definition of 'KM Software' is debatable (Jackson, 1998). KM Software can be regarded as computer-based programs that support at least one element of the sub-processes of KM. Several KM software products can therefore be linked and fully integrated to form a 'complete KM software package' which eventually forms an essential part of the KM system in an organization.

RESEARCH METHODOLOGY

The research methodology used to identify the weaknesses in existing KM software include literature review, survey questionnaire, and semi-structured interviews. The literature review was generally aimed at identifying weaknesses reported in KM software from the perspective of academic researchers. To address the weaknesses of KM software related to specific KM sub-processes, a survey questionnaire was distributed to 37 software vendors, participating in a KM exhibition in London. The questionnaire was aimed at exploring the KM sub-processes that existing KM software do not support. Nine responses were received indicating a response rate of 24%. Semi structured discussions were also conducted with some vendors during the exhibition for a deeper understanding of the features of these software. Most vendors claimed that their software could support most, if not all, of the sub-processes of KM. However, these responses, which were received from vendors who were marketing their products, required further investigation. Semi-structured interviews were conducted with nine large UK construction organizations as a part of an on-going research project to verify the vendors' claims. The interviews aimed to achieve an evaluation of existing KM software from users point of view. It was found that most of the organizations recognize the role of KM software in supporting the KM process. However, there were some concerns about the maturity of the software products and their applicability in construction organizations.

KNOWLEDGE MANAGEMENT SOFTWARE MARKET

Literature Review

Any KM process consists of several sub-processes, which are also called typologies, categories, or families of KM. The literature review undertaken shows that there is a debate about the names, definition, and scope of these sub-processes as there may be some overlaps. Examples of some of the KM sub-processes are shown in Table 1. These sub-processes can be further subdivided into third level processes. For example, Ruggles (1997) divides generation into acquisition, syntheses, and creation while Jackson (1998) divides gathering into pulling, searching, and data entry.

Table 1: Examples of KM sub-processes identified by different authors

Author	KM sub-processes				
Ruggles, 1997	Generation	Codification	Transfer		
Davenport and Prusak, 1998	Generation	Codification	Utilization/ Transfer		
Jackson, 1998	Gathering	Storage	Communication	Dissemination	Synthesis
Laudon and Laudon, 1998	Creation	Capturing and Codifying	Distribution	Sharing	
Patel *et al.*, 2000	Generation	Representation	Retrieval	Sharing	
Anumba *et al.*, 2001	Obtain new Knowledge	Locate and Access	Propagate or Transfer	Maintain or Modify	

Jackson (1998) identifies two ways in which KM software can be categorized. The first is with respect to KM sub-processes (academic approach) and the second is according to software market (market approach). In the market approach, Jackson groups software into common categories: document management, information management, searching and indexing, communications and collaboration, expert systems, and systems for managing intellectual property.

In the academic approach, Ruggles (1997) is one of few who named KM software according to the sub-process they support (Table 2).

Table 2: Ruggles KM software categorization according to KM sub-processes (Source: Ruggles, 1997)

KM sub-process		KM software
Generation	Acquisition	GrapeVine
	Synthesis	IdeaFisher
		Inspiration
	Creation	Idea Generator (Project Kick-Start)
		MindLink
Codification		KnowledgeX
		Excalibur RetrievalWare and Visual RetrievalWare
		TeleSim
Transfer		(Lotus) Notes
		NetMeeting
		EnCompass

Bair and O'Connor (1998), however, categorized KM software in a different way. They identified software vendors and organized them by technology family (Table 3). Three technology families were considered and the classification of the systems was according to the capacity for collaboration over time and across the organization.

