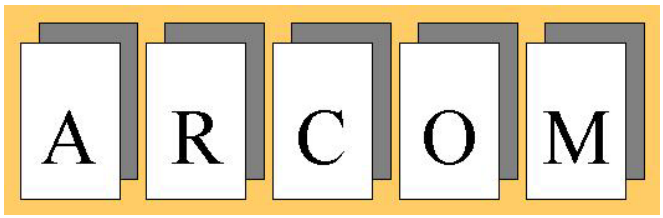

Association of Researchers in Construction Management

ARCOM Doctoral Workshop

Managing Innovation and Knowledge Management in the Construction Industry

The School of Built & Natural Environment
Glasgow Caledonian University, Scotland, UK

18th June 2003

Workshop Convener: *Dr. Andrew Dainty*
(Loughborough University)

Workshop Chairman: *Professor Charles Egbu*
(Glasgow Caledonian University)

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ARCOM DOCTORAL RESEARCH WORKSHOP

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Glasgow Caledonian University
Wednesday 18th June 2003, 11.00-17.30

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Welcome and Introduction

The School of the Built and Natural Environment, Glasgow Caledonian University (GCU) cordially welcomes you to Glasgow and to this Doctoral Workshop organised by the Association of Researchers in Construction Management (ARCOM). GCU is, indeed, very pleased to be hosting this event. This workshop is also supported by the newly formed Joint Glasgow Caledonian University and University of Strathclyde Student Chapter of the International Council for Research and Innovation in Building and Construction (CIB).

The Association of Researchers in Construction Management brings together all those interested in construction management research. ARCOM's aim is to further the advancement of knowledge in all aspects of management in construction by supporting education, dissemination and research.

The Doctoral Workshop is a very important activity, which ARCOM organises. The Workshop has three aims: they give the opportunity for students writing PhDs to present papers and thus benefit from feedback on the methodological issues raised by their work; they give all delegates an insight into current research; and they provide a chance to meet other researchers working in similar fields. In achieving these aims, they also help ARCOM to strengthen its contribution to the research community.

The theme of this Doctoral research workshop is "*Managing Innovation and Knowledge Management"*. The workshop will address issues relating to innovation (processes, products, services, technologies and markets; and innovative approaches to managing construction networks and supply chains) and knowledge management (including learning organisations, intellectual capital and the 'management of intangible assets').

I hope you find the papers assembled in these proceedings and the discussions during the workshop, informative and stimulating.

Dr. Andrew Dainty
Prof. Charles Egbu

Introduction to Innovation and Knowledge Management Research

What is innovation? Is innovation the same as creativity? Is it the same as invention? Can all innovations be managed? Are construction organisations innovative? How can organisational innovations help to improve the health and safety performance of construction organisations? Can we manage 'tacit knowledge'? How does knowledge management contribute to innovation and how can this be measured? What role does individual and organisational knowledge play in improving E-business initiatives in this information and knowledge era? How does knowledge transform along and across complex supply chains, especially as the construction industry embraces more collaborative forms of procurement? These are some of the questions that challenge us as researchers. Do we have answers to them?

It is now generally accepted, within the construction industry, that there is a relationship between a firm's efficiency or profitability and its ability to innovate. But defining innovation and what constitutes innovation is not easy. For researchers, having an operational definition provides focus for a research study. The same can be said for knowledge and for knowledge management, especially when the distinction between data, information, knowledge and wisdom is not clear-cut.

Innovation can be classified in different ways. From an economic perspective there is a differentiation between product and process innovation. Product innovation is seen to focus on cost reduction by obtaining a greater volume of output for a given input. Process innovation, on the other hand, describes new knowledge, which allows the production of quality superior output from a given resource. There is also the issue of incremental and radical innovations. Similarly, from the perspective of the sources of organisational innovations, there are emergent, imposed and adapted/adopted innovations. Innovation also has a social and psychological dimension. There are also important issues to contend with such as: whether innovation is about the successful exploitation of an idea or the idea itself. Also is innovation about 'absolute novelty' or new to the 'unit of adoption'? Similarly, the notion of whether innovation leads to significant 'intentional' benefit or 'serendipitous change' is an interesting one. The above might lead us to define innovation as the successful and intentional introduction and exploitation of an idea, where the idea is new to the unit of adoption, and has a significant benefit to the unit. The idea can be in the form of a process, product, service, technology or market.

A variety of factors have been identified as influencing the rate of innovations in organisations. This can be seen through different schools of thoughts and perspectives. The individualist perspective, which is grounded in social psychology, is predicated on the assumption that the individual is the source of innovation. They are the 'champion[s] or 'change agents' in an organisation. In contrast, the structuralist perspective hinges on the idea that the structure and function of an organisation is the fundamental dynamic of innovation. There is, however, a highly charged debate about what components of an organisation have a bearing on innovation and how this is determined. For example, the link between organisational size and innovative capacity is fiercely contested. Some suggest that larger organisations are more innovative while others stress that size does not matter. It is also assumed that the organisational characteristics such as structure, strategy and longevity play a central part in

organisational innovations. The structural variables of centralisation, formalisation, complexity and stratification have been shown to have contrasting effects at the initiation and implementation stages of the innovation process (the so-called 'innovation dilemma'). Low levels of centralisation and formalisation, and high level of complexity facilitate the initiation stage of the innovation process. The implementation stage is facilitated by high centralisation and formalisation and low complexity. The consensus view is that a high level of stratification inhibits innovation, because it leads to over preoccupation with status and insufficient freedom for creative thinking. The consensual view, points out the deleterious effect on creativity of the 'elevator mentality' of organisations dominated by rigid vertical relationships and 'top down dictate'. Similarly, 'an organic, matrix and decentralised structure could provide the creative individual with freedom sufficient to be creative'.

It is therefore important to take a more multivariate approach to understanding organisational innovation. The integration of both the individual and organisational levels of analysis to achieve a synthesis between action and structure should be considered. Attempts to incorporate these diametrically opposed concepts have influenced developments in process theory. The process perspectives on innovation need to recognise the unpredictable and dynamic nature of innovation. It is therefore a complex process with cognitive, social and political dimensions that should be understood in particular organisational contexts.

From the discussion so far, the suggestion is that Innovation is a complex, context-sensitive social process. It is therefore doubtful if there is one best theory that explains successful innovations in all organisations. Again, it appears that no one best strategy exists or is suitable for managing innovations in every organisation. Construction organisations need to determine their positions in terms of processes, services, products, technologies and markets. Since an organisation's innovation strategies are constrained by their current position, and by specific opportunities open to them in the future based on their competencies, construction organisations will need to determine their technological trajectories or paths. This will involve due cognisance of strategic alternatives available, their attractiveness and opportunities and threats, which lie ahead.

The innovation process is therefore dynamic. The dynamics of innovation, which have become increasingly intensive, result in high levels of risk and uncertainty arising, for example, from difficulties associated with accessing, transferring and assimilating knowledge which is external to the organisation. These externalities include the heterogeneity of the knowledge sources, which are important to innovation; technological complementarities (including those between product and process innovations); cumulativeness, path dependency and incrementalism; compatibility between innovations; user-producer relationships; inappropriability; and bounded rationality.

The organisational processes, which an organisation adopts in integrating the transfer of knowledge and information across functional and divisional boundaries (strategic learning), is essential and needs to be consciously managed. Since competitive advantage and financial success are bound up with industry dynamics, it is necessary to place strategic change in competitive context and identify what kinds of changes

lead to strategic innovation, and when these changes result in benefits for the organisation.

It is therefore important to consider innovation through the determination of the contingencies that govern when various innovation theories hold. The implication of the above statement is that what is perceived as a critical success factor for one organisation may not necessary be the same for another organisation. It is important to point out that organisations operate along different innovation trajectories.

Since innovations, especially radical or 'rule breaking' innovations, are associated with challenging thinking, unlearning as well as learning, entrepreneurial organisations appear to need general learning capacity. It could be argued that the ability to learn from others, from the organisation around oneself and from one's own past, are critical elements in making progress. All these provide challenges in term of research focus and the appropriateness of research methodology to be employed in their investigation.

Creativity is an important aspect of innovation. Knowledge creation is also an important aspect of knowledge management (KM). Knowledge consists of truth, beliefs, perspectives, concepts, judgements, expectations, methodologies and 'know-how'. Knowledge management is about the processes by which knowledge is created, acquired, transferred, shared, effectively applied/utilised and its benefits measured; in order to meet existing and emerging needs, to identify and to exploit existing and acquired knowledge assets. Knowledge exists in individuals and in organisations (e.g. in routines and repositories).

Different classification of knowledge exists, including the classification that sees knowledge as 'explicit' and 'tacit'. Explicit knowledge describes the type of knowledge that is documented and public, structured, fixed-content, externalised and 'conscious'. Tacit knowledge can be generally understood as the form of knowledge that exists within an individual, and is intuitive and unarticulated. People conceptualise knowledge according to their subjective interpretations. There is a complex dialectic between those who define knowledge as a scientific truth that exists independently of human action, and those who argue that knowledge is socially constructed. The literature on KM is too complex to reduce to such linear categorisation. There are recurrent overlaps and transitory diversions that mark one school of thought apart from the other.

