INFORMATION TECHNOLOGY TOOLS FOR CAPTURING AND COMMUNICATING LEARNING AND EXPERIENCES IN CONSTRUCTION SMEs IN DEVELOPED AND DEVELOPING COUNTIRES

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EDITOR: A. Serpell and S. V. Barai

Cynthia ChinTian Lee, PhD Candidate
School of Built and Natural Environment, Glasgow Caledonian University, UK
email: leec@gcal.ac.uk

Charles O. Egbu, Professor of Construction and Project Management
School of Built and Natural Environment, Glasgow Caledonian University, UK
email: c.egbu@gcal.ac.uk

SUMMARY: *The cross-boundary knowledge transactions between foreign companies and local companies in developing countries can be a useful source of knowledge for both foreign companies and local companies. With the increased investments in buildings and infrastructure by developing countries, the cross-boundary knowledge transactions between foreign companies and local companies in developing countries if captured, transferred and reused will bring significant benefit to organisations and potential benefits to the wider construction industry. This paper is based on an 18-month research project funded by the UK Department of Trade and Industry (DTI), which aimed at improving knowledge management in small medium enterprises (SMEs). The research project adopts a simple and yet robust approach in assisting SMEs to capture their learning experiences, explicate the significant knowledge embedded in the participants' experiences and transform it into knowledge accessible to a wider audience. The objective of this paper is to show how IT can be utilised by developing countries in their knowledge management. In this paper, the challenges faced by project participants in their knowledge management process is examined and it is concluded that to build knowledge assets, developing countries can adopt a similar approach as that in this research minus the technology involved.*

KEYWORDS: *knowledge assets, knowledge management, learning experience, small medium enterprise.*

1. INTRODUCTION

The building industry has been pivotal to the robust economic growth of developing countries. To expand further growth, investments in building and infrastructure are needed (Raftery et al., 1998). Research has shown that developing countries suffer from construction time and cost overruns (Okpala and Aniekwu, 1998; Elinwa and Buba, 1993; Mansfield et al., 1994; Assaf et al., 1995; Yong, 1988; Kaming et al., 1997). Some of the causes of the mentioned problems identified by Kaming et al. (1977) in his research on the Indonesian construction industry are that there have been dire shortages of skilled manpower to cope with the boom in construction activities, and a lack of technological knowledge and contractor experience with regard to particular types of projects. Studies on the construction industry in developing countries have recognised the problems of low level of technological development and the lack of skilled construction personnel (UNCHS Habitat, 1984; Wells, 1986; Ofori, 1993).

Developing countries rely heavily on foreign companies for construction of major projects (Trinh and Sharif, 1996). In the main, these foreign companies tend to use familiar practices, methods or techniques employed in their home country rather than adapting or modifying them to conform to local situations (Moavenzadeh and Rossow, 1975; Imbert, 1990). The cross-boundary knowledge transactions between foreign companies and local companies in developing countries can be a useful source of knowledge for both foreign companies and local companies. In addition to the significant indigenous knowledge that developing countries have, if this cross-boundary knowledge is effectively managed i.e. collected, structured and disseminated, it will bring significant

benefit to organisations, potential benefits to the wider construction industry of the developing countries and also enhance economic development.

Knowledge resides in many different places such as: databases, knowledge bases, filing cabinets and peoples' heads. It can be seen as the entirety of cognitions and abilities, which are used by individuals to solve problems. This comprises theoretical perceptions as well as pragmatic day to day rules and guidelines and is an organised set of statements of facts or ideas, presenting a reasoned judgement or an experimental result. The construction industry is essentially an information processing industry (Aish, 1999); where most knowledge comes from the successful completion of projects (Conheeney et al, 2000). With the increasing pressure for competitiveness on construction organisations, it is necessary to capture, transfer and reuse project knowledge and use lessons learned from previous projects to improve project performance. The reliance on project participants to share knowledge in order to succeed in project delivery has never been greater (Whelton et al., 2002). Transferring knowledge and information across projects is a major challenge for construction organisations. Much of construction work is project-based, 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 (Egbu & Botterill, 2002). In this knowledge driven global economy, knowledge itself can be seen as a commodity that offers the only 'true sustainable competitive edge'. For the developing countries, it is recognised that an appropriate strategy to manage knowledge as a factor of production in order to attain acceptable levels of economic growth is needed (Abu-Rashed et al, 2005). Developing countries are encouraged to utilise their existing knowledge and develop strategies to acquire new knowledge (The World Bank, 1999).

Knowledge management (KM) is defined as any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance in organisation (Scarborough et al., 1999). Knowledge management involves knowledge identification, creation, acquisition, transfer, sharing and exploitation. Knowledge management is vital for efficient working in projects and for improving organisational competitiveness (Egbu, 2000a, 2001) and the need for knowledge management in the construction industry is fuelled by the need for innovation, efficiency, improved business performance and client satisfaction. Knowledge management can promote innovation and business entrepreneurship; help in managing change, and for emancipating and empowering employees (Nonaka and Takeuchi, 1995; Egbu, 2000b; McAdam and McCreedy, 2000; DTI, 2000).

