AN INVESTIGATION INTO THE DEVELOPMENT OF KNOWLEDGE MANAGEMENT SYSTEMS WITHIN THE LEADING IRISH CONSTRUCTION COMPANIES

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The benefits that Information and Communication Technologies (ICT) can bring to a construction company within the Irish Construction Industry have yet to fully materialise. However the membership and activities of the Construction Information Technology Alliance (CITA) indicates a genuine desire of the leading participants in the industry to take advantage of these technologies. The focus of this paper shall primarily be that of a review of recent literature pertaining to Knowledge Management, both in general business, and particularly in the construction domain. The paper shall also set the context for Knowledge Management from a leading Irish construction company's perspective, and map out the research methodology that will be undertaken. This methodology will include a detailed survey of the top 20 construction companies (ranked by their 2004 turnover), narrowing down to interviews with key personnel in 5 of these companies, and then undertake case study research of a single organisation.

Keywords: Construction IT Alliance (CITA), information and communications technologies (ICT), Irish construction industry, knowledge management, research methodology.

INTRODUCTION

The nature of the construction industry makes managing knowledge a difficult task for a construction firm. Time and cost constraints leave little room for reflection and learning in an intensely competitive industry, leading to continuous problems. Due to this ever-increasing competitiveness, contractors should now begin to consider Knowledge Management (KM) as a tool for achieving greater organisational effectiveness, to drive innovation, and ultimately gain a competitive edge. As Egbu et al (2004) state: *"Construction organisations have been managing knowledge informally for years, but the challenges facing today's industry mean that most organisations now need a more structured, coherent approach to KM."*

This need for a *'more structured, coherent approach'* has led to an increase in research into KM in recent years in the UK construction industry, within a broader research base, which is examining the use of Information and Communications Technologies (ICT) in the industry. At the forefront of examining KM in the field of construction management are initiatives such as KLICON, Constructing Excellence, CIRG and C-Sand.

The extent of ICT related research in the Irish construction industry has been somewhat limited to date. One organisation that is trying to address this issue is the

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Construction Information Technology Alliance (CITA). It was founded in 2001 with the mission *"to actively encourage the Irish construction sector to take full advantage of current and emerging Information and Communications Technologies."*

The membership of CITA comprises some of the biggest construction organisations in Ireland, who have a desire to take advantage of emerging technologies, but are perhaps hesitant in the adoption of these technologies. This would seem to relate well to a study undertaken by Peansupap and Walker (2004), in which they stated: *"although the benefits of ICT are well recognised, its adoption as a normal part of construction practice still face barriers."* There appears to be consensus that some of the barriers to ICT and indeed KM implementation are time, cost, culture, people, organisational structure, and ad hoc adaptation (Al-Ghassani et al. 2004, Carrillo 2004, Bresnen 1999).

Based on the identified barriers, the following are the issues that need to be explored in order to assess the suitability of an organisation for KM; organisational structure, people and culture, strategy and technological capabilities.

RESEARCH AIMS AND OBJECTIVES

This paper is part of an on-going MSc in Construction Management by Research at Waterford Institute of Technology (being undertaken in association with CITA), entitled *'Knowledge Management in the Irish Construction Industry: An Investigation into the Development of Knowledge Management Systems within the Leading Irish Construction Companies.'* The aims and objectives of the study are to:

1. Identify current formal and informal Knowledge Management Systems within leading Irish construction companies.

2. Evaluate the overall effectiveness of identified Knowledge Management Systems within leading Irish construction companies.

3. Critically evaluate current Knowledge Management initiatives in Ireland and overseas.

4. Identify processes and activities within a contractor's organisation where value can be best added through the application of a Knowledge Management System.

5. Establish the role of ICT within a Knowledge Management System.

6. Propose a generic Knowledge Management System, tailored specifically to the needs of a leading Irish construction company.

The hypothesis which shall be tested by the research is:

'The development of an effective Knowledge Management system is essential if leading Irish construction companies are to remain competitive in the short/medium term.'

In terms of the overall MSc, this paper shall deal with a review of literature relevant to KM in general and in construction. It will also outline the research methodology that will be undertaken in order to achieve the aims and objectives stated.

KNOWLEDGE MANAGEMENT

The British Standards Institute (2003) define KM as: *"The creation and subsequent management of an environment which encourages knowledge to be created, shared,*

learnt, enhanced, organised and utilised for the benefit of the organisation and its customers." Many others have attempted to define KM (Kreiner 2002, The KM Forum 1996, Wiig 1997, Davenport and Prusak 1998, Payne 2003), with the common theme of utilising knowledge in order to enhance the overall effectiveness of the organisation.