There is also the resource-based perspective, which sees knowledge as a resource principally intended for economic exploitation. The resource-based perspective regards knowledge as an economic resource, similar to labour or land, neglecting the human and social aspect of knowledge in organisations. In contrast to those who view knowledge as a resource, knowledge is also understood in terms of its creative capacity. The knowledge-based perspective is ontologically grounded in the systems or contingency theory of management in which an organisation is viewed as a system of interdependent parts. This perspective emphasises a bottom-up approach to KM where people drive the managerial process rather than top down approach, where people are managed to be creative and consequently more productive. The knowledge-based perspective offers a more complex view of organisations, as social episodes that rely heavily on creative individuals to drive them and therefore advocate open and

flexible organisations where the learning process is actively encouraged. However, those who view the human being as a profit-making resource would warn against too much openness, associating it with issues of outsourcing, etc. There may be issues over the security of innovation, which in turn may threaten competitive advantage. However, too much protection of intellectual capital may in fact stifle the innovation process and create an organisational culture dominated by bureaucracy and hierarchy. Therefore, there needs to be a balance between the two competing theories to overcome, what is often termed, the 'boundary paradox'

Understanding how organisations manage knowledge assets involves due cognisance of a number of factors. These include an understanding of the strategies that underpin KM practices within organisations, the structure and culture that sustains KM, the tools and technologies that support KM and how organisations measure the contributions of KM. Equally important, are the issues of organisational readiness and competencies, the changing markets and other wider environmental factors. It is the understanding of these complex and interwoven issues (including ‘hard’ and ‘soft’ issues) that researchers would have to pay due cognisance to in their investigations and chosen research strategies.

Finally, the assembled papers in the workshop proceedings inform us of the complexities associated with undertaking research in the areas of innovation and knowledge management. They also show how diverse research in these areas is, and the need for appropriate research methodologies governed by the context and the *modus operandi* of the ‘unit’ of study.

Prof. Charles Egbu

KNOWLEDGE MANAGEMENT AND E-BUSINESS INITIATIVES IN THE CONSTRUCTION INDUSTRY: BENEFITS AND CHALLENGES

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Abstract: This paper is based on an on-going study looking at knowledge management (KM) and e-business initiatives in the construction industry. The paper will briefly discuss some of the benefits and challenges facing construction organisations in successfully exploiting e-business initiatives through appropriate application of KM processes. The challenges facing organisations in implementing e-business initiatives are both technical and non-technical (i.e. softer management issues). The latter include organisational culture, organisational structure, legal and human issues. All these issues need appropriate KM measures to help pave the way for e-business to be adopted and implemented successfully. This paper also briefly discusses the research methodology that is proposed to be used in carrying out this research project, including some of the problems faced in trying to collect preliminary data for the pilot interviews. In addition, some tentative results of the pilot study are presented.

Keywords: E-business, Internet, knowledge assets, knowledge management.

INTRODUCTION

In the last decade there has been an awakening in the academic community and those in practice of the importance of knowledge (Amidon, 1997; Nonaka and Tackeuchi, 1995; Stewart, 1998) as an asset for organisations to realise cultivate and exploit in meeting their emerging needs. This realisation came about as organisations had to retrench employees and, soon found the effect of organisational knowledge base eroding as people leave their jobs. This created an awakening in organisations, as they now have to devise mechanisms to help capture the knowledge of their employees through appropriate means. This has given rise to the need for knowledge management (KM). KM is described as a process of explicit and systematic management of vital knowledge assets and its associated processes of creating, capturing, codifying, organising, diffusing, use, exploitation and measurement in the pursuit of organisational objectives (Egbu, *et. al.,* 2001; Skyrme, 1999). Knowledge is now the vital asset of any organisation in this 'era', as land, labour and other capital in the industrial era, and therefore needs organisational attention (Amidon, 1997; Stewart, 1998). KM can play a significant and vital role for organisations through e-business initiatives in gaining a competitive advantage.

With the advent of the Internet and improved Internet and communication technologies (ICT), new possibilities for conducting business are becoming realisable (Fahey, *et. al.* 2001; Kalakota, et al., 2001; Turban, et. *al.,* 2000). This has enabled organisations to transfer their business processes on-line through e-business

initiatives. E-business involves any business activity that is conducted within any organisation or externally with other organisations using electronic medium via the 'net' (DLC, 2002; Kalakota, et al., 2001; Turban, et. *al.,* 2000). The Internet has removed time and geographical boundaries (Turban, *et al*., 2000) and the barrier of organisational size as an obstacle to business operations. By combining these two areas and trying to address the key challenges and benefits, KM and e-business can help make construction organisations rethink the way they have been conducting their business processes. By highlighting the challenges faced by implementing KM and e-business, and benefits that can be realised, it is envisaged that this research project can produce a business case guide for organisations to consider KM and e-business initiatives.

AIMS AND OBJECTIVES

The aims and objectives of this study are divided into two parts. Part one (1) involves objectives a-c, (see below) which leads to an MPhil, whilst part two (2) comprising d-g (see below) are anticipated to lead to PhD. The objectives are as follows;

a) To investigate the types of 'knowledge assets'[1] used in e-business solutions in construction organisations.
b) To investigate the challenges facing organisations in using Internet to commercialise their knowledge assets.
c) To examine the characteristics of on-line trading of organisational knowledge assets and its commercialisation in the construction industry.
d) To examine and document the different methods by which organisations "package" and exploit knowledge assets through e-business initiatives.
e) To assess the extent to which organisations are ready to launch a knowledge business, the level of competency needed and educational and training needs.
f) To examine and document the critical success factors associated with effective k-business in construction organisations; and,
g) To specifically examine the extent to which organisational structure, strategy and culture impact upon the effective exploitation of knowledge for e-business initiatives.

This paper, however, will articulate some of the main issues associated with the benefits and challenges associated with 'profitable' exploitation of knowledge asset through knowledge management and implementation of e-business initiatives.

RESEARCH METHODOLOGY

The full study programme leading to a PhD will employ a robust research methodology in trying to meet the aims and objectives of this research topic. The research methods to be employed will involve both qualitative and quantitative methods. It will employ semi-structured and structured interviews and postal questionnaires. Case studies will also be conducted with selected construction organisations. This triangulation approach is necessary because of the complexity of the topic which involves social, cultural and technological issues. Appropriate

[1] Knowledge assets refer to organisational skills, competencies, experiences, unique processes, patents, brand names that can be exploited to earn revenue for the organisation to meet its obligations and maintain competitive advantage against it rivals.

software packages like SPSS and NIVO will be used to vigorously test the collected data. The data will be tested and refined in real business application with organisations to be involved in the case studies.

RESEARCH PROGRAM STAGES

As noted earlier, the program of study leading to an MPhil is still in progress with semi-structured pilot interviews. The pilot interviews were originally aimed at engaging at least fifteen (15) organisations. To date, only eleven (11) organisations have been successfully engaged in the initial pilot interviews. The pilot interviews were planned to engage both the small, medium (SMEs)[2] and large organisations to represent the industry. However from the initial pilot study, it has not been practical to engage SMEs because most SME's that were contacted to organise for pilot interviews did not have any e-business initiatives in operation.

PROBLEMS ENCOUNTERED IN PILOT STUDY

Organisations representing the cross section of the construction supply chain, based in Scotland and within the proximity of Glasgow, were targeted in the pilot interview. Those who were interviewed included IT director (s), director (s) or senior partner (s). This is expected to provide both a consistent overview of the organisation's e-business strategy and also get a clearer indication of the senior management's perception on e-business initiatives within their respective organisations. The main problem encountered was trying to engage personnel's of similar or equal positions in the senior management level within different organisations. This was seen to be very important because then it would be easy to compare across different organisations. However, this was not possible as some organisations had their IT department based in their head offices in London or elsewhere.

CHALLENGES TO OVERCOME IN IMPLEMENTING E-BUSINESS INITIATIVES

There are many challenges facing organisations in adopting and implementing KM and E-business initiatives in construction organisations. Some of the challenges were identified in the literature reviews whilst some came up during the pilot interviews with eleven (11) organisations. These are as follows and not documented in any order of importance:

- The lack of awareness and training.
- Lack of compatibility in the supply chain.
- Lack of initiative amongst supply chain members for initial injection of investment into the supply chain.
- Cultural and organisational complexities.
- Cost justifications involved in implementing an e-business initiative.

As KM and e-business are integrated in an organization, employees can be relieved to perform tasks that add more value to their business processes. Also it speeds up the process of delivering goods and services thus improving customer satisfaction which can guarantee repeat business.

[2] *SMEs fall under the category of less than 250 employees.*

TENTATIVE RESULTS DISCUSSION

The organisations interviewed perceive e-business as a means of facilitating business transactions electronically and improving the business processes. The use of Internet as a business tool is not yet fully understood and embraced in construction organisations. There needs to be more appropriate training and awareness. From the analysis of the pilot study, there seems to be an agreement amongst the interviewees that, e-commerce, e-procurement, and e-learning are areas of importance now and in the next five (5) years.