With over 90% of the construction industry in the UK made up of SMEs and the existence of a large number of SMEs in developing countries, this research project therefore looks at the improvement of knowledge management in small medium enterprises (SMEs). Given the fact that developing countries lack the sophisticated and enabling environment and policies that efficiently contribute to knowledge and economic growth, Abu-Rashed et al, 2005 have put forward that economists and researchers dealing with knowledge management in developing countries to focus on the utilisation of information communication technology (ICT) rather than the production of ICT. Although this paper illustrates an information technology (IT) tool that was developed in a developed country like the UK to operate the knowledge management process of capturing, transforming and disseminating the learning process of individuals in construction organisation, this paper aims to show how IT can be utilised by developing countries in their knowledge management efforts.

1.1 Knowledge Management and Small Medium Enterprises

Small and Medium Enterprises (SMEs) are organisations that have less than 250 employees. Hylton (2002) suggests that SMEs are in need of knowledge management just as much as large enterprises. The reasons cited are that the world has changed rapidly over the past decade and continues to do so. There are more contenders for every dollar or profit, which put great pressure on companies, large and small, to innovate and to develop products rapidly. Both innovation and rapid development require accelerated use of knowledge, knowledge that must be managed efficiently, effectively and securely. To remain competitive, companies have to know something and then co-ordinate and use what they know, quickly. SMEs therefore must first know what their knowledge assets are and then see how to manage and make use of these assets to get maximum return. However, compared to large companies, SMEs are usually technologically weak, cannot invest heavily in innovation and development, and take a less-formal strategy in management (Boyd et al., 2004). Other weaknesses identified by Rothwell and Dodgson (1994) are that SMEs suffer from little management experience, power imbalance if they are to collaborate with large firms, difficulty in coping with complex regulations and

associated cost of compliance. With limited, and often very stretched staff resources in SMEs, their people need a broad range of skills and experience to undertake multiple tasks (Sexton and Barrett, 2003).

The weaknesses of SMEs pertaining to knowledge management as identified by Egbu (2001) are:

- Inability to fund long-term and risky knowledge management programmes
- Weakness in specialised range of technological competencies
- Weakness in investment on training and education

The strengths of SMEs on the other hand are:

- Its less formal strategies increase the communication of knowledge, speed of decision making and improve informal networks
- Its informal network improve employee commitment and their receptiveness to knowledge management regimes
- They are also able to react faster to changing market requirements and the requisite knowledge to satisfy market needs.

The main strategic concern of SMEs is survival in the fiercely competitive market and their biggest operational issue is cash flow as they will be out of business if they cannot get the money in (Storey, 1994). The knowledge in SMEs tends to be small, oral, tacit and contextual and some of the knowledge management concepts and methods developed for multi-national enterprises may not apply to SMEs (Boyd et al. 2004). There is, therefore, a need to develop knowledge management approaches suitable for SMEs in the construction industry. Such approaches of sharing knowledge or tapping into the knowledge pool must be simple, straightforward and efficient in order to encourage employees' participation and maximise the benefits of knowledge management (Alazmi and Zairi, 2003).

2. A THEORETICAL PERSPECTIVE

Knowledge management is a complex process which involves the management of explicit and tacit knowledge (Nonaka and Takeuchi, 1995). Explicit knowledge refers to the knowledge which can be articulated in formal language such as grammatical statements, mathematical expressions, specifications, manuals, and thus can be transmitted across individuals formally and easily. On the contrary, tacit knowledge refers to the knowledge which is hard to articulate with formal language, but is personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspective, and value systems (Nonaka and Takeuchi, 1995). There is evidence to suggest that it is tacit knowledge that contributes more to organisational innovations and competitiveness (Boyd and Belcher, 2002). Compared to explicit knowledge, tacit knowledge is more difficult to access, communicate, share and audit and human behaviour is vital in its transmission (Nonaka and Takeuchi, 1995).

In much of the activity in construction, complex problems are solved by site managers and project managers in their day-to-day work using their experience and intuition, i.e. their tacit knowledge. A simple yet robust knowledge management approach for SMEs targeted at this knowledge was devised and adopted in this research. The theory behind this approach centres on the Kolb learning cycle (Kolb, 1984) as show in Figure 1. This study concentrates on the capture and exploitation of tacit knowledge. It is argued that capturing knowledge from experience involves two main operations. The first is based on recording events i.e. diary and the second is based on personal reflection and abstract conceptualisation of the events i.e. debriefing.

Personal knowledge that is involved in day-to-day events is very complex and is not generally available outside the person. However in practice, sometimes knowledge transformation and dissemination does take place through people telling stories about the events they have experienced. In story telling, tacit knowledge is transformed into explicit knowledge by means of 'metaphors', which is a distinctive method of perception (Koskinen, 2003). Through metaphors, people put together what they know in new ways and begin to express what they know but cannot express verbally. By the metaphorical approach, specific experiences are used to engender greater learning for present and future applications (Boyd et al., 2004). Zimmerman and Weider (1977) proposed diaries as a simple tool for encouraging people to capture events. A diary is a record of events, maintained by the subject over time, which can then be reviewed, and analysed (Burns and Grove, 2001). It provides the participants in the research an opportunity to record their experiences, perceptions and feelings about their daily operations on site relatively soon after they occurred. But diaries require writing skills and time

for composition, which are barriers to SMEs. Indeed, construction practice communicates substantively using spoken language. It is rich in meaning because of nuances of delivery, body language and context which provide many dimensions of information useful for practice. It is this multi-dimensional world of oral communications which contains much of the tacit knowledge and also the ability to transfer it. In order to relate better to construction SMEs an oral method of diary keeping is required. Therefore, audio diaries were used to collect events in this research. This would also minimise the disruption to the participants' daily work, encouraging their participation and cooperation.

