INFORMATION TECHNOLOGIES FOR KNOWLEDGE MANAGEMENT: THEIR USAGE AND EFFECTIVENESS

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SUMMARY*: Knowledge is increasingly being recognised as a vital organisational resource that provides competitive advantage. Managing knowledge assets can be a challenge, especially in the construction industry, where short-term working contracts and temporary coalitions of individuals can inhibit knowledge sharing. The role of information technology (IT) in knowledge management (KM), is an essential consideration for any company wishing to exploit emerging technologies to manage their knowledge assets. This paper presents research, which has been conducted to identify the technologies that are currently used to manage knowledge in the construction industry. The effectiveness of these technologies has also been explored, highlighting the strengths and weaknesses of particular IT for KM. In addition, it attempts to highlight some of the challenges and complexities associated with managing knowledge in a project-based environment. A postal questionnaire was distributed among construction organisations in order to obtain generalisable data about the role of IT for KM, in the construction industry. This approach was supplemented by ethnographic interviews to reveal richer data about the nature of IT for KM, in five small, medium and large construction organisations. The research revealed that conventional technologies, such as the telephone, are used more frequently to manage knowledge, than more radical IT, such as Groupware or video-conferencing. In construction organisations, the potential benefits of IT for KM, are not fully exploited and many have expressed a need for greater implementation of IT, appropriated by sufficient training and education of staff.*

KEYWORDS: *Information Technology, Information Communication Technology, Knowledge Management*

1. INTRODUCTION

There is currently a compelling debate about the changing nature of business environments and the sources of competitiveness in advanced economies. It is asserted that knowledge is fast overtaking capital and labour as the key economic resource in advanced economies (Edvinsson, 2000). The intangible assets in an organisation are widely celebrated as vital elements in improving competitiveness (Egbu, 2000; Edvinsson, 2000). This has compelled academics and practitioners to discuss the way in which knowledge assets are managed; thus knowledge management (KM) is emerging as a significant concept in management science. KM has been extolled as "one of the major driving forces of organisational change and wealth creation" (Chase, 1997, p.83) but remains a source of ambiguity, both theoretically and practically.

In the absence of a universal and comprehensive definition of KM, it is common myth that KM and IT are conceptually interchangeable. However, KM means much more than IT and it is crucial to view them as mutually exclusive. This is because an organisation does not have to employ IT for it to manage some of its knowledge assets. An example is in some smaller organisations, where 'Quality Circles', 'Story telling' and 'Lessons Learned Registers' are used for managing knowledge. These approaches do not have to employ information technology as we know it.

In this paper, KM should be understood to mean the processes by which knowledge is created, acquired, communicated, shared, applied and effectively utilised and managed, in order to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets. There have been debates about the role of the 'whole system' of knowledge management, such as core competencies and knowledge building for achieving competitive advantage (Leonard-Barton, 1995). Other discussions have been levelled at the data – information-knowledge typologies (Coleman, 1998). In this regard, information is viewed as organised facts and data, and 'knowledge consists of truths and beliefs, perspectives, concepts, judgements, expectations, methodologies and know-how, and exists in different forms (Egbu, 2000). For Sanchez et al (1996), organisational knowledge is the shared set of beliefs about causal relationships held by individuals within a group. From Sanchez et al's definition, it could be inferred that strategically relevant knowledge is never certain, but rather only exists in the forms of belief. An extension of this viewpoint would suggest that knowledge is not absolute or deterministic, but consists of more or less firmly held beliefs based on probabilistic assessments of possible causal relationships between phenomena. Another take on their definition would suggest that knowledge originates with and exists within individual humans, but that organisations may also have knowledge that may exist in various forms understood by more than one individual within an organisation. Finally, Sanchez et al's (1996) definition views the concept of knowledge as conscious mental processes (beliefs) as opposed to lower-level neural processes at the level of sensory-motor co-ordination. From the above discourse, it could be argued that knowledge adds value to data by providing selectivity and judgement.

It is important, at the outset, to assert that the knowledge management paradigm is a complex one. Knowledge can also be considered as existing in arrays of forms, such as symbolic, embodied, embrained and encultured (Collins, 1995). In a sense, this typology helps us to differentiate, for example, knowledge of information (such as catalogue and explanatory knowledge) and context dependent knowledge relating to skill and competence (e.g. process, social and experiential knowledge). Catalogue and explanatory knowledge are symbolic in nature and therefore are more readily transmittable than the contextually sensitive encultured knowledge (e.g. process, social and experiential knowledge). One explanation of this is because encultured knowledge is learned through socialisation, or through immersion in communities of practice (CoP). As a result, encultured knowledge is intrinsically tied to its context. The knowledge is 'situated' and produced – in-use. For such knowledge to be formally transmitted, it will need to be decontextualised, and may lose its 'special character'. Knowledge within an organisation may therefore exist at different levels of usefulness. This is to say that an individual or organisation may have varying abilities to apply different forms of knowledge to carry out actions that help an organisation to accomplish its goals. The above discourse shows that managing knowledge in organisations is not a punctual act. It involves the consideration of a host of factors. In their conceptual framework for understanding and studying knowledge management in project-based environments (Figure 1) Egbu, Bates and Botterill (2001), highlighted culture, people, process as well as technology as being worthy of consideration.

