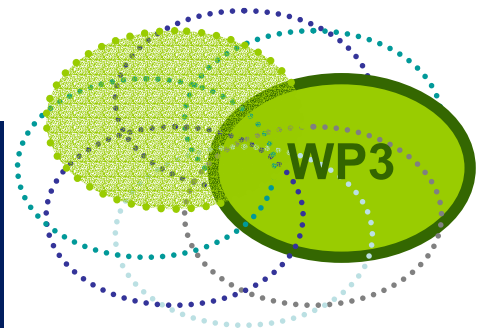


Techniques & Technologies for
Knowledge Management
Work Package 3- Interim Report



Knowledge Management for
Sustainable Construction Competitiveness 



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1. Introduction

This interim report is one of the deliverables of a 2-year comprehensive study, which commenced in July 2002 and funded by the Department of Trade and Industry (DTI) as part of the Partners in Innovation Programme (PII). The study is entitled “*Knowledge Management (KM) for Sustainable Construction Competitiveness*” (Partners in Innovation: CI 39/3/709). The primary aims of the study are to investigate the challenges associated with the management of knowledge resources and capabilities for construction. Also, to establish how effective the strategies for managing these resources and capabilities are at contributing to project success and sustained organisational competitiveness. The targeted objectives for addressing the above aims are:

1. To identify the specific features of knowledge production in the construction industry – i.e. identifying what are the key types of knowledge resources and capabilities relevant to the sector (e.g. theoretical construction, engineering and design knowledge, plus experiential knowledge, etc.), the triggers of knowledge production and the challenges associated with producing ‘new’ knowledge.
2. To investigate and document the main challenges (including economic, social, technological, environmental) associated with the implementation, exploitation and embedding of KM practices within construction organisations of varying sizes and specialisms.
3. To examine and document the different approaches (including processes and technologies) used for knowledge production, absorption (across boundaries), capture & retrieval, transfer, sharing, exploitation and for measuring and comparing KM performance; together with their relative effectiveness as knowledge management tools. It will also investigate and document the vagaries of factors that lead to successful KM practices in different sizes of organisations and in organisations that are at different levels of KM implementation.
4. To explore knowledge management practices in other sectors (e.g. manufacturing, finance, IT, retail) with the view of documenting good and best practices for the benefit of the construction industry.
5. To examine the backgrounds and on-going training and skills of knowledge management specialists. Map out their career paths, examine and document the impact of this new role on the future of the construction industry.
6. Produce a study report, which could be used as a policy document and would influence the direction of both government and those concerned with improving the industry’s performance.
7. Produce a training material on KM and disseminate the outputs of the study on KM widely in the industry.

The planned outputs of the study include reports for construction organisations and policy makers, fact sheets, training materials for workshops, seminars and CPD purposes; journal and conference articles. The dedicated web-site for detailed information on the study and for disseminating some of the study outputs is:

<http://www.knowledgemanagement.uk.net>

1. 1. Executive Summary

This interim report attempts to address some aspects of objective 3 above. By adopting a generic approach, it is primarily aimed at providing an overview of the technologies and techniques available for knowledge management in organisations. It also alludes to the different approaches currently used by organisations in selecting knowledge management techniques and technologies.

The final report for this aspect of the study, which is due in September 2003, will, *inter alia*, identify the limitations in existing approaches in selecting appropriate technologies and techniques for knowledge management and provide some guidance in this regard. In addition, it will document the efficacy of different technologies and techniques for knowledge management in construction and provide a framework for evaluating the performance of knowledge management technologies and techniques for the benefit of construction organisations.

The main conclusions and recommendations drawn from the interim report are:

- The term 'tools' for knowledge management (KM) is used very loosely in industrial settings, with very few practitioners providing a definition for this. Too often, KM "tools" is used to mean only IT tools. There is a need for a better understanding of the IT and non-IT tools, their differences and characteristics.
- A host of technologies (IT-based) and techniques (non-IT based) exist for knowledge management in organisations. In the main, the selection of appropriate technologies appears to follow a more structured approach than the selection of techniques for knowledge management.
- In industrial settings, there are two main approaches for selecting appropriate KM technologies. The first approach is based on KM "sub-processes". The second approach is based on "technology families". The former appears more popular as it allows the 'users' to identify sub-processes that they need to manage and then select the most appropriate technologies geared for the need of the identified sub-processes.
- There is a need for some guidance in the approaches employed by organisations for selecting appropriate technologies and techniques for knowledge management.