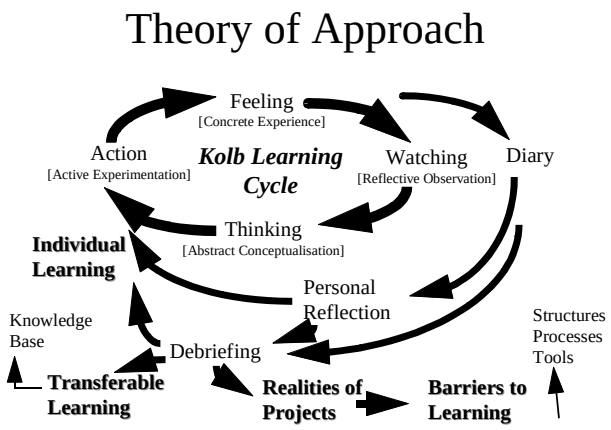

FIG. 1: Theory of the Approach.

Diary keeping forces participants to reflect on events. Reflection challenges perceptions and it is at this point when past thinking is shown to be inadequate that new theories are built (Boyd and Wild, 1996). This is a fertile time for knowledge management, however, there is a need to formalise the new knowledge to make it more generally available. In addition, knowledge transfer of tacit knowledge requires socialisation (Nonaka and Takeuchi, 1995) and so, this knowledge can only be brought out and developed in dialogue with others. Debriefing was taken as a sufficiently formalised technique of dialogue to be useful in this approach. Thus, after a number of audio diary entries, participants are debriefed to analyse their learning and to provide a deeper interpretation of the events. Debriefing is a powerful tool, which can make explicit the tacit learning so that it can be transferred to a wider audience and ultimately to the knowledge base of the industry. Originally, debriefing was a term in military campaigns and war games, which meant to question and examine persons who had returned from a mission or exercise to determine what had occurred and then to develop new strategies as a result of the experience (Pearson and Smith, 1985). Now, debriefing refers to a purposeful reflection in a social interaction which assists learners to develop generalisations and to transform experience into learning. The rationale behind debriefing is that the individual learning can be enhanced by this purposeful reflection, and the individual lessons can then be aggregated, validated, and synthesized to produce organizational learning. It is this second operation of debriefing that involves the transformation of tacit knowledge to explicit knowledge thus formatting it for dissemination.

3. THE RESEARCH METHODOLOGY

The research methodology adopted in this research is narrative research – a branch of interpretative research whose mode of research is of understanding, interpreting and communicating.

The research reported herein concerns the building of knowledge assets within SME organisations in the construction industry. This is done through the process of knowledge generation, storing and sharing.

Knowledge generation - is the processes executed to increase the stock of knowledge assets. Knowledge can be generated through knowledge acquisition and creation. Knowledge acquisition is the process of capturing and bringing knowledge from the external environment into the company whilst knowledge creation is the process of developing new knowledge assets primarily within the company (Marr, 2003). In the context of this research, knowledge generation was operationalised through knowledge creation.

Knowledge storing - is the process of 'saving' knowledge within the organisation so that knowledge can be made available anytime and anywhere. Knowledge storing can take the form of knowledge databases, in which codified knowledge is stored in appropriate information codes. This is based on the idea that knowledge can be codified and made available to be retrieved electronically and this approach was adopted in this research.

Knowledge sharing - is the process by which knowledge is disseminated across the organisation. Knowledge sharing can be done through formal and informal process; formal knowledge sharing can be in the form of meetings, seminars and workshops and informal knowledge sharing in the form of informal discussions between individuals in an organisation. Knowledge sharing can be supported by the use of information and communication technology (ICT) for example online databases, data warehousing/knowledge repositories and intranets. The strategy to adopt ICT is one of the most followed managerial practices within organisations (Marr, 2003) and ICT can be a facilitator to encourage individuals to share their knowledge.

28 site managers from 12 UK construction SMEs were involved in the study, coming from organisations that included general contractors, specialist contractors and consulting companies.

Once a week, the research participants record stories of problem-solving events, which these managers had experienced using Dictaphones provided for the project. The recording of problem-solving events will enable participants to communicate learning. The participants were encouraged to select events that were useful for learning; i.e., events that were challenging, successful, worrying, complicated, difficult, frustrating, or annoying. A set of structured but open questions was provided to help the participants in recording their stories. The use of audio diaries in this task minimised disruptions to the participants' daily work, and encouraged their participation and cooperation. Nearly three hundred audio diary entries were recorded and their stories yielded rich qualitative data.

After about four diary entries per manager, the storyteller was debriefed by the researcher to analyse for learning from these stories and to provide a deeper interpretation of the events. The debriefing process will enable participants to interpret, reflect and understand on their learning. The debriefing sessions were recorded by Dictaphones and were structured to facilitate the data analysis. The structuring was done with reference to principles discussed by Pearson and Smith (1985). Over ninety debriefings were conducted with the research participants (i.e. the 28 participants).