Although, IT is important in its own right and remains a critical success factor in the development of an effective KM programme. Browning (1990) contends that "information technology is no longer a business resource; it is the business environment". Since the 1960s, IT has become an all-pervasive force in the business world, superseding more conventional tools for data storage and communication. It has been argued that IT has the potential to "redefine the management and control of innovation on a global basis through the removal of barriers such as time and distance" (Egbu, 2000, p.109).

The purpose of this paper is to explore the role of IT for KM in the construction industry. Construction organisations have been slow to acknowledge the benefits of IT in managing knowledge (Egbu *et al*., 2001), suggesting that the role of IT for KM in these organisations, needs to be addressed.

This paper begins by exploring the potential of IT in managing knowledge, drawing from multi-disciplinary literature and previous research. The empirical evidence will be analysed, identifying the existing technologies used in the construction industry and how effective these are in managing knowledge. Finally, the future usefulness of IT to manage knowledge in the construction industry will be considered, drawing evidence from postal questionnaire responses.

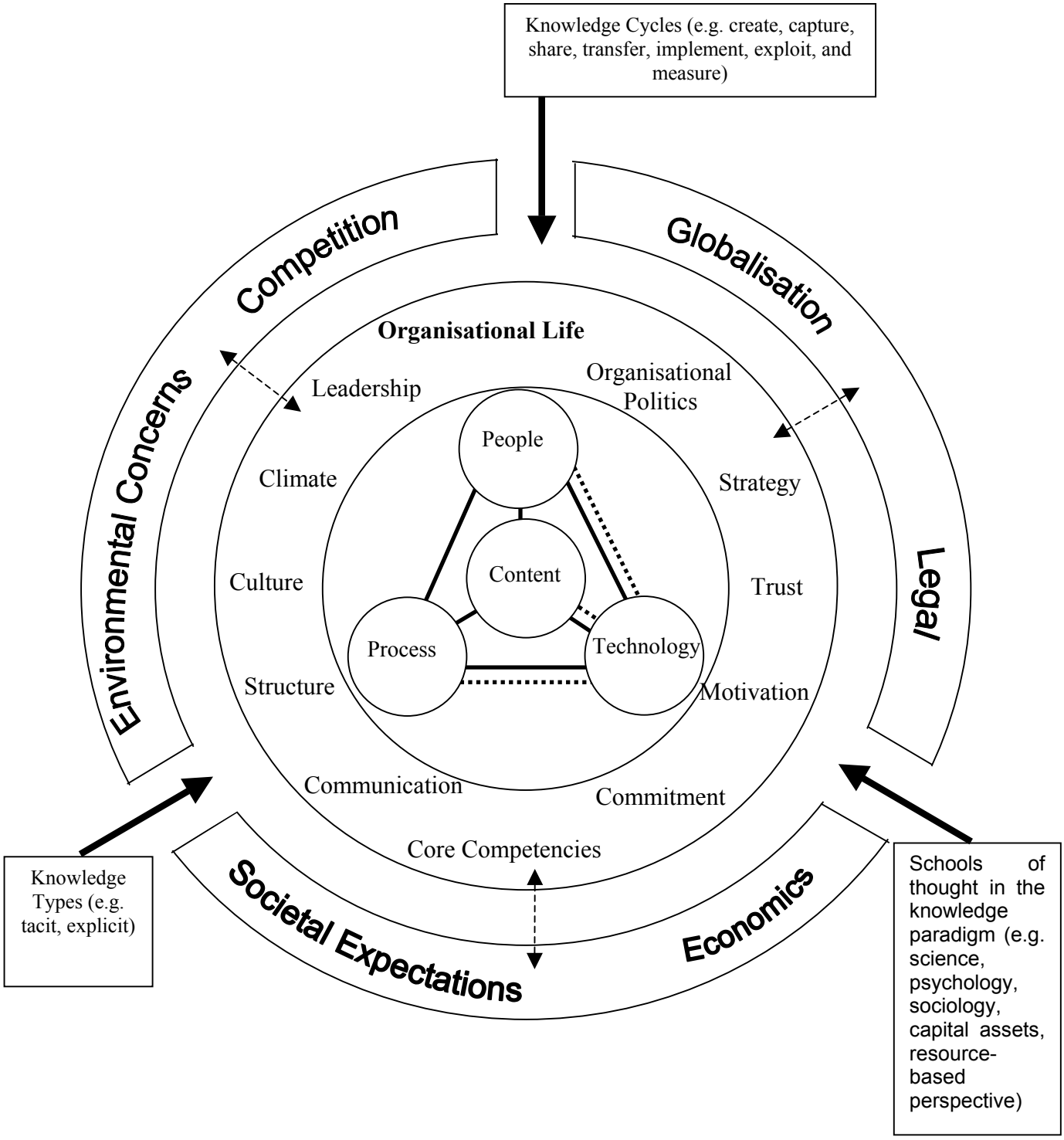

FIG. 1: Knowledge Management: A Conceptual Framework

2. RESEARCH METHODOLOGY

The research on which this paper is based was conducted between October 2000 and October 2001. The research employed a combination of qualitative and quantitative research methods. Nineteen (19) ethnographic interviews were conducted among five UK project-based organisations to reveal contextually rich descriptions about the nature of KM in these organisations. These organisations include private and public sector organisations from diverse backgrounds, including construction, manufacturing and housing industries. Small, medium and large organisations were targeted. Each organisation arranged for 3-4 people to be interviewed on an individual basis. The interviewees were chosen from senior management, middle management and junior level personnel. These interviews conducted served as multiple case studies. Table 1 presents a profile of the project-based organisations that participated in the ethnographic interviews, stating their current turnover, number of employees and main area of business. The number of interviewees from each organisation is specified and their general job title is given. To supplement these findings postal questionnaires were distributed to project-based organisations in UK construction, manufacturing, aerospace and the utilities. Fifty-five (55) usable questionnaires were received. Of these, 40 were from the construction industry. The interviews were analysed using the NVIVO software package that assisted in establishing relationships between variables. The postal questionnaires were analysed statistically using the SPSS software package.