There are numerous definitions of knowledge offered in the literature (Davenport and Prusak 1998, SAIC 2004, Rabelo 2004, Hussain and Lucas 2004). The most important facet in defining knowledge stems from the socio-technical debate (Offsey 1997, McCrea 2004, Tyndale 2002, Malhotra 2004, Kazi 2005), which has its roots in the distinction between Western and Japanese philosophy (Nonaka and Takeuchi 1995, Egbu 2004). This has led to the definition of two types of knowledge; tacit and explicit, with the following characteristics (Payne 2003):

- *Tacit* – not easily visible or expressible, highly individualised and context specific, difficult to share and manage.

- *Explicit* – can be readily codified into words and numbers, easily shared, easy to distribute, and can be managed as information.

KM has its roots in Information Systems (IS) and managing explicit knowledge, which focused on capturing and codifying the knowledge and storing it in databases. Numerous applications and systems have been touted as KM systems (KMS), when they are nothing more than an IS (Offsey 1997, Malhotra 2000, Tyndale 2002). Progressively, there has been a shift towards more emphasis being placed upon tacit knowledge and the social aspects of KM, with ICT taking a more supportive role (Bresnen et al 2003, Rabelo 2004, McLaughlin and Smith 2004). McCrea (2004) has identified some KM tools (see Table 2), which encompass both sides of the socio-technical debate. Interestingly, Ruggles (1998) identified a number of KM *'efforts underway'* and KM *'should-do efforts,'* the former relating to *Technologies* and the latter to *Techniques* in Table 2. One of the main proponents identified to have pioneered and implemented some of these tools in practice is British Petroleum (BP). *"BP business managers have attributed around $260 million of added value as a direct result of using this approach (SAIC 2004)."*

Table 2: Knowledge Management Tools

Techniques	*Technologies*
Brainstorming	Data and text mining
Communities of practice	Groupware
Face to face interactions	Intranets
Knowledge gatekeepers	Extranets
Recruitment	Knowledge bases
Training	Taxonomy/ontology

KNOWLEDGE MANAGEMENT IN CONSTRUCTION

The nature of the construction industry does not serve effective knowledge management well; it is complex and disparate, well known for its adversarial relationships and employee migration. In addition the project nature of the industry; one-off project teams, the non-repetitive nature of work undertaken, pressure to complete and the lack of incentive to appraise performance, pass learning on or improve overall delivery, all contribute to ineffective KM (Elhag et al 2000). In recent years, however, there has been a concerted effort in the UK construction

industry to address the needs of construction firms in terms of knowledge management, especially as *"a structured approach to managing knowledge derived from construction projects is still in its infancy in the UK construction sector (Al-Ghassani et al 2004)."*

In attempting to manage knowledge in construction, the nature and type of knowledge must first be understood. Chien and Johnson (2002) identify *"two distinct categories of knowledge that are accrued – knowledge gained in the physical building of a project, and knowledge gained in the management of the construction process. Both are equally important, for the success of one depends on the other."* This correlates well with what Salisbury (2003) describes as two *"grades of knowledge:"*

- *Kernel knowledge* (management of the construction process) – knowledge that needs to *"remain and be nurtured within a company in order to sustain high project performance in the long-term"*

- *Ephemeral knowledge* (gained in the physical building of a project) – *"project-specific knowledge"* which is *"usually generated externally to project teams, for instance by regulatory bodies, suppliers, and customers."*

Many construction companies have had problems in formulating an effective strategy to capture, retain and reuse this knowledge efficiently in such a way that allows learning on a consistent basis, whilst improving organisational performance (Chien and Johnson 2002, KLICON 1999).

Table 3: Benefits and Barriers

Benefits	*Barriers*
• Cost/time reduction	• Lack of time & money
• Process & product improvement	• Employee resistance
• Innovation, success & market leadership	• Poor organisational culture & structure
• Client orientation & satisfaction	• Piecemeal, ad hoc adoption
• Improved decision support & problem solving	• Problems of measurability and validation
• Less repeated mistakes and duplication of work	• Lack of incentives to encourage knowledge sharing
• Improved staff quality, satisfaction, motivation & retention	• Lack of understanding of the benefits of KM
• Increased awareness, accessibility and availability of knowledge	• Conflicting orientations to change and lack of sensitivity to context
• More effective teamwork	

Some of the potential benefits that KM can bring to construction projects (Carrillo 2004, Payne and Sheehan 2004, Anumba and Mohamed 2004, Offsey 1997), along with some barriers to successful KM implementation (Al-Ghassani et al 2004, Carrillo 2004, Bresnen 1999) are identified in Table 3. These benefits and barriers relate to a number of previously identified area; people and culture, organisational performance (as a result of business strategy) and organisational structure.