In this research, knowledge is generated by the research participants when they reflect on their experiences and record them in the event register and post project review forms. The tacit knowledge of site managers is captured initially and inadvertently through diary entries, whereby events which arise through daily operations of their work is recorded in the event register and made explicit. Issues such as circumstances underpinning the event, the feelings and actions of the participants, the reactions of other people involved in that project and the lessons learned from the event may be discussed in the event register. Similarly, at the end of a project, a post project review is done through the exploration of what contributes to the successes of the project, the problems/challenges faced and the lessons learned. The recorded knowledge in the event register and post project review is stored as knowledge database, made available and shared throughout the organisation via the intranet. Through this process, the organisation's knowledge assets are built up.

4. INFORMATION TECHNOLOGY (IT) AND KNOWLEDGE MANAGEMENT

Much of knowledge management focuses on the role of information technology (IT) and information systems (IS) and the tools that aid knowledge transfer and storage (Egbu, 2000; 1999). Although IT and IS are essential requirements in 'enabling' knowledge management, the true asset of an organisation is its brainpower (Edvinsson, 2000). Intellectual Capital (IC) is recognized as a key strategic asset for organizational performance and its management is critical for the competitiveness of organizations (Roos et al., 1997, Marr et al, 2003). Three components of IC identified are human, structural and customer capital (Edvinsson, 2000; Bontis, 1998; Bontis et al., 2000). Structural capital is the internal structure of an organisation, such as its strategies, core competencies and culture, which is always context specific. Customer capital on the other hand encompasses the external intangible assets of an organisation. Customers are the principle determinants of the market position and strength of an organisation (Smith and Saint-Onge, 1996). Human capital is asserted as the most important intangible asset in an organisation, especially in terms of innovation (Edvinsson, 2000; Stewart, 1997; Roos et al., 1997; Brooking, 1996). The unique tacit knowledge of individuals is of immense value to the organisation as a whole, and is the "wellspring of innovation" (Steward, 1997). It is essential for organisations to maintain and

grow their IC stocks and knowledge management is one way of helping them to do this (Brooking, 1997). It is argued that few know how to use this knowledge in a systematic way in order to gain real business benefits (Marr, 2003).

4.1 Differences between Knowledge and Information

Very often, knowledge management is confused with information management (Sveiby, 1997). Sveiby (1997) contend that the confusion between knowledge and information has caused managers to sink billions of dollars in information technology ventures that have yielded marginal results. He asserts that business managers need to realise that unlike information, knowledge is embedded in people, and knowledge creation occurs in the process of social interaction. Unlike information management, which in general is the conservation, sharing and recycling of information or data for specific business use, knowledge management is about people (Dougherty, 1999). A distinction made between information and knowledge by Ash (1998) and Kirchner (1997) is that information has little value and will not become knowledge until it is processed by the human mind and that knowledge involves the processing, creation, or use of information in the mind of the individual. Other definitions on information and knowledge include knowledge is 'information combined with experience, context, interpretation, reflection and perspective' (Davenport et al., 1998; Kirchner, 1997; Frappaolo, 1997). Although information is not knowledge, it is an important aspect of knowledge (Martensson, 2000). If the process of knowledge management is led by IT, knowledge can too easily become "information" or data only: to be stored and theoretically retrieved, from databases (Dougherty, 1999). Thus, it is essential that the use of IT to manage knowledge should be done ingeniously.

IT is becoming increasingly important to KM in construction organisations (Egbu & Botterill, 2002). Many organisations employ IT in one form or another to manage their knowledge and, in general, IT is used primarily to store and transfer explicit forms of knowledge. In addition, IT can also be used to aid collaboration and co-operation between people, and as a tool to assist the transfer of knowledge and information between project teams, enabling the development of new knowledge for innovation. However, the construction industry has been slow to recognise the benefits of IT as a major communication tool (Egbu et al., 2001). Research (Egbu & Botterill, 2002) has shown that the most frequently used techniques and technologies in construction organisations are: telephone, Internet/intranet/email and documents and reports. These are closely followed by face-to-face meetings and interaction with the supply chain. Although construction organisations are investing more in some aspects of IT, such as the Internet, greater emphasis is put on the more conventional techniques for acquiring, developing, sharing and storing knowledge. IT should be understood less in its capacity to store explicit information and more on its potential to aid collaboration and co-operation between people (Egbu & Botterill, 2002). Dougherty (1999) argues that IT should be seen as a tool to assist the processes of KM in organisations.

Communication is a vital part of organisational activity and IT has a central role to play in communications within and across organisations (Egbu et al., 2001). However, IT is a poor substitute for converting information into knowledge (Bhatt, 2001). It is only through people, that information is interpreted and turned into knowledge. The role of IT in knowledge capture in SMEs is not significant. Although IT has been extensively used for communication in SMEs, the use of IT as a knowledge capture tool is still in arrears. This may be due to the lack of awareness of knowledge management in the SMEs; let alone in knowledge capture, financial limitations of SMEs and their weakness in the provision of education and training which hinders their skills in IT.