TABLE 1: A profile of the participating organisations in the ethnographic interviews

Company	No. of Employees	Turnover £	Main Area of Business	No. of people Interviewed	Positions of People Interviewed
A	400	146,349,000	Facilities management in the built environment	4	• Director • Senior Manager • Mid-level Manager • P.A. to the Director
B	272	12,636,000	Manufacturing of electronic components for industry clients	4	• Principal Consultant • Project Manager • Mid-level Manager • Junior Engineer
C	230	7,705,000	Public sector development agency for economic regeneration of urban areas	4	• Head of Project Management • Project Manager • Chartered Surveyor • Junior Surveyor
D	30	257,500,1	Community housing association, regeneration and development of local areas	4	• Senior Manager • Project Manager • Development Officer • Development Assistant
E	100	400,000,0	Quantity surveying services in construction industry	3	• Senior Manager • Senior Manager • Quantity Surveyor

3. USING INFORMATION TECHNOLOGY FOR KNOWLEDGE MANAGEMENT

Many organisations employ IT in one form or another to manage their knowledge. It is primarily used to store and transfer explicit forms of knowledge. However, IT is not just about computers. Tools such as video-conferencing may also be useful for the transmission of tacit knowledge as it is, in crude terms, a form of socialisation (as defined by Nonaka and Takeuchi, 1995). Capturing tacit knowledge and then storing it in

repositories is vital for effective KM. Many organisations have developed sophisticated methods for storing their intellectual capital, including patenting knowledge assets to protect trade secrets.

It is argued that KM is about mobilising the intangible assets of an organisation, which are of greater significance in the context of organisational change than its tangible assets, such as IT. While IT is an important tool for a successful organisation, it is often too heavily relied upon as a guarantee of successful business. Edvinsson (2000) contends that such tools as the Internet are merely 'enabler [s]' and that the true asset of an organisation is the brainpower of its workforce. He stresses that it is the intellectual capital (IC) of an organisation that is the key to success (as cited in Dearlove, 2000, p.6). Thus IT is not just about databases or information repositories. “In computer systems the weakest link has always been between the machine and humans because this bridge spans a space that begins with the physical and ends with the cognitive” (McCampbell *et al*., 1999, p.174).