BENEFITS ASSOCIATED WITH IMPLEMENTING E-BUSINESS

The application of e-business in construction organisations can help to make organisations to:

- Improve business practices with real time access to best practices and new knowledge within the organisation and across the supply chain.
- Tighter integration of business making the organisation more lean and agile and responsive to business demand.
- Increase of the employee productivity and satisfaction.
- Business transactions 24 hours, 7 days a week and across multiple geographical boundaries in real time (Kalakota, *et. al.*, 2001).

Other benefits include creation of new and improved work processes, increased market share; reduction of invoicing errors, litigations and delays due to multiple data re-entry and shorter time in deliver products and services. These associated benefits are not exhaustive and are not listed in any hierarchical order.

CONCLUSIONS

This paper has highlighted that KM plays a vital role in facilitating the implementation of e-business initiatives in construction. KM helps provide the organisational framework that can facilitate e-business by addressing issues that are both technical and non-technical in nature. The application of KM and e-business initiatives can provide a synergy that places an organisation in a competitive position. The challenges highlighted such as lack of awareness and training, lack of compatibility in the supply chain, lack of initiative amongst supply chain members for initial injection of investment into the supply chain, cultural and organisational complexities and cost justifications are worth paying attention to in this regard. The highlighted benefits of improve business practices and business processes, tighter integration of business making the organisation more lean and agile and responsive to business demand, increase of the employee productivity and satisfaction and business transactions 24 hours , 7 days and 365 days are worth considering in making investment in KM and e-business initiatives. Problems encountered in the pilot interviews shows that in analysing the pilot interviews, appropriate measures need to be considered in interpreting the data before proceeding to the next stage of the study programme. The tentative results discussed only provide a general overview of the results that are coming out of the pilot interviews. Finally, there is paucity in research in construction industry regarding this area. Therefore, there is ample scope for research in this area.

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THE BRIEFING PROCESS- A KNOWLEDGE TRANSFER AND CREATION PERSPECTIVE

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Abstract: Briefing is commonly perceived as the process of understanding and defining client requirements. The existing prescriptive literature tends to see briefing primarily as a data and information collection process. As a result, numerous checklists and flow charts are repeatedly advocated as guides to better practice. It is contended that the dominant information-processing paradigm perpetuates an impoverished and mechanistic approach to the briefing process. This research proposes the need of an alternative perspective on the interpretation of the briefing process. A new perspective is offered by drawing from the emerging concept of knowledge management (KM). The KM literature relating to the problems of 'knowledge transfer' between organisations is highly relevant to the briefing process. The underlying proposition is that client requirements containing the essence of organisational knowledge cannot simply be transferred from one organisation to another. Knowledge relating to organisations is frequently tacit in nature and uniquely embedded in context. In contrast, the information-processing model of briefing takes it for granted that knowledge relating to client requirements can be easily codified and transmitted. The perception of client requirements not only depends upon explicit knowledge, but also depends upon tacit knowledge. Drawing from related theories in the field of KM literature, it is argued briefing becomes a creative process of knowledge transfer and creation between the client representatives and the consultants. In particular, a designed process to capture tacit part of client requirements becomes of central importance to the briefing process. Issues of data collection and information management remain important for the transfer of explicit knowledge. Nevertheless, the client requirements cannot be understood fully without also sharing tacit knowledge embedded within the client's organisational context. With the establishment of a new framework, the briefing process is perceived as a cross-sectoral organisation knowledge transfer and creation process, which passes through five phases of knowledge creation process to identify the client requirements – 'sharing tacit knowledge', 'forming ideas of requirements', 'justification of ideas', 'creating design concepts', and 'transmitting explicit knowledge' while four modes of knowledge conversions – 'socialisation', 'externalisation', 'combination', and 'internalisation' between tacit and explicit knowledge are carried out. As a result, it is concluded that the knowledge transfer and creation perspective provides fresh insights of the briefing process and highlights the limitations of current research trends.

BUILDING THEORETICAL PROPOSITION

The theoretical proposition is built by an extensive review of the literature to date on the briefing process, and to identify the need of an additional perspective that is offered drawing from the knowledge management theory.

1. Current Perceptions of the Briefing Process:

Briefing can be perceived differently depending on the aspect from which it is considered. Generally, the briefing process has been discussed under three aspects in the literature,

- Procedural stages in briefing: pre-project stage, project stage, post-project stage
- Brief formulation (an Information Processing Process): checklist and matrix frameworks, client requirements processing model, design issue-based approach
- Relationship with Client Organisation: client's role in the briefing process, a social interaction process (communication and interpretation processes)

2. Briefing Problems and Limitations:

Descriptions of briefing problems will change according to the perspective adopted and then will lead to different solutions for improvement. According to the literature review, three divergent perspectives have been employed to discuss the limitations in current briefing practice:

- Briefing in an engineering processing perspective: information-processing protocols and critique on its underlying presumptions
- Briefing in a design methodology perspective: nature of design problems, relation to the design process (Rational methodology Vs. Learning methodology)
- Briefing in a decision-making perspective: Rationalist Vs. Non-rationalist models (limits of rational operation research)

Summary of existing perspectives (implications for the research propositions):

- A rationalist processing model can function satisfactorily only under very limited conditions. Due to its unrealistic presumptions, refining existing processing models are unlikely to result in much improvement in practice, but may stifle and impoverish the practice in progress
- The critique on a rationalist model of decision-making and design methodology has introduced human and social considerations to the briefing practice. Briefing in no longer seen as an engineered processing to collect client requirements like data and information, but as a social learning process to understand the client requirements
- Current perspectives on briefing tend to be an 'outputs-led' approach in lack of a cogent explanation of a 'briefing mechanism', and also in lack of innovation or creation aspect (germ ideas) in the process itself

In general, an alternative perspective is needed to introduce and cover social and innovative maters into the briefing process in order to achieve a full understanding of client requirements.

3. Knowledge Transfer and Knowledge Creation Theory

- Knowledge management literature review: main themes in KM, understanding organisation knowledge, management of tacit knowledge
- Knowledge transfer: problems of knowledge transfer, tacit knowledge transfer

- Knowledge creation theory (Nonaka and Takeuchi, 1995): 4 modes of knowledge conversions – 'socialisation', 'externalisation', 'combination', and 'internalisation' between tacit and explicit knowledge, and 5 phases of knowledge creation spiral – 'sharing tacit knowledge', 'creating concepts', 'justifying concepts', 'building an archetype', and 'cross-levelling knowledge'

4. A New Framework for the Briefing Process

There are three bridging issues to establish a new framework of the briefing process from a knowledge transfer and creation perspective:
- Bridging issue 1: the nature of client requirements with the notion of knowledge (from data and information to knowledge essence, three epistemologies' knowledge perspectives on the nature of client requirements and its formation)
- Bridging issue 2: appearances of client's business knowledge and consultant's building knowledge brought in the briefing process
- Bridging issues 3: retrofitting briefing activities in terms of knowledge transfer and creation perspective
- A new framework of the briefing process: (see Figure 1)

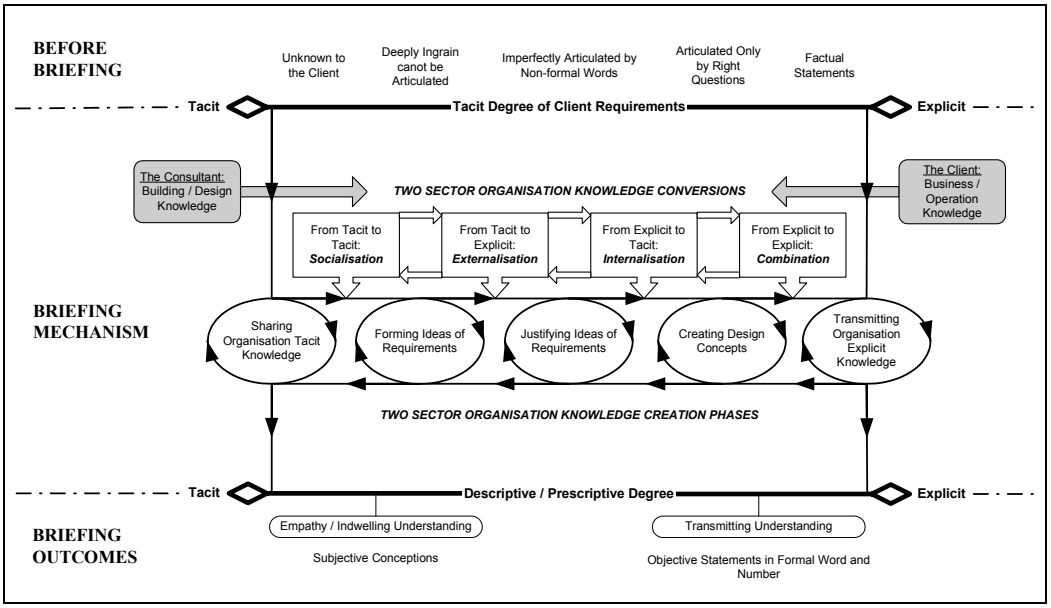

Figure 1 Two-Sector Organisation Knowledge Transfer and Creation Framework of the Briefing Process

RESEARCH METHODOLOGY

According to the research proposition, the research methodology can be discussed as following issues:

1. The philosophical stance of the research: An Interpretative Paradigm Position:

The central argument of the interpretative paradigm is that 'the study of human activities is fundamentally different from the study of physical phenomena' [Seymour et al 1998:p110]. This dichotomy paradigm refutes all assumptions of rationalist

paradigm that distort reality. Instead, it takes individuals' points of view as the focus of research to understand reality. Accordingly, this approach is concerned with understanding meaning rather than causality, and recognizes the respective views of participants in the process [Seymour, 1997:p.118]. Regarding the research concern, the research methodology is based upon the interpretative paradigm position to develop the qualitative research methods.

