Managing Technical Knowledge to Enhance Organisational Best Practice

James Bishop

CICE

Loughborough University

CICE

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James Bishop

Ramboll Whitbybird
60 Newman Street,
London
W1T 3DA

Centre for Innovative and Collaborative Engineering
Department of Civil & Building Engineering
Loughborough University
Loughborough
Leicestershire, LE11 3TU

MANAGING TECHNICAL KNOWLEDGE TO ENHANCE ORGANISATIONAL BEST PRACTICE

By
James Bishop

A dissertation thesis submitted in partial fulfilment of the requirements for the award of the degree Doctor of Engineering (EngD), at Loughborough University

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Ramboll Whitbybird
60 Newman Street,
London
W1T 3DA

Centre for Innovative and Collaborative
Engineering
Department of Civil & Building Engineering
Loughborough University
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Leicestershire, LE11 3TU

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ABSTRACT

In recent years the construction industry has become increasingly aware of the potential of the technical knowledge held by construction professionals and the need to manage it effectively. However, organisations have experienced numerous problems in implementing and sustaining Knowledge Management (KM) initiatives. A key reason for this, which has been cited both within industry and academia, is a lack of understanding of the best-suited KM approaches available and how to adopt them. In particular, the importance of people-orientated KM practices, specifically in the case of construction firms who have a high level of dependence on the tacit knowledge of their employees, has been well documented with many KM authors calling for further research in this area.

The research undertaken for this study was initiated in response to the need for further research and an improved understanding of KM (people-orientated KM in particular) best practice. The research was also focussed on establishing an effective KM initiative within Ramboll Whitbybird; the sponsoring organisation. The central aim of the research was therefore to "*deliver a framework that facilitates the retention and reuse of knowledge, which will increase Ramboll Whitbybird's potential to drive engineering best practice and respond appropriately to conventional and emerging business opportunities.*" To achieve this an action research approach was adopted, facilitated through the use of literature reviews, interviews, focus groups, and other data collection methods, to enable the findings to be implemented within an industrial setting.

Through extensive industry involvement the research highlighted the core components necessary for a successful KM initiative, and the actions necessary from those involved in implementing, managing and sustaining KM activities within construction firms. The findings demonstrated that an organisation wishing to realise effective KM needs to establish a clear definition and understanding of KM across the business, which can be achieved through the compilation of a KM strategy (statement) and action plan. It also needs to acknowledge the importance of addressing the critical factors that will determine the success of its KM initiative such as the need for KM champions and a supporting team, a fit with the way people work and an alignment with business objectives. The research also highlighted the importance of people-orientated KM practices, and that construction organisations in particular should identify and prioritise KM activities such as Communities of Practice (CoPs), due to their reliance on tacit knowledge transfer. However, in order to maximise the benefits to individuals and the business, the organisation will need to take a 'light touch' approach to the management of CoPs. Supporting people-based KM activities with the right technology is an important factor, particularly as organisations expand and become more geographically dispersed. To ensure that this technology is an effective supporter of KM it needs to be tailored to fit with the KM needs of the business, and will need to become de-centralised in its operation. Finally, the research outlined the importance for the organisation to consider the integration of KM within the daily operation of the business by incorporating KM effectively into communication and reporting structures, while also ensuring that it becomes a core aspect of its Quality Assurance (QA) procedures.

KEY WORDS

Knowledge Management (KM), Communities of Practice (CoPs), initiatives, management, construction industry, engineering consultancy.

PREFACE

The research presented within this thesis was conducted to fulfil the requirements of an Engineering Doctorate (EngD) at the Centre for Innovative and Collaborative Engineering (CICE), Loughborough University. The research programme was supervised by CICE, undertaken within an industrial setting and sponsored by Ramboll Whitbybird, a multi-disciplinary engineering design consultancy.

The core of the EngD is the solution of one or more significant and challenging engineering problems with an industrial context. It therefore represents a radical alternative to the traditional PhD, being better suited to the needs of industry, and providing a more vocationally oriented doctorate in engineering[1].

The EngD is examined on the basis of a thesis supported by publications or technical reports. This thesis discourse is supported by two journal papers and an international conference paper, each of which is numbered 1-3 and located in Appendices A-C. The main discourse provides an overview of the work undertaken, while the papers offer a more in-depth perspective of the research, and should therefore be read in conjunction with the thesis.

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[1] CICE Website (Available at: www.lboro.ac.uk/cice)

USED ACRONYMS / ABBREVIATIONS

3D	-	Three Dimensional
CAD	-	Computer Aided Design
CICE	-	Centre for Innovative and Collaborative Engineering
CoP	-	Community of Practice
CRM	-	Client Relationship Management System
EngD	-	Engineering Doctorate
HR	-	Human Resource
H&S	-	Health and Safety
HTML	-	Hyper Text Markup Language
IIP	-	Investors in People Scheme
IMS	-	Integrated Management System
IT	-	Information Technology
JMS	-	Job Management System
KM	-	Knowledge Management
KPI	-	Key Performance Indicator
MD	-	Managing Director
MMR	-	Monthly Management Reporting System
MOSS	-	Microsoft Office SharePoint Server 2007
MSc	-	Master of Science
PD	-	Projects Database
PhD	-	Doctor of Philosophy
PIT	-	Process Improvement Team
QA	-	Quality Assurance
RE	-	Research Engineer
RWB	-	Ramboll Whitbybird
TG	-	Task Group

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LIST OF PAPERS

The following papers, included in the appendices, have been produced in partial fulfilment of the award requirements of the Engineering Doctorate during the course of the research.

PAPER 1 (SEE APPENDIX A)

Bishop, J., Bouchlaghem, D., Glass, J., and Matsumoto, I. (2008a), "Ensuring the Effectiveness of a Knowledge Management Initiative", Journal of Knowledge Management, Vol. 12, No. 4, pp. 16-29.

PAPER 2 (SEE APPENDIX B)

Bishop, J., Matsumoto, I., Stapleton, J., Glass, J., and Bouchlaghem, D. (2008b), "Identifying the critical factors that determine the success of communities of practice within an engineering design consultancy", C.P. Lima and M. Bauer (eds), Proceedings of the CIB W102 3rd International Conference: Information and Knowledge Management – Helping the Practitioner in Planning and Building, Stuttgart, October 2007, Germany, Fraunhofer IRB Verlag, pp. 325–334.

PAPER 3 (SEE APPENDIX C)

Bishop, J., Bouchlaghem, D., Glass, J., and Matsumoto, I. (2008c), "Identifying and Implementing Management Best Practice for Communities of Practice", International Journal of Architectural Engineering and Design Management, Vol 4, pp. 160-175.

PAPER 4 (SEE APPENDIX D)

Bishop, J., Matsumoto, I., Glass, J., and Bouchlaghem, D. (2009), "One Size Doesn't Fit All: Using Technology to Support a Balanced KM Initiative, (*In Progress*).

1   INTRODUCTION

This chapter provides an introduction to a thesis on the subject of Knowledge Management within the construction industry. It sets out the context of the research, both within the construction industry and within the industrial sponsor (Ramboll Whitbybird), presents justification for the study, and outlines the aims and objectives of the project.

1.1   THE RESEARCH DOMAIN

Over the last decade, successive reviews of the UK construction industry have emphasised the need to improve culture and working practices (NAO, 2001). Of these, several have emphasised the necessity for improved design processes and the need for more innovative solutions (Latham, 1994; Egan, 1998, 2002; Fairclough, 2002). In his report 'Rethinking Construction', which was commissioned by the Deputy Prime Minister to assess the efficiency of the UK construction industry, Egan (1998) stated that "*at its best the UK construction industry displays excellence.*" However he expressed a deep concern that the industry as a whole was underachieving, with a low profitability and contributing little investment in capital, research and training, with many dissatisfied clients. Egan (1998) suggested that despite these problems, there is no doubt that substantial improvements in quality and efficiency are possible and that these are vital if the industry is to satisfy all of its customers and become world leading.

In his following report 'Accelerating Change', Egan (Strategic Forum for Construction, 2002) cited the need for a radical change in the way UK construction firms deliver projects, and identified the most severe problems as being;

- A low and unreliable rate of profitability;

- Too little investment in research and development;

- A crisis in training; and

- Too many clients who are undiscriminating, equate price with cost, and generally dissatisfied with performance.

The importance for an improvement in the overall performance of the UK construction industry is emphasised when considering the contribution of the industry to the national economy, which contributes 8.7% per cent of the nation's gross value added (GVA) and employs 2.1 million people (Dept. for BERR, 2009). The UK construction industry consists of approximately 186,107 construction firms, 180,131 of which have less than 24 employees with just 56 firms employing more than 1,200 people (Dept. for BERR, 2007). In terms of less obvious contributions to the UK economy, research undertaken by the Construction Industry Council (CIC, 2003) suggested that the informal or black construction economy is worth £10 billion and the DIY (products) economy around £5 billion. International construction is worth over £10 billion to the UK economy with 500 construction firms working overseas.

Within the Construction Industry Council's (CIC) 2006 annual report, engineering firms are covered under the heading 'Professional Services'. The report outlines that in 2006 there were approximately 27,950 professional services firms in the UK, employing 270,000 people.

The professional services sector includes the following disciplines (CIC, 2006):

- Engineering services (28% of all professional services work; £3.9bn).

- Architecture services (24% of all professional services work; £3.3bn).

- Surveying services (17% of all professional services work; £2.3bn).

- Management (12% of all professional services work; £1.7bn).

The necessity for all construction firms to improve performance in an increasingly competitive global market has meant that they are constantly striving to make the most of their assets and resources. This has meant that from the 1990's onwards knowledge and innovation have rivalled efficiency and quality as the main source of competitive advantage (Bolwijn and Kumpe, 1990; Edvinsson, 2000; Egbu, 2004).

1.2   THE INDUSTRIAL SPONSOR

Whitbybird was founded in 1984 as a small structural design consultancy based in the UK. It has grown rapidly over the past 25 years to become an internationally renowned leader in engineering. Table 1.1 illustrates the growth (turnover) of Whitbybird between 1996 and 2008. In 2007, Whitbybird merged with 'Ramboll', a Scandinavian-based engineering consultancy of over 7,000 employees to become 'Ramboll Whitbybird' (RWB). Driven by international demands, the merger was seen as an opportunity to take a step towards 'future-proofing' the firm against economic downturn, to expand engineering capabilities, and to create a 'one-stop-shop' for its clients. Ramboll Whitbybird consists of over 800 staff working on multidisciplinary engineering design projects across 16 offices based both in the UK and internationally. As well as structural engineering (its core business) it also offers a number of other disciplines including; building services, fire, façade, and geotechnical engineering, bridge design, infrastructure and public health, environmental assessment, and sustainable and renewable projects. Tables 1.2 and 1.3 highlight the changes in the distribution of the different disciplines across the company between 2003 and 2007. The company has made a conscious effort to ensure it offers a balanced yet diverse range of services, which not only allows it to respond to the ever increasing demands of its clients, but also to protect it from downturns in the market. Tables 1.4 and 1.5 outline the changes in the splits across the different sectors in which the company specialises between 2003 and 2008.

Table 1.1: Actual and Forecast Turnover (1996 - 2008)
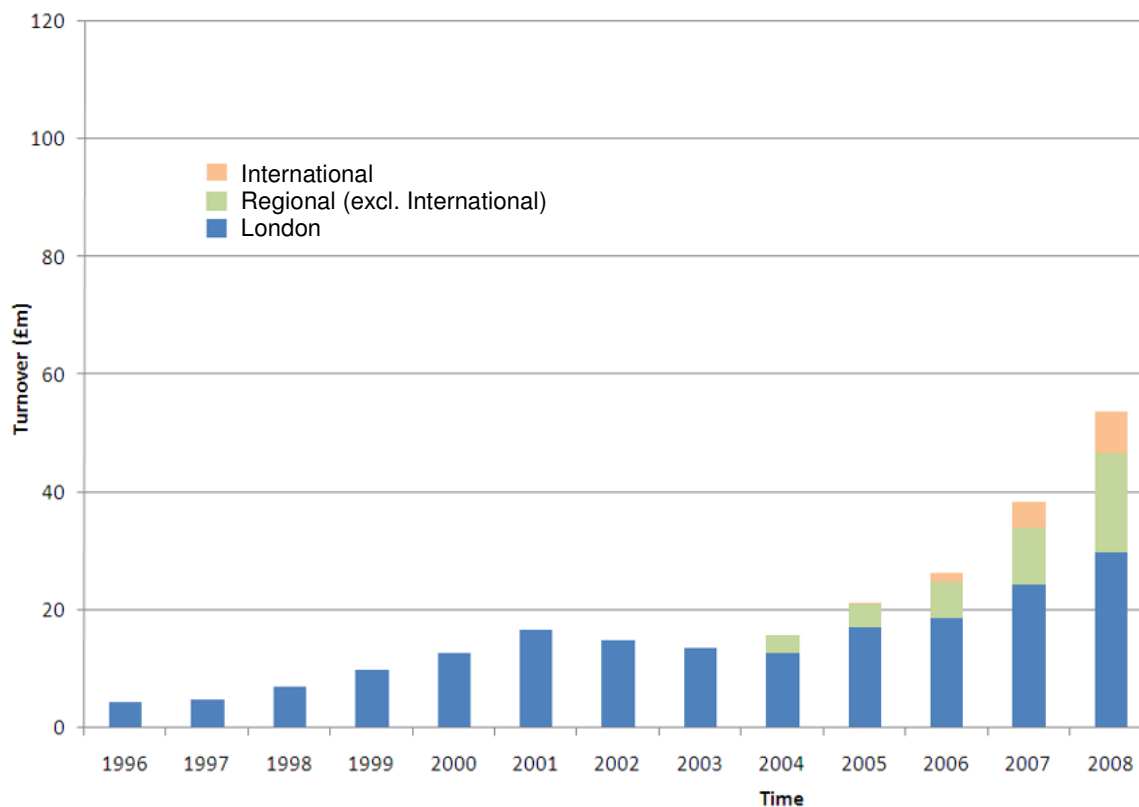
Table 1.2: Turnover by Discipline (2003)
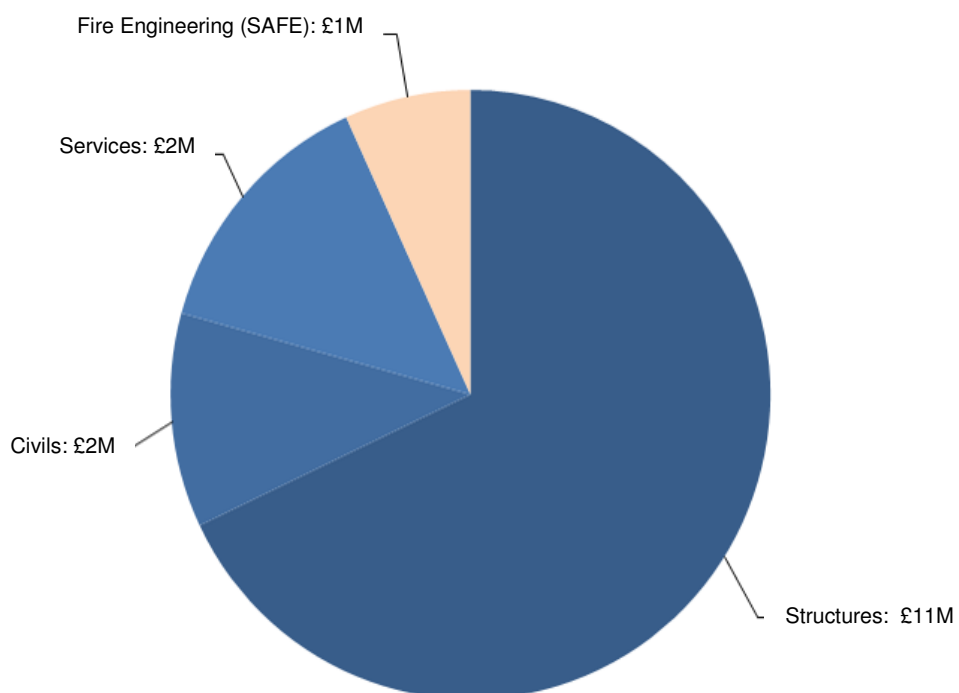
Table 1.3: Turnover by Discipline (2007)
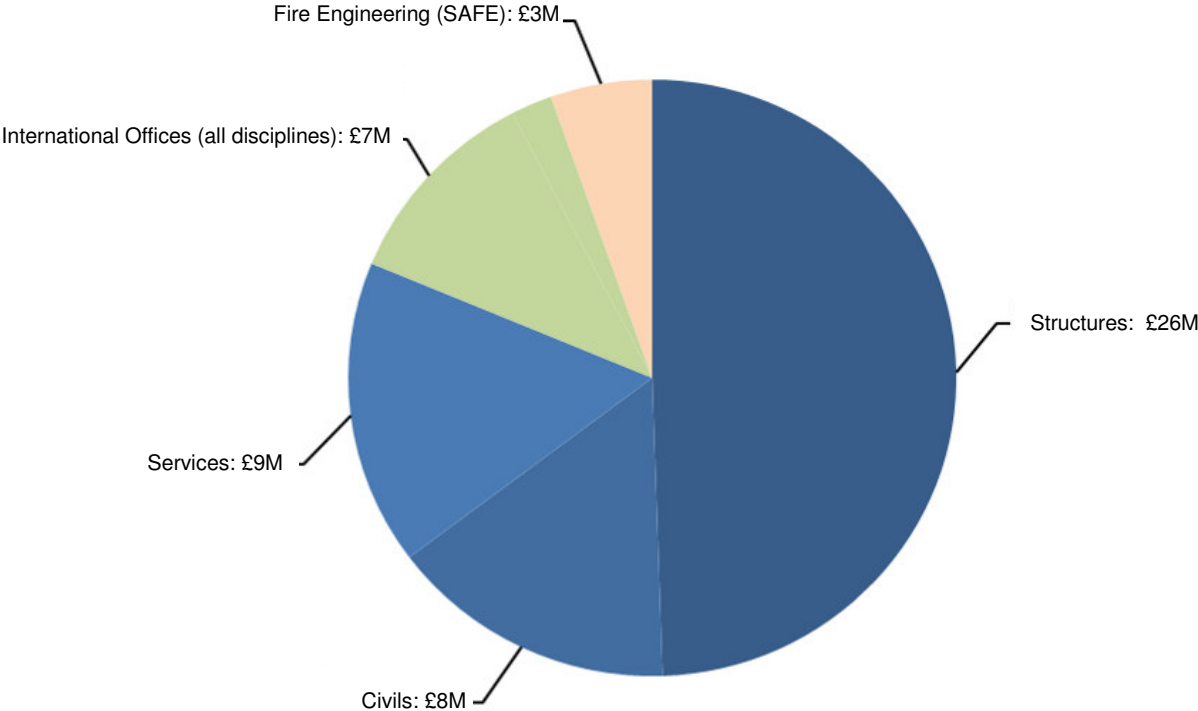
Table 1.4: Sector Split (2003)
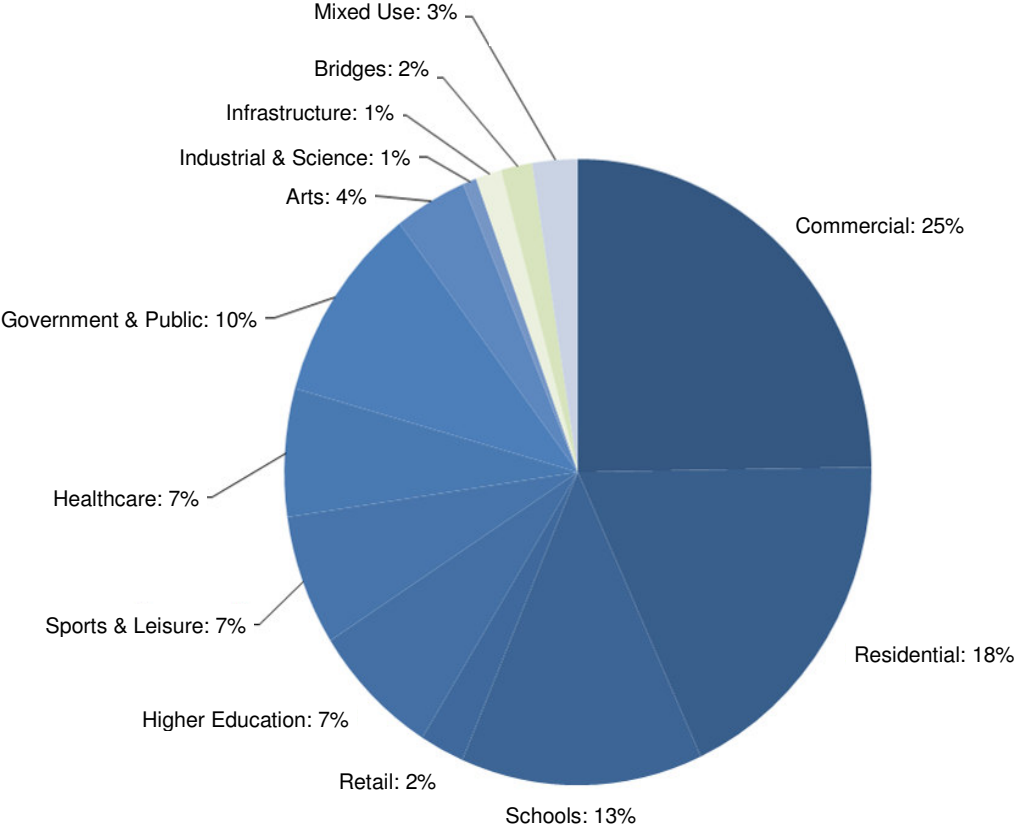
Table 1.5: Sector Split (2008)