CASE STUDIES OF KM IN CONSTRUCTION

Carrillo et al (2005) identifies some approaches to sharing knowledge throughout a construction organisation (see Table 4) that have been utilised in a KM case study. As opposed to Table 2, the practices outlined here tend to lean more to the social aspect of sharing knowledge, i.e. utilising more techniques than technologies.

Table 4: Organisational Knowledge-Sharing Practices

Informal knowledge workshops	Knowledge exchange seminars
Departmental meetings	Site visit programme
Summary Reports	Project award scheme
Coaching and mentoring	Intranet and e-library

Some major construction organisations have implemented KM initiatives employing some of the tools and practices outlined in Tables 2 and 4. Fluor developed Knowledge Online, using Internet technologies to diff use knowledge throughout its organisation. Bovis Lend Lease implemented *ikonnect,* a web-based application which matches *"seekers of information"* with *"sharers of expertise and information."* In compiling an 'intellectual capital report,' Danya Cebus were able to identify *"hidden and intangible values that provide the company's competitive advantage and growth potential,"* they also host informal brainstorming sessions known as 'Knowledge Cafes' in which *"employees from all over the organisation discuss strategic and management issues, as they sit in small groups over a cup of coffee."* Arup use mentoring and apprentice-style practices, communities of practice and corporate yellow pages, which is a *"web-based, knowledge-sharing tool for identifying experts throughout the worldwide staff in a matter of seconds."*

THE IRISH CONSTRUCTION INDUSTRY

In recent years, the Irish economy has enjoyed unprecedented growth. The economic boom in the mid to late 1990s became known as the 'Celtic Tiger,' and despite a predicted slowdown, the Irish economy continues to grow. In 2004, the construction industry accounted for almost 24% GNP (over €28bn, compared to €6.3bn in 1995), making it, according to DKM economic consultants, *"a significant factor in the context of overall economic activity (2004)."* Indeed a recent survey conducted by the Central Statistics Office states that there are *"approximately 1,000 private building and construction firms with 5 or more persons engaged,"* with Sweetman (2005) reporting that *"direct employment in the sector has reached a staggering 222,000."* Contributing factors to the expansion of output in the construction industry include:

- Increased government expenditure (including the National Development Plan) and grants from the EU for infrastructural development.

- Attractive tax incentives which have encouraged large multinational companies to locate in Ireland, leading to the construction of multi-million euro facilities.

- An increase in demand for housing (a result of, amongst other things, a vibrant rental market, changing demographic profile and returning migrants).

The housing sector alone accounted for 65% of construction output in the industry in 2004, with civil engineering making up 20%, and general building, 15%. The fact that housing accounts for such a high percentage makes *"the construction sector very vulnerable to any correction in the housing market (DKM 2004)."* However, with a slowdown in the housing sector forecast, Davis Langdon state that: *"We anticipate the slow reduction in housing completions will be replaced in part or in whole by increases in general construction and infrastructural investment (2005)."* Factors such as an increase in the Public Capital Programme, health expenditure, educational building, and the decentralisation of government offices, should contribute to an increase in general construction and civil engineering over the next two to three years.

Despite these facts and figures, Kevin Kelly, Chairman of the Forum for the Construction Industry (FCI), at a recent Construction Industry Federation (CIF) master class on innovation, *"expressed deep concern over what he described as the conservatism, lack of innovation and low levels of R&D in what is arguably one of Ireland's most important industries."* In addition he stated that *"unless there is a greater move towards joint ventures and vertical consolidation of existing Irish players, he warned that the industry would begin to see an increase in the number of international partnerships moving in and winning contracts."*

In 2003, a preliminary study regarding the business case for an Applied Construction Innovation Centre (ACIC) in Ireland was undertaken by the FCI. The study surveyed a range of companies within the Irish construction sector, including the leading 20 building contractors, its aim being to identify current levels of innovation within each firm and areas where the ACIC could potentially improve the construction process. One of the areas identified as *"strategically important for the development of Irish construction"* was KM within the subject area of *"information, knowledge and communication, and associated technologies,"* with the report stating that *"CITA led by the Dublin and Waterford Institutes of Technology could have a role of taking forward developments in the ICT area."*

RESEARCH METHODOLOGY

The 20 leading construction companies in the Republic of Ireland were chosen as the subjects of the research, a definition of leading was made in terms of turnover for the year 2004. A combination of two lists was used to identify these firms, namely the CIF's *"Top 150 Construction Companies"* and the Irish Construction Industry Magazine's *"Ireland's Top 200 Construction Companies."* From the outset, it was decided that any firms chosen must undertake general building and civil engineering works as its core business and be based in, and undertake the majority of its work in the Republic of Ireland. Within the 20 chosen, the disparity between them in terms of turnover is quite significant, with the top firm having in excess of €700m, and the 20th having €60m. This is not an issue at this stage, but may require the companies to broken down into clusters as the research progresses.