4.2 Building Knowledge Assets with IT

There is a plethora of knowledge management tools and solutions in the marketplace. However, the increasing attention of knowledge management is unsurprisingly targeted at very large multinational organisations, with little at the SMEs; and even less at construction-related organisations. In this research project, we have employed the use of IT in building knowledge assets by capturing, storing and sharing knowledge for SMEs through:

- event diary,
- debriefing,
- post project review

A website using Microsoft Frontpage as illustrated in Fig. 2 below was created, whereby users are able to conduct online debriefing, record an event diary or do a Post Project Review. Under the event diary section, users are given the option to listen to events recorded by their colleagues, record an event orally using the audio diary or key in an event which they have encountered in the process of their work.

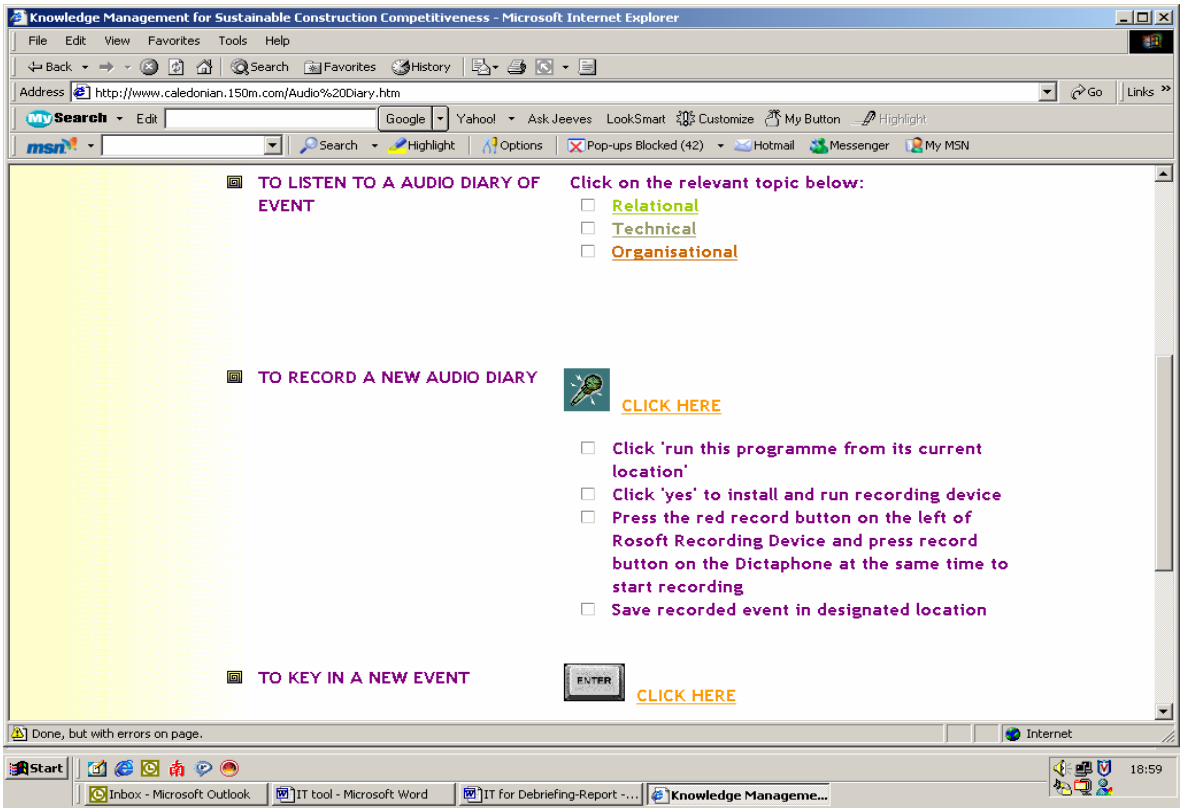

FIG. 2: Screenshot of the webpage created for knowledge capture.

In this project, the audio diaries recorded by users are kept under three broad areas: Relational, Technical and Operational. Users are able to click onto the relevant topic to listen to an event recorded by their colleagues. Audio Diary can be created using Rosoft Audio Recorder. This software can be downloaded free of charge fromhttp://www.downloads.com. To do a recording, the software is activated and a recording screen will appear on the computer. Users will need to plug in their Dictaphone and press the record button on the Rosoft Audio Recorder as well as on the Dictaphone and the events can be recorded and saved into their company database. Upon creating the above said audio diary under different topic, it will be stored in the database where users can select to listen to the audio diaries of their colleagues and learn from their experiences by simply clicking the appropriate button on the relevant topic and the audio diary will be played.

Next, to key in an event and create an event database, Microsoft Access was used (see Fig. 3 for an illustration of the database). A link is created on the website and users will need to click on the 'ENTER' button and download the file to key in the event. In addition, users can conduct an online debriefing. The created document can be uploaded to their intranet and answers to the debriefing questions can be keyed into the text boxes by individuals (Please see Fig. 4 below). Then a submit button is set at the bottom of the page and answers to the questions are submitted electronically and kept in the company database. Similar to the event database, users can also create a database for post project review which enables users to evaluate projects and learn from them. This will enable project information to be captured, retained, indexed so that people external to the project can retrieve and apply it to future tasks/projects. By reviewing projects, it will prevent 're-inventing the wheel' and repeat mistakes.