Mixed Use: 7%
Development & Planning: 2%
Bridges: 1%
Infrastructure: 7%
Industrial & Science: 2%
Arts: 3%
Government & Public: 4%
Healthcare: 4%
Sports & Leisure: 7%
Higher Education: 6%
Retail: 8%
Schools: 16%
Residential: 14%
Commercial: 20%
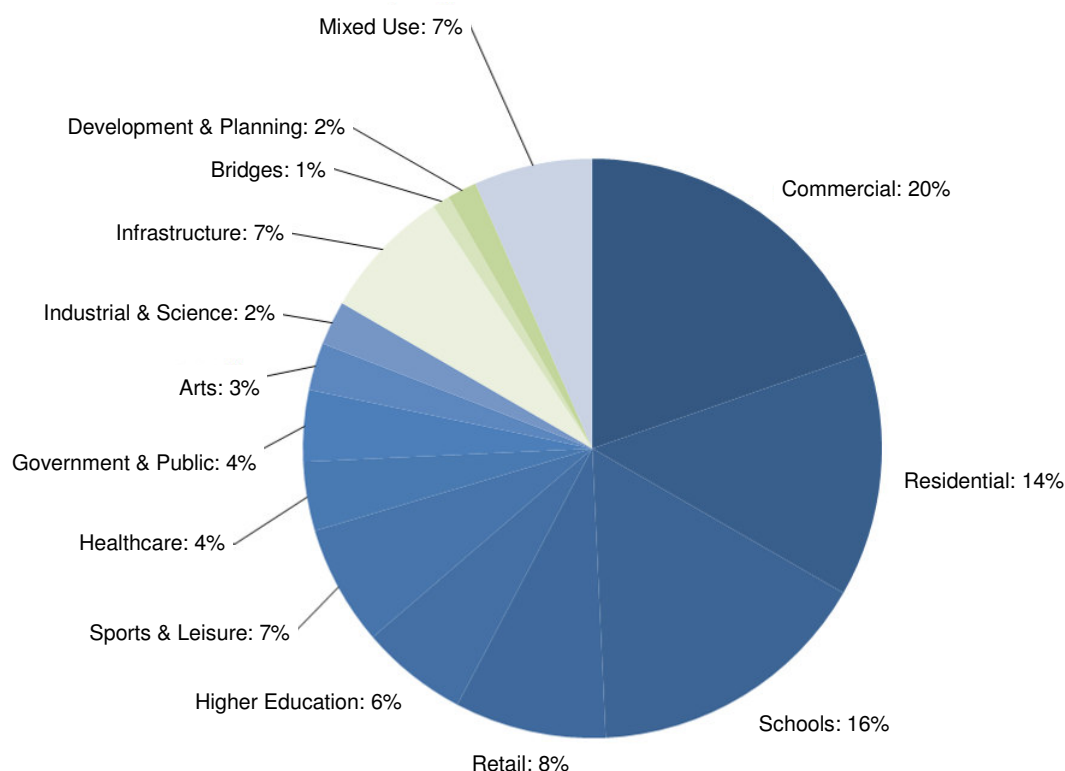
RWB sets itself apart from traditional engineering consultancies not only through its multidisciplinary approach, but by working closely with contractors, clients and architects throughout the design process, focussing on a holistic approach to design and construction processes. The company has emphasised its desire to continue to provide innovative solutions and to increase its competitive advantages. RWB has stressed that the value of a design consultancy is based on its technical knowledge, expertise and experience. It has identified that this technical knowledge is embedded in the organisation's assets and systems, and managing these is paramount to the success of the business. The company has recognised the potential of knowledge as a key resource, and shares an enthusiasm to manage this resource effectively with leading research practitioners.

Although Ramboll Whitbybird has grown rapidly over the last two decades, it has constantly strived to sustain its open and collaborative culture. Indeed, all of its offices still maintain an open plan arrangement. Although the organisation has a relatively flat structure, there is some hierarchy in terms of its reporting system. The basic level of the reporting structure is at the team level (Figure 1.1). Each team (of which there are approximately 60) has a Director responsible for it, with day-to-day management responsibility held by dedicated team leaders. Weekly meetings are held by the teams to discuss various issues affecting them or the projects that they are working on. Key issues, which require organisational input and wider contributions, are then carried forward to the Operations Board meetings. Items can also be carried forward to the company's Task Groups, which are its version of Communities of Practice. The highest level in the reporting structure is the Main Board. These monthly meetings are intended primarily for strategic decision making concerning issues, which are critical for the progression of the business.
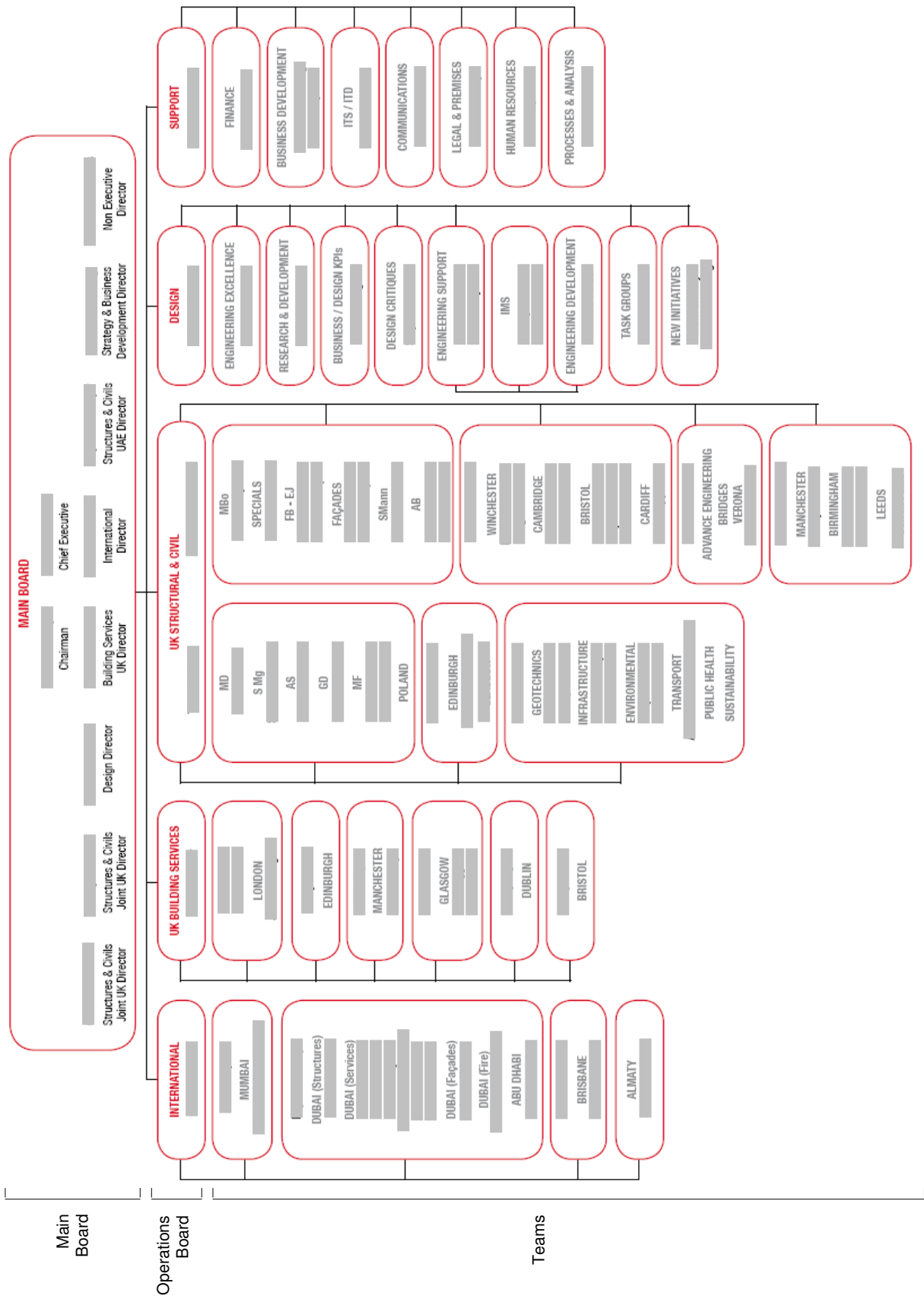
Figure 1.1: Team / Reporting Structure

Throughout the research the EngD Research Engineer (RE) has been a member of the Process Improvement Team (PIT). The team operates from the Head Office in London and consists of six people, responsible for the management and operation of various business and process systems, the intranet, quality and client management systems. The team has also been involved in Knowledge Management initiatives as part of previous EngD research (Matsumoto, 2006; Matsumoto *et al*. 2005a, 2005b, 2005c, 2002).

1.3 CONTEXT OF THE RESEARCH

In recent years it has become widely accepted throughout UK construction, that firms must realise the full potential of the intangible resources available to them in order to remain competitive. In particular, knowledge is increasingly being recognised as a vital organisational resource that provides competitive advantage (Egbu & Botterill, 2001). This has led to a focus on understanding how to make the best use of this resource. The growing emphasis on the value and potential of organisational knowledge is reflected in the increasing amount of research output on this subject, as well as the growing number of firms, which have implemented Knowledge Management initiatives as a way of systematically mobilising and utilising their knowledge assets (Huang & Newell, 2003).

Construction organisations have always managed their knowledge in some form and have always relied on the expertise of key members of staff. However the terminology used and the increased awareness that knowledge should be managed in a more structured manner is new to the industry (Carrillo, 2004). 'Knowledge Management' (KM) relates to unlocking and leveraging different types of knowledge to make it available as an organisational asset (Robinson *et al.* 2005). KM is a relatively new concept and there are many definitions (Carrillo, 2004). However Swann *et al*. (1999) broadly define KM as "*any processes and practices concerned with the creation, acquisition, capture, sharing and use of knowledge, skills and expertise.*"

KM could be easily dismissed by industrial practitioners as yet another management fad. However, the growing emphasis on innovation through 'knowledge work' and 'knowledge workers' and on leveraging 'knowledge assets' suggests that the need to manage knowledge will endure as a core business concern, even if the label may change (Drucker, 1996). For this reason and those mentioned above, the CICE, RWB and the RE saw great potential for further research in this subject area.

The research builds on previous work, undertaken as part of an EngD research project titled "*A Structured Approach to Improving Organisational Knowledge, Business Processes and Management Systems*" with RWB (Matsumoto, 2006; Matsumoto *et al*. 2005a, 2005b, 2005c, 2002). The firm has recognised the need to build on this research to further strengthen its ability to effectively manage and share its knowledge. The requirement from RWB was for a framework, which would enable it to achieve a strategic approach for KM. This would enable it to recognise and prioritise the actions necessary to drive KM forward within the business by creating, developing and sustaining the best-suited KM activities and practices, to form an overall KM initiative for the firm. The importance of technical knowledge to the firm meant that this initiative needed to support its engineering projects and enhance the professional progression of its staff.

1.4   OVERALL AIM OF THE RESEARCH

The value of a design consultancy is based on its technical knowledge, expertise and experience. This technical knowledge is embedded in the organisation's assets and systems, and managing these is paramount to the success of the business. This is particularly apparent when new techniques are developed and applied by engineers. Any weaknesses in the systems or assets can result in previous mistakes being repeated. For instance, as new environmental management systems are implemented and more sustainable construction methods are adopted, engineers will need to adopt a more comprehensive design approach. In this scenario leveraging the multidisciplinary knowledge available across the organisation becomes invaluable.

Therefore the overarching aim of this research project is to:

"Deliver a framework that facilitates the retention and reuse of knowledge, which will increase Ramboll Whitbybird's potential to drive engineering best practice and respond appropriately to conventional and emerging business opportunities."

1.5   OBJECTIVES

To achieve this aim, four key objectives were established at the outset. These were as follows:

- **Investigate patterns of knowledge exchange within Ramboll Whitbybird, and examine the constraints that determine their effectiveness;**

- **Identify the best suited Knowledge Management approaches for adoption within Ramboll Whitbybird;**

- **Establish best practice for the use of the Knowledge Management approaches identified;**

- **Develop a balanced KM approach to enable an engineering design consultancy to better capture and share knowledge, and implement the optimum solutions within Ramboll Whitbybird.**

1.6   JUSTIFICATION FOR THE RESEARCH

As a leader of cutting edge and innovative engineering, RWB has invested in research to understand how it can improve the way in which it operates on both an operational and strategic level. Previous EngD research undertaken within the firm was focussed on understanding and developing business processes such as project and human resource management, in order to improve business efficiency (Matsumoto, 2006; Matsumoto *et al*. 2005a, 2005b, 2005c, 2002). The research examined some elements of KM and resulted in the implementation of several KM solutions. However, these were primarily focussed on managing harder 'explicit' knowledge, and were primarily concerned with IT-orientated solutions such as a 'skills database' and a 'workload resource management' tool. RWB had acknowledged the need to build on this research by supporting the organisation's ability to manage 'softer' tacit knowledge resources such as the experiences gained and lessons learned on past projects. This would ultimately enable it to recreate project successes and avoid the repetition of mistakes. To deliver this approach, RWB has recognised the importance for a 'balanced framework' incorporating elements focussed on both tacit and explicit aspects of KM, which will also provide it with a strategy to consolidate its KM activities.

The importance of KM to RWB is relevant now more than ever, as a result of large scale changes to the organisation including rapid expansion to double the size it was four years ago and a merger with Ramboll; a Scandinavian-based multidisciplinary engineering consultancy of over 7,000. This has opened up numerous opportunities for RWB and the wider Ramboll group, with each company previously specialising in different areas of engineering and in different geographic locations. Although the business has previously implemented a number of KM solutions, it recognised that the potential of these could be further enhanced.

Within the UK construction industry there is a distinct uncertainty surrounding the implementation of KM best practice within construction firms. Numerous failed KM initiatives within the industry are highlighted within KM literature (Al-Ghassani *et al.* 2004; Carrillo, 2004b) despite the existence of effective KM initiatives, which have been implemented by a handful of construction firms and a large number of businesses external to UK construction. The literature also identified a change in perspectives across the industry concerning the focus of KM initiatives on IT and people, which has resulted in a lack of understanding as to the correct approach to take and how to achieve a balanced KM strategy (Egbu, 2004; Egbu and Botteril, 2001; Oltra, 2005).

Within academia there are consistent calls for research, which examines balanced approaches to KM utilising a balance of different KM activities to effectively capture and share technical knowledge. There are also ongoing discussions and debates on the best suited KM initiatives for construction firms, particularly in the area of KM initiatives that are focussed on people. Although there is extensive research on KM theory, there is a lack of research projects that examine actual KM practice, particularly balanced KM strategies.

1.7   SUMMARY

The overall aim of this research study was to "*deliver a framework that facilitates the retention and reuse of expertise, which will increase Ramboll Whitbybird's potential to respond appropriately to conventional and emerging business opportunities.*"

By establishing an understanding of the needs of the industrial sponsor, the necessity for the research to build on that, which has preceded it, and the overall context of the research, the RE could ensure that it addressed the core objectives and satisfied the requirements of all stakeholders in the research.

The following discourse outlines the research undertaken, the findings which resulted, and the subsequent conclusions drawn. Table 1.6 outlines the structure of the research (thesis) and the papers written in order to fulfil the research objectives and respective work packages.

Table 1.6: Research Structure

Thesis	Overall Aim: Deliver a framework that facilitates the retention and reuse of technical knowledge, which will increase Ramboll Whitbybird's potential to respond appropriately to conventional and emerging business opportunities			
	Objectives	**Work Tasks**	**Papers**	**Status**
Stage 1	Investigate patterns of knowledge exchange within Ramboll Whitbybird, and examine the constraints that determine their effectiveness	1.1 Determine RWB's KM requirements. 1.2 Identify the range of KM activities, which exist across RWB. 1.3 Identify KM activities, which are in need of improvement and assess the extent to which these can be improved.	**Paper 1** Bishop, J., Bouchlaghem, D., Glass, J., and Matsumoto, I. (2008a), "Ensuring the Effectiveness of a Knowledge Management Initiative", *Journal of Knowledge Management*, Vol. 12, No. 4, pp. 16-29.	Published
Stage 2	Identify the best suited Knowledge Management approaches for adoption within Ramboll Whitbybird.	2.1 Investigate approaches for the use of CoPs within construction organisations. 2.2 Establish a set of critical success factors for CoPs. 2.3 Provide RWB TGs with an improved method of sharing knowledge and communicating deliverables.	**Paper 2** Bishop, J., Matsumoto, I., Stapleton, J., Glass, J., and Bouchlaghem, D. (2008b), "Identifying the critical factors that determine the success of communities of practice within an engineering design consultancy", C.P. Lima and M. Bauer (eds), *Proceedings of the CIB W102 3rd International Conference: Information and Knowledge Management – Helping the Practitioner in Planning and Building,* Stuttgart, October 2007, Germany, Fraunhofer IRB Verlag, pp. 325–334	Published
Stage 3	Establish best practice for the use of the Knowledge Management approaches identified.	3.1 Identify recommendations made within CoP literature for the coordination and management of CoPs. 3.2 Examine CoP approaches taken by leading organisations which have been recognised as demonstrating excellence in KM, both within the construction industry and external to it. 3.3 Implement CoP best practice improvement initiatives within RWB.	**Paper 3** Bishop, J., Bouchlaghem, D., Glass, J., and Matsumoto, I.. (2008c), "Identifying and Implementing Management Best Practice for Communities of Practice", *International Journal of Architectural Engineering and Design Management*, Vol 4, pp. 160-175.	Published
Stage 4	Develop a balanced KM initiative to enable an engineering design consultancy to better capture and share knowledge, and implement the optimum solutions within Ramboll Whitbybird	4.1 Provide support for people-based KM activities with technology-based KM solutions . 4.2 Investigate measurement criteria for technology-based KM solutions. 4.3 Examine process-based KM solutions.	**Paper 4** Bishop, J., Matsumoto, I., Glass, J., and Bouchlaghem, D. (2009), "One Size Doesn't Fit All: Using Technology to Support a Holistic Knowledge Management Initiative", (*In Progress*).	In Progress (to be completed 2009)

2   REVIEW OF KM LITERATURE

An initial task, which was essential for the research, was a review of current literature on KM. The purpose of this review was to gain an overview of related research to date, and the level of understanding concerning the different facets of KM. Further to this, it was important to establish areas of uncertainty within the literature as well as areas of research, which were lacking. Following the initial review of generic KM literature, further reviews were undertaken to investigate more specific areas of KM such as CoPs and KM approaches, as the research progressed.

The review established that although construction firms are increasingly recognising the importance of knowledge and the need to manage it, there are numerous difficulties associated with understanding and defining KM, and ultimately in adopting a successful KM initiative. Although the focus of recent KM literature has shifted towards the area of people-orientated KM solutions this remains as an area, which is in need of further research. This is partly due to continued focus on IT-orientated KM solutions within the literature despite the acknowledgement that more balanced KM initiatives focussing on both people and IT offer the greatest potential for success. The review underpinned the first two research objectives in particular by identifying a number of factors, which may either hinder or contribute to the effectiveness of a KM initiative, and also in providing an outline of KM practices, which have been adopted within industry, recommended by academics, or both.

2.1   KNOWLEDGE

Defining knowledge has been a topic of much interest and discussion for many years. Nonaka and Takeuchi (1995) have developed and adopted a variation of a traditional definition of knowledge through their understanding that "w*hile Western epistemology has focussed on 'truthfulness' as the essential attribute, we highlight the nature of knowledge as 'justified belief'*." They therefore define knowledge as "*a dynamic human process of justifying personal belief toward the 'truth'*."

When considering the meaning of 'knowledge' there are several other factors to take into account. Nonaka and Takeuchi (1995) emphasise that although the terms 'information' and 'knowledge' are often used interchangeably, there is a clear distinction between the two. They suggest that:

> "*Information is a flow of messages while knowledge is created by that very flow of information, anchored in the beliefs and commitment of its holder, and that this understanding emphasises that knowledge is essentially related to human action.*"

Nonaka and Takeuchi (1995) continue to define knowledge by describing two distinct types; *tacit* and *explicit*. Explicit knowledge is defined as that, which can be articulated through formal language, including grammatical statements, mathematical expressions, specifications and manuals. This kind of knowledge can be shared by individuals formally and easily and is often referred to as *hard* knowledge. Tacit knowledge is described as that, which exists as personal knowledge, embedded in an individual's mind and is often defined as *soft* knowledge. This type of knowledge is influenced by factors such as personal belief and perspectives, making it hard to formalise and difficult to communicate or share with others.