2. Qualitative Research Methods:

Under the qualitative research concept, two research methods are adopted to conduce the empirical study:

- Semi-structured Interviews with 24 Briefing Practitioners:

- Aims: 1) to achieve a grounded understanding of the briefing practice based upon the interpretations of experienced practitioners in order to find empirical evidence of the research proposition. 2) to gain the experienced briefing practitioners' responses to a knowledge transfer & creation perspective on the briefing process in order to discuss and establish the validity of the new framework
- Semi-structured interview design: five key questions 1) briefing service commission, 2) perceptions of the briefing process (methods and approaches, relation to the design, definitions of good briefing and brief, important skills and knowledge, etc.), 3) problems and difficulties encountered, 4) perceptions of the nature of client requirements and formation, 5) responses to the new framework
- 24 experienced briefing practitioners: it focuses on the practitioners, who specialise at the briefing process and have special interests in it. In terms of professional disciplines, they include briefing consultants, space planning consultant, architects, interior designers, project managers, in-house professionals, building engineers, etc.
- Interview analysis method: the interviews are transcribed verbatim into the word-processed documents, and analysed by QSR Nvivo software

- Case Studies of 3 Briefing Projects:

- Aim: the case study is to examine the extent to which the theoretical framework of an organisation knowledge transfer & creation perspective on the briefing process is usually applicable in a 'real world' situation. The analyses of 3 case studies demonstrate how the actual briefing process can be explained and interpreted from a two-sector organisation knowledge transfer & creation perspective (client requirements with the notion of knowledge, briefing mechanism – five phases of knowledge creation spiral and four modes of knowledge conversions). As a result, the validity of this new framework can be discussed and established in a real situation.
- Case study method: to construct the development of the project's briefing process in detail by 1) collecting and allaying the brief reports and related published documents (such as stage reports, meeting minutes), 2) interviewing key participants (client representatives and consultants); the stories and information collected from the interviews and the related documents are reinterpreted and analysed from the new framework

- 3 case study projects: 1) A new primary school project led by the briefing consultant, 2) A university engineering laboratory building extension and refurbishment project led the project manager, 3) A temporary department store fit-out project led by the in-house professionals

OUTLINE CONCLUSIONS

A paradigm shift of briefing process:

- From Information Processing Paradigm:

  - Organisation as unitary, passive and static all the time
  - Innovation as problem-solving process, an input-output sequence
  - Client's requirements as pre-existent, static, detectable and quantifiable information

- To Knowledge Creation Process Paradigm:

  - Organisation as to create information and knowledge in response to a changing environment
  - Innovation as an on-going process of creating and defining problems by the creation of knowledge
  - Client's requirements contains the essence of organisational knowledge

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LEVERAGING SHARED KNOWLEDGE AS A CORE CAPABILITY IN ACHIEVING SUSTAINABLE COMPETITIVE ADVANTAGE IN CONSTRUCTION ALLIANCES: A CASE STUDY DISCUSSION

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Abstract: The incidence of alliances has increased on a global scale and the construction industry too has seen significant developments taking place on formation of alliances. Review of literature shows that alliances are effective "vehicles" for performing knowledge sharing and learning. Although the alliance route is an effective vehicle for knowledge sharing and learning considering the context that it creates for collaboration, the processes are far from being smooth and self propelled. However arguments are also presented in literature, which show that partners in an alliance engage in overly short-term oriented work processes rather than a balanced short and long-term approach in performing their collaborative tasks, given that sustained collaboration presents unique opportunities for alliance participants. Research, as reported through this paper attempts to bridge this gap between short-term and long-term orientations by emphasising the importance of mechanisms used to share knowledge in gaining sustainable competitive advantage. Case studies related to construction alliances are conducted to address the research hypotheses. The purpose of this paper is to present results of a case study (XYZ Alliance) pertaining to this ongoing research. The presentation highlights how data is analysed using the cognitive mapping tool thereby demonstrating the utility of a software tool for data analysis.

INTRODUCTION

The concept of alliancing is well established in many industries as a means of gaining mutual benefits out of shared resources. Bleek and Ernst (1995) points out that on a global scale incidence of alliances have increased at 25% per annum in the first half of 1990's. A later study done by Contractor and Lorange (2002:14) asserted that "the alliance phenomena is here not (*only)* to stay but is set to grow rapidly". Alliances in various forms such as joint ventures, licensing agreements, distribution and supply agreements, research and development partnerships and technical exchanges exist in many industries (Inkpen, 1998). In the construction industry too the concept of alliancing has gathered momentum as an appropriate procurement route (Walker and Johannes, 2003; Dainty et al, 2001; Holt et al, 2000; Walker et al, 2000; Kwok and Hampson, 1996; Barlow and Jashapara, 1998; Bresnen and Marshall; 1998; Sarkar et al, 1998; Carrillo, 1996).

Although there is an increase both in the incidence of alliances as well as in the number of studies been undertaken on various related issues, it is argued that most of the alliance collaborations are short term focused and alliance partners devote most of their time on resolving issues related to contractual matters, profit sharing and accounting problems rather than sustaining their relationships for more long-term benefits. Kanter (1994) for example argued that a unique opportunity for sustained

collaboration out of collaborative work performed in alliances is often under exploited. Havens and Haas (1999) view the sharing of knowledge as the basis of collaborative work. Although certain studies (for example Inkpen, 1998; Mowery et al, 1996; Hamel et al, 1989) address the issues of resource sharing and collaboration and the benefits of alliancing that accrue, the emphasis has been to learn from the alliance partner rather than to sustain the relationships and exploiting shared knowledge to develop new capabilities. Therefore, at present, shared knowledge arising out of alliances is not adequately recognised as a means of achieving sustainable competitive advantage. In construction related literature this area has not received appropriate attention apart from a few studies mentioned earlier (Walker and Johannes, 2003; Holt et al, 2000; Barlow and Jashapara, 1998). This research attempts to bridge this gap between short-term and long-term orientations by emphasising the importance of mechanisms used to share knowledge in gaining sustainable competitive advantage.

OUTLINE OF THE PROJECT

The following meta hypothesis is proposed as the main focus of this research:

> "Currently there are concerted efforts in construction alliances targeted at performing knowledge sharing as a means of gaining short term competitiveness and this emphasis will have a negative impact on alliances' long term progress towards sustainable competitive advantage, if these efforts are not concentrated on leveraging knowledge sharing as a core capability"

Mechanisms used to share knowledge play an important role in the concentration of efforts to leverage knowledge sharing as a core capability. Dixon (2000) presented a model on knowledge sharing where the selection of a proper knowledge transfer system results in more common knowledge being gained in a systemic way, thus linking knowledge sharing with knowledge transfer. Partly due to this link between knowledge sharing and transfer and for easy reference, we denote the mechanisms used for knowledge sharing as "knowledge transfer mechanisms (KTM's)". To focus on KTM's we discuss two of its important attributes: media richness and task relatedness. Media richness (Sexton et al, 2003; Daft and Lengel, 1986; Mudambi, 2002) is an attribute described as using rich communication media having features such as feedback capability, availability of visual and audio cues, language variety and personal focus (individual attention). Task relatedness (Sexton et al, 2003; Hollingshead & McGrath, 1993) on the other hand measures the relatedness of the particular communication to the task that is being carried out by the people.

KTM's covered in the study include face-to-face communication, telephone conversations as well as IT enabled mechanisms such as web conferencing, Intranets, email and discussion forums. The extent to which the mechanisms determine the effectiveness and efficiency of knowledge sharing is taken in this study to be dependent on four interacting variables: strategic direction (SD), alliance culture (C), media richness of KTM's (MR / KTM) and task relatedness of KTM's (TR / KTM). The following conceptual framework (in Fig 1) combines the interrelationships of the KTM's. We use this model, which has been derived by the organisation factors of

innovation model (Sexton and Barrett, forthcoming), as an exploratory model to investigate the effectiveness and efficiency of knowledge sharing.

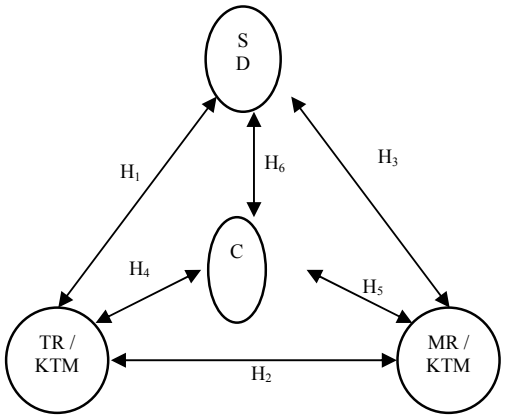

Fig 1 – Conceptual model of knowledge sharing

As shown above six hypotheses (H_1 – H_6) were set out, which link each of the variables in Fig. 1 and they were tested through empirical investigation. However the hypotheses are not detailed here due to space limitations.