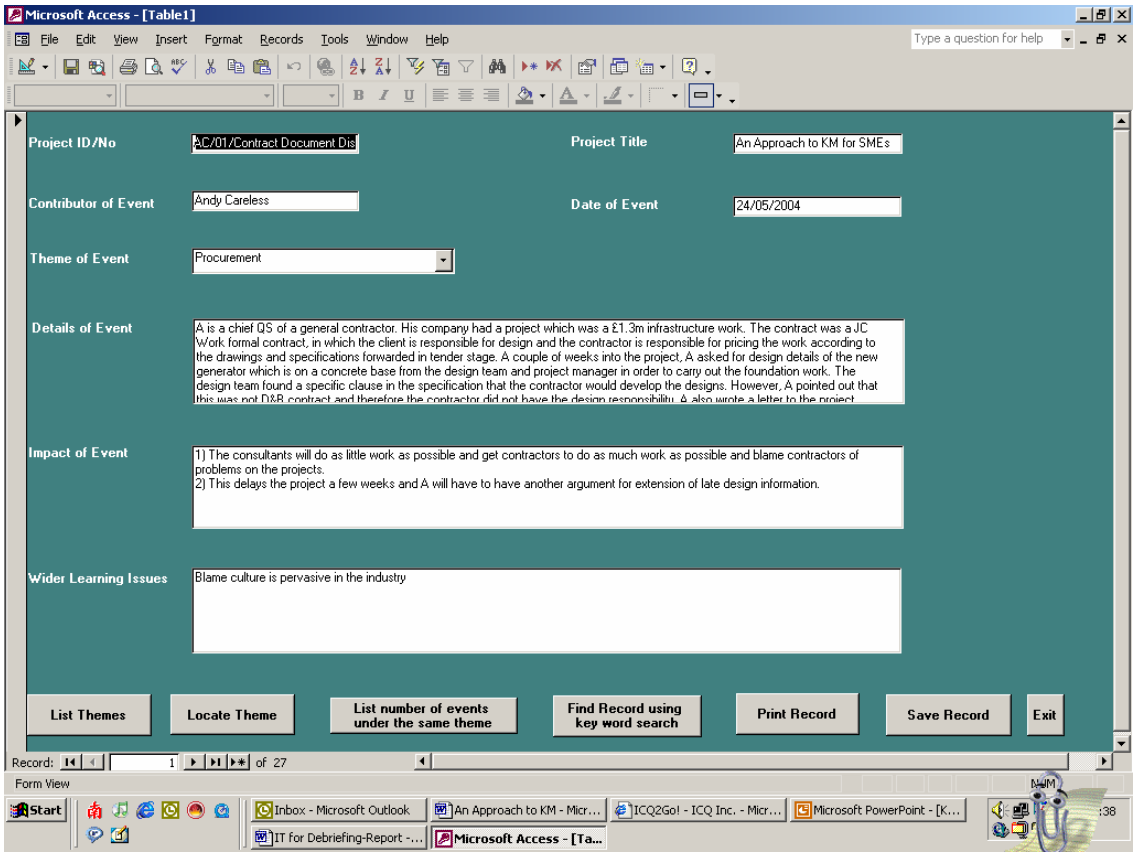

FIG 3: Screenshot of Event database.