In relation to the collective knowledge held by an organisation, Nonaka and Takeuchi (1995) describe the concept of 'organisational knowledge creation' as being:

> *"A continuous and dynamic interaction between tacit and explicit knowledge….For tacit knowledge to be communicated and shared within the organisation, it must be converted from tacit to explicit, and that it is precisely during the time this conversion takes place from tacit to explicit and back again into tacit that organisational knowledge is created….Organisational knowledge creation is a spiral process, starting at the individual level and moving up through expanding communities of interaction, that crosses sectional, departmental, divisional, and organisational boundaries."*

Nonaka and Takeuchi (1995) identified four modes of knowledge conversion, which are created when tacit and explicit knowledge interact. They define these four modes as:

1. *Socialisation*. The process of sharing experience and thereby creating tacit knowledge.

2. *Externalisation*. The process of articulating tacit knowledge into explicit concepts.

3. *Combination*. The process of systemising concepts into a knowledge system.

4. *Internalisation*. The embodiment of explicit knowledge into tacit knowledge, or 'learning by doing'.

The relationships between the four modes and the process of knowledge creation are illustrated by Nonaka and Takeuchi (1995) in the form of 'the spiral of knowledge creation' (Figure 2.1). In this respect, organisational knowledge creation relates to the capability of a company as a whole to create new knowledge, disseminate it throughout the organisation, and embody it in its products, services and systems.
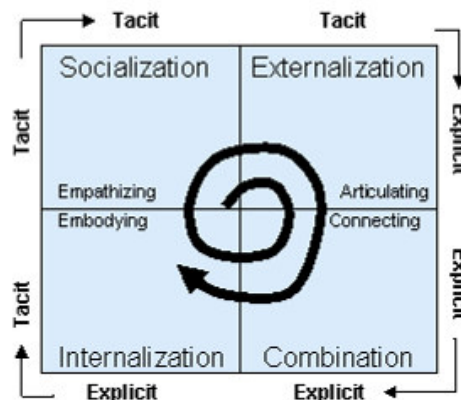
Figure 2.1: 'The Spiral of Knowledge Creation' (Nonaka and Takeuchi, 1995)

2.1.1 USING KNOWLEDGE FOR COMPETITIVE ADVANTAGE

The issue of knowledge as a competitive advantage has been raised by many authors, who are in agreement that there is now a general acceptance in competitive business environments and project based industries that knowledge is a vital organisational resource (Nonaka and Takeuchi, 1995; Pan and Scarbrough, 1998). Edvinsson (2000) emphasises this by suggesting that knowledge is fast overtaking capital and labour as the key economic resource in advanced economics, while Johannessen and Olsen (2003) state that an organisation's capacity to create and sustain competitive advantages lies in what it knows, not what it owns.

2.2 KNOWLEDGE MANAGEMENT (KM)

As a result of increasing interest from a large number of organisations across numerous different industries (Ribeiro, 2000; Teleos, 2007), a large amount of literature has been

published on Knowledge Management (KM). Different authors have presented different definitions of KM. Davenport and Prusak (1998) suggest that KM is "*the process of capturing, distributing and effectively utilising knowledge.*" This is closely reflected by Scarbrough *et al.* (1999), who describe KM as the process of "*creating, acquiring, capturing, sharing and using knowledge to enhance organisational learning and performance.*" Robinson *et al.* (2005) suggest that KM is a method of "*exploiting or transforming knowledge as an asset for organisational use, to facilitate continuous* improvement." Several authors also outline the distinction between KM and *intellectual capital,* which is often cited as an area of misunderstanding amongst academics and practitioners (Paper 1, Appendix A).

Different KM approaches are described throughout the literature by numerous different terms. Clarke and Rollo (2001) describe the different approaches adopted by various companies as 'KM initiatives', which incorporate the shared characteristic of a company's commitment to developing the production and flow of knowledge, and the dissemination and use of knowledge to create economic value. A KM 'initiative' denotes an overall approach to managing knowledge. This is different from the term 'system', which is often used in KM literature to describe IT-orientated approaches to KM. 'KM initiative' is therefore the term utilised throughout this research study to describe the overall KM strategy adopted by an organisation.

2.3   KM IN CONSTRUCTION

The need for effective mobilisation of knowledge in sourcing expertise quickly and providing clients with confidence of a firm's competence in specific areas of work (Carrillo, 2004) has meant that KM within the construction industry has become an area of particular interest within KM literature. The 'one of a kind' nature of construction projects necessitates that construction firms are able to effectively reuse and mobilize existing knowledge of different project elements, and means that KM is likely to take a central role in future competitive strategies for construction organisations (Koch, 2002).

UK Government identified the *knowledge driven economy* as being one where the generation and exploitation of knowledge is a major contributor to the creation of wealth within the economy (CIC, 2003). Today's UK construction industry shares a number of characteristics with a knowledge economy, where organisations rely on professional knowledge or expertise relating to a specific technical or functional area, and are recognised by their multi-task responsibilities, teamwork, job rotation, and speed of production (Anumba *et al.* 2005). Anumba *et al.* (2005) state that construction firms are knowledge-intensive; characterised by their use of a high degree of tacit knowledge. They outline specific examples of both tacit and explicit knowledge in the context of construction firms:

Tacit Knowledge (where skills are acquired over a period of time):

- Estimating and tendering;
- Preparing bids;
- Understanding the construction process;
- Interaction with clients, customers and project team members; and
- Understanding tender markets.

Explicit Knowledge (which is stored as written documents or procedures):

- Design codes of practice;

- Performance specifications;

- Drawings (in paper-based or electronic form);

- Materials testing procedures;

- Design sketches, images and 3D models; and

- Text books.

The importance for consideration of the use of techniques, which address both types of knowledge within construction firms is due to the enormous variation in the types of knowledge, which exist across the life cycle of a construction project (Carrillo, 2004b).

Egbu and Robinson (2005) suggest that "*decisions on what knowledge a construction organisation needs or the knowledge intensity depends on the context of the business environment.*" They continue by identifying three aspects of knowledge to manage in the construction context:

1) *Product*-based factors relate to the characteristics of the 'end product' being produced, which for construction organisations can be classified as being standard construction, traditional construction or innovative construction. The type of project therefore renders knowledge about clients, end-users and market characteristics an important consideration.

2) *Process*-based factors relate to the technical and management systems required for the delivery of projects. While technical processes will have a heavy reliance on explicit knowledge, management processes may rely on either tacit or explicit knowledge depending on the complexity (standard, traditional or innovative) of the end product.

3) *People*-based factors relate to skills, problem-solving abilities and the characteristics of teams. Although standard construction requires individuals with basic knowledge and skills, more innovative projects, which are often ill-defined and complex to implement will require problem-solving or creative people. Individuals with tacit knowledge are therefore central to the creativity required in the design and construction of innovative projects.

Within RWB, the necessity to manage knowledge, which has the potential to contribute to the production of innovative design solutions that demonstrate engineering excellence, makes the people-based knowledge factors outlined above a critical consideration. This knowledge (primarily tacit) is held by those individuals (and teams) with expertise gained through previous project experiences such as the production of innovative design solutions or the occurance of a specific engineering-related problem, and is defined within this study as 'technical' knowledge.

Egbu (2004) outlines the importance of considering knowledge as a key organisational resource for construction firms by suggesting that it not only provides market leverage, but also contributes significantly to project success. Further to this he suggests that the ability of construction firms to innovate depends largely on the way in which an organisation uses and exploits the resources available to it. He states that it is the requirement for construction firms to become more innovative and to maximise the use of their resources, which renders 'knowledge' as a key organisational asset.

The importance of knowledge to a construction firm in improving its ability to innovate, increase its competitive advantage, and contribute to project success has meant that UK construction firms have become increasingly interested in implementing various KM

solutions (Carrillo and Chinowsky 2006, Robinson et el. 2001). Such firms include industry leaders such as Amec, Arup, Balfour Beatty, Bovis Lend Lease, Cyril Sweet, Taylor Woodrow, Turner Townsend and Wates Construction (Carrillo, 2004). Carrillo (2004b) explains that:

> "*The increasing size and the geographical spread of construction organisations makes it difficult to source expertise quickly or indeed know what expertise is available within the organisation. In addition, the high turnover of employees means that there is a need to provide clients with confidence that the organisation is competent in specific areas of work. The greater awareness of KM is also particularly timely given the newer types of procurement in the UK, such as the repetitive nature of some PFI projects.*"

2.3.1   BENEFITS OF EFFECTIVE KM

There are several key drivers in particular, which are identified within the literature as being key in encouraging organisations to actively implement KM initiatives. These include the following (Al-Ghassani *et al.* 2004):

- Businesses are becoming knowledge intensive rather than capital intensive;

- Unstable markets necessitate organised actions with regards to replacing old products and introducing new ones;

- Businesses are increasingly looking to lead change;

- Acknowledgement that only the 'knowledgeable organisations' survive;

- Cross-industry amalgamation is already breeding complexity;

- Recognition that knowledge supports increasingly complex decision-making;

- Requirements for the retention of tacit knowledge, which is lost easily; and

- The existence of worldwide competition.

Carrillo (2004) and Robinson *et al.* (2001) identify several benefits in particular, which organisations can achieve through effective KM:

- Employees are able to tap into the expertise of wider networks;

- Organisations can retain intellectual capital if key employees are lost;

- Project success can be re-created, while repeat mistakes can be avoided;

- The need for the 're-invention' of previous solutions is reduced;

- The dissemination of best practice is enhanced;

- Tacit knowledge is retained; and

- Continuous improvement is promoted.

2.3.2   BARRIERS TO KM

The difficulties associated with understanding and managing organisational knowledge has meant that many organisations experience problems in successfully implementing and sustaining their initiatives (Egbu, 2004; Oltra, 2005). A possible explanation for this is provided by Al-Ghassani *et al.* (2004), who state that organisations' different cultures and business goals make the application of a generic KM solution across different organisations

impossible. Other reasons for organisational KM failure given within the literature (Carrillo, 2004; Carrillo and Chinowsky, 2006; Egbu, 2004; Oltra, 2005) include; a lack of KM vision, information sharing culture, appropriate knowledge sharing tools/processes/structures, willingness to share knowledge; time constraints; and fear of IT (Paper 1, Appendix A).

Carrillo (2004b) emphasises the danger of having a lack of coherent KM vision or ownership by describing the failure of a KM initiative within a large construction firm, citing the reason as a lack of senior level support. Carrillo (2004b) continues by suggesting that this is a common occurrence, which results from a lack of awareness of KM initiatives amongst senior managers due to an 'overload' of different management initiatives. Egbu (2004) suggests that support from top-level management and of 'innovative champions' is vital in realising a successful KM initiative. A number of other recommendations for overcoming the obstacles mentioned above are presented within KM literature and include:

- Linking KM to economic performance and strategy and establishing coherent knowledge vision;

- Obtaining senior management support;

- Developing a technical infrastructure (systems to obtain, organise, restructure, warehouse or memorise and distribute knowledge) including intranet, internet, repositories, databases and videoconferencing;

- Developing an organisational infrastructure (teams, relationships and networks), which includes face-to-face meetings, brainstorming sessions, apprenticeships, job rotation, coaching and mentoring, communities of practice (CoP) and quality circles, reports and project summaries, help desks and bulleting boards;

- Providing standard, flexible knowledge structures;

- Establishing a knowledge friendly culture, clear purpose and shared language and meaning of KM;

- Establish a change in motivational practices (including performance management and team based rewards);

- Enable multiple channels of knowledge transfers/dialogue with functional departments, interaction with clients/customers and suppliers; and

- Provide formal education and training.

2.4   KM SOLUTIONS: PEOPLE, PROCESS & TECHNOLOGY

Robinson *et al.* (2005) state that historically, KM solutions have been centred around two different types of strategy: codification (IT) and personalisation (people). Codification strategies use IT-tools to capture and leverage explicit knowledge, whereas personalisation strategies focus on non-IT-tools or human interactive systems. Anumba *et al.* (2005) explain that people-based KM solutions relate to skills, problem solving abilities and the characteristics of teams. Carrillo and Chinowsky (2006) suggest that the two perspectives of people and technology relate back to Nonaka and Takeuchi's (1995) distinction between tacit and explicit knowledge, and suggest that:

"Explicit knowledge is that which could be documented and therefore physically stored in either paper or electronic format. For the construction industry these include standard operating procedures, best practice guides, etc. Explicit knowledge thus lends

itself to an IT-centric strategy. Tacit knowledge is that which is stored in people's heads and is acquired through experience. This is much more difficult to document. For construction this covers the know-how of experienced staff, e.g. team leaders. Tacit knowledge is better shared using communication channels."

The existence of both IT and people-based KM solutions is a consistent theme throughout much of the literature (Anumba *et al.* 2005; Bresnen *et al.* 2003; Carrillo, 2004b; Egbu, 2004; Oltra, 2005; Robinson *et al.* 2005; Swann *et al.* 1999; Swann and Scarbrough, 2001), while the *process* side of KM has also been highlighted as being a third aspect of KM (Dash, 1998; Edwards *et al.* 2005; Egbu 2004; Kaplan, 2002; Robinson *et al.* 2005). Robinson *et al.* (2005) and Kaplan (2002) suggest that it is in fact people and process that are the key aspects to consider for successful KM, due to the fact that IT is not capable of capturing some tacit knowledge without losing its context. Robinson *et al.* (2005) state that process-related KM factors relate to the technical and management systems used by an organisation in creating its end product, which can be highly labour-intensive relying on tacit knowledge or automated based on explicit (codified) knowledge.

2.4.1   TOOLS & ACTIVITIES

A number of KM tools, which have been utilised to facilitate effective KM are outlined within the literature. Anumba *et al.* (2005) make a clear distinction between KM techniques and KM technologies, and refer to *techniques* as tools that do not require technology to support them (people-based), while *technologies* are tools, which depend heavily on IT for their implementation (IT-based). The most commonly documented of both types are outlined in Table 2.1 (Anumba *et al.* 2005; Carrillo, 2005; Carrillo, 2004b; Egbu and Botteril, 2001).

Early discussions in KM literature tended to focus on the use of IT-orientated solutions, which in 1998 were the focus of almost 70% of all articles written on KM (Oltra, 2005). However, the limitations of approaches too narrowly focussed on IT have long been emphasised and the key importance of cultural and people-orientated aspects is now widely recognised (Bresnen *et al.* 2003; Oltra, 2005). Research projects, which have examined balanced approaches to KM (people, process and technology-based KM practices) have concluded that a multifaceted approach focusing on all aspects of KM is vital (Carrillo, 2004b; Pan and Scarbrough, 1998).

Table 2.1: Knowledge Management Techniques and Technologies

Knowledge Management Techniques	
Type	**Description**
Communities of Practice (CoPs)	Groups of individuals with a common interest, although they may work for different business units.
Succession Planning	Formal process of grooming specific employees for a role once the incumbent leave the organisation.
Mentoring	Process where a junior employee or trainee is assigned to a senior member of staff for advice relating to career development.
Tutoring	A third party (retired employee or external consultant with knowledge of the internal operations of the company) is employed to coach junior employees. Replaces the role of a *mentor*, who may be too busy to carry out their role effectively.
Technical Forums	Sessions which bring together employees from different business units to share knowledge, which last several days.
Face-to-Face Interaction (Socialisation)	Informal approach to sharing tacit knowledge, encouraging strong social ties and tacit shared understanding leading to collective sense-making. This can take a formal approach in the form of meetings.
Lessons Learned / Post project reviews	Conducted close to or after project completion, these are designed to enable an open, blame free environment in which a forum can discuss project successes and failures in order to understand them better. In some cases these are linked to quality control procedures.
Brainstorming	A problem is presented to a group of employees who are encouraged to suggest as many solutions as possible. Ideas are then evaluated after the brainstorming session.
Recruitment	Method for acquiring external tacit knowledge, especially of experts. Other employees can learn from the new recruits.
Training	Technology, which helps to improve staff skills and therefore increase knowledge.
Knowledge Management Technologies	
Type	**Description**
Expertise / skills database	Used to source individuals, encouraging communication.
Intranets / Extranets	An *intranet* is an organisational internet, guarded from outside access by security systems (firewalls). An e*xtranet* is an intranet with limited access to outsiders, allowing them to collect and deliver knowledge on the intranet.
Electronic Document Management Systems / Data & Text Mining	Allow extraction of meaningful knowledge from a large amount of data or text.
Video-Conferencing	Allows geographically dispersed employees to communicate and facilitates socialisation through IT support.
Groupware	Software product enabling employees to communicate, share information, increase their work performance, and to collaborate through group decision-making using IT.
Knowledge Bases	Repositories, which store knowledge in a structured manner.
Taxonomies / Ontologies	*Taxonomies are* collections of the terms commonly used within the company. *Ontologies* present definitions of the terms and their relationships.
Telecommunication	Enable people to communicate and exchange tacit knowledge.

2.4.2   IMPLEMENTING KM INITIATIVES

Gold *et al.* (2001) illustrate the necessity for effective KM, by explaining that a successful KM initiative enables an organisation to become more innovative, better coordinate its efforts, rapidly commercialise new products, anticipate surprises, become more responsive to market change and reduce the redundancy of the knowledge and information available to it.

Egbu and Botteril (2001) state that due to the short-term, task-focussed nature of construction projects, which can promote a culture that inhibits continuous learning, cultural considerations are important for the successful implementation of KM. The importance of culture and the

people involved in achieving effective KM within construction firms, is a consistent theme within the literature (Al-Ghassani *et al.* 2004; Carrillo *et al.* 2000; Kamara *et al.* 2005; Oltra 2005). Al-Ghassani *et al.* (2004) suggest that because cultures and business goals differ from one organisation to the next it is impossible for one KM system or tool to suit every company. They state that developing methods and strategies for managing knowledge requires the integration of several issues such as people and culture, and that adequate planning is important in order to design sufficiently robust KM initiatives. Bresnen *et al.* (2003) also emphasise this point by stating that the recent focus of KM literature has shifted towards the area of people and culture. A number of key themes within this area of the literature are highlighted by KM authors (Paper 1, Appendix A) including; facilitating effective communication; fostering and facilitating knowledge-orientated activities; communicating the benefits of KM; integrating KM with the way people work; and the recognition and reward of KM success (Al-Ghassani *et al.* 2002; Carrillo *et al.* 2000; Davenport and Prusak, 1998; Fong, 2005; Robinson *et al.* 2005).

Integrating a KM initiative within an organisation will require a change in the way people work. Many authors have examined best-practice for implementing and managing change, presenting numerous models and recommendations. Mintzberg and Westly (1992) suggest that an organisation can implement change on a number of different levels, from a very broad and conceptual level, to a narrow and concrete level. They outline the importance of an holistic approach to change by considering the necessary lower-level changes such as structures, systems and people in order to effectively tackle high-level changes such as an organisation's culture and vision. Similarly, Kotter (1990) outlines the steps necessary to reach cultural change and describes this process in terms of eight different stages, while Berenschot (ten Have *et al.* 2003) describes his '*seven forces model*', which provides an overview of the key elements of the change process (Paper 1, Appendix A).

2.4.3   PEOPLE-BASED KM SOLUTIONS

Many academics have identified the importance of people-based KM as the area for greatest potential. Numerous authors have identified the dependence of KM solutions on the staff and managers within an organisation, and the importance of their willingness and ability to act cooperatively and share their knowledge with that of others (Kamara *et al.* 2005; Fong, 2005). Davenport and Prusak (1998) report that people-based KM relates to those personnel working within the firm, who share the requirement to create, share, search out, and use knowledge in their daily routines.

Swan *et al.* (1999) state that despite the apparent enthusiasm from numerous recent publications for people and managerial-orientated solutions for KM, many articles continue to focus on IT-based methods. They also recommend that organisations must not neglect the human issues, and should aim to achieve a people-centred implementation of KM. This is a topic, which is also reported on by Smith and McLaughlin (2004), who suggest that during the development of KM solutions, people-related factors typically remain not acknowledged or discussable. Research into the specific factors that affect the willingness and cooperation of people to contribute to KM initiatives is limited (Swan *et al.* 1999).

Despite acknowledgement within KM literature that 'softer', people-orientated KM factors are important in ensuring the success of a KM initiative, Carrillo (2004) identifies the limited amount of research within this area of KM, which is the main drive for the debate amongst academics over the most appropriate methods. The importance of engaging people to participate in KM initiatives and the subsequent need for KM solutions, which are focussed

on people relates to the fact that there is widespread evidence, which shows that most organisational knowledge is held within people's heads (tacit knowledge) and cannot be captured in its entirety by IT without losing its context (Robinson *et al.* 2005). Carrillo (2004b) supports this argument by stating that the softer, opaque and more difficult side of KM requires careful consideration from knowledge managers.

Construction firms in particular are extremely knowledge-intensive and can be characterised by their use of a high degree of tacit knowledge, resulting from the need for high levels of problem solving and technical ability (Anumba *et al.* 2005; Robinson *et al.* 2005). Despite the difficulty associated with the transfer of tacit knowledge, it has been well documented that *Communities of Practice* (CoPs) present a suitable KM solution (Ardichvili *et al.* 2006; Carrillo *et al.* 2002; Garavan *et al.* 2007; Grisham, 2006; Lesser and Storck, 2001; McDermott, 2000; Verburg and Andriessen, 2006; Wenger *et al.* 2002). Wenger *et al.* (2002) suggest that CoPs are the best-suited tool for codifying knowledge, due to their ability to combine both tacit and explicit aspects. This is also reflected by Egbu and Robinson (2005) who suggest that large international construction companies have the greatest need for, and benefit most from CoPs.