Questionnaire
The first part of the primary research will involve sending out a postal questionnaire to the 20 leading Irish contractors. The questionnaire is intended to address the objective: *"Identify current formal and informal Knowledge Management Systems within leading Irish construction companies."* In addition, it also aims to gain a better understanding of the capabilities and future direction of ICT within each organisation, so that they can be assessed for suitability for the use of a knowledge management system. To this effect, two separate questionnaires are being administered to each organisation:

1. *Managing Director* – to gain an insight into areas such as strategy, culture, ICT and knowledge management.

2. *ICT Manager* – to establish the role of ICT within the organisation, it's capabilities, and future direction.

Managing Director Questionnaire
This questionnaire has 20 questions, divided into 5 sections. Owing to the business pressures on a director of a leading construction firm, the questionnaire was kept

relatively short, with particular emphasis on a straightforward layout, simplistic methods of answering questions, 18 of which require tick box answers and only 2 requiring a small amount of written input (percentages). The 5 areas covered are as follows:

a) *General Information* –identify the type of construction work undertaken (housing, civil, general) and type of clients (public or private) for 2004.

b) *People* – much of the literature reviewed places emphasis on initiatives to promote learning and motivation of staff. The presence of a CPD programme, mentoring, staff appraisal and motivational incentives are all aspects which many authors feel are part of the KM process.

c) *Strategy* – with reference to the stated hypothesis, this section aims to assess the strategic foresight of the company, and find the director's views on competitive factors in the industry, at present, and in the next 3 to 5 years. By identifying the presence of an R&D budget, it is hoped to identify the presence of innovation in the company.

d) *Information and Communications Technology* – in order to see how seriously ICT is considered by each organisation, ICT strategy, the role of ICT, investment and measurement of return on investment are covered.

e) *Knowledge Management* – the purpose of this section is to identify the presence (if any) of formal or informal KM within the organisation.

ICT Manager Questionnaire

Covering four topics, this questionnaire covers the technological aspects of the organisation, in order to assess its suitability for a KM system. Again, in a similar format to the Managing Director's questionnaire, 14 of the questions require boxes to be ticked, with only 3 requiring written input. The questionnaire covers the following topics:

a) *Role of ICT Department* – covers the ICT manager's background, number of people in the ICT department, functions of the department and current use of ICT within the company.

b) *Communications Technology* –explores the presence and use of an intranet, use of communication technologies use of collaboration software and use of PCs, laptops and handheld computers.

c) *Network Infrastructure* – concentrating on the network set-up both in offices and on-site, this section looks at the site/office link.

d) *The Future* –examines factors affecting, and the amount of investment in ICT, it also looks to identify ICT initiatives that the company plan to implement over the next 3 to 5 years.

Interviews

Semi-structured interviews with various personnel from 5 of the organisations that participated in the questionnaire shall be conducted. The interviews shall deal with evaluating *"the overall effectiveness of identified KM systems within leading Irish construction companies"* and identifying *"processes and activities within a contractor's organisation where value can be best added through the application of a KM system."* The personnel it is hoped to interview include:

a) *Managing Director* – to investigate further the company's strategy in the short to medium term, particularly in relation to ICT and KM, identify how knowledge is currently managed, and areas where KM could improve business performance.

b) *ICT Manager* –examine in greater detail the role and responsibilities of the ICT department and the potential for the development of a KM system.

c) *Project Manager* –the identification of site management processes and activities where KM can add value to the organisation to the forefront of discussions.

Case Study

With the cooperation of the organisation sponsoring this study, the full development of a case study methodology shall be considered upon the successful completion of both questionnaire and interview stages. It is anticipated that much of the case study shall involve the identification of the processes and activities where value can be best added through a KM system, and also lead to the proposal of a KMS suitable to such an organisation.

CONCLUSIONS

While KM may still be at an early stage in the UK construction sector, there are valuable lessons to be learned from its work to date. A number of construction firms have reported benefits of certain KM initiatives, in addition to barriers encountered during implementation. Irish construction organisations should begin to seriously consider the application of KM in order to consolidate their position in the marketplace. In identifying areas where KM can be applied, it is vital to explore the types of knowledge to be managed, explicit and tacit, kernel and ephemeral, thus dictating to a large extent, the KM tools which will be employed. This research project intends to identify *"processes and activities within a contractor's organisation where value can be best added through the application of a KM system,"* and so propose a suitable KM approach for leading Irish construction firms.

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