IT should be understood less in its capacity to store explicit information and more in its potential to aid collaboration and co-operation between people. Dougherty (1999) argues that IT should be seen as a tool to assist the process of KM in organisations. Such a process relies more on the face-to-face interaction of people than on static reports and databases (Davenport and Prusak, 1998). Some organisations have developed software to encourage social interaction in organisations in the hope that a unique forum for tacit knowledge exchange will be established. For example, Teltech is a consultancy service offering KM services to businesses, including an Expert Network which brings together a network of thousands of technical experts to share and develop knowledge in technical areas (McCampbell *et al*., 1999). A more holistic approach to integrating technology and people is BP’s Virtual Teamwork (VT) initiative connecting employees all over the world through IT, such as video-conferencing, Lotus Notes, electronic whiteboards and a corporate intranet. In a global forum, knowledge can be shared instantly which leads to the development of an ‘empowered culture’ and a set of structures that transcends traditional boundaries (Chase, 1997).

4. IT AND THE CONSTRUCTION INDUSTRY

IT is becoming increasingly important to KM in construction organisations. However, the construction industry has been slow to recognise the benefits of IT as a major communications tool (Egbu *et al.*, 2001). Transferring knowledge and information across projects is a major challenge for construction organisations. Much of construction work is project-based, characterised as short-term and task-oriented, promoting a culture where continuous learning is inhibited. Specialist and technical knowledge is lost from one project to the next stifling an organisation’s ability to develop knowledge and generate new ideas. Gann (2000) argues that IT can assist the transfer of knowledge and information between project teams, enabling the development of new knowledge for innovation.

The concept of knowledge management technologies is both broad and difficult to define (Egbu, 2000). Even some information infrastructure technologies that appear not to fall naturally within this concept can be useful in facilitating knowledge management. Examples are video-conferencing and the telephone. Although it is arguable whether these technologies capture or distribute structured knowledge, many would contend that they are useful at enabling people to transfer tacit knowledge. The British Petroleum (BP) Exploration Virtual Teamwork Programme discussed earlier, in the main, used a desktop video-conferencing infrastructure to help people exchange knowledge across vast distances. In fact, the hardware and software chosen for Virtual Teamwork stations included desktop video-conferencing equipment, multimedia e-mail, shared chalkboards, a document scanner, tools to record video clips, GroupWare, and a Web browser. Also, Hewlett –Packard (HP) has a Web-based system called “Connex”, in its Research and Development (R&D) laboratories to identify experts. Connex makes it possible for HP employees to search for an HP laboratory expert in a given area of discipline. The motivation of scientists to provide and include their biographies into the system is important in this regard.

There are also “Real-Time Knowledge Systems”. The technologies that fall under this category are useful where time is of the essence. An example is the Case based Reasoning (CBR) technologies. CBR applications require an individual or groups of individuals to input a series of ‘cases’, which represent knowledge about a particular domain expressed as a series of problem characteristics and solutions. When the user of the technology is presented with a problem, its characteristics can be compared against a set of cases in the application, and the

closest match is then selected. The technology can therefore be useful where the user is a 'limited expert', capable of understanding problems but not normally of solving them or classifying their symptoms. Such a technology could be adapted for use by large building materials suppliers who deal with many materials requisition from contracting organisations nationwide.

Other KM technologies include intranets, portals, semantic engines and ontology-based tools. For organisations with a lot of time in their hands and a user with requisite knowledge and appreciation of statistics, neural networks are useful for turning data into knowledge, i.e. 'data mining'. Neural networks have been described as a statistically oriented tool that excels at using data to classify cases into one category or another. Other data mining tools include artificial intelligence tools as well as conventional statistical analysis. Strong proponents of these tools advance the view that the pattern identification and matching capabilities of software can eliminate human intervention. It could be argued, however, that an intelligent human is required to structure the data in the first place, interpret data and understand identified patterns; and of course make a decision based on the knowledge generated.

It could be argued that whilst technologies designed to manage data are structured, typically numerically oriented, and address large volumes of observation, knowledge technologies deal more frequently with text rather than numbers. Technology alone will not make an organisation a knowledge-creating company. Since knowledge technologies are more likely to be employed in an interactive way by their users, the roles of people in knowledge technologies are vital to their success. This is particular point is important since the level of expertise of individuals in using particular knowledge technology, team composition and dynamics are likely to impact upon the decision on the choice and take-up of IT tool, and hence the full exploitation of IT tools for managing knowledge.

The results of the study, presented below, provide an indication of the typical tools and technologies employed by construction organisations to manage knowledge.

From a list of technologies and techniques, respondents of the postal questionnaire were asked to rank their usage, on a 5-point scale. They were then asked to rank how effective these tools and technologies are in managing knowledge. Table 2 presents the mean score for each technology & technique listed according to their usage in construction organisations and how effective they are in managing knowledge. The mean values for the usage of the technologies & techniques were calculated on the following scale 5=Always, 4=Very often, 3=Sometimes, 2=Rarely and 1=Never. Similarly, the mean values for the perceived effectiveness of the technologies & techniques were calculated on the following scale 5=Highly effective, 4=Effective, 3=Of some effect, 2=Of little effect and 1=Of no effect.