2.5   COMMUNITIES OF PRACTICE (COPS)

Wenger *et al.* (2002) define Communities of Practice (CoPs) as:

> *"Groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis."*

Similar definitions are proposed by Davenport and Prusak (1998) and Lesser and Fontaine (2004), who describe CoPs as self-organising groups that establish a regular system of interchange, which are initiated by employees who communicate with one another because they share common work practices, interests or aims. Although 'Communities of Practice' (CoPs) has become a well-used term within the literature, they are also referred to as 'knowledge communities', 'knowledge networks', 'learning communities', 'communities of interest' and 'thematic groups' (Al-Ghassani *et al.* 2004). The literature also highlights the existence of different forms of CoPs and the characteristics, which they demonstrate (Paper 2, Appendix B).

Several authors have examined the specific issues that contribute to CoP effectiveness and have identified a number of key issues. Vestal and Lopez (2004) identify the following nine key factors necessary for CoP success:

1. A clear and compelling business case for all involved.

2. A dedicated and skilled facilitator or leader.

3. A comprehensive knowledge map outlining the required focus of the CoP.

4. An outlined and easy-to-follow knowledge sharing process.

5. A supporting technology to facilitate knowledge exchange, retrieval and collaboration.

6. Communication and training plans for members and others outside of the CoP.

7. An updated and dynamic roster of CoP members.

8. Metrics of success to show business results.

9. A recognition plan for CoP participants.

Lee and Neff (2004) examined the impact of supporting technology on CoPs. They state that face-to-face contact is essential, and suggest that technology can, at best, support CoPs in-between such events. They also state that although technology is important, it cannot launch and/or sustain an effective CoP on its own. Further success factors are outlined by Wenger *et al.* (2002), which include the design of CoPs for 'evolution', input from people external to the CoPs, the need for CoP coordinators, and the necessity for regular CoP activity (Paper 2, Appendix B).

Despite the CoP critical success factors outlined in the literature, authors have called for further research and understanding of the conditions necessary for successful CoPs. While Verburg and Andriesson (2006) state that little is yet known about the best ways in which CoPs can operate and what would constitute useful success conditions, Soekijad *et al.* (2004) state that despite the acknowledgement form organisations of the importance of CoPs, academic interest is still limited.

2.6   SUMMARY

The importance of people-orientated KM solutions and the need for further research in this area, particularly in the form of CoPs, in establishing and sustaining a successful KM initiative within a construction firm, was a core finding from the literature review. Although RWB's open and collaborative culture suggests that it would lend itself to this type of approach, as outlined in the literature, different firms will have different KM requirements and it was important to examine RWB's KM needs on an individual basis.

The literature highlighted the need for a balanced approach to KM, consisting of people, process and technology-based KM practices. This further emphasised the need to examine current RWB KM activities, as outlined by the work packages for Objective 1 (Table 2.1). This was necessary in order to establish an understanding of where improvements or additions would be needed, and to ensure the right balance of KM activities was achieved within RWB.

3   RESEARCH METHODOLOGY

3.1   OVERVIEW

The development of a research methodology facilitated the evaluation and interrogation of the research objectives by providing a strategy, which ensured that the research followed a systematic route, starting with the objectives and finishing with a set of conclusions (Naoum, 1998). The research (thesis) was broken up into four main stages. Each stage corresponds to one of the four research objectives and consisted of a number of different work packages, which were developed to address the research objectives (Figure 3.1).
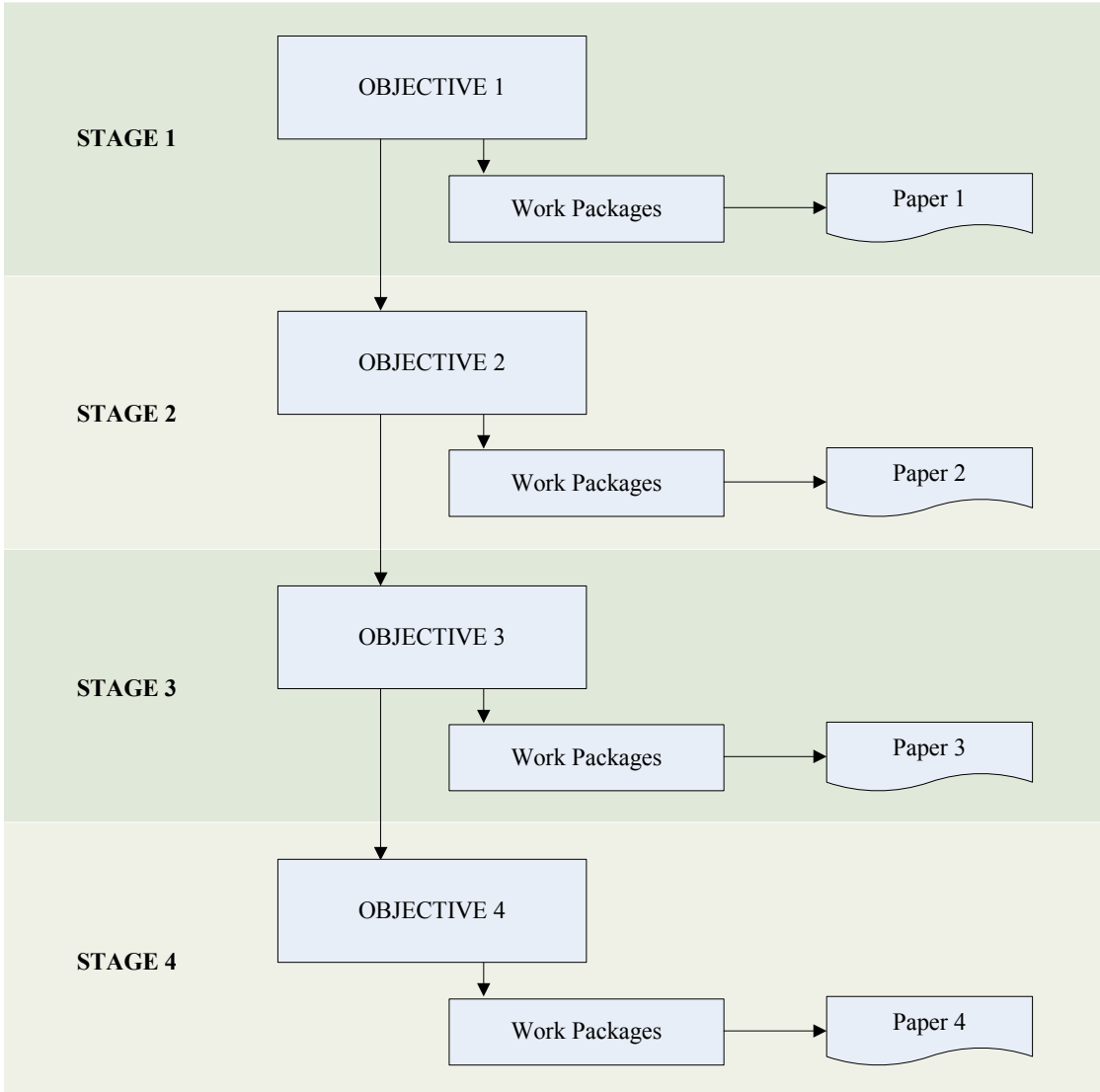
Figure 3.1: Research Map

An important initial stage of the research was also in undertaking a number of preliminary studies, which were necessary in 'getting to know' the sponsoring organisation (RWB) and also in establishing an understanding of the context of the research. Although it was important to adopt an overall research approach, the various work packages required their own specific research methods, each of which is outlined in the following section (Figure 3.2).

3.2 RESEARCH APPROACHES

The research required for this study was *applied research*, of which there were two types to consider: (1) quantitative and (2) qualitative. Quantitative research is 'objective' in nature (Naoum, 1998) and can be considered as an inquiry into a human problem, based on testing a hypothesis or a theory composed of variables, measured with numbers, and analysed with statistical procedures (Creswell, 1994; Naoum, 1998). Quantitative data is therefore not abstract and is hard and reliable, consisting of measurements of tangible, sensate features of the world (Naoum, 1998). By contrast qualitative research is 'subjective' in nature and involves an exploration of the subject without prior formulations, enabling an understanding through the collection of information and data, such that theories will emerge (Fellows and Liu, 1997). This enables the research to diagnose a situation, screen alternatives, and discover new ideas through the analysis of rich data (Naoum, 1998). The comparisons between the two different strategies are demonstrated in Table 3.1 (Bryman, 1998).

Table 3.1: Comparisons between Quantitative and Qualitative research

	Researcher Constraints	Quantitative	Qualitative
1	Role	Fact-finding based on evidence or records	Attitude measurement based on opinions, views and perceptions
2	Relationship between researcher and subject	Distant	Close
3	Scope of findings	Nomothetic	Idiographic
4	Relationship between theory / concepts and research	Testing / Confirmation	Emergent / Development
5	Nature of Research	Hard and Reliable	Rich and deep

The need for this particular research study to address subject areas where limited knowledge exists, the necessity for it to focus on meaning and understanding within naturally occurring situations, the requirement for the collation of rich data and information, and the difficulty of controlling experimental variables in a commercial environment (Glatthorn and Joyner, 2005; Naoum, 1998) meant that exploratory qualitative research was needed.

In relation to qualitative research approaches, the term 'approach' in this case refers to the overall research strategy adopted. For this study case study and action research were the two key qualitative research approaches utilised in addressing the four main objectives, and in meeting the overall research aim.

3.2.1 CASE STUDY RESEARCH

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (Yin, 1984). Cassell and Symon (1994) state that although the phenomenon is not isolated from its case, it is of interest precisely because it is in relation to its context. The most common use of the term associates the case study with a location, such as a community or organisation, and tends to be focussed on the intensive examination of the setting (Bryman, 2004). The value of a case study approach during the EngD research was not only in facilitating an understanding of the particular and unique features of the case(s) but also to draw out an analysis, which was applicable on a wider basis (Cassell and Symon, 1994). During Stages 1 (4.1) and 2 (4.2) this approach facilitated an understanding of the critical factors that affected KM within RWB (Paper 1, Appendix A; Paper 2, Appendix B).

3.2.2 ACTION RESEARCH

Action research is a research approach with which the action researcher and a client (in this case RWB) collaborate in the diagnosis of a problem and in the development of a solution based on the diagnosis (Bryman and Bell, 2007). Action research is aimed at both taking action and creating knowledge or theory about that action through a cyclical process of (a) planning; (b) taking action; (c) evaluating the action, leading to further planning and so on. The other aspect of action research is that it consists of a collaborative approach, involving the participation of the members of the system being studied (Coghlan and Brannick, 2005; Seale *et al.* 2007). A core focus of the EngD was to carry out research within the sponsoring organisation over the course of the four year programme, with a view to implementing improvements within the firm. This dictated the necessity for action research to be a primary research approach. The action research approach followed-on from the case study strategy utilised during Stages 1 and 2. While the case study approach facilitated an understanding of KM and CoP best practice, the action research approach enabled the application of these findings within RWB during stages 3 (Paper 3, Appendix C) and 4 (Table 3.2).

Table 3.2: Action Research Undertaken

Action Research Cycle	Stage 3 (of research)		Stage 4 (of research)	
	Action research undertaken	Thesis section	Action research undertaken	Thesis section
a) Planning	Identification of CoP management best practice	4.3.1 & 4.3.2	Use of KM critical success factors for development of KM-supporting technology (MOSS)	4.4.1
b) Taking action	Implementation of TG management approaches within RWB	4.3.3	Implementation of MOSS TG pages within RWB (Paper 3)	Appendix C
c) Evaluating action	Analysis against KM success indicators (Paper 3)	Appendix C	Analysis against MOSS KPIs and interview findings	4.4.3
Further planning	Call for further research examining cross-CoP collaboration	5.4	Call for further research examining long-term use of MOSS and KPIs	5.4

Action research, in the context of this EngD research study, immediately presented the research with a novel approach due to the lack of research, which is conducted and presented by action researchers who are full time members of the organisation (Coghlan and Brannick, 2005). However, the implementation of improvements within the sponsoring firm through action research required another key methodological consideration; the process of change. To achieve a strategic approach to change the action research was applied in a planned manner, by adopting the following steps (Coghlan and Brannick, 2005):

- Identifying the need for change;

- Defining the required future state;

- Assessing the present in terms of the future to determine the work to be done; and

- Managing the transition.

Further to this, consideration of the political climate (within RWB) during the implementation of change was also a critical consideration, which ultimately determined the steps outlined above.

3.3 RESEARCH METHODS

Within each of the two research approaches outlined above, a number of research *methods* were adopted (Table 3.3). Research methods, as the term is used here, are the specific techniques used to collect data with respect to the main research objectives (Glatthorn and Joyner, 2005). The research methods adopted during the research are outlined as follows (Figure 3.1):

3.3.1 LITERATURE REVIEWS

The analysis of relevant theory and literature formed an essential part of the research process, revealing previously formulated theories and research projects associated with the research subject (Fellows and Liu, 1997). Initial investigative work on related literature provided the means for determining and confirming the aims, objectives, and also in confirming specific topics for study.

The literature review facilitated a critical review of the contribution of other people's work and enabled an awareness of:

- The similarities in the statements made by previous writers;
- Common issues raised by previous writers;
- Differences in the findings presented by previous writers; and
- Critiques made by previous writers.

Throughout the research, the literature review has been ongoing. By examining the most up-to-date, cutting edge literature on KM an appreciation of what the industry understands by KM, where it currently stands on the issue, the direction in which it wishes to take the subject, and the different arguments and perspectives that exist across the industry and academia could be established. Following the initial review of generic KM literature, more refined literature reviews were undertaken to address the specific work packages. In particular, the review of CoP literature was a core aspect of Stages 2 (4.2) and 3 (4.3) of the research (Paper 2, Appendix B; Paper 3 Appendix C).

3.3.2 ETHNOGRAPHIC RESEARCH METHODS

The nature of the EngD research undertaken within RWB (the sponsoring organisation), and the need for an application of findings in the form of action research, necessitated the use of *ethnographic* research methods.

Ethnography, a term which is also used interchangeably with 'participant observation' and 'fieldwork' (Delamont, 2004), entails the extended involvement of the researcher in the social life of those he or she studies, in order to observe people, talk with them and form an understanding of what they are doing, thinking and saying (Bryman, 2004; Delamont, 2004). The nature of the research undertaken during this study meant that observation and involvement in the daily operation of the business would be a mandatory research requirement, and therefore that ethnographic research methods would be an important aspect. The specific ethnographic research methods were as follows:

1. Interviews

In-depth interviewing represents the most common of all qualitative methods (Easterby-Smith, 1991) and in the case of this study provided a suitable medium for obtaining the rich,

detailed research material that was required, by facilitating a suitable level of control for the researcher over the proceedings while enabling the collection of the most relevant information (Bryman, 2004). The value of qualitative interviews for this study was primarily in providing a research method, which enabled access to individuals' attitudes and values and achieved a level of depth and complexity, which would not have been provided by other, particularly quantitive-based, approaches (Silverman, 2004).

A semi-structured interview format was adopted for all interviews undertaken during the research, which ensured that the RE and respondent had more flexibility than conventional structured interviews, questionnaires or surveys (often used in quantitative research), while also providing a loose enough structure to enable the RE to cover all key topics and areas of enquiry. This technique also provided the research with extensive levels of detail by enabling an examination of particularly interesting avenues that emerged during the interviews, and providing the respondent with greater opportunities to outline a fuller picture of the subject.

Table 3.3: Use of Interviews during the Research Stages

Research Stage	Number of Interviews Undertaken	Number of Focus Groups Undertaken	Interviewee Type	Purpose of Interviews
Stage 1	9	2	RWB Directors and MD	To determine RWB's KM needs/ objectives, barriers and potential solutions to KM within RWB.
	20	-	RWB Engineers	To identify KM activities within RWB and patterns of knowledge exchange
	10	-	Leading academics in the field of KM	To identify KM critical success factors
Stage 2	18	1	RWB TG chairs (interviews) RWB Directors (focus group)	To establish the way in which RWB TGs operated
Stage 3	7	-	Leading industrial practitioners in the field of KM and CoPs	To establish CoP best practice
Stage 4	19	-	Cross-section of RWB staff (users of MOSS)	To determine the effectiveness of MOSS in supporting KM
	-	4	RWB Directors	To establish RWB requirements for KM-supporting technology

Each interview undertaken was recorded and a summarised transcript, outlining all key points raised by the respondent, was compiled. Table 3.3 outlines the (qualitative) interviews carried out at the different stages of the research and their purpose.

RWB's culture of continuous improvement, and an acknowledgement from senior management of the importance for the business to remain at the forefront of engineering excellence, was an important factor in establishing a business case for undertaking interviews with RWB employees. Senior employees in particular, who are allocated a percentage of their working hours for team management and business development activities, are expected to contribute to the overall improvement of the business. The importance of the research for continuous improvement was acknowledged by senior managers within the firm, and as a result RWB employees were encouraged to contribute to it.

2. Focus Groups

The use of focus groups relates to an interviewing style where interviewees discuss specific issues in groups (Bryman, 2004). The combination of focus groups and interviews carried out

with members of the sponsoring organisation were critical to the research in gaining collaborative input from members of staff and in feeding the research findings back into the organisation. These techniques enabled the research to gain perspectives from both operational and strategic levels of the organisation. A focus group research approach was utilised during Stage 2 (4.2) of the research to interview three RWB directors to determine the way in which TGs currently operated within the business. Focus groups were also adopted in the form of TG Workshops during Stage 3 (4.3), which facilitated group interviews with TG chairs and directors, while also enabling active collaboration between the participants. As with the interviews, transcript summaries were compiled.

3.3.3 FURTHER DATA COLLECTION

The review of RWB documents, reports and the intranet (desk studies) also formed an important aspect of data collection. Further to this, during Stage 4 (4.4) statistical data was collected to support the qualitative interview findings, which enabled the RE to establish the usage of KM-supporting technology within RWB.

Table 3.4: Research Methods Used

Key

P	Primary Method		S	Secondary Method

Research Stage	Objectives		Literature Reviews	Interviews	Focus Groups	Note Taking	Further Data Collection
Stage 1	Investigate patterns of knowledge exchange within Ramboll Whitbybird, and examine the constraints that determine their effectiveness.	Case Study Approach	S	P	S	S	S
Stage 2	Identify the best suited Knowledge Management approaches for adoption within Ramboll Whitbybird.		P	S	S	S	S
Stage 3	Establish best practice for the use of the Knowledge Management approaches identified.	Action Research Approach	S	P		S	S
Stage 4	Develop a balanced KM approach to enable an engineering design consultancy to better capture and share knowledge, and implement the optimum solutions within Ramboll Whitbybird.		S	P	S	S	S

The central aim in selecting the most appropriate research methods was to opt for those, which were most likely to achieve the research objectives. Further to this, specific methods were utilised based on their functionality and lack of unnecessary complexity in order to provide results which could be rapidly applied within an industrial setting. To avoid distorted results, methods were also chosen based on whether they were likely to intrude or not. For example, interviews with engineers in RWB meeting rooms presented them with a familiar activity (RWB engineers hold team and project meetings on a daily basis) and a natural setting. Stages 1, 3 and 4, required the collection of rich in-depth research data on subjects, which had not been widely documented or previously researched. This necessitated the use of a method that would facilitate a review of the experiences of individuals involved in KM

within academia, RWB and across industry. For this reason semi-structured interviews were selected as the primary method. However numerous KM practices, which have been recommended by academics or utilised within industry, have been documented within the literature. A review of KM literature therefore formed the primary research method during Stage 2.

3.4 ANALYSING THE RESEARCH DATA

In order to move from the data collected into some form of explanation, interpretation and understanding, data analysis methods were an important consideration for the research. Due to the fact that the qualitative data collected through the research methods outlined above consisted of large volumes of unstructured textural material, it was not straightforward to analyse (Bryman and Bell, 2007). In order to draw meaningful conclusions from the data, the analysis approaches adopted in this study were focussed on identifying themes and establishing relationships between them. The key (qualitative) data analysis approaches used are as follows:

3.4.1 THEMATIC ANALYSIS

The research areas under investigation in this study were those, which represented a relative lack of previous academic research or understanding. As this often precluded the testing of existing hypotheses, issues were allowed to emerge from the data as it was collected in an approach broadly based on Glaser and Strauss' (1967) concept of *grounded theory*. More specifically this approach was closely aligned with *thematic analysis* techniques.

Thematic analysis is a process of reducing data into meaningful groupings, which is primarily concerned with the identification of patterns (themes) within the data, and is considered as the main route in examining themes, which arise as a result of active inspections of raw data (Gomm, 2004; Grbich, 2007; Shank, 2006). As themes were identified they were collated in a framework, or 'thematic grid' consisting of a spreadsheet, which summarised all key points raised during the research interviews and facilitated comparisons and contrasts between the perspectives of the different respondents (Gomm, 2004; Moore, 2006). By working through the spreadsheet, highlighting evidence of themes such as repeated words, phrases or evidence of answers to the original research objectives, the RE was able to build up a good understanding of the connections that existed between different responses and formulate conclusions as a result.