The construction industry will benefit from the documentation of the efficacy of different technologies and techniques for knowledge management in given contexts, together with a framework for evaluating the performance of knowledge management technologies and techniques.

2. Knowledge Management Tools

Very few authors have defined KM tools. Gallupe (2001) states that they are not simply information management tools as they should be 'capable of handling the richness, the content, and the context of the information and not just the information itself'. A popular definition by Ruggles (1997) describes them as the technologies used to enhance and enable the implementation of the sub-processes of KM (e.g. knowledge generation, codification, and transfer). He identifies that not all KM tools are IT-based as everyday tools such as papers, pens, and videos can be utilised to support KM.

In fact, most authors use the term KM tools to mean IT tools. In this report, KM tools will be used to refer to both 'non-IT tools' and 'IT tools'. To distinguish between them, the terms 'KM techniques' and 'KM Technologies' stand for 'non-IT tools' and 'IT tools' respectively (Al-Ghassani, 2002). The main differences between KM techniques and technologies are presented in Table 1 and discussed thereafter.

Table 1. KM tools: A comparison between the techniques and technologies (Al-Ghassani, 2002).

KM Tools	
KM Techniques	KM Technologies
<ul style="list-style-type: none"> • Require strategies for learning • More involvement of people • Affordable to most organisations • Easy to implement and maintain • More focus on tacit knowledge • Examples of tools: <ul style="list-style-type: none"> – Brainstorming – Communities of Practice – Face to face interactions – Recruitment – Training 	<ul style="list-style-type: none"> • Require IT infrastructure • Require IT skills • Expensive to acquire/maintain • Sophisticated implementation/maintenance • More focus on explicit knowledge • Examples of tools: <ul style="list-style-type: none"> – Data and text mining – Groupware – Intranets/Extranets – Knowledge bases – Taxonomies – Ontologies

2. 1. Techniques

KM techniques do not depend on IT, although it provides support in some cases. For example knowledge sharing, a sub-process of KM, can take place through face-to-face meetings, recruitment, apprenticeships, mentoring and training. The importance of KM techniques, according to Table 1, comes from several factors. Firstly, they are affordable to most organisations. This is because no sophisticated infrastructure is required although some techniques require more resources than others (e.g. training requires more resources than face-to-face interactions). Secondly, KM techniques are easy to implement and maintain due to their simple and straightforward nature. Thirdly, they focus on retaining and increasing the organisational tacit knowledge, a key asset to organisations.

KM techniques are not new, as organisations have been implementing them for a long time, mainly under the umbrella of several management approaches, e.g. organisational learning and learning organisations. Using these tools for the management of organisational knowledge requires their use to be enhanced so that their benefits, in terms of knowledge gain/increase, are properly managed. Some KM techniques are described below:

Brainstorming is a process where a group of people meet to focus on a problem, or idea, and explore such ideas with a view to coming up with solutions, or further developing the ideas. The participants express or contribute their ideas as they strike them and then build on the ideas raised by others. All the ideas are noted down and are not criticized. Only when the brainstorming session is over are the ideas evaluated. Brainstorming helps in problem solving and in creating new knowledge from existing knowledge (Tsui 2002a & b). The following rules are important to brainstorm successfully:

- A facilitator (or a leader as appropriate) should take control of the session and keep it on course. Initially the problem to be solved is defined with any criteria that must be met. He or she should encourage an enthusiastic, uncritical attitude among brainstormers and encourage participation by all members of the team. The session should be announced as lasting a fixed length of time, and the leader should ensure that no train of thought is followed for too long. The leader should try to keep the brainstorming on subject, and should try to steer it towards the development of some practical solutions.
- Participants in the brainstorming process should come from as wide a range of disciplines with as broad a range of experience as possible. This brings many more creative ideas to the session.