Table 3: KM technology families (Source: Bair and O'Connor, 1998)

Information Retrieval/ Knowledge Retrieval– IR/KR	Document Management (DM) GroupWare (GW)	Integrated Systems KR+DM+GW+ Data Management
Fulcrum		IBM – Lotus
Dataware	IBM-Lotus	(1999 onwards)
Verity	(1998 and prior)	
Excalibur		
OpenText-IDI	Documentum	
Lycos +	PCDOCS	
InMagic		
CompassWare	FileNet	
Sovereign Hill		
Inference		Novell
InXight	Autonomy	
Plumtree		
Perspecta	Firefly	Netscape
SageWare	Wiseware	
Wincite	GrapeVine	
Magnifi		
Individual	Group	Organization

Strength ↑

Capacity for collaboration over time and across the organization

WEAKNESSES IN CURRENT KNOWLEDGE MANAGEMENT SOFTWARE

Software products are being developed by vendors to support the KM process. These products have some common features, which have both strengths and weaknesses. Based on the literature review, survey questionnaire, and semi-structured interviews with construction organizations, KM software products are found to have the following weaknesses:

- *They are not easy to use and require extensive training* (Jackson, 1998). For example, PC PACK, a portable knowledge acquisition (KA) tool, contains difficult terminologies that are hard to understand (Milton *et al.*, 1999). Users find it difficult to decide when and how to best use the large number of tools that are available in a software. They also find it difficult to decide upon the category of the knowledge that has been captured;
- *They focus on managing explicit knowledge with very limited success in managing tacit knowledge* (Bair and O'Connor, 1998). The only tools that are found useful for managing tacit knowledge are "skills' yellow pages" also called "personal profiling systems" and groupware. Although these are very useful for enabling the sharing of knowledge, they remain incapable of capturing, validating, and storing the shared knowledge. In addition, experiences of individuals change rapidly leaving yellow pages outdated;
- *They are not sufficiently capable of capturing context even of explicit knowledge*. When explicit knowledge is captured, its context also needs to be captured, stored, and linked to this knowledge in a way that keeps the full and correct meaning of the knowledge. Knowledge loses its value and relevance if its context is not captured. This capture of context is not evident in current KM software;

- *They are inconsistent in retrieving knowledge*. In knowledge retrieval (KR) software, if a question is asked, the answer may be that "the knowledge requested does not exist". If the same question is rephrased, an overload of results may be obtained, some of which may not be relevant. These two extreme outputs will easily create a new barrier to KM as users will lose faith in the quality of output they get;
- *They are poor in updating and modifying the stored knowledge*. Knowledge gets outdated and this requires continuously updating the knowledge repository. If a KM system does not allow knowledge updating and modification, it will fail to provide up-to-date information;
- *They cannot be linked to many electronic information sources* (Jackson, 1998). The knowledge required by an organization is normally contained in several repositories. These systems can be within or external to the organization (e.g. databases, knowledge bases, the Internet, etc). Linking these different information sources shows limited success due to the dissimilar nature of the various systems containing the information;
- *They neglect human aspects and organizational cultures* (Scarborough *et al.*, 1999). Software vendors tend to focus on the technological aspects of their products, ignoring the fact that these products will not be successful if human aspects and organizational culture are not addressed. Software tools that measure the amount of knowledge contributed, who contributed it, and its validity and relevance can play an important part in supporting the incentive schemes which are important for the success of KM systems;
- *They are of 'One size fits all'*. Having software products, which are broad in their functions aim to make the software valid for use by anyone and any type of organization. This makes the software too general and impractical in many cases, leading to difficulties in using the software and the need for customization;
- *They focus on some elements of the KM sub-process*. Available KM software focus on the elements that are easier to manage. For example, many focus on how and where to store the gathered knowledge although it is more important at that stage to first focus on how to capture knowledge;
- *They cannot be linked to other KM software*. If an organization buys two KM software products each supporting one of the KM sub-processes, they will definitely need to link these products. Current KM software do not support this linking and this prevents the integration of software products to support the KM process. Being unable to link these software products discourages many organizations from implementing KM until they find a group of KM software that can work together as one system;
- *There is no one "Integrated KM Software System" or "Complete KM Software"* that can support all KM sub-processes (Bair and O'Connor, 1998; Jackson, 1998; Tiwana, 2000).
- *They focus on the operational/implementation level of KM.* No KM software was found to address the requirements of the strategic level, which precedes the implementation level. The strategic level is a stage that includes pre-implementation tasks where the problem needs to be defined, the system requires to be designed, and the likely impact of using the system needs to be identified;

- *They not address the specialized needs of construction organizations*. Sheehan (2000), the knowledge manager of a leading UK construction organization, states that they did not find an off-the-shelf tool that could manage the organization's knowledge. Some of the specialized needs of construction organizations are discussed in the next section.