3.4.2 TRIANGULATION

Validation of the research findings was an important process, and was achieved for this study by combining two research methods in an approach based on the principles of *triangulation*. Although when it was originally conceptualised, triangulation was largely associated with quantitative research, it can also be utilised effectively within a qualitative research strategy (Bryman, 2004). It represents a process of converging upon a particular finding by using different sorts of data and data-gathering techniques to cross-check research findings (Shank, 2006). It was undertaken in this case by interrogating the interview and focus group findings against those established during reviews of KM literature. By combining the two different strands of data, the research approach incorporated a degree of rigour and added breadth, complexity, richness and depth to the study (Shank, 2006; Silverman, 2006). In turn, this provided a means to establish reliable conclusions and recommendations (Figure 3.2).
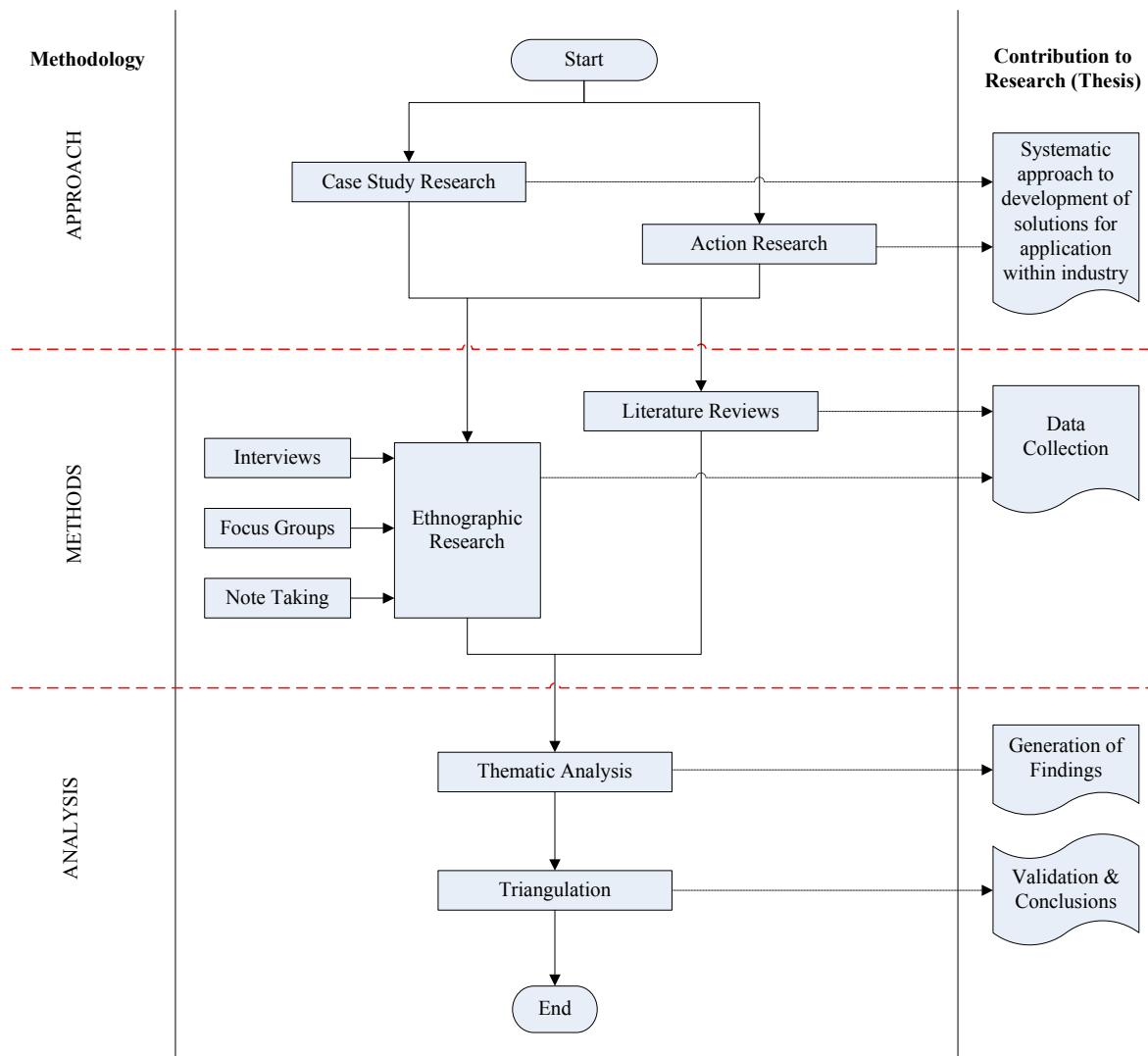
Figure 3.2: Research Methodology Flow Chart

3.5   METHODOLOGICAL CONSIDERATIONS

The core requirement of the industrial sponsor was that the research would contribute to improved organisational performance with tangible changes implemented within the business. Although the research spanned four years, it needed to deliver both quick and long-term 'wins' for the firm. The involvement of key (senior) members of staff in the research was vital in ensuring that the research delivered the results required, and that the solutions developed were integrated effectively within the organisation. It also provided feedback on the impact of the research on the business and supported buy-in to the research from staff. The involvement of engineers, project managers and directors was also important in providing them with up-to-date information on the progress of the research, and in raising its profile at different levels within the organisation. To ensure the research contributed to change and improvements within the business, the role of the RE within RWB was a very active one, involving the development and implementation of business solutions in response to the commercial environment.

From the outset of the study it was recognised that over the course of its four year duration, changes within the sponsoring organisation and within the construction industry itself were

likely. As a result it was acknowledged that the focus of the research may need some alterations to accommodate such changes.

As discussed in the previous section, action research was the primary approach for this study. However, due to the requirement for action research to adopt methods which are inherently linked with the day-to-day activity of the sponsoring organisation, there were several critical factors to consider to ensure that the approaches adopted were flexible yet focussed. The combination of academic research and industrial implementation meant that the study took the form of applied rather than theoretical research.

3.6   SUMMARY

The research incorporated *case study* and *action research* approaches in accordance with the main research objectives, and made use of the best suited methods to address the specific work packages. The use of in-depth, semi-structured interviews and focus groups for initial data collection provided the research with an understanding of how interviewees perceive their professional knowledge and relationships. A combination of direct interpretation and categorical aggregation defined the most significant issues outlined during each interview. By comparing such issues across interviews, and in relation to other resources such as field notes and internal RWB reports, themes began to emerge. In this way, analysis could focus on key issues as determined by the participants' actual experiences, rather than by pre-existing theories. The links that became evident between empirically derived themes and the existing literature were therefore in no way pre-determined, while validation, which was achieved by adopting the principles of triangulation, ensured reliable findings and conclusions to the main research objectives.

4 RESEARCH UNDERTAKEN

In order to achieve the aim of '*delivering a framework that facilitates the retention and reuse of technical knowledge, which will increase Ramboll Whitbybird's potential to respond appropriately to conventional and emerging business opportunities*', the research was divided into 4 key stages. Each stage relates to one of the four research objectives and consisted of a number of different work packages. The following section outlines the preliminary studies undertaken, the subsequent work packages, and the findings that were established.

Research carried out during the first few months of the programme entailed a period of investigation, learning and participation in numerous internal business activities. The first two years also involved participation on an MSc course in Engineering Management and Innovation as part of the EngD programme. This meant that a sustained period of time during the first two years (approximately 25% of the overall programme) was spent at Loughborough University, undertaking different MSc modules, coursework and exams. The MSc component, and the modules selected facilitated a better understanding of best practice with respect to construction and engineering management.

There were several key aims for the initial investigative stage of the research, which included:

- Develop an understanding of the sponsoring organisation's culture and work ethics;

- Establish an appreciation of the methods by which engineering projects are undertaken;

- Build relationships with members of staff who would be closely involved with the research including engineers, project managers, and directors; and

- Interpret the specific organisational needs of the research.

Involvement in internal company meetings, attendance at presentations, technical highlights and seminars, participation on carefully selected MSc modules and a review of KM literature were all key in gathering the information necessary to outline and address the research context and objectives.

Early involvement of key members of RWB staff was important, and within the first few months a 'KM Steering Group' was established. The group was formed to provide a forum within which the RE could present to and update senior members of staff within the organisation on the progress of the research, the findings to date and any KM activities, projects and initiatives proposed, while also facilitating strategic feedback for the research from senior members of staff. The steering group consisted of three directors and one associate director, enabling the RE to communicate and collaborate at a very high-level within the business. Regular presentations were also made at management meetings and several at board level. The subsequent feedback gained was incorporated into the research. The communication channels offered through the steering group encouraged a level of ownership from high-level members of staff, enabling the research findings to be driven forward within the company and integrated into the operation of the business.

Attendance at external conferences, workshops and seminars was also an important aspect of the EngD research at an early stage. As the research programme progressed, attendance at these events continued, with the RE able to make valuable contributions as a result of the ongoing research. The REs participation at these events was also important in networking with academics and industrial practitioners in the field of KM, and ensured that the research constantly incorporated cutting-edge thinking and ideas.

4.1 STAGE 1 WORK PACKAGES: PATTERNS OF KNOWLEDGE EXCHANGE

It was important throughout the research that its objectives were in line with those of RWB, and that there was a clear understanding of how the research fits within the context of engineering design. This stage of the project focussed on investigating on-going RWB practices to establish patterns of knowledge exchange, enabling the necessity and extent to which these practices needed to be improved or managed to be gauged. It also ensured that the implementation of KM initiatives and solutions (during Stages 3 and 4) developed as a result of the research findings, helped to ensure that the engineers were able to work as effectively as possible.

4.1.1 DETERMINING RWB'S KM REQUIREMENTS

The importance of establishing an understanding of the specific KM problems of an organisation, and how these fit with the business objectives of the firm is highlighted by Carrillo *et al.* (2002), who discusses the importance of establishing a clear strategy to ensure the effectiveness of any KM initiative. This understanding was achieved in the first few months of the EngD programme. During this time the RE undertook nine qualitative interviews with senior members of RWB staff, five of whom were directors (including the company chairman). The interviews were undertaken in collaboration with three Open University Business School Professors, who wished to use RWB as a case study for an Open University Business School research project focussed on examining the way in which different organisations manage their knowledge.

In order to facilitate an understanding of RWB's KM requirements, the interview questions were orientated around identifying the organisation's KM objectives, approaches staff would like to take towards managing knowledge, what they see as the current knowledge sharing activities, how successful they think these activities are, and what they see as barriers to knowledge sharing. The results provided a comprehensive study of the views of the highest-level members of staff on KM.

One key finding from the interviews was that although there was awareness from senior members of staff as to the importance of KM to the company, there were differing views on what activities constituted KM practices and how these should be utilised to effectively capture, store and disseminate knowledge. Several of the participants highlighted the need for a better understanding of what KM activities existed within the company, and which of these are in need of improvement to support the firm's central business objectives. This highlighted the necessity to map out the KM activities that existed within the company.

The RE presented a report to the board of directors outlining the key findings and recommendations resulting from the interviews. Two (focus group) meetings were then undertaken; the first with the KM Steering Group and the second with the Steering Group and Managing Director (MD). These were intended to gauge their feedback and incorporate any subsequent requirements into the research. Their responses in relation to KM were as follows:

- More work needs to be done to ensure that the company is effectively managing its technical knowledge;

- The Operations Board directors should lead KM; and

- KM should always be people led, as it will rely on commitment and motivation from our employees for it to succeed.

The MD also identified key areas for future action in the area of KM as being:

- The need for an improved knowledge sharing/management system that provides greater focus on project related issues and more versatile techniques that expand on the current informal processes; and

- The need for top-level staff to drive knowledge sharing and the necessary attitude to be taken towards knowledge sharing/management by RWB staff in order to achieve this.

4.1.2 IDENTIFYING THE RANGE OF KM ACTIVITIES, WHICH EXISTED ACROSS RWB

Identifying the different activities which facilitate KM within RWB was central to the research. This was carried out using a number of different methods including literature reviews, desk studies, (including a review of RWB past and present business plans), KM steering group meetings, a review of the RWB intranet and its content, attendance at a number of project and management meetings, semi-structured interviews with 20 RWB engineers (at varying levels within the business), and PIT assessments.

As identified in the earlier literature review, it was imperative that from the outset, the research maintained a balanced perspective of KM, incorporating people-based, process-based and technology-based aspects of KM. Therefore, during the identification of KM activities that existed within RWB through the above methods, they were listed as people-based, process-based or technology-based KM activities. The full list of KM activities is outlined in Table 4.1.

The KM activities were assessed for their current performance and ability to effectively capture, store and disseminate knowledge. This process determined which activities were performing well as KM activities, those that were in need of improvement, and those that were underperforming.

Table 4.1: Ramboll Whitbybird Knowledge Sharing Activities & EngD Research Focus

People-based	Process-based	Technology-based
Director Forums [PIT]	Project documents [PIT]	JMS (Finance system)
Birthday Meetings (annual performance reviews) [PIT]	H&S procedures	Project Finance Dashboard
Main Board meetings [PIT]	Policies [PIT]	Opera (Finance system)
Operations Board Meetings [PIT]	Manuals	Online Billings System
Function Meetings [PIT]	IMS (QA) Procedures [EngD]	MMR (Monthly Management Reporting system) [EngD]
Management Meetings	Staff Documents [PIT]	Invoice Scanning [PIT]
Engineering Excellence Meetings [PIT]	Management Documents	Recruitment
Team / project meetings [PIT]	Strategic Documents	Training System
Project Delivery ('project highlight' presentations) [PIT]	Client Feedback	HR Central (Human Resource database) [PIT]
Fee Review Meetings	Competency Framework	Skills Central (Skills database)
Practice to Practice Meetings [PIT]	Meeting Schedule [EngD]	IT Tasks [EngD]
Sector Group Meetings [PIT]	Management & Communication Diagrams [EngD]	Hardware / Software Provisions [PIT]
Task Groups (CoPs) [EngD]	Business Plan [PIT]	Projects Database [EngD]
IIP (Investors In People) Initiative [PIT]		Image Database [PIT]
Business Plan Objectives		(Project) Feedback
KPI Monitoring [PIT]		Technical Intranet Pages
Project Reviews		IMS (Integrated Management system)
Project Critiques [PIT]		Email [PIT]
Project (internal / external) meetings		Approved Companies
Friday morning presentations		CRM (Client Relationship Management system) [PIT]
Induction sessions		Ramboll whitbybird. com (website)
Training sessions		Archive Database [PIT]
Recruitment (interviews)		Microsoft Office SharePoint Server (MOSS) [PIT/EngD]
IMS / H&S Best Practice (audits)		RWB Intranet
		(Internal) Feedback System
		Engineering Software
		CAD Software
		Legal Database
		Claims Database
		Licensing

Key

[EngD]	EngD research project
[PIT]	PIT Improvement Project

4.1.3 IDENTIFYING KM ACTIVITIES IN NEED OF IMPROVEMENT & ASSESSING THE EXTENT TO WHICH THEY CAN BE IMPROVED

The assessment of RWB KM activities was also an important step in determining the need for the introduction of additional KM activities, which had been highlighted in the literature but had not been considered for implementation within RWB. The importance of tacit KM in particular for RWB and the potential of people-based KM practices in leveraging this knowledge, as identified in the literature, meant that this type of KM approach was of primary importance to the firm. The performance indicators used to review the existing and potential KM activities included; the support provided for core business objectives (which included RWB's need for high levels of engineering excellence, creativity and innovation on projects, a focus on people and talent management, securing increasingly significant projects, maintaining the business's core culture, and fostering an open and creative working environment); the (potential) impact of the KM activities on daily engineering project activity; the potential for both short and long-term KM benefits (the impact on both current and future projects); accessibility to expert knowledge across the business; and anticipated timescales and costs for KM activity improvement projects.

The resulting assessment of existing and potential KM activities identified Task Groups (RWB's equivalent of CoPs) in particular as being a key KM activity for RWB, which was in need of improvement. This was inline with the literature review findings, which highlighted CoPs as being a well-suited tool for managing both tacit and explicit knowledge, particularly in the case of construction organisations. Further to this, the improvement of the Meeting Schedule, Management and Communication Structure/Diagrams, Projects Database, and the Microsoft Office SharePoint Server system were also identified as existing RWB KM initiatives, which would need input from the EngD research to ensure a balanced approach to KM.

In parallel to the EngD research, the PIT utilised Table 4.1 to address the other KM activities in need of initial focus from the team. Before any action was taken, it was vital that the research established exactly what makes a KM initiative successful, in particular with respect to people-based KM activities, and the factors that determine their effectiveness. This was in line with earlier literature review findings, and was an essential aspect of the research in addressing the first research objective. As a result this became the core focus of Paper 1 (Appendix A).

4.1.4 FINDINGS

At this stage, the research incorporated of a review of current KM literature and ten qualitative interviews with leading academics and industrial representatives in the field of KM within construction. These were carried out in line with the first research objective; to provide data, which would facilitate the collation of a set of KM critical success factors. The analysis of the data collected from the literature and interviews identified eight critical factors, which need to be considered before, during and after the implementation of a KM initiative, to ensure its effectiveness (Paper 1, Appendix A). These are as follows:

- Establish a high level of understanding and a clear definition of KM throughout the organisation;

- Ensure that the KM initiative fits with the needs of the individuals and the organisation's business objectives;

- Integrate the initiative seamlessly into the organisation and the daily lives of employees;

- Implement KM champions and a supporting team;

- Establish top-level support;

- Clearly demonstrate and communicate the benefits and initial successes of the initiative;

- Determine the suitability of financial and non-financial rewards; and

- Achieve a balance between people and IT.

4.1.5 SUMMARY

The research findings indicated that the people involved with the implementation and management of a KM initiative play a vital role in determining its effectiveness within a construction organisation, and that there are a number of critical success factors, which require consideration in order to realise an effective KM initiative. It also highlighted the importance of incorporating change management strategies into the implementation of KM initiatives.

4.2 STAGE 2 WORK PACKAGES: APPROACHES FOR KM

'Task Groups' (TGs) were identified by the RE, PIT and steering group as a people-based KM practice, which already existed within the company but was in need of improvement. This was also highlighted by RWB's MD, who voiced concerns over the efficiency and effectiveness of TGs, and that the process for assessing them did not provide enough scope for an adequate analysis. Concerns raised included that the TGs were not meeting; members were not attending TG meetings and functions regularly enough; and deliverables were not communicated clearly. It appeared that knowledge was not being communicated well enough from TGs to the various levels of the business, and that it was being lost as it is passed along the chain.

Task Groups (TGs) are RWB's equivalent to a 'Community of Practice' (CoP), which consist of groups of employees of between 5 and 10 staff who volunteer to address issues for a particular area of the business. At the start of the research there were 33 TGs in total covering a wide range of subjects, which involve approximately 200 members of staff. TGs can address topics raised by the company's management meetings, issues highlighted by anyone within the organisation through a feedback system on the company intranet, or topics communicated to them informally. Following the resolution of an issue by the TG, its members then determine how to disseminate that information. TGs can be divided into 'technical' and 'support' TGs, where technical TGs are those focussed on project-related areas of engineering such as *reinforced concrete detailing*, *fire engineering* and *design risk*, while the support TGs are focussed on management and administration topics such as *training* and *brand development*. Initially RWB was primarily interested in improving the 18 TGs that were focussed on 'technical' engineering-related topics, which had the potential to contribute directly to the production of its engineering design projects (the end product). These 18 TGs therefore became a key focus of the EngD research. TGs have always been fundamental to the organisation's culture and it has previously implemented improvements, based on research examining how the organisation can enhance the way in which it supports TGs (Matsumoto,

2006). The company wished to build on previous research, and continue to drive TG best practice.

4.2.1 INVESTIGATING APPROACHES FOR THE USE OF COPS WITHIN CONSTRUCTION ORGANISATIONS

A review of CoP literature was important at this stage in establishing an understanding of different approaches for the use of CoPs for effective KM, as used within industry and recommended by academia (Paper 2, Appendix B; Paper 3, Appendix C). Communities of practice (CoPs) have generated an increasing amount of interest in recent years, both within KM literature and the construction industry. It has already been established that construction firms are extremely knowledge-intensive and can be characterised by their use of a high degree of tacit knowledge, resulting from the need for high levels of problem solving and technical ability (Anumba *et al.* 2005; Robinson *et al.* 2005). As a result tacit knowledge is particularly important in producing innovative projects, which incorporate design and construction solutions that cannot be met by established answers (Robinson *et al.* 2005). It is the importance of tacit knowledge to construction organisations that has led to increasing recognition of the potential benefits to be gained by implementing effective CoPs (Ardichvili *et al.* 2006; Carrillo *et al.* 2002; Garavan *et al.* 2007; Grisham, 2006; Lesser and Storck, 2001; McDermott, 2000; Verburg and Andriessen, 2006; Wenger *et al.* 2002).

Despite CoP best-practice guidance outlined in the literature, authors have called for further research of the conditions necessary for successful CoPs. While Verburg and Andriesson (2006) state that little is yet known about the best ways in which CoPs can operate and what would constitute useful success conditions, Soekijad *et al.* (2004) state that academic interest in CoPs is still limited. As a result, further examination of best practice approaches for the adoption of CoPs became a central aspect of the research.

4.2.2 ESTABLISHING A SET OF CRITICAL SUCCESS FACTORS FOR COPS

The literature review identified that CoPs represent an important KM tool for construction organisations in facilitating effective management of both explicit and tacit knowledge. Particularly within other industries, organisations have demonstrated proven benefits and increased competitive advantage through the adoption of CoPs. Although CoPs already existed within RWB in the form of TGs, senior managers had acknowledged that minimal CoP activity was leading to a lack of KM support for both the individuals involved with them and the business. As a result this work package was aimed at facilitating an understanding of how TGs were currently operating within RWB, and establishing a set of critical success factors for CoPs in order to improve the effectiveness of RWB's TGs.