METHODOLOGY

The research adopts the case study methodology to test each of the hypotheses in fig. 1. The choice of this methodology is justified with its ability to rely on the use and triangulation of multiple sources of data (Johnston et al, 1999), within a case study and to perform cross case comparisons (Yin, 1994).

To help in the data gathering exercise and to maintain the rigor of structuring, organising and analysis of multiple sources of data, the cognitive mapping technique was used (Huff, 1990, Eden, 1990, Brightman et al, 1999). Cognitive mapping is a technique that helps to structure, organise and analyse data by creating a map indicating the perceptions of people being interviewed (Eden, 1990). The technique is seen therefore as aiding the interview process, through capturing of chains of argument and linking together insights into the nature of the issues acquired. Software is used to aid the mapping process known as "Decision Explorer©. By attaching a meaning to the statements proffered by the interviewees, some of their concepts can be clustered, highlighted and presented in a unique way to derive a meaning. The constructed maps help in understanding some of the key issues and identifying any emerging patterns of people's perceptions on knowledge sharing.

The next section will present an ongoing case study work on a construction alliance to explore the nature of knowledge sharing.

CASE STUDY RESULTS

The XYZ Alliance is an international alliance between a petroleum retail company and a project management company. The alliance was formed in 1996 in United Kingdom, and currently operates in twelve countries. The main purpose of XYZ Alliance is to deliver an effective and an efficient project management service, and to reduce the cost of construction and maintenance of the petroleum retail company's petrol stations.

To obtain primary data for the case study, the interview technique was used. Initially, four interviews over one hour were held with senior executives based on an open-ended type of interview guideline and then by adopting a more structured approach six other interviews with project managers were conducted. Cognitive maps were built around the four senior executive interviews, which recorded their perspective. The interviews with the two management levels (senior executives and project managers) on the one hand were utilised to gauge their perspectives on issues raised and on the other hand the two sets of data were used for purposes of triangulation.

The overall results indicate that the existing cultural dimensions were supportive for knowledge sharing. This was evident in both senior executive perspectives as well as the project manager perspectives. However in terms of the strategic direction, it was observed that most of the tasks that the team carried out were driven by the need to achieve short-term targets. This short-term focus prevented some of the KTM's being utilised in an effective and an efficient way. For instance, the alliance intranet did not contain specific information that helped people in performing their tasks (not specifically task related). Although it is expected that this situation to improve with time, people's lack of commitment was shown particularly with the project managers' responses in enhancing the task relatedness of this KTM (Alliance Intranet). Further the "web conferencing" KTM was used only by the senior executives and the project managers did not see how it could be of benefit to them, thus highlighting the inappropriate use of KTM's. This case study performs an informing role on the use of KTM's for knowledge sharing in the context of this alliance and need to be compared with other case studies to gain richer insights on knowledge sharing.

The main focus of the workshop presentation will be on providing results of the case study highlighting the utility of the cognitive mapping tool used for data analysis.

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THE EFFECT OF STANDARDISATION AND PRE-ASSEMBLY ON HEALTH, SAFETY AND ACCIDENT CAUSALITY IN CONSTRUCTION (HASPREST)

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Abstract: The advent of off-site fabrication, prefabrication, pre-assembly and modularisation generally termed off-site production (OSP) is expected to improve health and safety performance (Egan, 1998; Strategic Forum for Construction 2002) . The increasing use of the innovative techniques of OSP have introduced a new challenge to the management of health and safety (Gibb, 1999). This paper reports on the preliminary findings of a research project which aims to develop a strategic management tool for health and safety in OSP to inform the efficient management of a company's health and safety strategy taking into account the organisations current approach to health and safety, production management and the resistance to change. This process will involve 1) the initial modelling of accident causation in OSP, and 2) the development of a health and safety risk model for OSP. The model will be tested in industry.

OFF SITE PRODUCTION IN CONSTRUCTION

Off site production is an important innovative technique that may allow clients, contractors and project managers to seek greater cost controls and improve health and safety (Gibb, 1999). Health and safety issues in OSP are influenced by several factors within an organisation. Figure 1 illustrates the conceptual framework for discussing health and safety in OSP in this paper, and illustrates the complex interaction between the major influences in the management of the manufacturing process.

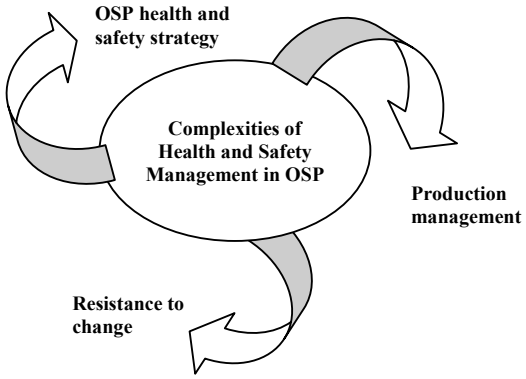

Figure1. Factors influencing health and safety in OSP

The main influences of OSP health and safety management are resistance to change, production management and the OSP health and safety strategy within the organisation. The resistance to change within the organisation as described by (Judson, 1991) may take the form of an operative doing only what is ordered or in the

form of group action, whereby a number of operatives or a functional group may withhold information. Production management within OSP companies vary greatly and may fail to embrace the health and safety techniques of manufacturing (Mckay et al. 2002). The OSP health and safety strategy aims to ensure that the organisation's activities are in compliance with the relevant legislation and that the health and safety of the employees are protected (HSC 2000; 2001). These interrelated factors can influence health and safety in OSP.

CHALLENGES OSP MANUFACTURERS MUST EMBRACE

A selection of some of the challenges that OSP manufacturers should embrace include:

- *the use of continuous flow manufacturing including group work cross training on the different tasks in a group and job rotation linked with the redesign of selected machines and workstations for the elimination of awkward postures* (HSE, 2000);
- *the adoption of a systems approach to safety in manufacturing the initiation of safety awareness programmes, specialised training on ergonomics for machine operators* (HSE, 2000);
- *the layout of the OSP facility to utilise the techniques of an in-line arrangement where the production lines are long straight and "in-line" and provides access to both sides of a considerable portion of the production runs* (Fawcett and Wood, 1982);
- *the use of medical surveillance in the form of a pre-employment examination is one of the cornerstones of an effective comprehensive program of health for manufacturing employees* (Fawcett and Wood, 1982).

These factors may contribute to the organisations OSP health and safety strategy, to minimise risk and increase employee health and safety protection. In addition to these factors within the organisation a number of external factors apply to organisations in the OSP sphere. These include legislation especially that which relates to health and safety, the changing labour market and the economy. In addition, there are a number of specific influences that relate particularly to the OSP industry that differ from that of conventional manufacturing:

- *Projects tend to be prototypes, with construction techniques new and untested;*
- *The short lead time between project start and delivery of complete units;*
- *Client pressure* (Respect for people working group, 2000);
- *Lack of skilled workforce* (Clough *et al,* 2000).

The challenge for the OSP community is to overcome these influences that may create barriers to the efficient health and safety management at the operational level, and to embrace a culture similar to that in the manufacturing industry.

METHODOLOGY

The overall paradigm adopted for the research was that of interpretivism (Dilthey, 1911/1977). Exploratory discussions took place with a group of individuals who were engaged in safety management within ten of the sponsoring organisations. The discussions took the form of a focus group. Focus group methodology uniquely

combines elements of group dynamics and qualitative research methods to yield information (Dilorio, 1994) on a wide variety of issues. Focus discussion groups are a well established research technique and are particularly suited to this research because it concerned 1) gaining information on a new innovative field of enquiry; 2) generating hypotheses based on participants insights; 3) developing survey methods; and 4) evaluating the research and assisting in the key stages of the development of the health and safety risk model for OSP. The technique is characterised by the use of the group interaction to produce data and insights that would be less accessible without the interaction found in a group (Morgan, 1988).

In addition to the qualitative data collected from the focus group discussions, quantitative data were collected via structured questionnaires. The survey instruments were developed and completed in consultation with the project sponsors. A workplace hazard checklist was included to gauge individuals appraisals of their hazard environment. This checklist was based on 1) a similar checklist developed by (Tomas and Oliver, 1995), 2) a hazard listing proposed by (Cox, 1992), and 3) additional hazards and amendments suggested by a group of safety practitioners from the sponsoring organisations. The initial hazard checklist included 23 common hazards, for example forklift vehicle movements, using compressed gasses, slipping and tripping, working with hazardous substances etc. The list is shown in Table 2.
The research is collecting in-depth information from the respondents, which will in turn be used to advise industry. The information is provided by a number of industrial collaborators from a wide spectrum of both conventional construction organisations and off site manufacturing to reflect the diverse nature of the construction industry and improve the quality of the data collected.