- Brainstormers should be encouraged to have fun brainstorming, coming up with as many ideas as possible, from practical ones to wildly impractical ones in an environment where creativity is welcomed.
- Ideas must not be criticised or evaluated during the brainstorming session. Criticism introduces an element of risk for a group member in putting forward an idea. This stifles creativity and cripples the free running nature of a good brainstorming session.
- Brainstormers should not only come up with new ideas in a brainstorming session, but also should 'spark off' from associations with other people's ideas and develop other people's ideas.
- A record should be kept of the session either as comprehensive notes or a tape recording. This should be studied subsequently for evaluation. It can also be helpful to write down and explore the ideas on a board, which can be seen by all brainstormers.

Communities of Practice (CoP) are also called knowledge communities, knowledge networks, learning communities, communities of interest and thematic groups. These consist of a group of people of different skill sets, development histories and experience backgrounds that work together to achieve commonly shared goals (Ruggles, 1997). These groups are different from teams and task forces. People in a CoP can perform the same job or collaborate on a shared task, e.g. software developers, or work together on a product, e.g. engineers, marketers, and manufacturing specialists. They are peers in the execution of "real work." What holds them together is a common sense of purpose and a real need to know what each other knows. Usually, there are many communities of practice within a single company and most people normally belong to more than one.

Face-to-Face Interaction is a traditional approach for sharing the tacit knowledge (socialisation) owned by an organisation's employees. It usually takes an informal approach and is very powerful. Face-to-face interactions also help in increasing the organisation's memory, developing trust and encouraging effective learning. Lang (2001) considers it to provide strong social ties and tacit shared understandings that give rise to collective sense-making. This can also lead to an emergent consensus as to what is valid knowledge and to the serendipitous creation of new knowledge and, therefore, new value. This provides an environment within an organisation where participants see the firm as a human community capable of providing diverse meanings to information (i.e. knowledge).

Post-Project Reviews are debriefing sessions used to highlight lessons learnt during the course of a project. These reviews are important to capture knowledge about

causes of failures, how they were addressed, and the best practices identified in a project. This increases the effectiveness of learning as knowledge can be transferred to subsequent projects. However, if this technique is to be effectively utilised, adequate time should be allocated for those who were involved in a project to participate. It is also crucial for post-project review meetings to take place immediately after a project is completed as project participants may move or be transferred to other projects or organisations.

Recruitment is an easy way for knowledge buy-in. This is a “tool” for acquiring external tacit knowledge especially of experts. This approach adds new knowledge and expands the organisational knowledge base. Another benefit is that other members within the organisation can learn from the recruited member formally and informally so that some knowledge will be transferred and retained if the individual leaves the organisation. Some organisations also try to codify the recruited person’s knowledge that is of critical importance to their business.

Apprenticeship is a form of training in a particular trade carried out mainly by practical experience or learning by doing (not through formal instruction). Apprentices often work with their masters and learn craftsmanship through observation, imitation, and practice. They focus on improving the skills of the individuals so that they can later perform tasks on their own. This process of skill building requires continuous practice by the apprentices until they reach the required level.

Mentoring is a process where a trainee or a junior staff is attached or assigned to a senior member of an organisation for advice related to career development. The mentor provides a coaching role to facilitate the development of the trainee by identifying training needs and other development aspirations. This type of training usually consists of career objectives given to the trainee where the mentor checks if the objectives are achieved and provides feedback.

Training helps in improving staff skills and therefore increasing their knowledge. Its implementation depends on plans and strategies developed by the organisation to ensure that employees’ knowledge is continuously updated. Training usually takes a formal format and can be internal where seniors train juniors within the organisation or external where employees attend courses managed by professional organisations.

2. 2. Technologies

KM technologies depend heavily on IT. Examples of KM technologies for capturing knowledge are Knowledge Mapping Tools, Knowledge Bases, and Case-Based Reasoning. Although there is a debate about the degree of importance of such technologies, many organisations consider them as very important enablers to support the implementation of a KM strategy (Skyrme and Amidon, 1997; Kanter, 1999; Anumba et al, 2000; Egbu, 2000; Storey and Barnett, 2000) as they consume one third of the time, effort and money that are required for a KM system. The other two-thirds mainly relate to people and organizational culture (Davenport & Prusak, 1998; Tiwana, 2000). From a return on investment (RoI) perspective, there is a need for the organisations to capitalise and exploit IT for KM. With the evolution in IT hardware and software, IT tools can act as dynamic capabilities or core competences for organisations, if effectively exploited. KM technologies consist of a combination of hardware and software technologies.