TABLE 2: The Usage and Effectiveness of Technologies and Techniques for KM in Construction Organisations

Technologies &Techniques	**Mean Values**		**Technologies & Techniques**
	Usage	**effectiveness**	
Telephone	4.3	4.1	Telephone
Internet/Intranet	4.0	4.0	Face-to-face meetings
Documents and reports	3.9	4.0	Documents and reports
Face-to-face meetings	3.9	4.0	Interaction with supply chain
Interaction with supply chain	3.7	4.0	Internet/Intranet
Formal on-the-job training	3.5	3.7	Formal on-the-job training
Formal education and training	3.4	3.7	IT-based database
IT-based database	3.4	3.6	Informal networks
Work manuals	3.3	3.6	Formal education and training
Informal networks	3.2	3.4	Coaching and mentoring
Brainstorming sessions	2.9	3.3	Brainstorming sessions
Project Summaries	2.8	3.2	Project Summaries
Coaching and mentoring	2.7	3.1	Cross-functional teamwork
Bulletin boards	2.6	3.1	Work manuals
Cross-functional teamwork	2.5	2.9	Job rotation

Help Desks	2.1	2.8	Knowledge-based Expert systems
Knowledge-based Expert systems	2.0	2.7	Bulletin boards
Job rotation	1.8	2.5	Decision support systems
Communities of Practice	1.8	2.4	Help desks
Decision support systems	1.8	2.4	Quality circles
Storytelling	1.7	2.2	Communities of Practice
Quality circles	1.5	2.2	Video-conferencing
Knowledge Maps	1.4	2.1	Knowledge Maps
Groupware	1.4	2.0	Storytelling
Video-conferencing	1.4	2.0	Groupware

From the data it is evident that the most frequently used techniques and technologies in construction organisations are: the telephone, Internet/intranet/e-mail and documents and reports. These are closely followed by face-to-face meetings and interaction with the supply chain. This suggests that conventional techniques for acquiring, developing, sharing and storing knowledge are still used frequently among construction organisations. For example, the telephone is a simple and familiar tool for communicating and sharing knowledge. In addition, these were also seen to be the most effective tools and technologies at managing knowledge. The telephone remains important for KM because it could be used to capture and distribute structured knowledge but also enable people to share tacit knowledge (Egbu, 2000). Importantly, face-to-face meetings was ranked as being one of the most effective techniques, supporting the notion that social interaction is a pre-requisite for successful KM (Davenport and Prusak, 1998).

The technologies that ranked lowest in terms of their mean values were mostly less conventional forms of IT, such as Knowledge maps and Groupware. Such technologies have been extolled by academics and practitioners as essential tools for the effective management of knowledge. Robinson *et al* (2001) maintain that Groupware is important collaborative software for the sharing and transferring of knowledge in organisations. However, the quantitative data shows that this tool is rarely used and it is perceived as being of little or no use to the majority of respondents. It is possible that in construction organisations traditional forums for collaboration, such as face-to-face meetings, are preferable to a more formal investment in sophisticated IT packages. Perhaps the potential benefits of using such technologies are not fully understood and organisations are more incremental in their implementation of IT. It is not surprising that video-conferencing has been ranked low by the respondents. This technology is often perceived as a revolutionary technology and there may be reluctance among managers to take risks with new forms of IT.

The evidence suggests that although construction organisations are investing more in some aspects of IT, such as the Internet, greater emphasis is put on the more traditional or familiar methods of capturing, sharing, transferring and storing knowledge, such as the telephone, documents and reports. Ironically, the tools perceived to be the least effective are those that have the potential to substantially benefit the construction industry. Collaboration is a fundamental aspect of project-based work and it is therefore, recommended that organisations pay attention to the different types of collaborative technologies that exist.

The type of IT used by construction organisations depends ultimately on the context of the work that is done. Organisations should implement tools that will be of specific use for a specific purpose, rather than embracing IT in a generic sense. For example, it is expected that smaller organisations implement fewer formal procedures than larger organisations. Generally, smaller organisations tend to have less economic power and therefore, cannot commit the resources to implementing formal strategies. The extent to which organisations use formal techniques for KM has been quantified. Of those who responded to the questionnaire and claimed that formal education and training was a strategy that is ‘always’ used in their organisations, 85 per cent were from large organisations. Moreover, all of the respondents who claimed never to use this strategy were from small organisations.