Table 2: Hazard checklist items

	Hazards
1.	Slipping and tripping
2.	Objects falling onto personnel
3.	Workplace design and layout
4.	Working with hazardous chemicals
5.	Working with irritant substances
6.	Actions leading to repetitive strain injuries
7.	Explosion from hazardous flammable/flammable gases
8.	Ultra violet light, lasers and or radio frequencies
9.	Electrical hazards including proximity to electric current
10.	Use of sharp hand tools
11.	Entanglement and trapping in machinery
12.	Fire protection of combustible or flammable materials
13.	Use of compressed gas cylinders
14.	Forklift truck operation
15.	Loading and unloading of vehicles
16.	Safe storage and stacking of goods
17.	Manual handling of heavy goods
18.	Compressed air hazards
19.	Failure of pressure vessels
20.	Contact with hot objects and surfaces
21.	Working with display units
22.	Noise
23.	Conditions leading to hand or body vibration

PRELIMINARY RESULTS; The conflicts of health and safety and production requirements
A number of issues relating to the conflict between the operatives health and safety and the organisations production needs were brought to the fore within interviews and

observations. The most common ***external influence*** on health and safety mentioned by the respondents were clients changing the specification at short notice thus triggering increased production with the associated health and safety risks inherent during learning curve development. Several managerial respondents also indicated that they were unaware of standard regulations such as those relating to manual handling.

In connection with ***internal influences***, it was identified among a number of collaborators that the managements strategic choice was to devolve health and safety responsibilities to the operative. However, the organisations culture was said to be "extremely health and safety conscious at all times" with safety at the heart of all operations by both managers and operatives. Some confusion arose with regard to operatives health. Managerial respondents stated that they attempted to ensure the health of their employees at all times especially with regard to workstation. However, operatives responses varied: some believed that management were taking their health into account, whilst others felt that their health needs were being left to themselves or even ignored.

The distinction between the ***engineering sector*** and the ***building sector*** in organisations involved in off-site pre-assembly suggested that more emphasis was placed on layout and design for safety of workstation and environment in the engineering off-site manufacturing sector than the building sector. The engineering sector placed greater emphasis on visitor control, the use of designated storage areas, colour coded delineated walkways and material storage areas.

Unexpectedly, ***health and safety training*** issues were considered after staff development by the interview respondents. The operative respondents believed that health and safety training should be included in the overall staff development programme. The managerial respondents focused on the employee development training as being inclusive of health and safety training. The training in health and safety appear reactive rather than proactive and needs to be focused and task specific (Fawcett and wood, 1982).

The administration of health and safety, particularly employee health details was found to be of a poor quality. The systems used tended to be paper based using a manual filing system, with no involvement of health and safety staff. As there were no records of the employees health and safety details or there skill levels deployment decisions were based on the subjective assessment by line managers. The employees views on the companies health and safety practices confirmed the managerial responses. The formal aspects of health and safety training culminated in half yearly "toolbox talks". The focus group discussions supported these findings revealing that managers placed considerable importance on the shorter-term operational issues regarding health and safety. This suggests a need for a more focused and continuous health and safety programme, which has the flexibility to inform management in the specific aspects of OSP health and safety.

CONCLUSIONS

In conclusion, there does exist commonalities across the sponsoring organisations in regard to the managerial aim for good employee health and safety management. However, several of the safety representatives in the case studies complained about

the way management dealt with the competing priorities of safety and productivity. At times production was given priority over safety where safety management intervention would result in loss of production. Nevertheless, the desire for assistance and guidance on health and safety issues in OSP forms a solid basis for the development of more organised health and safety management system. A full analysis of the sponsoring organisations health and safety practice, approach and management will follow this preliminary appraisal. It will involve the modelling of accident causation in OSP and the development of a health and safety risk model, This will enable the development of a strategic management tool for health and safety in OSP. The tool will be tested and refined in industry to ensure it provides a practical benefit.

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KNOWLEDGE MANAGEMENT IN CONSTRUCTION SMEs

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Abstract : Small and Medium Enterprises (SMEs) make up about ninety percent of all the firms in the construction industry. However, there exists a paucity of empirical research in the area of Knowledge Management (KM) involving SMEs. This paper is based on a survey conducted among 11 SMEs in Glasgow to investigate KM challenges, the use and exploitation of information technology for KM, enablers and barriers for the implementation of KM programme in SMEs. This is part of a pilot study of an on-going PhD programme at Glasgow Caledonian University, UK. The paper suggests that SMEs should adopt a holistic and integrated approach to KM by considering culture, technology and people at the core of their KM strategy, if KM is to lead to a source of sustainable competitive advantage.

INTRODUCTION

Small and Medium Enterprises (SMEs) are being increasingly recognised as "the life blood of modern economies" (Ghobadian and Galler 1996). Small and medium enterprises deliver 52% of the construction industry's workload in monetary terms (DETR, 2000). Over the last two decades, organisations have increasingly recognised the importance of knowledge as an asset. Organisational success is critically dependent on staff knowledge about aspects of micro-environment such as customers, suppliers, competitors and the internal organisational processes. This is important for maximising business opportunities, and for minimising the risk of missed opportunities or not meeting stakeholder expectations.

Saunders (2000) states that, "every day, knowledge essential to the business walks out of the door and much of it never comes back. Employees leave, customers come and go and their knowledge leaves with them. This information drain costs time, money and customers for the organisations". Hence adopting KM strategies in SMEs will help to identify, create and disseminate knowledge of employees and customers, thereby enabling sustainable competitive advantage.

For the purpose of this study, KM is defined as a process by which knowledge is identified, created (acquired/ captured), codified, stored, disseminated (shared/ transferred), implemented (adapted, transformed, synthesised) and measured for the benefit of an organisation. Knowledge is a complex concept which consists of information and skills acquired through experience; truth and belief, perspectives and judgements, expectations and methodologies. Knowledge exists in individuals, groups and in organisations, in various forms.

This paper also presents the aim and objectives of an on-going PhD research, its methodology and the findings of a pilot study.

AIM AND OBJECTIVES

The aim of the on-going PhD research is to facilitate KM initiatives for improved competitiveness of SMEs in construction. A combination of research methodologies (triangulation) is being employed in the study, including semi-structured interviews, postal questionnaires and case studies. In this paper some findings of the pilot study are presented. The objectives of the pilot study are:

- To investigate the challenges associated with KM.
- To investigate the current and future (5years) use and exploitation of IT/ICT for KM.
- To explore and document the main enablers and barriers of KM implementation in SMEs.

METHODOLOGY

The definition adopted for SMEs is based on the size of employees and adheres to the Department of Trade and Industry's definition (DTI 2002). The sample of the pilot study is 11 SMEs with number of employee's ranging from 13 to 200. The period of the pilot study was from 25th Feb – 11th April 2003. All interviews were conducted in Glasgow, Scotland, UK. Names and details of participant organisations in the pilot study were obtained from a host of sources including a database from the Centre for the Built Environment (CBE), Glasgow, Scotland. A semi-structured interview approach was employed to achieve the objectives of the pilot study. Semi-structured interviews provided some flexibility to probe various areas and discuss specific queries during the course of the interview. The interviews lasted between 30 minutes to 1 hour. Interviews were taped and later transcribed. As part of the analyses of the interviews, content analysis was employed.

FINDINGS

Main challenges associated with KM for SMEs

Most of the respondents felt that some aspects of KM are being practiced. It was, however, noted that KM was not exploited to its full potential. The analysis of pilot study interviews focused on three sub-processes of KM, i.e. Knowledge creation, knowledge capture and knowledge dissemination. Knowledge dissemination involves knowledge sharing and knowledge transfer within the organisation.

The findings of the pilot study suggested that eight out of the twelve interviewees considered knowledge capture as the main challenge. The concern was that very little is done to identify and capture tacit knowledge during the employee's stay in the organisation. Fifty percent (50%) of the interviewees noted that knowledge dissemination is a challenge followed by knowledge creation (17%).

Use and Exploitation of IT/ICT for KM

Compared with large organisations, smaller organisations tend to have less economic power and therefore, find it difficult to commit the resources to implement formal KM strategies (Egbu and Botterill 2002). This was evident in the pilot study, where

informal face-to-face social interaction was the most effective technique used in the sharing of knowledge. Due to a host of complex factors, including finance, size and structure of the firms, most of the KM strategies adopted are informal. The tacit knowledge which is difficult to codify was shared, captured and transferred mainly through telephones, mobile phones and meetings held by the project team. Tacit knowledge is also shared through brainstorming and mentoring schemes.

A mixture of formal and informal approaches for dealing with KM was noted. Some of the formal approaches included formal meetings, where meetings were minuted and circulated. In addition there are central databases for capturing project reviews (capturing explicit knowledge). Some of the interviewees also reported instances were they had to submit reports after attending external seminars and exhibitions. Two out of the eleven organisations produced newsletters twice a year. In one of the organisations interviewed, knowledge transfer was through video conferencing.

Currently the IT/ICT provisions for KM in the study organisations were mainly phones, followed by E-mails, faxes, intranet and internet. From the pilot study it is evident that only half of the interviewees claimed to use E-mail for knowledge transfer. E-mail is mainly used as a means of communicating information and knowledge widely. Nine out of the eleven organisations interviewed had public corporate website for marketing purpose. Three out of the eleven organisations had intranet facilities for knowledge identification. This is basically a data warehouse with data on employees involved in projects and their skills and competencies. The interviewees were asked to volunteer information on the IT/ICT, they are likely to use for KM in the future (next 5years). The interviewees revealed that the technologies they intend to use include wireless handheld field communication devices and web based (internet, intranet and extranet) provisions.