Hardware technologies and components are very important for a KM system as they form the platform for the software technologies to perform and the medium for the storage and transfer of knowledge. Some of the hardware requirements for a KM system according to Lucca *et al*, 2000 are:

- Personal computer or workstation to facilitate access to the required knowledge;
- Highly powerful servers to allow the organisation to be networked;
- Open architecture to ensure interoperability in distributed environments;
- Media rich applications requiring Integrated Services Digital Network (ISDN) and fibre optics to provide high speed;
- Asynchronous Transfer Mode (ATM) as a multi-media switching technology for handling the combination of voice, video, and data traffic simultaneously; and
- Use of the public network (e.g. Internet) and private networks (e.g. Intranet, Extranet) to facilitate access to and sharing of knowledge.

Software technologies play an important part in facilitating the implementation of KM. The number of software applications has increased considerably in the last three years. Solutions provided by software vendors take many forms and perform different tasks. The large number of vendors that provide KM solutions makes it extremely difficult to identify the most appropriate applications. This has resulted in organisations adopting different models for establishing KM systems. Tsui (2002b) identifies five emerging models for deploying organisational KM systems where one or a combination may be adopted:

- *Customised Off The Shelf (COTS)* – this is the traditional and most popular way of deploying application services. Based on the organisational needs, the applications will be identified and then examined against the functional needs of the organisation. A short-period test may follow to identify the most suitable application. Once an application is acquired, customisation of the standard features is usually performed to integrate it into the organisation's information system.
- *In-house Development* – These systems are developed within the organisation, usually with external technical help. Examples are Notes, Domino, and Intranet applications. However, there are several reasons that make this option generally less attractive or less preferred by organisations. This includes the difficulty of establishing KM systems' requirements, high cost, risk and the complexity of developing bespoke systems.
- *Solution Re-engineering* – This involves adapting, with the help of KM consultants and technical architects, an existing generic solution that matches the organisation's requirements. Although similar to COTS, the adapted solution is not packaged as a product that can be marketed. Examples are online knowledge communities, and virtual collaboration tools.
- *Knowledge Services* – These are knowledge applications provided by a third party that hosts the application on the Web. The user accesses the service via a thin-client (e.g. a browser). The main benefits are the waived software licensing fee and the avoidance of in-house maintenance. However, many organisations do not find this option attractive because of the reduced security and privacy.
- *Knowledge Marketplace* – Modelled on the E-Business NetMarket concept, several knowledge-trading places have recently been established. In a Knowledge Marketplace, a third party vendor hosts a web site grouping together many suppliers of knowledge services. Suppliers may include expert advisors, vendors providing product support services, KM job placement agencies, procedures for the evaluation of KM and portal software, and research companies providing industry benchmarks and best practice case studies. Two types of Knowledge Marketplace exist. One

provides common information and services to all industries while the other offers only certain services to a specific industry.

KM software technologies have seen many improvements since the year 2000 due to many alliances, and mergers and acquisitions between KM and Portal tool vendors (Tsui 2002b). However, none of them makes a complete solution to KM. These tools are better described within technology groups such as data and text mining, groupware, etc. Some of these are described below.

Data and text mining is a technology to extract meaningful knowledge from masses of data or text. Data are single facts (structured) about events while text refers to unstructured data. The process of data/text mining enables meaningful patterns and associations of data (words and phrases) to be identified from one or more large databases or 'knowledge-bases'. The approach is also very useful for identifying hidden relationships between data and hence creating new knowledge. It is mostly used in business intelligence, direct marketing and customer relationship management applications. However, this technology is not widely used because it is difficult to access data via an enterprise-wide corporate portal where most organisations only have a small group of data miners (Tsui 2002 a, b).

Groupware is a software product that helps groups of people to communicate and share information (Haag and Keen 1996). This is useful for group decision-making. Groupware supports distributed and virtual project teams where team members are from multiple organisations and in geographically dispersed locations. Groupware tools usually contain email communications, instant messaging, discussion areas, file area or document repository, information management tools (e.g. calendar, contact lists, meeting agendas and minutes) and search facilities (Tsui 2002b).