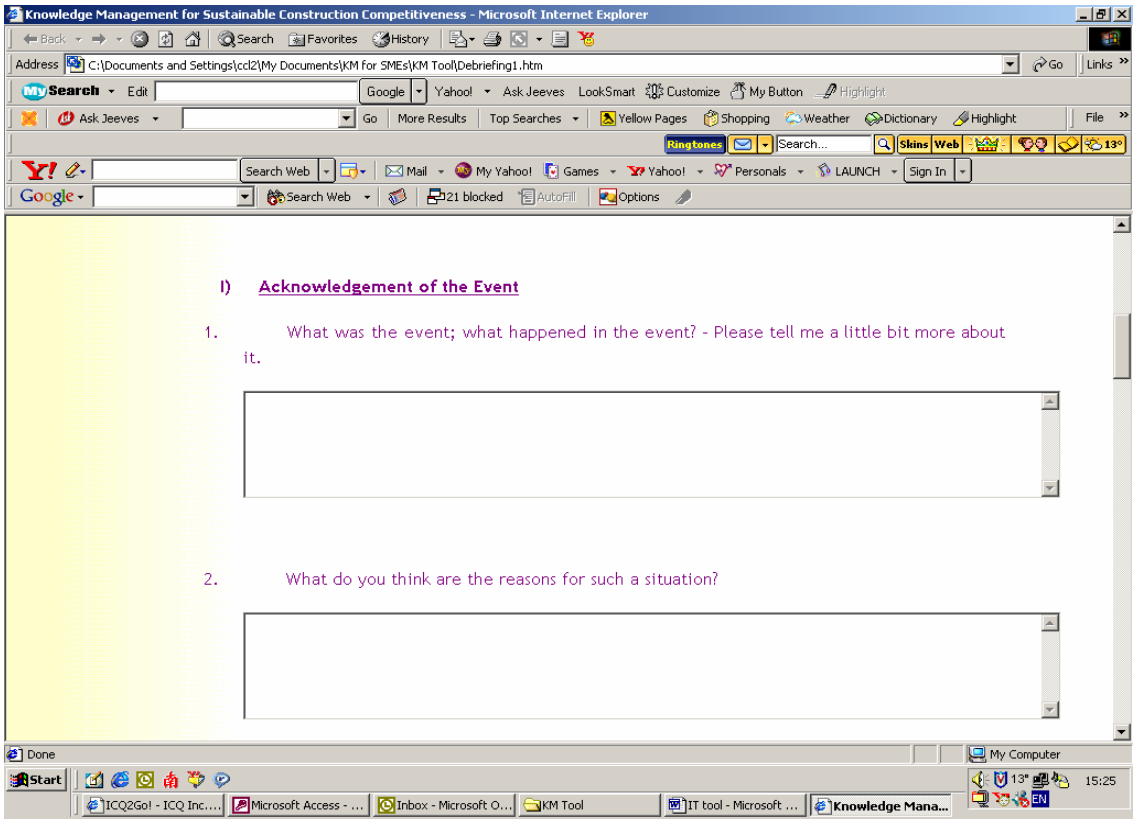

FIG 4: Screenshot of Online Debriefing.

5. CHALLENGES FACED BY PROJECT PARTICIPANTS

Along with the benefits of knowledge management many barriers exist, thus turning the management of knowledge into a very challenging task. A barrier can be considered to be 'Everything related to human, organisational and/or technological issues that obstructs the intra- and inter-organisational management of knowledge ….' (Wunram et.al, 2000).

The approach adopted in this research was designed around the needs of SMEs so that it would work with the way that they operate and not require substantive extra resources for it to deliver successful learning. SMEs need different sources and types of knowledge as their concerns are substantively operational with an emphasis on survival and cash flow. Their knowledge is small, oral, tacit and contextual with any approach to knowledge management delivering immediate outputs. Thus, this project has utilised simple technology and works on the immediate experience of managers. The project has captured 264 events and undertaken 109 debriefings from 12 SMEs. These have delivered immediate knowledge to the individual participants and through company workshops used the knowledge-events to enhance the knowledge around the companies. A number of the companies have used the technique themselves and have developed the approach to be appropriate to their circumstances.

Barriers and enablers have been raised both from the events themselves and also the problems participants had in operating the approach. The latter were gleaned from questioning during debriefing and through a questionnaire at the company workshops. Removal of a barrier will become an enabler. Successful knowledge management operates through enablers at company, project and individual level. Barriers and enablers exist at industry, company, project, and individual levels. Some enablers identified in this research require work at all four levels and they are:

1. Industry
   Construction work is project-based, short-term and task-oriented, promoting a culture where continuous learning is inhibited. The industry needs to promote a wider understanding of itself rather than focus all the time on specific training. An industry culture of learning and knowledge management would assist the lower levels to undertake it.

2. Company
   Sharing experience and knowledge is not part of most jobs, thus it is not appraised and so not taken seriously. Knowledge in companies currently relates closely to power and job security. People working in construction are happy to talk to outsiders (like in this research) about their problems, but many of them are reluctant to do so with their own managers or someone from their own company. People can learn more from mistakes, but due to the rigid management processes, people are not empowered to try new things and learn. The blame culture is pervasive in construction industry. Companies can start to remove the blame culture and to value knowledge sharing. Thus, senior management in the company and practitioners should realise the importance of knowledge management practice and put it as at least one of their priorities, and allocate specific time.

3. Project
   Constant time and cost pressure causes people to search for quick fixes to their problems and then move on to the next problem. They do not have time to slow down and reflect on their experience to establish root causes. In the end, the same mistakes are repeated. This Knowledge Management Approach overcomes this barrier and the participants agree that it is a good way to learn by reflecting their own experience and discussing it with others.

4. Individual
   Knowledge management is not just the duty of knowledge manager but needs to involve all members of an organisation. Valuing each individual's unique experience and skills in handling their day-to-day work is an enabler of knowledge management. Everyone has something to share and to contribute in the knowledge management practice. Individuals benefit from learning to take a wider view of their work and the development of skills in debriefing encourages this. Senior individuals can encourage others through their practice to do knowledge management and they present the model for effective participation and action. Without proper procedures and sufficient training and practicing, it would be difficult to achieve the expected results. In order that companies can operate by themselves, some simple and concise operation manuals and training packages need to be designed and provided. To implement knowledge management, an

organisational culture and environment should be created to promote openness and trust and encourage people to innovate and learn from mistakes, and share their experience and learning.

Other challenges faced by participants faced in their knowledge capture process in this research are identified as below and these barriers can be basically allocated to the TOP (Technology, Organisation, People) categories of socio-technical systems classification by Thoben (2002):

- Technology
  As discussed earlier, SMEs are weak in specialised range of technological competencies. The technologies employed in their knowledge capture process are also usually equipments used in their day-to-day running of their tasks. Although attempts may have been made to capture knowledge, no advanced or innovative technologies are roped in to help in the process.