To our knowledge, there is no completed empirical study in construction similar to our own, and based on similar methodology, to allow comparative analysis to be conducted. However, we know of on-going studies by the University of Loughborough, and by Taylor Woodrow, UK.

5. USING IT IN CONTEXT: EVIDENCE FROM ETHNOGRAPHIC INTERVIEWS

In the ethnographic interviews the subject of IT was raised in a general context, i.e. how does IT play a part in the work that you do? This stimulated responses about the use of IT, its advantages and disadvantages in different contexts and more specific information about the types of technologies used. The following analysis reflects the perceptions of individuals in construction organisations and there are no general assumptions made.

In the main, each organisation used IT in similar ways but there was some variation. One large, facilities management company displayed a formal approach to IT, with an official IT department and the development of a corporate intranet to store important company-wide information that could be accessed throughout the organisation. A corporate intranet is an efficient tool for the storage and flow of explicit knowledge. It has been argued that such a tool can improve company decision-making, quicken employee responses to enquiries about products, which can lead to greater innovation (Bennett and Gabriel, 1999). In addition e-mail was used to share knowledge and ideas across the organisation, and externally with clients and customers. However, it was argued that most formal IT use is backed up with informal IT use, such as the telephone where people can communicate casually and build up rapport, especially between offices. One participant noted that:

> *"Technology is good because you're progressing but you shouldn't lose sight of the fact that you've got to communicate with people"*

This demonstrates that the type of IT used depends ultimately on the context of the work. Moreover, it illustrates that technological capabilities should not overshadow the capacity for people to interact. There is a danger that over reliance on IT may subdue the potential for interaction between people, creating a situation where "our machines are increasingly lively, and we are increasingly inert" (Haraway, as cited in Ruggles, 1997, p.3).

Most participants saw both advantages and disadvantages to IT in organisations. Interviewees from a medium-sized, public sector development company expressed resounding support for IT as a tool to assist knowledge sharing. All participants saw Lotus Notes as a useful tool for sharing knowledge. One participant favoured the use of Quickplace, an interactive web-based tool for sharing knowledge and ideas, including CAD drawings, with other people on-line. It is evident that in this organisation, IT is being used as a communication technology, bringing together different members of the project team to collaborate on project issues. This strengthens the claim that the role of IT is as an "integrator of communications technology, rather than solely a keeper of information" (McCampbell *et al*., 1999, p. 175). However, it was asserted that without appropriate understanding the tool would be redundant. One participant noted that:

> *"It's very easy to 'wing' off an e-mail without really thinking about the mode of communication and the larger issues of persuasion, influence and team-building"*

This is supported by Rozell and Gardner (2000) who assert that although the use of e-mail speeds up communication and reduces the need for paper, it can diminish the importance of social interaction as a means of communication.

Two smaller companies, one Quantity Surveying practice and a public sector Housing Association, limited their IT usage to efficient information storage rather than as a tool for communication. Both made use of IT as repository for important documents, such as a template for financial appraisal of construction sites and spreadsheets. It was agreed that such useful documents needed to be readily accessible to everyone inside the organisation and IT speeded up this process. Storing explicit knowledge in repositories and databases is important for knowledge retention. "By putting the knowledge held by individuals into databases, companies [can] ensure much of their expertise [is] retained even if employees [leave]" (Rajan, 1998 as cited in Scarbrough *et al.*, 1999, p.50).

However, there was commitment by some interviewees, to the development of IT in their companies. One participant argued for a more formal approach to IT based on the Egan (1998) report and noted that he is involved in the development of a formal IT strategy. It is possible that the absence of any formal IT strategy has

caused IT use to be less effective. Staggered and inefficient use of IT can be detrimental to KM, "creating a corporate 'Tower of Babel' where information drives out understanding" (Scarbrough *et al*., 1999, p.36).

The installation of IT must be complemented by a willingness to share information and knowledge. In a medium-sized, public sector development company, one participant claimed that there is some reluctance among older employees to use IT, or use it effectively, generating doubts about the success of IT in this organisation. Nahapiet and Ghoshal (1998) acknowledge this problem and assert that "the availability of electronic knowledge exchange does not automatically include a willingness to share information and build new intellectual capital" (as cited in Scarbrough *et al*., 1999, p.35). It is clear that attitudes about IT can affect its effectiveness as a business tool. Anxiety surrounding the introduction of IT reflects a wider feeling about change. Some people may feel that IT will change working patterns to such an extent that their job will become redundant and they will be replaced by a computer. Anxiety among older employees about change is evident in other areas, such as the apparent reluctance to share knowledge or take up new ideas.