Intranet is an inter-organisational network that is guarded against outside access by special security tools called firewalls (Haag *et al*, 1998). **Extranet** is an Intranet with limited access to outsiders, making it possible for them to collect and deliver certain knowledge. This technology is very useful for making organisational knowledge available to geographically dispersed staff members and is therefore used by many organisations.

Knowledge bases are repositories that store knowledge about a topic in a concise and organized manner. They present facts that can be found in a book, a collection of books, web sites or even human knowledge. This is different from the knowledge bases of expert systems, which incorporate rules as part of the inference engine that searches the knowledge base to make decisions.

Taxonomy is a collection of terms (and the relationships between them) that is commonly used in an organisation. Examples of a relationship are 'hierarchical' (where one term is more general hence subsumes another term), 'functional' (where terms are indexed based on their functional capabilities), and 'networked' (where there are multiple links between the terms defined in the taxonomy).

Ontologies also define the terms and their relationships but in addition, they support deep (refined) representation (for both descriptive and procedural knowledge) of each of the terms (concepts) as well as defined domain theory or theories that govern the permissible operations with the concepts in the ontology. There are at least three ways to develop a taxonomy/ontology: manually constructed (using some kind of building tools), automatically discovered (from a repository of knowledge assets), or purchased off-the-shelf. Taxonomies/Ontologies serve multiple purposes in an organization. They can be used as a corporate glossary holding detail descriptions of every key term used in the organisation. They can also be used to constrain the search space of search engines and prune search results, identify and group people with common interests, and act as a content/knowledge map to improve the compilation and real time navigation of Web pages. (Tsui 2002 a, b).

2. 3. Tools used by UK Construction Organisations

There is a range of techniques and technologies that can be used in construction organisations for knowledge management. Some of the techniques are not new but most of the technologies are relatively new and are still evolving. A recent survey of 170 UK construction organisations carried out by Loughborough University (Carrillo et al, 2002) shows that communities of practice is the most widely used technique for knowledge management particularly in large organisations. Large construction organisations with a range of specialist skills tend to have the need and resources to set up communities of practice and to benefit significantly from them. Other techniques that are used include brainstorming, job observation and rotation systems, research collaboration, conferences and seminars. Conferences and seminars were identified by small construction organisations as the most popular technique to facilitate knowledge sharing and to update knowledge.

The survey also shows that the most widely used technology is the Intranet (Carrillo et al, 2002). Intranets provide the platform for knowledge sharing particularly in large construction organisations that are often geographically dispersed with diverse knowledge to share. Other popular technologies are document management systems (e.g. Documentum and Sage Desk), groupware (e.g. Lotus Notes, Lotus Quickplace, Live Link and e-Room)

and taxonomy tools (e.g. Autonomy). The use of these technologies may increase as collaborative working becomes more important in construction supply chains. Extranets and electronic discussion forums are used to a limited extent. It is expected that the use of the Extranets will increase as new procurement approaches involving different and several construction supply chains, such as in partnering arrangements, Private Finance Initiative (PFI) and prime contracting become more widely used.

These techniques and technologies provide valuable support for knowledge management. However, it is difficult to select the most appropriate tools for a particular organisation. The large number of technologies available in the market place makes it difficult for organisations to identify the most appropriate tools, and construction organisations are no exception.

The next section describes the existing methods for selecting the most suitable KM tools for an organisation.

3. Selecting Appropriate Tools for Knowledge Management

Having developed a KM strategy, the organisation must identify the tools (techniques and technologies) with which to implement the strategy. The selection of techniques and technologies will be informed, for example, by the goal of the KM strategy, the nature and location of knowledge and the capabilities of the tools.

3. 1. Selecting Knowledge Management Techniques

In many organisations, the selection of the most appropriate KM techniques does not follow a structured approach. This is probably because of the relatively low initial capital outlay of such techniques and the ease of their implementation. Another reason is that most organisations already implement some KM techniques and therefore develop plans for improving these techniques. This can cause the improvement of some techniques that may not be critical to the KM system.