A set of semi-structured interviews with the 18 technical TG chairs (Table 3.2), and a focus group with three company directors who are responsible for KM issues were carried out. This provided the research with both operational and strategic TG perspectives. The interview and focus group findings were then compared with the key recommendations outlined in the literature. The examination of RWB TGs as a case study methodology facilitated access to staff who could explain the importance of CoPs to the organisation, and the factors that affect CoP success.

Based on the critical success factors identified by Wenger *et al.* (2002), Vestal and Lopez (2004), and Lee and Neff (2004), the TG chair interview topics were as follows:

- How TG objectives are determined and how the organisation provides support for TGs;

- How regularly face-to-face TG meetings/events are held, and who the TG members are;

- How the TG chairs feel their TGs support the business;

- How the TGs disseminate the knowledge generated within their meetings, and how they communicate this across the business;

- How technology is used to support the TGs; and

- How TG success is measured and recognised.

Each of the six areas was discussed in turn with the TG chairs, who presented their views and ideas. Each interview lasted approximately 45 minutes and was supplemented by information available on the company intranet, internal (TG) reports, and copies of presentations made by the TGs to various members of the organisation. During the focus group the directors were presented with the key TG topics identified by the TG chairs during the earlier interviews, and their views and reactions were recorded. The two sets of data enabled an understanding of the factors that the members of staff involved with CoPs considered as critical to their success.

An analysis of the data collected identified several key considerations, which need to be made by those involved in overseeing, or the day-to-day operation of CoPs within an engineering design consultancy. The two sets of responses confirmed the importance of the CoP success factors identified in the literature, and highlighted a number of methods for their improvement within RWB. These were as follows (Paper 2, Appendix B):

1. Consider CoP member requirements

Enthusiasm and commitment from CoP members, and leaders in particular, is vital for CoP success within any organisation. As a result CoPs must support the engineers (both experienced and inexperienced), who in turn will be able to support the business by sharing their knowledge and experience.

2. Establish both short and long-term CoP objectives

Although CoPs may need to tackle short-term engineering project-related issues, it is important for the progression of the business that they also consider longer-term objectives. These are key in supporting the organisation's ability to create and react to emerging business opportunities.

3. Establish regular CoP meetings and events

Ongoing CoP activity is important in raising their profile and perception within the business. During periods of reduced activity CoPs should look to address long term objectives and build on the existing knowledge base.

4. Provide specific time allocations for CoPs

CoP members, and in particular CoP chairs, require time away from their daily project work in order to contribute to CoPs. It also ensures that CoPs are seen as an important resource, which is valued by the organisation.

5. Facilitate regular communication of CoP work

It is important to provide CoPs with clear processes and opportunities for communicating their work. This is key in sharing the knowledge held by CoPs across a cross-section of the business. Communication channels should be clear to those involved with CoPs, who may be enthusiastic in sharing knowledge but are being hindered by a lack of opportunities for doing so.

6. Consider the use of supporting technology

Technology should be considered in providing support for the collaborative aspects of CoPs. However, face-to-face interaction should be a priority and encouraged wherever possible.

4.2.3 SUMMARY: IMPROVING KNOWLEDGE SHARING & COMMUNICATION ACROSS TASK GROUPS

The research undertaken during Stage 2 highlighted the importance of CoPs and the necessity for both operational and strategic input in achieving a balanced composition of CoP objectives, activities and deliverables. The findings also highlighted a number of critical success factors for CoPs within an engineering design consultancy and best-practice approaches for their implementation. However, the findings suggested that further research was needed in order to assess the application of the critical success factors within an industrial setting. It also identified the need to examine the implementation of CoPs within other technically-orientated organisations both within the construction industry and external to it. This dictated that the next stage of the research needed to incorporate a cross-industry examination of CoP best practice before any major changes were implemented within RWB.

4.3 STAGE 3 WORK PACKAGES: KM BEST PRACTICE

The importance of people-based KM, and in particular CoPs, has been well established during Stages 1 (4.1) and 2 (4.2). However, having highlighted the problems facing TGs and identified the critical factors, which determine their success it was important for the research to consider the actions necessary for improving TG performance within RWB. Prior to any action being taken, the research needed to incorporate an examination of CoP practices undertaken within other successful technically-orientated professional services firms. This was carried out with a view to incorporating CoP approaches within RWB, which had been identified as being particularly effective within these firms. This was a core component of the research and formed the basis for Paper 3 (Appendix C).

The need for further research of KM practices within firms external to the construction industry has also been highlighted within KM literature. The literature suggests that due to the fact that many construction firms are still at an early stage of development with their KM initiatives (Carrillo *et al*. 2002), they are keen to find out what KM practices are being adopted by other firms in other industry sectors in order to benchmark their efforts and improve performance; an area in which further research is necessary (Carrillo, 2004). In particular, firms within the energy (including oil and gas), manufacturing, IT and software, pharmaceuticals, chemical, and financial sectors have been involved in KM for a much longer period than construction (Ribeiro, 2000; Teleos, 2007), and have proved the effectiveness of their initiatives through the demonstration of benefits including increased revenue, shorter design and production times, improved customer and staff satisfaction, and market leadership. Further to this, CoPs in particular, have attracted an increasing amount of interest from construction firms who are keen to mirror the benefits outlined above (Carrillo *et al*. 2002; Egbu and Robinson 2005; Grisham, 2006; Koch, 2002; Poole and Sheehan, 2005).

4.3.1 Recommendations for the Coordination & Management of CoPs

Despite increasing interest in CoPs within industry and academia, the literature review suggested that there is a lack of understanding as to the most appropriate management approaches to adopt for CoPs, and the impact that this has on those involved. There is an argument that because CoPs emerge as a result of the interest of its members in a particular subject area rather than to perform a specific task, the focus of the organisation should be to recognise and support CoPs rather than to create and manage them (Brown and Duguid, 1991). However, the literature suggests that there is an increased awareness that CoPs can be managed and leveraged for competitive advantage by creating knowledge resources for teams and business units, creating opportunities to capture and consolidate knowledge across business units, and supporting business strategy (Garavan, *et al*. 2007; Robers 2006; Saint-Onge and Wallace, 2003; Swan *et al*. 2002; Wenger *et al*. 2002).

While some authors are of the view that CoPs are naturally forming, self-organising groups (Lesser & Storck, 2001) that are resistant to management (Venters and Wood, 2007), others consider CoPs to be an integral part of the business, which should be set-up intentionally and managed by the organisation (Dubé *et al*. 2005; Gongla and Rizzuto, 2001). As a result, several authors have called for further research examining the impact that CoPs have on an organisation in order to establish a better understanding of how businesses can accommodate and contribute to CoP development (Gongla and Rizzuto, 2001; Loyarte and Rivera, 2007; Roberts, 2006).

The review of CoP literature highlighted several areas of uncertainty with respect to CoP management, which included:

- The appropriate level of managerial intervention in the operation of CoPs within different organisations;

- How CoP objectives are determined and aligned with business strategy;

- The way in which CoP leaders and members are attracted and established;

- How to facilitate and sustain effective CoP collaboration;

- How commitment and enthusiasm for CoPs can be sustained; and

- How to identify and recognise CoP value and successes.

4.3.2 Examine CoP Approaches Adopted by Leading Organisations

It was therefore important for the research to address these areas of uncertainty to ensure the success of any CoP management initiatives implemented within RWB. It was the intention of the examination of practices adopted by leading firms in the field of CoPs, to identify solutions to these areas of uncertainty. The initial review of KM (CoP) literature also served to highlight a number of firms that have been recognised for their success with the use of CoPs. Attendance at various external conferences, seminars and workshops also facilitated the identification of leading organisations in this field and supported the literature review findings. Seven leading organisations in particular were identified, and following initial discussions with members of staff responsible for KM within each of the organisations, they agreed to participate in the research. These organisations are outlined in Table 4.2.

Table 4.2: Case Study Organisations

	Organisation	Description of Organisation	Interviewee Position	Turnover (2007)			
				£0.5-5bn	£5-10bn	£10-50bn	£50+ bn
Construction	A	One of the UK's leading homebuilding and construction companies	**Knowledge Manager** and central coordinator for CoPs		✓		
	B	One of the UK's leading construction companies	**Project and Contracts Manager** responsible for the overall coordination of CoPs	✓			
	C	UK construction subsidiary of one of the world's leading homebuilding organisations	**Resource Planner** involved with supporting the operation of a number of CoPs	✓			
Non-construction	D	One of the world's largest energy companies	**Engineering Excellence Network (CoP) Leader**				✓
	E	One of the world's leading oilfield services providers	Two members of the **Knowledge Management Team**, responsible for the development of KM-supporting software and supporting the overall operation of CoPs			✓	
	F	One of the worlds leading IT systems providers	**Software Architect** involved with setting-up and running CoPs			✓	
	G	One of the worlds leading tax, transaction and advisory services firms	**Knowledge Leader** responsible for overall KM and coordinating CoPs			✓	

A sample size of seven case study organisations provided a balanced mix of three construction organisations and four non-construction organisations, enabling sufficient comparisons of the various CoP management approaches. One member of staff from each organisation was interviewed for the research although two members of staff from organisation E were interviewed as their roles were interrelated. The interviewees selected were all members of staff responsible for the coordination and management of CoPs. However, all of the interviewees had also been participants of various CoPs, which provided the research with both strategic and operational perspectives. The interviewees proposed a number of solutions for the management of CoPs, which addressed the areas of uncertainty in the literature. These formed the basis for the following set of CoP management best practices:

- Utilise a **'strategic guidance'** approach rather than direct management;

- Establish senior-level management **sponsors and/or steering groups**;

- **Objectives** determined by CoP members and aligned with the business strategy through close collaboration with management sponsors/steering groups;

- **Selection of CoP leaders** based on ability, experience, commitment and recognition from CoP members;

- Secure dedicated CoP **'work time' & funding**;

- **Integrate CoPs** with existing business processes and establish the right CoP culture at an early stage of development;

- Support face-to-face collaboration with **effective communication channels and the best-suited technology** to empower CoP members; and

- Monitor CoP performance through **non-intrusive means** and provide both strategic and operational-level feedback.

4.3.3   IMPLEMENT COP BEST PRACTICE IMPROVEMENT INITIATIVES WITHIN RWB

Following discussions with the PIT and KM steering group each of the above practices were implemented within RWB through the introduction of a number of CoP management initiatives (Paper 3, Appendix C). These also considered the critical success factors for KM established during Stage 1 (Paper 1, Appendix A) and those identified for CoPs in Stage 2 (Paper 2, Appendix B) and are described below.

1.   Company Directors as KM Champions

Two operations board directors were established as champions of KM. By establishing regular collaboration between the KM champions, the RE and PIT, a KM approach focussed on people-based solutions and encouraged through 'light touch' management techniques (see below) was driven from a senior level within the business. It also increased awareness of KM and demonstrated the commitment to KM from RWB directors.

2.   TG Steering Group

Monthly 'engineering excellence' meetings, of which one of the KM champions was a member, were identified as being a well-suited group to provide guidance and managerial support for TGs in the form of a TG steering group. These well respected, senior-level meetings had become well established over a number of years as a focus group for engineering-related topics and issues. By giving responsibility for TG guidance to this group, the meetings provided TGs with a forum to which they could present their TG project findings and any issues on a monthly basis, and gain senior-level feedback and recognition.

3.   TG Details Sheets

To encourage both long and short-term TG objectives, TG 'details sheets' were developed. These consisted of a template, which TGs could use to map out their current members, purpose, aims and objectives, and were compiled by building on the research carried out by Matsumoto (2006). The details sheets had two key purposes; to support the TGs by encouraging a clearer focus and direction; and to support senior managers (KM champions and engineering excellence group) in monitoring TG progress and providing the most appropriate support.

4.   New TG Chairs

The importance of TG chairs in determining the success of their respective TGs meant that it was imperative that the best-suited people held these roles. RWB TG chairs were often very senior members of staff who, due to their other responsibilities had limited time to commit to their TGs. As a result the TG chairs and members who were affected by this scenario were asked to nominate and elect a new TG chair (with the old chair remaining as a key member of the TG). The most successful replacement chairs proved to be those who were not only keen and enthusiastic but who were also seen as 'up-and coming future senior managers'.

5. Annual TG Funding

One of the key findings was that dedicated work time and funding needed to be secured for CoPs. As a result, the RE compiled two reports detailing the need for TG funding, which were submitted to the Design Operations Board. This was subsequently approved by the Board and an annual budget was secured for the technical TGs. Further to this, a director from the Design Operations Board has been made responsible for the coordination and management of the TG budget, which has also created greater visibility and recognition of the value of TGs to the business. TGs are encouraged to submit a funding proposal for particular CoP projects, or time to complete activities. This has been carried out by sending out an email to all TG chairs with a funding proposal template attached detailing the funding available, the process by which they can apply for it, and encouraging TGs to come up with innovative projects. Following the submission of funding proposals by the TGs, the RE together with the Design Operations Director and Business Analyst, hold a monthly meeting to carry out a preliminary review of the proposals and to prepare a report to be presented at the Design Operations Board.

In the first two months of funding being available, 17 proposals were put forward by the TGs. TG projects included the development of an environmental assessment tool for structural design, compilation of seismic design best practice guidance, collation of experiences and lessons learned on past historic structures projects carried out by RWB, compilation of best practice guidance for a piece of engineering design software, and composition of technical papers for presentation at conferences. The range of projects proposed by the TGs covered a number of different engineering disciplines, supporting knowledge creation, capture, storage and dissemination across numerous specialist areas of the business. This is particularly important in the current construction climate, where the business needs to specialise in a range of different areas, which are at the 'cutting edge' of engineering. The allocation of TG funding has meant that the time taken by members to complete TG-related tasks outside of their project work has been recognised as being productive time, rather than as a 'spare time' activity. A percentage of the budget was also intended for rewarding the TGs; an area which the board has opened up to the TG members for suggestions on how successes should be recognised.

6. Best-Suited Technology

A big breakthrough in supporting TG collaboration and knowledge exchange across the business was the move from an initial HTML TG intranet page to the use of Microsoft Office SharePoint Server 2007 (MOSS). This software actively supports collaboration through discussion boards and 'wiki-type' encyclopaedias, as well as helping the TGs to manage and coordinate meetings, documents and images (Figures 4.1 - 4.3). A page on the MOSS system was created for each TG, providing them with their own work and collaboration space on the RWB intranet, which they were given ownership of and manage on a day-to-day basis. The template for the TG pages was designed by the RE to replace the *details sheets* by providing areas for the TGs to outline their purpose, aims and objectives (they were required to do so before the page could go 'live').

As well as empowering the TGs to take greater control of their actions, the use of MOSS has also created a greater awareness of TGs and their activities across the business, while also facilitating effective management as the pages could be viewed during engineering excellence meetings as a reviewing and presentation tool.
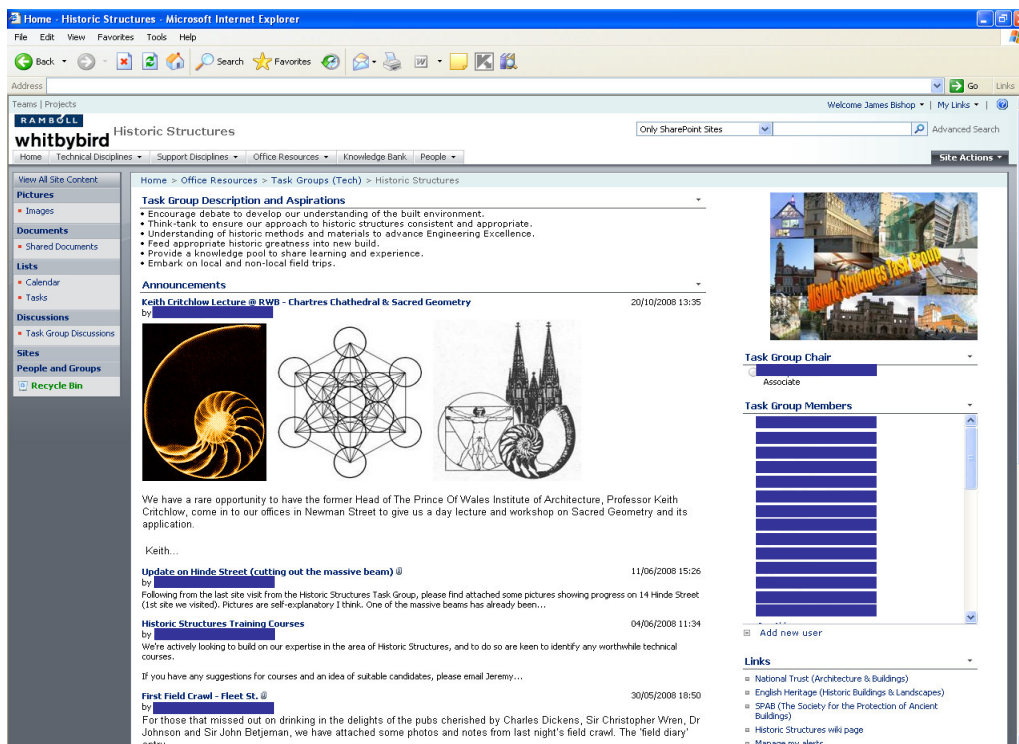
Figure 4.1: Example of Task Group Page (Home Page)
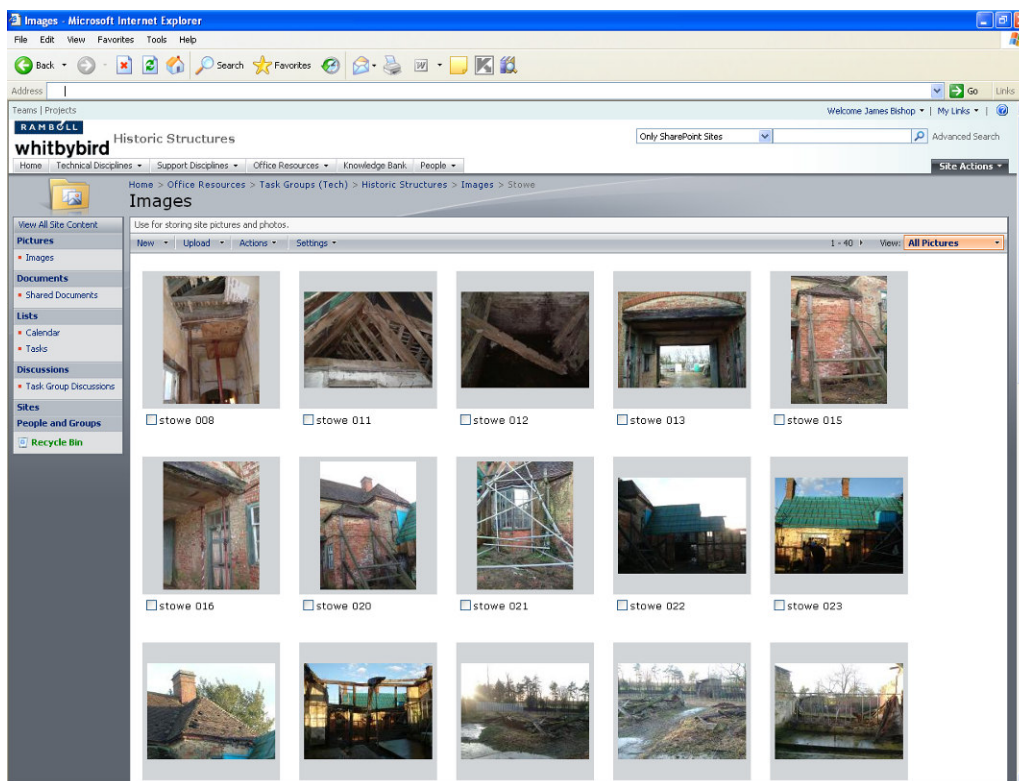
Figure 4.2: Example of Task Group Page (Image Library)
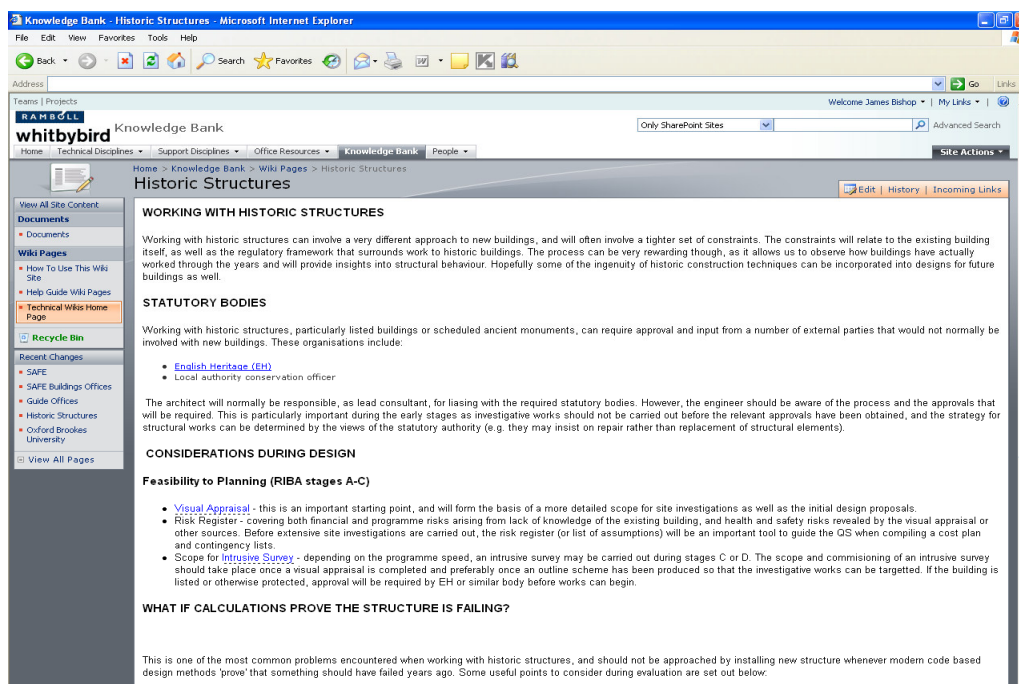
Figure 4.3: Example of Task Group Page (Wiki Page)

The SharePoint pages have also made it easier for new TGs to form and announce their existence, by creating an announcement on a central 'home page' on the SharePoint system. As a result of this simplified process several new TGs have formed in recent months, with 25 technical TGs now operating within the business and 36 TGs in total.