6. THE FUTURE OF IT FOR KM IN CONSTRUCTION

IT is evolving. An organisations' IT policy is subject to continual change as new and far-reaching technologies are invented and become more accessible to organisations. It is for this reason that a supplementary question was posed addressing the usefulness of IT in the future. The same list of tools and technologies was provided and respondents were asked to assess how useful each would be for managing knowledge in the next 5 years. Table 3 presents the mean score of responses for each tool and technology, in relation to their future usefulness in the construction industry. The mean was calculated using the following scale 5=Very useful, 4=Useful, 3=Of some use, 2=Of little use and 1 =Of no use.

TABLE 3: Future Usefulness of Technologies and Techniques for KM

Technologies and Techniques	**Mean Values**
Internet/Intranet/e-mail	4.6
IT-based database	4.4
Telephone	4.2
Face-to-face meetings	4.2
Coaching and mentoring	4.1
Interaction with supply chain	4.1
Formal on-the-job training	3.8
Formal education and training	3.8
Cross-functional teamwork	3.8
Informal networks	3.7
Brainstorming sessions	3.6
Documents and reports	3.6
Project Summaries	3.5
Knowledge-based Expert systems	3.3
Work manuals	3.2
Video-conferencing	3.2
Job rotation	3.1
Decision support systems	3.1
Bulletin boards	2.8
Help desks	2.8
Quality circles	2.7
Knowledge Maps	2.6
Communities of Practice	2.5
Groupware	2.5
Storytelling	2.0

Respondents saw the Internet, Intranet and e-mail as the most useful tool for the future, demonstrating that there is an awareness of the increasing significance of newer communication tools over older ones, such as the telephone. However, conventional techniques for sharing and transferring knowledge, such as the telephone and face-to-face meetings remain high on the list. Respondents continue to value these tools and techniques implying a belief that more sophisticated IT hardware, software and criticalware, will not surmount the usefulness of these inherently social tools and techniques.

The technologies and techniques that were perceived to be least useful for KM in the next 5 years are similar to the least effective tools and technologies mentioned earlier. Groupware and Knowledge maps were seen to be of little use suggesting that the potential benefits of these tools are not fully understood. Many of the tools and technologies that scored low have received widespread acclaim from academics and practitioners within the KM field. For instance, 'Communities of Practice' (COP) are social groups involved in a common activity, where generative learning is encouraged. Adams and Freeman (2000) contend that such communities are the "ideal environments for the generation and transfer of knowledge work" (p.39). This opinion is not supported by the quantitative findings where COP's are regarded as being of little use to KM in the future. However, it is possible that most organisations cultivate a sense of community intrinsically, outside the constructs of a formal 'COP' strategy. Human relationships evolve naturally and communities tend to emerge out of a set of relationships that interact and intertwine. Within an organisation such communities exist where individuals are involved in a common work activity, such as a project, and where these individuals are required to interact with external groups frequently. It is likely that many of the organisations that participated in the questionnaire, are involved in COP's without being aware of it. This highlights a lack of awareness about specific KM terminology.

Overall, most tools and technologies were perceived to be of some use to KM in the next five years. This suggests that there is more awareness about the potential benefits of IT and that IT is becoming more important to the construction industry. Conventional techniques for sharing and transferring knowledge remain central to the success of construction organisations and perceptions about their effectiveness seems unaltered by the magnetism of newer, more sophisticated technologies. It is suggested that IT is a useful and effective tool for construction organisations and there is scope for further employment of IT, according to the context-specific requirements of an organisation. IT should be regarded as a tool to 'enable' people to work with greater efficiency and effectiveness, rather than an unshakeable panacea. Consideration should be given equally to the role of people as the creators, distributors and storehouses of knowledge so that such knowledge can be successfully exploited to create competitive advantage.

7. CONCLUSIONS AND RECOMMENDATIONS

It is clear that IT can be of much use for KM in construction organisations. It can be essential for the storage of explicit knowledge in databases and repositories but also as a communication device, through e-mail systems and Groupware. The empirical evidence suggests that IT is used to a certain extent within construction organisations, however, there is a general acceptance that it could be improved. It is also acknowledged that face-to-face interaction and verbal conversation are often more efficient in sharing and transferring tacit knowledge, while IT is more useful for the transmission of explicit knowledge and information. However, this may be due to the absence of a formal strategy or lack of awareness among staff of the potential benefits of IT specific to the organisation. It needs to be understood in the context of the corporate strategy and organisational culture so that IT usage can be tailored to the needs of the business.