3. 2. Selecting Knowledge Management Technologies

The selection of the most appropriate KM technologies requires a clear identification of the organisation's knowledge management needs. It also requires an awareness of the technologies available and their functional capabilities. Existing methods for selecting KM technologies vary between organisations. However, there are some common methods. There are two main approaches for selection; according to KM sub-processes and according to technology families. The former categorises the tools in terms of the KM sub-processes they support while the latter classifies them into general technology families that support KM.

3.2.1. Selection of Knowledge Management Technologies According to Knowledge Management Sub-processes

This method is popular because it allows users to identify the sub-processes that they need to manage and then select the most appropriate technologies. After identifying the KM sub-processes, opinion is divided on the method for selecting appropriate technologies. One group (see Table 2) identifies the software applications without putting the software into technology categories. The other group (see Table 3) identifies the technology categories, without naming the software applications (Al-Ghassani et al, 2002). Ruggles (1997) is probably the first to follow the pattern of the former group. Wensley (2000) adopts the same method in his consideration of web-based software applications.

Table 2. Software applications classified by KM sub-processes (Source: Al-Ghassani et al, 2002)

Author	KM Sub-processes	KM Software Applications
Ruggles (1997)	Generation	GrapeVine, IdeaFisher, Inspiration, Idea Generator, MindLink
	Codification	KnowledgeX, Excalibur RetrievalWare & Visual RetrievalWare, TeleSim
	Transfer	(Lotus) Notes, NetMeeting, EnCompass
Wensley (2000)	Acquire	Aeneid, Networker, Infoscout, Arbortext tools, Documentum
	Store	2 Share 2.0, Beehive, Action Technologies Tools, WebOS, Aeneid, Networker, Infoscout, Arbortext tools, Autonomy, Documentum
	Deploy	2 Share 2.0, Beehive, Action Technologies Tools, WebOS, Networker, Infoscout, Arbortext tools, Autonomy, Documentum
	Add Value	Action Technologies Tools, WebOS, Autonomy, Documentum

The second group (Table 3) which identifies categories of KM technologies that support the KM sub-processes without naming the software applications, also includes some technology categories that are not originally developed for KM but support its sub-processes. Jackson (1998) and Laudon & Laudon (2000) have adopted this pattern. A similar attempt by Tsui (2002a) focuses on the Personal KM technologies (PKM) rather than the Enterprise KM technologies.

Table 3. KM technologies classified by KM sub-processes (Source: Al-Ghassani et al, 2002)

Author	KM Sub-processes	KM Technologies
Jackson (1998)	Gathering	Pull, Searching, Data entry/OCR
	Storage	Linking, Indexing, Filtering
	Communication	Sharing, Collaboration, Group Decisions
	Dissemination	Push, Publishing, Notification
	Synthesis	Analysis, Creation, Contextualisation
Laudon and Laudon (2000)	Creation	Knowledge Work Systems: Computer Aided Design (CAD), Virtual Reality, Investment Workstations
	Knowledge capturing and codifying	Artificial Intelligence Systems: Expert Systems, Neural Nets, Fuzzy Logic, Genetic Algorithms, Intelligent Agents
	Knowledge distribution	Office Automation Systems: Word Processing, Desktop Publishing, Imaging and Web Publishing, Electronic Calendars, Desktop Databases
	Knowledge sharing	Group Collaboration Systems: GroupWare, Intranets
Tsui (2002a)	Creation	Associative Links, Information capturing and sharing, Concept/Mind Mapping
	Codification/Representation	Associative Links, Information capturing and sharing, Concept/Mind Mapping, E-Mail Management, Analysis and Unified
	Classification/Indexing	Index/Search, Meta-Search, Associative Links, Information capturing and sharing, Concept/Mind Mapping, E-Mail Management, Analysis and Unified
	Search and Filter	Index/Search, Meta-Search, E-Mail Management, Analysis and Unified
	Share/Distribute	Index/Search, Meta-Search, Associative Links, Information capturing and sharing, E-Mail Management, Analysis and Unified