Knowledge Enablers

People are seen as important enablers when trying to implement KM programmes. The findings are that people are key enablers since tacit knowledge resides in people's heads. The owner/manager's of small and medium enterprises play a crucial role in creating the right culture for knowledge management. They have the knowledge in their heads and should be encouraged to share their knowledge with others more widely.

Knowledge management like any other management programme in an organisation requires leadership commitment to create an environment within which people are able to share knowledge and are allowed to assimilate as well as practice the knowledge gained. To this effect, 33% of those interviewed acknowledged that leadership commitment is vital.

Knowledge Barriers

The findings of the pilot study also suggest that people-related issues, such as: people's unwillingness to share their knowledge, lack of commitment from the senior managers, and lack of time constraints are the main barriers to implement a KM programme. People do not like change. It takes time and effort to get people to accept and learn new ways of working in such a way that they are able to apply them with

ease. Owner/ managers of the SMEs have to understand the value of investing in knowledge management and the benefits of allowing people to have resources for effective KM practices. Employees should not be afraid of making mistakes but should be encouraged to share the lessons learnt in order to curb repetitions of the same mistakes. An environment that allows this to prevail is likely to contribute positively to a culture that supports KM in organisation.

CONCLUSION

Based on a pilot study, which is a part of an on going PhD study, this paper has considered KM issues in SMEs. Knowledge management provides both opportunities and challenges for SMEs. The main KM challenges faced are knowledge capture, knowledge dissemination, and knowledge creation. The main factors worthy of consideration for effective KM in SMEs are people, technology, culture, economies and leadership commitment. The main barriers to KM are lack of time, lack of commitment and unwillingness to share their knowledge. Small and Medium Enterprises should adopt a holistic and integrated approach in considering culture, technology and people at its core in order for a KM strategy to become a source of sustainable competitive advantage.

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THE DEVELOPMENT OF A TRIANGULAR TECHNOLOGY PROCESS CULTURE MODEL TO SUPPORT ADOPTION AND INTEGRATION OF IT INNOVATIONS

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Summary: During the last couple of decades, considerable research and industrial efforts have been devoted to implementing information technologies within the AEC industry. However it is generally believed that low level of value from IT investments has been achieved in AEC sector so far. Most AEC business managers still prefer traditional processes and methods and seem reluctant to embrace new IT based ways of working. Many well-developed technologies in the AEC sector failed at the implementation stage.

One possible reason for this obvious gap between expectation and result of IT implementation is that too many previous research projects and industrial-based IT initiatives adopted a technology-driven approach. There are not enough effort being given to understanding human behaviour, organizational culture, training and technology-process-culture combined issues, regarding adoption of the new IT tools and systems. It is general accepted that the successful adoption of IT innovations is a key contributor to organisation success. Our understanding of the processes of IT innovation adoption and assimilation has grown considerably since IT researchers first became interested in this area in the early 1980's (Fichman 2002). But it is noted that relatively little research effort addresses the problem of getting new IT innovations generally accepted and continually used in a specific AEC company. Pervious studies have also shown that technology push (i.e. technological solutions) is not sufficient to improve the efficiency and effectiveness of the working environments without clear consideration of the business processes and the human issues (Alshawi and Faraj 2002). In this research, the industrial adoption of advanced technologies in construction sector is described as a technology-process-culture (TPC) triangle. The IT adoption and implementation in the AEC industry will be analysed from an integrative perspective of technology, process and culture. It is postulated the three factors including their sub-factors will respectively and synthetically decide the selection (adoption) and performance (implementation) of IT innovations.

Currently, many managers in AEC companies know that they must innovate (at least occasionally) to thrive, however, it can be difficult to know why technologies should be adopted, which technologies to adopt, and how to manage the implementation process in order to realize business value. This research tries to answer those questions based on the TPC research paradigm.

Firstly, why technologies should be adopted? Through the comprehensive literature review and questionnaire, the particular drivers for the initial adoption, the criteria for selection decision-making of IT innovations will be identified and weighted. These factors will act as the inputs of a decision-making framework. Moreover, the reason

for adopting a specific IT innovation will be integratively addressed from technology, process, and culture perspectives.

Secondly, which technologies to adopt? Most current researchers investigate the IT projects selection based on a balanced assessment of benefits, risks and costs within the context of technologies. But behind those factors, there are too many other factors linked to particular aspects that affect the selection of IT innovations. Although researchers have considered many distinctive characteristics of IT innovations, there has been little effort to develop more sophisticated models that go beyond traditional approaches (such as the Traditional Diffusion of Innovation Model) to incorporate the effects of technology, process and culture. Fichmen (Fichman 2002) argues that a rich opportunity exists going forward to confirm these promising streams and synthesize them into more complex and realist models of IT innovation diffusion and assimilation. In this research, the factors analyzed in the first stage will be quantified and act as the main variables in the second stage. Based on the TPC paradigm and the Analytic Network Process (ANP) theory, which is the generalization of the most highly regarded and widely used decision-making theory Analytic Hierarchy Process (AHP); an advanced IT innovation selection and assessment framework will be developed to support decision-making.

Thirdly, how to adopt it? Adoption means continuous use of innovations. The most important task at the IT implementation stage is to monitor and evaluate its use to make the innovation continually used and gradually embedded in the company. There are few suitable tools available for the managers in AEC companies to help them manage the implementation process efficiently. Based on the data collected at the first stage of this research and interviews, success factors to implement IT innovations will be elicited from the factors pool. ANP theory will be used again to develop an implementation framework for the IT innovations. With the help of this framework, it will be much easier for the managers to grasp the importance and the priority of many related issues at the implementation stage of a specific IT innovation.

Moreover, a particular IT innovation will be selected to demonstrate the validity of the theory and framework developed in this research. It will focus on the adoption and implementation of particular technology – Construction Integrated System (CIS), because CIS represents one of the main development directions for IT in the AEC industry. CIS is considered to be a crucial IT tool, which could bring about a significant improvement if they are successfully implemented. However, the technology by itself will not lead to full implementation of such systems; other issues need be taken into consideration as mentioned above.

Methodologies utilized in this research depend on the desired objectives of this research stressed before. The published literature related to technology, process, culture, integrated system and innovation was structurally reviewed. A total of 70 papers or book pertaining to adoption and implementation of IT innovation were identified through a search of the literature. 56 sub-factors were drawn out to build up the items pool for the TPC model. Both fieldwork and pilot study have been conducted within industry and the academic community. After several trial rounds, the first structured questionnaire had been established on website to be ready for data collecting and sub-factors were included in the structured online questionnaire. The theory of diffusion of innovation (DoI) and Analytic Network Process Theory add

rigorous to the theoretical foundations of this research. The ANP provide a qualitative method to analyze the interaction and feedback within clusters and between clusters, which help us to understand the interaction between the sub-factors of Technology, Process and Culture and built up the frameworks supporting decision-making and implementation. Semi-structured interviews will be conducted on the selected questionnaire respondents to understand the current practice of the particular IT innovations implementation and to collect the input data for decision-making and evaluation framework.

This research will provide a new understanding of IT innovations adoption and implementation from an integrated perspective of technology, process and culture. Although many researchers and practitioner are devoted to investigate those three aspects respectively, how to synthesize them and their attributes into more complex and realist models of IT innovation diffusion is remained a relative under-developed research field.

The TPC model proposed by this research will help industry to rethink the IT innovation adoption comprehensively. The Three crucial questions related to innovative organisations are to be answered by original and brand-new ways. This research identifies the particular drivers for the initial adoption of IT innovation, and criteria for decision-making. Simultaneously, success factors to implement IT innovations will be elicited. The decision-making and evaluation frameworks presented in this work will be as formal planning and analysis methods for IT innovations adoption and implementation.

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AN INTEGRATED ANALYTICAL APPROACH TO ENVIRONMENTAL MANAGEMENT IN CONSTRUCTION

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Abstract: This paper presents a research for an integrative methodology, named E+ for dynamic environmental management (EM) in construction, which integrates various EM approaches with a general EMS process throughout all construction stages in a construction project. The EM approaches integrated in the E+ include an analytical approach of construction pollution index named *E+ Plan CPI*, an analytical approach of environmental-conscious construction planning named *E+ Plan EvironalPlanning*, an analytical approach of incentive reward program for material management named *E+ Logistics IPR*, and an analytical approach for waste material exchange named *E+ Logistics Webfill*. The E+ is expected to effectively and efficiently assist contractors to enhance their both environmental management and environmental performances not only in Mainland China but also in other areas.

Keywords: Environmental management, environmental management system.

INTRODUCTION

The adverse environmental impacts of construction such as soil and ground contamination, water pollution, construction and demolition waste, noise and vibration, dust, hazards emissions and odours, wildlife and natural features demolition, and archaeological destruction have been concerned since early 1970s and received more and more academic and professional interests in construction industry after ISO 14000 series environmental management (EM) standards enacted. In this regard, quantitative analytical approaches are not as available as qualitative approach such as regulations and practical guide currently due to the difficulties in transformation of practical data to abstraction data that are necessarily used in calculation. However, it is hard to accept an environmental management system (EMS) without background support of quantitative analytical approaches, or an EMS is not consummate if there are not adequate quantitative analytical approaches for sustainment. For the sake of practical approaches and their integrative application for quantitative EM in construction, a research project, i.e. *An Integrative Analytical Approach to Environmental Management in Construction* was set up in the Research Centre of Construction Management and Construction IT, Department of Building and real Estate, the Hong Kong Polytechnic University in 1999 and the finds of this research project including one integrative model and four supporting analytical approaches are described in details in this dissertation together with corresponding case studies.