7. Health-Check Workshops

Five 'health-check' workshops were held to review and discuss TG aims and objectives. Each workshop was chaired by one of the KM champion directors, and attended by between 5 and 10 technical TG chairs as well as the RE. The purpose of the workshops was to provide a forum where the TG chairs could present their ideas and objectives to other like-minded colleagues, and take on board interesting insights and feedback that resulted. They also provided the chairs with strategic guidance and demonstrated recognition for the importance of TGs. A direct result of the workshops was the change-over of several new TG chairs and a merging of two TGs. The workshops were well received, with further sessions being called for by the TG chairs and directors. As a result it is planned that they will become an annual event, with the next workshops scheduled for early 2009.

4.3.4   SUMMARY

This stage of the research demonstrated the importance of management support for KM, in particular in ensuring sustained success for CoPs. However, the reliance on enthusiasm and commitment from CoP leaders and members in achieving CoP effectiveness means that management intervention must not be too heavy handed and should be based on 'light touch strategic guidance'. Leadership, both from within the CoP and from the business itself were also critical factors as was the need to provide CoPs with the right resources, such as funding and technology.

Although Stage 3 briefly examined KM-supporting technology, further research in this area was necessary. Up to this point the research had been focussed primarily on people-based KM. However, in order to establish a balanced approach to KM, it needed to examine

technology and process-based KM approaches in greater detail. As a result these two facets of KM were the focus of the following stage of the research.

4.4 STAGE 4 WORK PRACTICES: BALANCED KM

A core aim of the research was to ensure that RWB adopted a balanced approach to KM. This required an examination of other KM approaches, which would provide support for the people-based KM solutions (CoPs) outlined in Stages 2 (4.2) and 3 (4.3). These approaches and their contribution to an overall 'KM framework' are outlined in the following discourse section.

4.4.1 PROVIDING SUPPORT FOR PEOPLE-BASED KM ACTIVITIES WITH MICROSOFT OFFICE SHAREPOINT SERVER 2007

From the outset, the EngD research has been closely involved with the implementation and adoption of Microsoft Office SharePoint Server 2007 (MOSS) across the business. The reason for this has been the need for MOSS to be a key supporter and enabler of KM within RWB. The main objectives for the implementation of MOSS were to:

- Create a robust single point of access to all RWB systems to access data, information, knowledge and best-practice effortlessly;

- Embody and reflect RWB's core values and culture, drives innovation and continuous improvement;

- Support both individuals and the business;

- Ensure an incremental change to the way in which people work;

- Avoid unnecessary data input;

- Effectively manage our project documentation, unlock project knowledge, and support the management of project risks;

- Incorporate consistent, efficient and lean business processes;

- Provide a benchmark for the way in which RWB people should work; and

- Provide good financial value.

The critical success factors identified in the research undertaken during Stage 1 (Paper 1, Appendix A) were key in establishing a clear brief for the implementation of MOSS across the business. The RE was responsible for reviewing each of the critical success factors and integrating them into the development of the overall brief and specification. This was important in ensuring that the role of MOSS was as a KM-supporting technology, specifically in supporting people-based KM activities across the company. As a result, the brief outlined the importance for MOSS to "*retain and enhance RWBs ability to create, capture, process, retrieve and disseminate data, information and knowledge….and enhance RWB's reputation of expertise in using effective Knowledge Management initiatives and systems.*" Further to this, the brief acknowledged that MOSS had specific requirements, which needed to be met by the business in order to facilitate effective KM, including:

- Full commitment from management and assignment of sufficient funds at project start-up. Extensive communication from management to ensure buy-in from all individuals impacted by the new technology;

- Assignment of accountable business and technical staff with enough time and the right skills and knowledge to plan, design and implement the new system. A managed transition from 'project' to operations within the line functions with provision of long-term co-ordination and support;

- Training that takes into account the system functionality as well as the business change;

- An innovative view and application of new technology that is aligned with business objectives;

- Consider that CoPs may operate most effectively when management has minimal involvement; and

- Utilise appropriate measurement criteria.

The critical success factors were also utilised during the implementation of MOSS. Key actions taken by the PIT to account for each factor included establishing; a MOSS steering group consisting of 8 directors, the PIT and RE; a director as champion for MOSS (presentations on were MOSS given across the business from an early stage in its development); an overall user group consisting of 15 engineers at different levels from across the business (to enable the system to be tailored to fit their needs, and demonstrate the benefits to be gained); a TG site user group consisting of 10 TG members; and a number of training sessions for all TG chairs and at least one other member from every TG.

4.4.2 PROVIDING SUPPORT FOR PEOPLE-BASED KM ACTIVITIES WITH A PROJECTS DATABASE

Although the MOSS pages for the TGs had been effective at supporting the softer (tacit) side of KM such as facilitating discussions (discussion forums); exchanging experiences (wiki pages); capturing best practice (announcements, document libraries and image libraries); and encouraging collaboration and communication (listing/providing email links to experts/TG specialists), there was a distinct need to support RWB engineers on a more technical (explicit) level by providing knowledge on engineering project-related technical data. The need for this arose from the fact that in many instances engineers had minimal structured technical data to benchmark their efforts against during the early stages of their projects. This meant that engineers were often starting projects from scratch, despite the fact that similar projects may have been carried out in the past, and knowledge of previous figures and calculations had been established.

Table 4.3: Requirements of KM-supporting Technology

RWB Staff (level)	Level of Support Needed from KM-Supporting Technology
Engineers	Support for decision-making during initial project stages by providing benchmark figures and quantities, identified from similar projects carried out by RWB in the past.
Project Managers	Support for decision-making during project meetings with their teams to identify design solutions and any issues, which had been experienced on previous similar projects.
Directors	Support for decision-making at strategy-related meetings to determine the number of projects, which had been carried out within different disciplines and sectors in the past. Further to this the directors would also need the tool to identify the number of projects *currently* being undertaken in these areas, therefore supporting an understanding of both the current and past balance of different specialisms and market presence within different areas of engineering.

To determine the need for a KM tool that would enable the capture and reuse of such technical data and knowledge, the RE held 4 focus group interviews with the KM steering group. It was established that the tool would need to support the business at a number of levels, particularly during project-related meetings (Table 4.3).

Additionally, the tool needed to provide support for team coordinators and the marketing team to help with the compilation of bid submissions. The focus was therefore to support people-based knowledge sharing across the business by developing and implementing a technology-based KM initiative, which needed to be intuitive and user-friendly. Although the requirement was for the system to capture technical data (explicit knowledge), it was also important that it would capture, store and disseminate experiences and lessons-learned from previous RWB projects (tacit knowledge), ensuring that it incorporated the appropriate balance of KM capabilities. As a result a specification for the system was developed by the RE. This was achieved through undertaking 10 interviews with engineers, project managers and directors to determine exactly what the tool would need to deliver in order to suit their requirements. As well as monthly update presentations to the KM steering group, additional bi-monthly meetings were also held with one of the directors from the KM steering group (established as PD champion) to provide additional feedback and reviews of the specification. The specification compiled by the RE consisted of 25 screen shots for the design of a '*Projects Database*' (PD), which would be developed 'in-house' by RWB's IT developers.

From the outset it was important that the PD was designed as a tool, which would become part of the way RWB engineers carry out their projects. It would become '*their*' tool, and RWB engineers needed to be empowered to be responsible for uploading data, information and knowledge of their projects into the system. It was imperative that the PD did not become, or be seen as something that was an additional activity to their existing workload, and was therefore designed to integrate with existing engineering project process. It needed to be simple and effective to use at any stage of a project to search for and retrieve knowledge, while also being simple and effective at capturing knowledge at the right project stages.

For this reason there were two aspects to the specification; *searching* and *capturing*. The searching aspect (see specification screen shot Figure 4.4) relates to the design of the system to enable anyone using it to find specific project(s) on the database by searching for particular types of project, project names, key words or specific project criteria (materials, type of structure, etc.). The capturing side (see specification screen shots Figures 4.5 - 4.8) relates to the design of the system to integrate with the engineers' project processes, enabling them to upload data, information and knowledge onto the system as they acquire it on their projects. This was based on aligning the key points of data entry with the completion of the different project stages (Stage C, D etc.) and RWB's Quality Assurance (QA) data collection requirements. The inclusion of a 'unique features' section would enable the technology to capture 'softer' tacit knowledge. Using this section of the PD the user can upload lessons learned, experiences, innovative solutions, or problems experienced on projects. The specification also featured a number of potential reports for engineers, project managers, and directors, which the system would generate automatically to provide them with the information and knowledge they require for their respective meetings or project tasks.

Figure 4.4: Searching aspect of PD specification

Figure 4.5: Search results – General (past) project data, information and knowledge captured for each project

Figure 4.6: Structures-specific (past) project data, information and knowledge captured for each project.

Figure 4.7: Explicit knowledge capture (Detail Design stage)

Figure 4.8: Tacit knowledge capture (unique features section)

4.4.3   INVESTIGATE MEASUREMENT CRITERIA FOR TECHNOLOGY-BASED KM SOLUTIONS

Following the adoption of MOSS pages by the TGs, it was important at this stage to understand how the technology was being received by the TG members and whether it was proving to be an effective KM tool. As outlined earlier, buy-in from the TG members would be a critical factor in determining its success. Within KM literature, the measurement of KM success is often highlighted as a complex subject due to the intangible nature of KM (Anantatmula and Kanungo, 2005; Tseng, 2006; Lee *et al*. 2005). However, several authors have established measurement criteria for KM initiatives, some of which by utilising a '*Balanced Scorecard*' approach (Chau and Goh, 2007; Smits and de Moor, 2004; Van Grembergen, 2001). Following a review of this literature, the key measurement criteria were consolidated, and a set of key performance indicators (KPIs) for monitoring the effectiveness of the MOSS pages (in line with the objectives set out for the implementation of MOSS in the brief) were developed by the RE.

In collaboration with the PIT and Steering group this list of KPIs was consolidated further to facilitate its use on a monthly basis by the PIT to monitor the effectiveness of MOSS as a whole and present the findings at the relevant management meetings. Annual targets were also developed. The final list of KPIs, developed by the RE, is detailed in Table 4.4.

The benefit to the business of using these measurement criteria was in ensuring that MOSS was performing as it was intended to. A large amount of time, resources and finance had been invested in acquiring, developing and rolling-out MOSS, which was intended to improve knowledge sharing and collaboration across an increasingly geographically dispersed organisation. To be effective at achieving this there needed to be a high level of uptake across all RWB offices. The data gained by utilising the KPIs demonstrated that there has been a steady increase over the last 6 months in the usage of MOSS, in particular the number of technical TG pages has increased from 16 in June to 25 pages (one for every technical TG). MOSS now contains nearly 3000 documents and 55 live sites, further emphasising its success

across the business. This data proved vital in communicating the effectiveness of MOSS in providing access to the data, information and knowledge, which was being created, shared and captured centrally on MOSS, to RWB senior management.

Table 4.4: MOSS (KM-supporting technology) KPIs

Aim	**Create a robust single point of access to all RWB systems to access data, information, knowledge and best-practice effortlessly**			
			Target	
		2008	**2009**	**2010**
KPIs	Existence of knowledge repositories			
	No. hits on system websites (% increase per year)	20%	20%	20%
	No. of documents published on system (% growth per year)	20%	20%	20%
	Existence of collaborative tools			
	No. team sites (% of total no. teams)	80%	80%	80%
	No. project sites (% of total no. new projects)	70%	70%	70%
	No. TG sites (% of total no. TGs)	70%	70%	70%
	No. meeting sites (% of total no. meetings)	80%	80%	80%
	Ease of access (average no. clicks for required navigation)	3	3	3
	Users from across global community (& indication of resistance to change - has implementation strategy been successful?)			
	% London users	70%	80%	100%
	% regional users	70%	80%	100%
	% international users	5%	80%	90%
	Downtime - no. working days per year	≤2	≤2	≤2
Aim	**Embody and reflect RWB's core values and culture, drives innovation and continuous improvement (supports both individuals and the business)**			
			Target	
		2008	**2009**	**2010**
KPIs	% staff trained in SharePoint	60%	70%	70%
	User satisfaction (survey results for Senior Engineers and below)			
	Performance of applications (% responding good or better)	70%	80%	80%
	Total no. hours spent on system by users (% increase per quarter)	30%	30%	30%
	No. employees championing KM through system			
	Experts in system technology (no. trained experts : total no. people trained)	1:80	1:50	1:30
Aim	**Provide good financial value**			
			Target	
		2008	**2009**	**2010**
KPIs	% overspend/underspend in relation to original budgeted cost (i.e. cost of additional development work)	± 5%	± 5%	± 5%
	Sales to 3rd parties (revenue from products/services/capabilities created by or as a result of SharePoint)	£20K	£40K	£80K

Some of the key statistics collected by the PIT in accordance with the above KPIs are outlined in Tables 4.5 - 4.8.

Table 4.5: Use of TG pages (2008)

Legend: Visits, Hits, Total Number of Hits
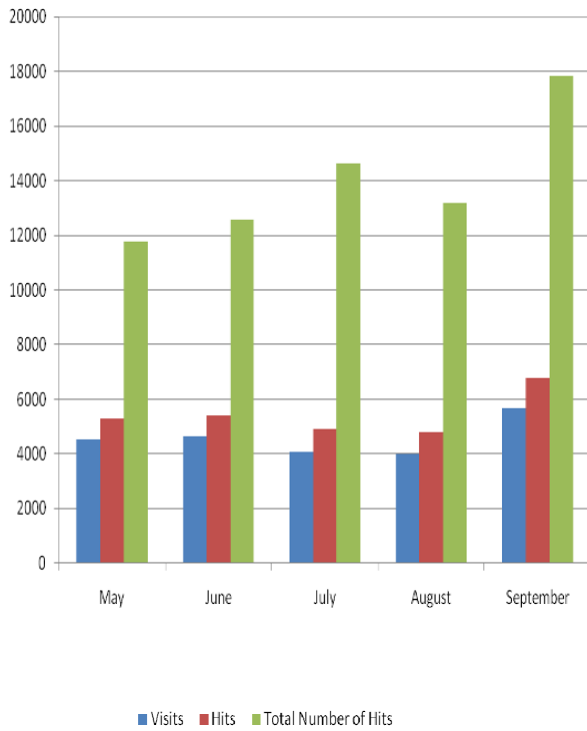
Table 4.6: Total Number of MOSS Sites (2008)

Legend: Total No of Sites, No. Team Sites, No. Project Sites, No. Task Group Sites, No. Management Meeting Sites, No. Discipline Sites
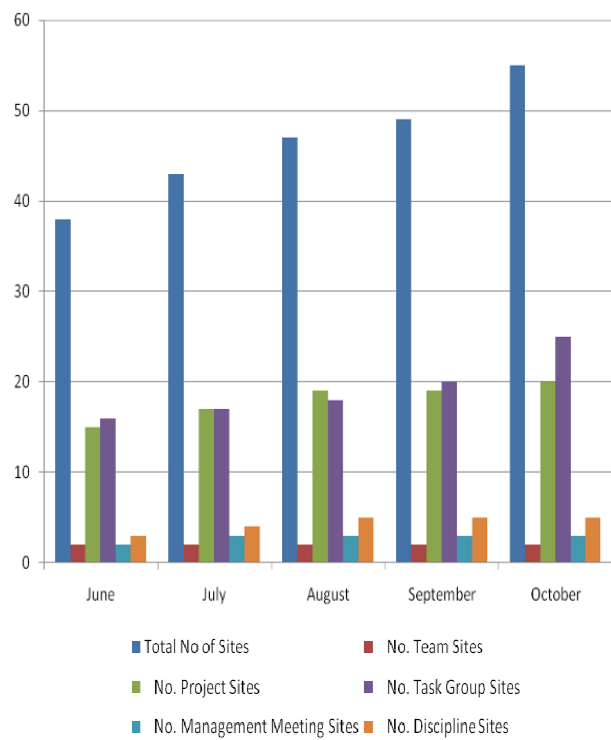
Table 4.7: RWB Staff Trained in MOSS (2008)

Legend: Total No of Staff Trained
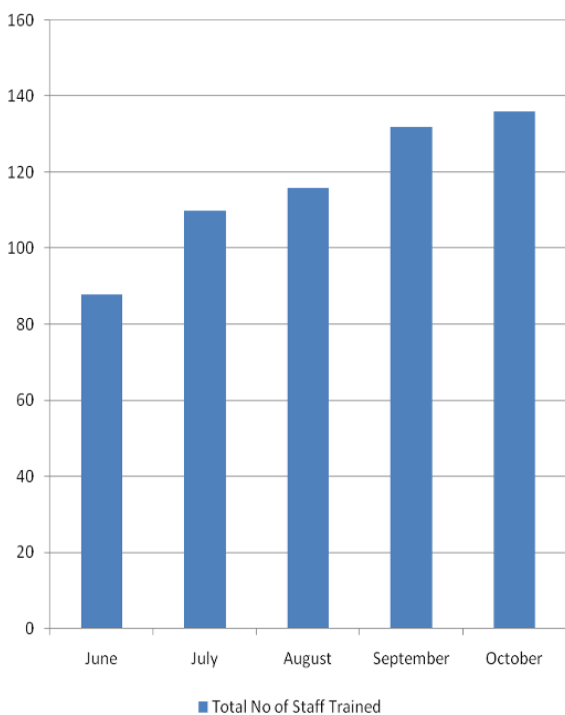
Table 4.8: Number of Documents on MOSS (2008)

Legend: Total No of Documents
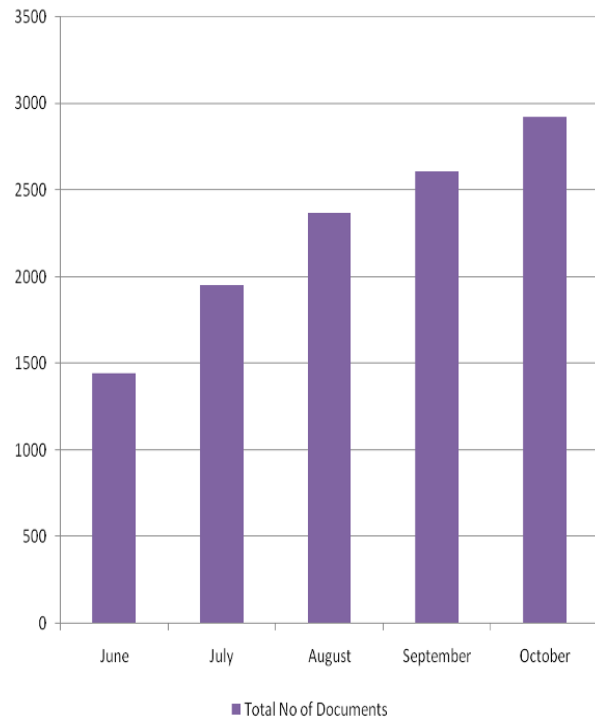
To support the KPI statistics generated, a set of interviews were carried out by the PIT with a number of key MOSS users from across RWB to determine how effective they felt the technology has been. In total 19 people were interviewed out of a list of 43 people who were involved in the SharePoint steering and user groups. In total 180 comments were captured, of which:

- 44 were comments that related to additional MOSS requirements;

- 38 were positive feedback comments;

- 26 were queries regarding various MOSS functions (for which, the PIT has subsequently communicated answers back to the interviewees);

- 55 were feedback comments and suggestions as to the configuration of MOSS;

- 8 were negative feedback comments; and

- 9 were comments that although related to MOSS are more general IT infrastructure issues.

Overall a balanced set of comments were collected suggesting that MOSS has been well received by those that are using it, which was further emphasised by the fact that out of 180 comments only 9 were negative. The comments also highlighted the need to improve certain aspects of MOSS as well as a number of wider IT issues to ensure that its effectiveness in managing knowledge is not impaired. The PIT carried out a number of follow-up interviews to provide answers for any queries highlighted in the initial interviews, to determine exactly which aspects of MOSS were in need of improvement, and to discuss some of the underlying configuration decisions that have been made by the team as a result. This was also an important process in gaining ongoing involvement, ownership and buy-in to the development of the system from the engineers.