3.2.2. Selection of Knowledge Management Technologies according to Knowledge Management Technology Families

Technology families are categories of commercial KM software applications such as document management, groupware, and search facilities. Table 4 provides examples of different classifications of technology families. Jackson's (1998) classification presents six technology families and identifies a few examples of commercial software applications for every category. Bair and O'Connor (1998) followed this method but in a more detailed way. They introduced identifiable technology families and then categorised KM software

applications accordingly through identifying software vendors and classifying them according to the capacity for collaboration over time and across the organisation. Wensley's (2000) classification focuses on web-based technologies. Gallupe's (2001) classification is based on a three-level model of KM systems. The three levels are tools, generators, and the specific KM system. He identifies tools and generators as the technologies that are used to acquire, store, and distribute knowledge. In this context, tools are basic technological building blocks for the KM system where individual tools can be combined to form a specific KM system that performs particular functions. On the other hand, generators are self-contained technologies and can be used to generate or build a variety of specific KM systems. A generator therefore consists of a number of tools such as document management, intelligent agent, and groupware. For example, Lotus Notes is a generator that contains a number of KM features that can be combined in various ways to make different KM systems. Tsui's (2002b) classification is based on the origin of technologies, alignment with business processes, and capabilities of the commercial KM software.

Table 4. KM technology families by different authors (Source: Al-Ghassani et al, 2002)

Author	KM Technology families
Jackson (1998)	Document management (e.g. Documentum, Panagon JetForm) Information management (e.g. SAP, Baan) Searching and indexing (e.g. Fulcrum, Retrievalware, Verity) Communications and collaborations (e.g. Notes, Exchange, Eudora) Expert systems (e.g. Trajecta, Cognos) Systems for managing intellectual property.
Bair and O'Connor (1998)	Knowledge Retrieval (KR) (e.g. Fulcrum, Verity, Excalibur) Document Management (DM) (e.g. Documentum) GroupWare (GW) (e.g. Lotus, Autonomy, GrapeVine) Integrated Systems: KR+DM+GW+Data Management (e.g. Lotus, Netscape)
Wensley (2000)	Traditional database tools Process modelling and management tools Workflow management tools Enterprise Resource Management Tools Agent tools Search Engines, Navigation Tools and Portals Visualising tools Collaborative Tools Virtual Reality Tools
Gallupe (2001)	Intranets Information Retrieval Programs Database Management Systems Document Management Systems Groupware Intelligent Agents Knowledge-Based or Expert Systems
Tsui (2002 a & b)	Search Meta/Web Crawler Process Modelling and Mind Mapping Case-Based Reasoning (CBR) Data and Text Mining Taxonomy/Ontological Tools Groupware Measurement and reporting E-Learning

4. Conclusions and Recommendations

The aim of this report was to investigate the KM tools available for organisations to use. The term 'tools' for knowledge management (KM) is used very loosely in industrial settings, with very few practitioners providing a definition for this. Too often, KM "tools" is used to mean only IT tools.

It had been identified that there was a need for a better understanding of the IT and non-IT tools, their differences and characteristics. Thus, two tool types have been identified, namely KM techniques (non IT based) and KM technologies (IT based). The differences between KM techniques and technologies have been highlighted and the features of each presented. It was also found that the selection of KM Techniques does not follow a structured approach while that of KM Technologies follows a more structured approach, mainly based on the KM sub-processes to be addressed or the KM Technology families.

There is a host of technologies (IT-based) and techniques (non-IT based) for knowledge management in organisations. The most widely used technologies are Intranets, Extranets and the Internet. Other popular technologies include document management systems, groupware, taxonomy and ontologies.

Communities of Practice (CoP), brain storming, job observation and rotation, research collaboration, workshops, seminars and conferences are the most widely used techniques.

In the main, the selection of appropriate technologies appears to follow a more structured approach than the selection of techniques for knowledge management. In industrial settings, there appear to be two main approaches for selecting appropriate KM technologies. The first approach is based on KM "sub-processes". The second approach is based on "technology families". The former appears more popular as it allows the 'users' to identify sub-processes that they need to manage and then select the most appropriate technologies geared for the need of the identified sub-processes.

There is a need for some guidance in the approaches employed by construction organisations for selecting appropriate technologies and techniques for knowledge management. The construction industry will also benefit from the documentation of the efficacy of different technologies and techniques for knowledge management in given contexts, together with a framework for evaluating the performance of knowledge management technologies and techniques. The final report will provide some guidance on these, together with information on appropriate resources (e.g. web-sites, reports) on techniques and technologies for KM in construction.

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