- Organisation
  There is a lack of awareness of knowledge management strategies and instruments in the SMEs that participated in the study. The necessary awareness of knowledge management is relatively low among the companies that participated in our study. There is a lack of knowledge capture strategy in place and no company had an explicit knowledge management strategy implemented, nor determined corresponding responsibilities. Very often, employees are not aware of the knowledge capture process and often look for quick fixes in their work to fight the symptoms of a problem and not its cause, thereby missing the opportunity to record their experiences let alone transferring their knowledge to colleagues. When questioning why people tended to look for quick fixes instead of lasting solutions, efforts related to time and costs were almost always mentioned. Although SMEs may be aware of the power of knowledge management and the importance of knowledge capture in their organisation, they often feel that they have other more pressing priorities and needs. In addition, knowledge capture is sometimes seen as a 'big boy's' thing or even as a fad that only big companies can afford to indulge in.

- People
  Communication barrier was mentioned as a problem when dealing with people. A common problem in this context occurs when two colleagues of the same company and are involved in the same project but belong to different domains. The understanding of what they are talking about can be significantly different. Although SMEs may have a less formal communication channel, the barrier of 'idea robbery' still exists; the fear that the idea of an individual employee could be taken by another who then gets the acknowledgement and rewards for that idea. Thus, there is a need for the protection of proprietary knowledge among employees and this could hinder knowledge transfer and capture. This issue needs to be addressed sensitively and pragmatically. Another barrier that SMEs faced is finding the time to capture knowledge. People are overstretched and the knowledge capture process may impact too much in their activities.

6. IMPLICATIONS FOR CONSTRUCTION SMEs IN DEVELOPING COUNTRIES

Many developing countries are grappling with the problems of providing access to education, health services and clean drinking water and hence facilitating access to the world pool of knowledge may not get as much attention as it deserves (Malhan and Gulati, 2003). ICT can assist in connecting people and making information more accessible to a large number of people. However, the lack of adequate ICT infrastructure in developing countries can be a barrier to gain knowledge at a wider level. It is acknowledge that people in developing countries have low income, and relatively few opportunities for training and education to obtain requisite qualifications. To meet knowledge needs and enable effective knowledge management, the enhancement of educational and training institutions and the recognition of education as a lifelong activity are needed in developing countries (Abu-Rashed et al., 2005).

Contractors in the developing countries are not competitive in construction technology and finance (Raftery et al., 1998). The lack of access to finance is a critical constraint for SMEs in developing countries to procure technical expertise (Eyiah and Cook, 2003). To move up the learning curve, SMEs in developing countries should take advantage of the cross-boundary knowledge transactions between foreign companies and local companies and incorporate knowledge management process in their work procedures. The main challenges facing developing countries on effective utilisation of ICT identified by d'Orville (2000) include the issues of awareness, advocacy and policy formulation and connectivity (i.e. affordable and equitable access to

telecommunication infrastructure, ICT hardware, software and networking facilities), capacity and institution building.

Given the fact that SMEs in developing countries lack the finance to invest in technology, approach to knowledge management as that in the research project may be an avenue for the SMEs. Furthermore, knowledge capture in the form of manual documentation of lessons learned from projects can be a starting point in their knowledge management efforts. In addition, financial assistance from the government for investment in education is required if developing countries are to build an educated labour force equipped with the relevant education and knowledge.

7. CONCLUSIONS AND RECOMMENDATIONS

Knowledge is rapidly becoming the most important asset of virtually all organisations and organisations in the construction industry are no exception. The ability to manage and exploit knowledge will be the main source of competitive advantage for the construction industry of the future. Knowledge management may help SMEs develop for the future and have more sustainable business practices, making them less vulnerable to the economic cycles of the industry. Knowledge sharing will minimise the knowledge loss that will result in the event of a straightforward transfer of tacit knowledge to explicit forms. McDermott (1999) argues that IT tools alone cannot effectively perform knowledge conversion, unless certain other conditions such as trust, face-to-face contact, time to interact between participants and creation of a common language are in place.

Outlined are the challenges faced by SMEs in the research project. This project has been dealing with a different character and form of knowledge which computers and email are less useful in managing. In addition, the approach targets small and medium sized construction organisations, which are unable to invest heavily in ICT. Thus, the ICT used in this research was kept to the minimum and appropriate but effective and efficient in carrying out the necessary tasks. In the future ICT will develop to undertake task more appropriate to this approach and the organisation will be more able to buy this and also to work with it. Thus, it is important to see the opportunity that ICTs have in helping to operate this approach. It is proposed that in order to bring knowledge management to its next lap, SMEs need to look into their work procedures and incorporate the knowledge capture process into it. In addition, SMEs also need to be able to identify their sources of knowledge in order to be able to capture it. For SMEs to implement knowledge management system, investment in education, training and infrastructure need to be increased. Like large companies, SMEs should take action to better manage tacit knowledge.

Knowledge management in construction SMEs in developing countries are crippled with a host of problems. Some of which are similar to their counterparts in developed countries and some which are different. Despite the presence of problems like inadequate technical infrastructure, finance, level of education and disciplined management approaches which make knowledge management efforts an uphill task, developing countries can still capture knowledge and lessons learned by adopting a less technological approach like appropriate use of project meetings, brainstorming exercises, use of quality circles, story telling and effective manual documentation of knowledge.

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