REQUIREMENTS FOR CONSTRUCTION KNOWLEDGE MANAGEMENT SOFTWARE

The construction industry is a highly fragmented project-based industry that produces mainly one-off products (Evbuomwan and Anumba, 1996). This makes it different from other business sectors and necessitates certain features to be available in KM software to make them suitable for construction organizations. The construction industry consists of several sectors e.g. clients, consultants, contractors, material suppliers, facility management organizations, etc. Although, the specific requirements of these sectors vary, it is important to have software products that can be used by all of them, as this will facilitate collaboration between the different sectors within the industry.

Based on the interviews with construction organizations, specific issues need to be addressed in KM software for construction use. Software vendors are required to produce new tools that are oriented towards the needs of the construction industry. These should:

- *contain previously defined tools that are oriented towards the industry*. For example, knowledge categories within the construction industry should be defined in the software where users can directly store knowledge into the relevant category. Users should also be allowed to add more categories. Examples of construction knowledge categories are (Kamara *et al.*, 2001): knowledge of organizational processes, and procedures including in-house procedures and best practice guides; technical/domain knowledge of construction design, materials, specifications, and technologies including knowledge of the environment in which the construction industry operates; and know-who knowledge of people with the skills for a specific task, and knowledge of the abilities of suppliers and subcontractors;
- *capture best practices and lessons learnt from previous projects and ongoing projects during the different stages* (e.g. design, construction, etc). This also includes adding lessons learnt and explanations to relevant clauses of contract documents, specifications, etc;
- *be easy to use with minimum training*. Using KM software may require a long period of training. Construction organizations work under pressure of project deadlines and low profits. Thus, they invest very little on training. Software vendors should consider the limited time allowed for training within the industry. Using simple terminology and only including the features that are required can help in achieving this.
- Along with the specific issues that need to be addressed in construction KM software, there are other issues that are equally important to non-construction organizations. KM software should also address the following common issues:
- *support the different KM sub-processes* such as capturing/gathering, storing/retrieving, transferring/sharing, updating, and using construction

knowledge. All these sub-processes may not be supported by one software but the different software tools should support techniques that allow linking them to one another and to other electronic information sources within and external to the organization;

- *store and index the captured knowledge in an easily retrievable format*. The user needs software that provide reliable output. The quality of this output depends on the way knowledge is stored and indexed;
- *allow for reviewing the stored knowledge for its relevance and validity*. If knowledge is automatically captured in an ongoing project then there should be some means of reviewing this knowledge. The software should also allow easy movement of knowledge from one knowledge category to another;
- *allow easily updating and modifying of stored knowledge* (Carrillo *et al.*, 2000). This includes adding and synthesizing new knowledge to existing knowledge including drawings, sketches, formulas, etc. The updating process should allow for changing the context of stored knowledge.

CONCLUSION

Based on the literature review, survey questionnaire, and semi-structured interviews with construction organizations, several conclusions can be made. There is a gap between the claims of software vendors and what users experience. This gap has been investigated in this paper and it is found that KM software do not fulfil significant requirements of construction organizations. A key weakness in existing KM software is that no KM software was found to support the whole KM process as they focus on some elements of the KM process and ignore the others. They also cannot be linked to one another or to legacy electronic information sources and systems. In addition, they are difficult to use and require extensive training. KM software were also found to focus on the operational/ implementation level of KM without addressing the strategic level. However, care is needed in the interpretation of these findings given the small sample size and the nature of the investigation. Further research with a larger sample size of users of key software is necessary for these findings to be generalized.

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