AIMS AND OBJECTIVES

The overall objective of the research is to develop an integrative analytical approach to EM in construction. This objective has been achieved though five part sub-objectives. First of all, an integrative methodology for dynamic environmental impact assessment (EIA) in construction is developed as a comprehensive frame model named E+. Next, four functional-different analytical approaches to be integrated into the comprehensive frame model are developed step by step including analytical approaches for construction planning such as construction pollution index named CPI method and evaluation of environmental-conscious plan alternatives named EnvironalPlanning method, and analytical approaches for construction logistics management such as incentive reward programme named IRP method and construction waste exchange model named Webfill method. Finally, the implementation of the integrative analytical approach is conducted and demonstrated by an experimental case study.

RESEARCH METHODOLOGY

Methodological Considerations

In this study, the research methodology is alternatively used for various analytical approaches depending on the problem being dealt with. For example, a questionnaire survey and quantitative survey data analysis were adopted for an investigation on the acceptability of ISO 14000 series of EM standards in construction industry in Mainland China, a construction site survey was adopted for investigation on the generation of construction and demolition (C&D) waste on site, and a computer simulation was adopted for examination on the effectiveness of a C&D waste exchange model, etc. The research methodology was selected based on the following methodological considerations:

- The integrative analytical approach (E+) to the EM in construction is a basic model and main thread throughout the research, and all functional-different approaches are to be a component of the E+ model. Regarding to the E+ model, it consists with three main functional components such as E+ EIA component for EIA, E+ Plan for environmental-conscious construction planning, and E+ Logistics for environmental-friendly construction property management. These three functional components is fixed based on the previous literature review on the contents of EM in construction, and contents other than the EIA, construction planning and property management will not be involved in this research. However, the E+ model to be developed in this research is open to other EM tasks to be embedded in further research and development (R&D).
- The E+ model is to be embedded into a standard process of ISO 14001 EMS that is currently in effect in ISO 14001 registered construction enterprises, and the simplified process of three-stage construction that is normally in effect in project construction. This treatment can enable the E+ model to be easily and crackfreely adopted in construction management (CM) in project construction.
- The functional-different approaches to EM in construction are basic components of the functional components of the E+ model, and all functional-

different approaches developed in this research are to be integrated individually into two E+ functional components i.e. E+ Plan and E+ Logistics.

- The functional-different approaches to E+ Plan are to be developed to be able to reduce potential adverse environmental impacts during the stage of construction planning. Moreover, the newly developed approaches should be easily adopted in construction planning, and preferably embedded into normally used planning software such as Microsoft Project®.
- The functional-different approaches to E+ Logistics are to be developed to enable reducing construction and demolition (C&D) waste not only inside a single construction site but also in local urban and rural area. Regarding to the property management already adopted in construction enterprises, the newly developed approaches should be effectively improve the efficiency of current property management such as material management and equipment management, and could benefit all anticipant including contractors, manufacturers, and landfill facilities, etc.

Methodology Development

Based on the basic considerations on the methodology for this research project, the methodology for the R&D of the E+ model will be undertaken through an integrative methodology, which involves various necessary methods adopted in the R&D of the E+ model and its subsidiary functional-different approaches. In order to clarify the integrative methodology for the R&D of the E+ model, Table 1.1 gives a straightforward description. According to the description, the integrative methodology for the R&D of the E+ model consists with eight methodological components such as literature review, on-site survey, questionnaire survey, statistical analysis, mathematical modelling, software application, case study, and computer simulation; and these methodological components are conditionally adopted in the R&D of different E+'s subsidiary approaches. Moreover, due to the open-to-design purpose of the E+ model, other components in layer 2 and 3 and adopted methodological components are listed but not available in this research.

Table 1 Methodology Development for the R&D of E+ Model

Model Layers	Layer 1	E+					
	Layer 2	EIA	E+ Plan		E+ Logistics		Others
	Layer 3	N/A	CPI	EnvironalPlanning	IRP	Webfill	Others
Methodological Components							
Literature Review		✓	✓	✓	✓	✓	N/A
On-Site Survey		×	✓	✓	✓	✓	N/A
Questionnaire Survey		×	×	✓	×	×	N/A
Statistical Analysis		×	×	✓	×	✓	N/A
Mathematical Modelling		×	✓	✓	✓	✓	N/A
Software Application		×	✓	✓	✓	✓	N/A
Case Study		✓	✓	✓	✓	×	N/A
Computer Simulation		×	✓	×	×	✓	N/A

The E+

The E+ is an integrative methodology for the EM in construction project in which a dynamic EIA process can be effectively and efficiently applied during construction. The successful implementation of an EMS in construction project requires far more than just the apparent prevention and reduction of adverse or negative environmental impacts in a new project and its construction process development cycles during pre-construction stage, continuous improvement of the EM function based on institutionalization of change throughout an onsite organization to reduce pollution during mid-construction stage, or efficient synergisms of pollution prevention and reduction such as waste recycle and regeneration in construction industry during mid-construction and post-construction stages. It necessitates a complete transformation of the construction management in an environmentally conscious enterprise, such as changes in management philosophy and leadership style, creation of an adaptive organizational structure, adoption of a more progressive organizational culture, revitalization of the relationship between the organization and its customers, rejuvenation of other organizational functions. In addition to the transformation for the EM in construction enterprises, the integrative methodology, E+, for the effective implementation of the EM in all phases of construction cycle including the pre-construction stage, the mid-construction stage and the post-construction stage is necessarily activated, together with other rejuvenated construction management functions such as human resources, expert knowledge, and synergetic effect.

The proposed E+ aims to provide high levels of insight and understanding regarding the EM issues related to the management in a construction cycle. In fact, current EIA process applied in Mainland China is mainly conducted prior to the pre-construction stage of a construction project when a contractor is required to submit an EIA report/form based on the size and significance of the project and the EIA process for the mid-construction stage is seldom conducted in normalized forms.

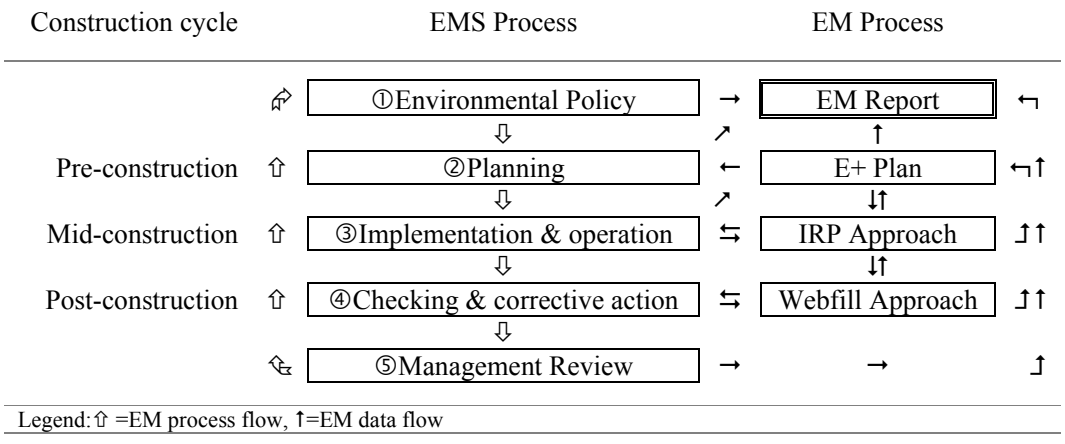

Figure 1. A conceptional model of the E+

Due to the alterability of the environmental impacts in the construction cycle, commonly encountered static EIA process prior to construction can not accommodate to the implementation of the EMS in project construction, and a dynamic EIA process is thus designed for the E+. In addition, current EM approaches are to be combined with a frame of the EMS (a process of the EMS including issuing environmental policies, planning, implementation and operation, checking and corrective action, and management review) according to their interrelationships with which various EM-related information/data can be organized. Because the main task of the EM in construction is to reduce adverse environmental impacts, the dynamic data transference in the framework is the prime focus of the E+. Thus, a conceptional model of the E+ is put forward in Figure 1.

CONCLUSIONS

This paper presents an integrative methodology for the EM in project construction where a dynamic EM process can be effectively and efficiently implemented in the construction cycle of a project. Three stages are divided for a construction cycle including pre-construction stage, mid-construction stage and post-construction stage corresponding with the ISO 14000 based EMS process. The weakness of static EIA applied in the construction industry in Mainland China is overcome by the dynamic EIA process where the necessary data for an EIA report can be updated in the construction cycle. The case study demonstrates the implementation of the dynamic EIA process and proves that the E+ model developed in this paper is effective and efficient.

In order to promote the implementation of the E+ model, further research is needed to transfer the E+ model to a computer software environment and develop more EM approaches dealing with other adverse environmental impacts in project construction.

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