Compared to the situation last decade ago, IT is becoming more sophisticated and is being recognised among construction organisations as a useful and effective tool for KM. The Internet and corporate intranets are especially commonplace in such environments, for the effective acquisition and transfer of knowledge and information. However, despite greater availability of more sophisticated IT, such as Groupware and Knowledge maps, perceptions about more conventional techniques for acquiring, developing and applying knowledge, such as telephone and face-to-face interaction, seem unchanged. This is perhaps explained by the fact that the construction industry is subject to cost and time constraints. Furthermore, projects are short- term endeavours, posing difficulties with building teams, 'Communities of Practice' and trust. There are, also, difficulties associated with investing time and money in educating employees about the potential benefits of IT to their working patterns. People tend to prefer familiarity over change and incorporating new technologies into the workplace takes time and effort. It is recommended that managers recognise the benefits of IT and implement

changes according to the specific organisational requirements. Such implementation must be accompanied by sufficient training and education for staff to ensure that IT is being used effectively.

8. REFERENCES

Adams, E.C. and Freeman, C. (2000) Communities of practice: bridging technology and knowledge assessment. Journal of Knowledge Management, Vol.4, No.1, pp.38-44

Bennett, R. and Gabriel, H. (1999) Organisational factors and knowledge management within large marketing departments: an empirical study. Journal of Knowledge Management, Vol.3, No.3, pp.212-225

Browning, J. (1990) Information Technology: The Ubiquitous Machine. The Economist, June 16, 1990, p. 5.

Chase, R.L. (1997) Knowledge management benchmarks. Journal of Knowledge Management, Vol. 1, No.1, pp. 83-92.

Coleman, D. (1998) "The challenges of electronic collaboration in knowledge sharing". IN: Knowledge management: A real business guide. Confederation of British Industry (CBI) (Ed.) Published in association with IBM, UK. Pp. 53 – 60.

Leonard-Barton, D. (1995) "Wellsprings of knowledge: building and sustaining the sources of innovation". Harvard University Press, Boston. USA

Davenport, T.H. and Prusak, L. (1998) Working Knowledge. Boston, Harvard Business School Press

Dearlove, D. (2000) Value your company's brainpower. The Times, October 26th

Dougherty, V. (1999) Knowledge is about people, not databases. Industrial and Commercial Training, Vol. 31, No.7, pp. 262-266

Edvinsson, L. (2000) Some perspectives on intangibles and intellectual capital 2000. Journal of Intellectual Capital, Vol. 1, No.1, pp. 12-16

Egan, J. (1998) Rethinking Construction: Report of the construction task force on the scope for improving the quality and efficiency of UK construction. London, Department of the Environment, Transport and the Regions

Egbu, C. (2000) The role of information technology in strategic knowledge management and its potential in the construction industry. In: Proceedings of UK National Conference on 'Objects and Integration for Architecture, Engineering and Construction', March 2000, BRE, Watford.

Egbu, C. O, Bates, M. and Botterill, K. (2001) "A conceptual research framework for studying knowledge management in project-based environments" Proceedings of the International Postgraduate Research Conference in the Built and Human Environments. 15 - 16th March 2001, University of Salford, UK)

Egbu, C., Gaskell, C. and Howes, J. (2001) The role of organisational culture and motivation in the effective utilisation of information technology for teamworking in construction. IN: Proceedings of the 17th Annual Conference of the Association of Researchers in Construction Management (ARCOM), 5-7 September, University of Salford, UK.

Gann, D.M. (2000) Building Innovation: Complex Constructs in a Changing World. London, Thomas Telford Publishing

McCampbell, A.S., Clare, L.M. and Gitters, S.H. (1999) Knowledge management: the new challenge for the 21st century. Journal of Knowledge Management, Vol.3, No.3, pp. 172-179

Nonaka, I. and Takeuchi, H. (1995) The Knowledge-Creating Company. Oxford, Oxford University Press

Robinson, H. S., Carrillo, P. M., Anumba, C. J. and Al-Ghassani, A. M. (2001) Knowledge management: Towards an integrated strategy for construction project organisations. In: Proceedings of Fourth European Project Management Conference, 6-7th June, London

Rozell, E. and Gardner, W. L. (2000) Cognitive, motivation and affective processes associated with computer-related performance. Computers in Human Behaviour, Vol. 16, pp. 199-222

Ruggles, R.L.(1997) Knowledge Management Tools. Boston, MA., Butterworth-Heinemann

Sanchez, R., Heene, A., and Thomas, H. (1996) "Towards the theory and practice of competence-based competition", In: Dynamics of competence-based competition – Theory and Practice in the New Strategic Management (Editors: Ron Sanchez, Aime Heene and Howard Thomas), Oxford: Elsevier.

Scarbrough, H., Swan, J. and Preston, J. (1999) Knowledge Management: A Literature Review. London, Institute of Personnel and Development