By asking the interviewees to describe the experiences they had while utilising MOSS, the interviews facilitated further assessment of the impact of MOSS on the business and provided the research with a qualitative evaluation of its effectiveness. In particular there were several success stories with regard to exploring and creating new business opportunities and areas of expertise. In one such case a TG chair described the use of MOSS to set up a new TG specialising in a specific area of engineering design. The TG then secured an allocation of funding for a TG project focussed on developing best practice guidance. As a result of the project, the TG is now seeking to utilise the knowledge developed within the TG as an additional consultancy service. Another example of the benefits of MOSS was in solving problems experienced on live projects. By starting a discussion forum on the TG pages, RWB engineers were able to gain knowledge from experts in that particular field without the need to identify specific individuals, which would have been difficult if using the traditional email route. Discussion forums were identified as being a 'new way of doing things' and as such, several of the interviewees highlighted that it will take more time for all MOSS users to become familiar with their use. However they recognised the benefits of discussion forums and suggested that they will become a powerful tool in the future.

4.4.4 EXAMINE PROCESS-BASED KM SOLUTIONS

To ensure a balanced approach, the research needed to ensure that RWB accounted for the third aspect of its KM initiative; process-based KM. Having identified the key process-based KM activities, which existed within RWB and were in need of improvement, it was important to integrate these within the research. The approaches to which this was undertaken are outlined as follows:

1. **Management and Communication Structure & Diagrams**

Although TGs had been a central aspect of RWB's culture for a number of years, prior to the research they had always existed on the periphery of RWB's official hierarchy and structure.

As established in Paper 3 (Appendix C) the perception of Task Groups (CoPs) as a valued aspect of the business is critical to their success, and as such require funding and resources. In order to achieve this, the TGs needed to be effectively incorporated into the management and communication structure of the business.

The first stage of this was in establishing the Engineering Excellence Group as a steering group for TGs. However, while management and guidance for TGs and their projects would be provided by the Engineering Excellence group, the funding secured for TGs needed to be approved at an Operations Board level prior to its allocation to TG projects. As a result the Design Operations Board was made responsible for approving an annual TG budget, which required the submission of a quarterly paper on the progress of TG projects (their spend to date and anticipated spend). These papers were prepared by the RE and Design Operations Board Director made responsible for the TG budget, and were also presented at the monthly Engineering Excellence meetings. This formalised the position of TGs as a core aspect of the business, which was further cemented through the re-structuring of the official management and communication structure diagrams published on the company intranet and in its annual business plan.

The final stage in integrating TGs effectively within the management and communication structure was in enabling the TGs to present their project findings across the business. This was done by including a slot for TGs at the monthly 'project delivery' presentations, which are broadcast across RWB through video conferencing. Presentations are given by the TGs following the close-out of their funded projects and are given in a Microsoft PowerPoint format, which is stored on MOSS and searchable by anyone.

2. Meeting & Reporting Schedules

To ensure that TGs were provided with regular management support it was important to establish reporting schedules for both the Engineering Excellence and Design Operations groups, which were transparent for all involved. A review of TGs and the level of alignment between their own objectives and those of the business, and therefore the level of support that they currently provided for the business was carried by the RE. This provided a basis for determining, which TGs needed to report to the Engineering Excellence group on a 6-monthly basis and those, which only needed to report once a year. Following discussions with and agreement from the TG chairs this was then developed into a reporting schedule, which was published on the MOSS TG home page. This also ensured that the best suited people are made aware of these meetings, ensuring that the right people were communicating and collaborating together.

Following the initial response from TGs to the funding provided for them, which was very positive with 17 funding proposals put forward in the first two months, the RE and Design Ops group decided that a quarterly review of the budget and progress of TG projects was necessary. As a result of the number of proposals and the importance of the proposed projects, the Design Ops group increased the budget by 30%.

3. IMS (QA) Procedures

A key critical success factor for any KM initiative is to "*integrate the initiative seamlessly into the organisation and the daily lives of employees*" (Paper 1, Appendix A). As well as encouraging the right KM culture within RWB, which is essential in linking KM activities with the daily routine of staff, it was important to appreciate the potential of the QA procedures in driving KM best practice as these are already part of the daily lives of staff and are a strict requirement during work on any RWB engineering project. In particular the

'project plan' was incorporated into the design of the projects database. The project plan is an RWB QA tool utilised on every RWB project, which records and monitors the services provided, people involved, any brief or design changes, the programme of project activities and resources, specific quality controls and other checks or audits undertaken, and details of any formal project submissions and approvals. By incorporating all fields from the project plan, which are required to be filled out by the engineers for every engineering project, into the specification of the PD it is anticipated that the PD will not only serve to capture project knowledge and information, but also as an electronic project plan. This will reduce administration time for the engineers and ensure that data, information and knowledge is being captured for every project from the outset.

As with technology-based KM, the importance of the process aspect of the KM initiative was in supporting people-based KM activities. However, while technology needs to support people-based KM by facilitating ongoing collaboration, the role of process-based KM was in integrating people-based KM within the daily lives of staff and the operation of the business.

4.4.5   SUMMARY OF KM-SUPPORTING TECHNOLOGY IMPLEMENTATION

The critical success factors identified during Stage 1 (Paper 1, Appendix A) were incorporated throughout the development and implementation of the KM-supporting technologies outlined above. Table 4.5 highlights the methods by which each success factor was accounted for.

Table 4.5: Use of Critical Success Factors during the development/implementation of RWB's KM-supporting technologies

Critical Success Factor	MOSS Development / Implementation Action	Project Database Development / Implementation Action
Establish a high level of understanding and a clear definition of KM throughout the organisation.	MOSS brief & specification compiled in accordance with EngD findings. Regular updates on objectives, progress and deliverables to MOSS steering group. Regular presentations on MOSS by (senior level) steering group members to RWB.	Regular updates on objectives, progress and deliverables to KM steering group and other RWB directors. Update presentations (on specification) made by RE to Engineering Excellence and Management meetings.
Ensure that the KM initiative fits with the needs of the individuals and the organisation's	Established different 'user groups' during the development of MOSS & close involvement of end users in its design.	Regular consultations with steering group / engineers / project managers / directors during development of technology.
Integrate the initiative seamlessly into the organisation and the daily lives of employees.	Introduction of MOSS undertaken on a 'step change' basis, based on a change strategy and vision. Integrated with QA procedures.	Designed to be integrated with intranet (MOSS). Aligned and integrated with QA procedures and existing IT systems (finance systems, CRM system etc.), minimising additional effort and data entry requirements.
Initiate KM champions, a supporting team & top-level support	MOSS steering group established. MOSS champion established (MOSS steering group).	Existing KM (EngD research) steering group utilised. PD champion established (KM steering group).

Critical Success Factor	MOSS Development / Implementation Action	Project Database Development / Implementation Action
Clearly demonstrate and communicate the benefits and initial successes of the initiative.	Presentations made to all RWB staff by senior steering group members. Presentations to individual regional offices by PIT.	Presentations by RE to KM steering group highlighting the benefits gained by other firms that have successfully implemented KM-supporting technologies. PD designed to incorporate 'reporting' capability (as a result of engineer consultations): reports generated automatically for engineers at varying levels to meet their respective needs.
Determine the suitability of financial and non-financial rewards.	Annual funding made available for all technical TGs: MOSS utilised to facilitate (funded) TG project outputs (wiki pages/ publication of best practice)	N/A: PD still at development stage (rewards to be considered at implementation/uptake stage). Engineers given ownership of PD through involvement in its development from an early stage.
Achieve a balance between people and IT.	Designed, developed and implemented to provide direct support (technology-based KM) for TGs and RWB teams (people-based KM).	Designed and developed to provide direct support (technology-based KM) for TGs and RWB teams (people-based KM).

5 CONCLUSIONS

5.1 OVERALL CONCLUSIONS

The research carried out in accordance with the four core objectives has demonstrated that to establish an effective KM framework, which enables an engineering design consultancy to *manage technical knowledge to enhance organisational best practice* there are a number of critical factors to acknowledge and several key stages to consider, from the inception of a KM initiative to its integration into organisational and project operation. These are outlined in the following section.

5.1.1 ESTABLISH AN IMPLEMENTATION / DEVELOPMENT STRATEGY FOR KM WITHIN THE ORGANISATION

By investigating patterns of knowledge exchange (Objective 1), the RE established an understanding of the organisation's current KM performance and need for improvement. The organisation itself must also establish a clear understanding of exactly what KM is; the benefits it can bring to the business; and the requirements of those involved, from an operational to a strategic level. To do this the organisation needs to develop a KM strategy (statement), which can be communicated to, and recognised by all those concerned. This will require an active marketing campaign for KM, with ownership at the highest level within the business in order to demonstrate the value of KM across the company and gain buy-in from staff. The KM strategy must also be aligned with both the objectives of the business and the needs of the members of staff.

The research carried out to address Objective 1 also highlighted the need for an examination of the factors that determine the success of a KM initiative. Paper 1 (Appendix A) outlined the necessity for managers at a strategic level to have an appreciation of these factors from the outset. The critical success factors will require consideration throughout the lifespan of any KM initiative to ensure effective development, implementation and management of the initiative. These factors, as identified in Paper 1 (Appendix A), include:

- Establish a high level of understanding and a clear definition of KM throughout the organisation;

- Ensure that the KM initiative fits with the needs of the individuals and the organisation's business objectives;

- Integrate the initiative seamlessly into the organisation and the daily lives of employees;

- Implement KM champions and a supporting team;

- Establish top-level support;

- Clearly demonstrate and communicate the benefits and initial successes of the initiative;

- Determine the suitability of financial and non-financial rewards; and

- Achieve a balance between people and IT.

5.1.2 IDENTIFY AND PRIORITISE PEOPLE-BASED KM ACTIVITIES

By examining the different KM solutions available (Objective 2), the research determined that people-based KM activities should be at the core of an organisation's KM initiative, as they have the greatest potential for the capture, storage and dissemination of both tacit and explicit knowledge (Paper 2, Appendix B). People-based KM activities should be identified and prioritised for development, improvement and/or invigorating. If no people-based KM activities exist, the introduction of these is critical for effective KM. Following an examination of people-based KM solutions and their effectiveness, as outlined in Objective 3, CoPs were identified as being a well suited KM activity for construction organisations (*and* organisations within numerous other industries) due to their reliance on tacit knowledge. Despite CoP management being a controversial subject, a number of effective CoP management approaches were established during the research and deemed essential in establishing successful CoPs, which are capable of contributing to the professional and personal development of CoP members and the business itself. The key CoP management approaches outlined in Paper 3 (Appendix C) are as follows:

- Consider CoP member requirements;
- Establish both short and long-term CoP objectives;
- Establish regular CoP meetings and events;
- Provide specific time allocations for CoPs;
- Facilitate regular communication of CoP work;
- Consider the use of supporting technology; and
- Integrate with business processes.

5.1.3 SUPPORT KM WITH THE BEST-SUITED TECHNOLOGY

Although people-based KM should be at the core of an organisation's KM initiative, particularly as the business grows and it becomes more difficult to communicate and collaborate across large numbers of people and dispersed geographic locations, technology is essential in supporting people-based KM. In accordance with Objective 4, the research demonstrated that in addition to people-based KM activities, technology-based KM represents the second aspect of a balanced KM 'framework'.

KM-supporting technology should be adopted by establishing a best fit with the KM requirements of the business. Technology needs to be tailored to fit the needs of individual members of staff and the way in which they work on projects on a daily basis. There is no one-size-fits-all solution with regards to KM-supporting technology and 'off-the-shelf' solutions require careful consideration, as although sometimes appropriate they may require further development to ensure a fit with the KM needs of the business. To ensure a best fit with the 'end-users' of KM-supporting technology, they should be involved in its development and implementation at an early stage, ensuring that it meets their needs, while also enhancing their ownership of it.

As part of ensuring that the technology is driven and developed by the staff involved in people-based KM activities, it needs to be de-centralised with high levels of ownership given to those individuals. Buy-in is therefore key and as well as empowering staff to utilise KM-supporting technology as they see fit, the organisation will need to invest in training, particularly for key users (e.g. CoP chairs and KM champions). The introduction of this

technology should represent small changes to the way in which people work and change management principles need to be considered. It is also important to manage expectations by communicating to staff that KM-supporting technology is just that; a *supporter* of KM, which will not solve all of their KM problems alone. They need to recognise that the effectiveness of this technology will reflect their input and efforts in utilising it and the performance of the people-based KM activities, which it supports.

5.1.4 INTEGRATE KM INTO THE DAILY LIVES OF MEMBERS OF STAFF AND THE WAY IN WHICH THE BUSINESS OPERATES

KM initiatives need to become part of the way in which people work as a matter of course and need to be recognised across the business as an integral part of it. Managers need to demonstrate the value of KM by providing the people involved in KM initiatives with the right resources (including funding and training), responsibility and accountability. The people involved need to feel that their work and efforts, are not only being recognised, but that they are making a contribution to the progression of the business. To achieve this, KM initiatives need to be integrated within the daily operation of the business by incorporating KM-supporting processes including the organisation's management and communication channels, reporting processes and QA procedures. Senior managers need to demonstrate their commitment to KM, and designated senior KM champions and steering groups should be visible across the business. The importance of knowledge to any technically-orientated organisation and the potential business gains, which can be realised such as improved competitive advantage and project success, necessitates that KM should be established as a key business objective in its own right.

Objective 4 highlighted the need to establish a KM framework, which enables an engineering design consultancy to better capture and share knowledge. This was also encompassed within the overall aim, which was to "d*eliver a framework that facilitates the retention and reuse of knowledge, which will increase Ramboll Whitbybird's potential to respond appropriately to conventional and emerging business opportunities."* The research demonstrated that successful KM is determined by the ability of an organisation to establish a balanced approach by adopting a framework, which incorporates three core elements; people-based KM, technology-based KM and process-based KM. The framework (Figure 5.1) presents a process by which an engineering design consultancy can achieve a balanced approach to KM by identifying and prioritising people-based KM practices and in particular CoPs, supporting them with the best-suited technology which fits with the needs of both the organisation and the employees themselves, and integrating KM within the daily operation of the business. This is the approach that was successfully adopted within RWB.

Input

Consider KM initiative critical success factors (Paper 1, AppendixA)

Undertake desk study (review of relevant documents, reports, business plans, intranet etc.) & Surveys (interviews) at both strategic & operational level

Consider CoP critical success factors (Paper 2, Appendix B; Paper 3, Appendix C)

Consider needs of individuals & business

Involvement of end users in development

Adopt a de-centralised approach

Provide training

Integrate with communication channels, reporting structures & QA procedures

Integrate within core business objectives

Demonstrate the value of KM

Provide adequate resources & recognition

Start

Establish a KM strategy (statement)

Identify all existing KM activities & develop action plan

Do people-based KM activities already exist?

Yes — Prioritise these for Improvement / Development

No

Introduce CoPs

Provide support for people-based KM activities with best-suited technology

Integrate KM into daily lives of staff & operation of the business

End

Review Action Plan

Outputs

Clear understanding of organisation's KM requirements

Establish necessity for improvement

Leverage technical knowledge & experience held by staff

Effective management of tacit (& explicit) knowledge

Improved KM (particularly across dispersed geographic locations)

Improved commitment to KM initiative from staff

Holistic approach to KM

Figure 5.1: People-orientated KM Initiative Framework

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5.2   IMPACT ON SPONSOR

The action research methodology adopted has resulted in a number of beneficial changes within RWB, which were implemented to improve RWB's KM capabilities and enhance engineering best practice. This was in accordance with Objective 4, which outlined the need to implement KM solutions within RWB. Prior to the research, although RWB had recognised the importance of KM, there was a lack of a clear plan to drive KM forward within the business. The development of a KM strategy statement, which was communicated across the business from a senior level was essential in enhancing KM awareness across the business. The development of a KM action plan also provided the PIT with a set of guidelines for ensuring the effectiveness of RWB's KM initiative.

By mapping out the KM activities that already existed within the business and carrying out an assessment as to how these were performing, several activities were highlighted as needing development and improvement. Task Groups (RWB's equivalent of CoPs) were cited as being a key people-based KM activity, which had great potential for providing improved support for KM, but were currently underperforming. As a result of the research a number of initiatives were implemented to improve the ability of TGs to manage knowledge and support the progression of the business including the allocation of time and funding, the replacement of TG chairs, and the introduction of a TG reporting structure.

The introduction of MOSS as a new intranet and document management platform for the company represented a major change in the way it operated as a business. However, in order for this technology to incorporate effective KM capabilities, the standard off-the-shelf solution required further development. In order to achieve the right KM solution from MOSS, the RE collaborated with the PIT to compile a brief and specification for the implementation and development of MOSS as a KM-supporting technology. Thirty MOSS TG pages were established, which proved to be key in supporting TGs, particularly in managing softer (tacit) knowledge. The development and implementation of a PD from the RE's specification will also represent a major change for the business, and it is anticipated that once officially rolled-out, this will be utilised on every RWB project. The development of the PD will create another KM-supporting technology, which will support engineers on a more technical (explicit knowledge) level.

The full list of KM practices implemented as a result of the EngD research, their impact on the business (number of staff affected), and the relation to the above conclusions (KM Framework) are outlined in Table 5.1.

Table 5.1: KM Practices Implemented as a result of the EngD research

KM framework component	KM Practices Implemented as a direct result of the research	Number of RWB staff affected by KM practice(s)
Implementation / development strategy	Introduction of KM Strategy Statement	RWB MD & Directors (6)
	Introduction of KM Action Plan	PIT (4)
	RWB Directors established as KM champions (Overall KM & TGs)	Directors (2)
	Company-wide presentations (presented by RWB directors) outlining the benefits of KM	All RWB staff (800)
	Presentation boards on KM (presented by directors) for annual directors forum	RWB MD & Directors (25)
	Introduction of KM Steering Groups • MOSS • TGs (Engineering Excellence Group)	Steering group (12) Steering group (15)
Identify & prioritise people-based KM	Restructuring of TGs • TGs closed down / merged / created • New leaders introduced • New members established • Reporting structure implemented	TG members (200)
	TG funding secured (17 TG projects funded to-date)	TG members (200)
Support KM with best-suited technology	MOSS TG pages for all TGs	TG members (200)
	Incorporation of KM requirements into MOSS brief / specification	All RWB staff (800)
	MOSS measurement criteria (KPIs)	PIT (6)
	PD specification	All RWB staff (800) (once implemented)
	Incorporation of QA procedures (project plan) into PD specification	All engineers (600) (once implemented)
Integrate KM within business	Updated meeting schedule	All meetings (200)
	Updated management & communication diagrams (to include Task Groups)	TG members (200)

5.3 IMPACT ON WIDER INDUSTRY

5.3.1 CASE STUDY EXAMPLE OF IMPLEMENTATION, DEVELOPMENT AND MANAGEMENT OF A KM INITIATIVE IN PRACTICE

The literature highlighted the fact that despite the increased interest in KM in recent years within the construction industry, KM is at an early stage of development with the majority of firms still focused on understanding, clarifying and tackling KM (Carrillo *et al*. 2002). A particular area of KM in need of further research and widespread understanding across the industry, was the use of people-orientated KM practices (in particular the adoption of CoPs), which despite being identified by a number of authors as being a key KM consideration, continued to be overlooked in many cases due to the continued focus on technology-based KM solutions within the literature (Carrillo, 2004; Soekijad *et al*. 2004; Smith & McLaughlin, 2004; Swan *et al*. 1999l; Verburg and Andriesson, 2006). To address this issue the research describes the process taken within a multi disciplinarily engineering design consultancy, which adopted a balanced approach towards establishing an effective KM initiative by focussing on people-based KM, supporting it with technology, and integrating it with other business systems and processes. This provides a benchmark for engineering consultancies as

well as other construction firms from across the industry, who share a reliance on technical experience, and tacit knowledge in particular.

5.3.2   KM BEST PRACTICE

The research outlines a framework, which provides any construction organisation with a process for developing, implementing and managing a KM initiative by adopting a set of generic principles and tailoring them to fit with the objectives of the business, the needs of its staff and the ways in which it operates as a business (Figure 5.1). Further to this the research highlighted the alignment of this process with key change management principles. Although the research examined KM approaches within construction, it also identified KM approaches taken within other professional services-based industries in using CoPs, including energy (oil & gas), IT and financial, demonstrating that generic CoP critical success factors and management principles can be applied across different industries effectively.

The process of prioritising people-based KM and supporting it with the best-suited technology and business processes is one, which should be adopted by any firm seeking to achieve an effective KM initiative, within any industry. However, the selection of the specific KM activities to be adopted must be done on an individual basis. In the case of RWB, its open and collaborative culture, the project-orientated nature of its work, the complexity of its end product, and its predominantly office-based workforce meant that CoPs, supported by MOSS was the best-suited solution. Organisations with different characteristics, within or external to construction, may find that alternative KM activities are more appropriate.

5.3.3   POTENTIAL INDUSTRY UPTAKE

Following the publication of the papers written as part of the research, the RE has been contacted by two leading construction firms (one engineering consultancy and one contractor) for consultation on the implementation of KM initiatives within their respective organisations. As a result two meetings have been held between senior members of staff from these firms (including a knowledge manager and senior directors) and the RE, at RWB's head office in London to discuss the use of CoPs and supporting technologies. The meetings provided an opportunity to emphasise KM best practice within the industry and also to gain further appreciation of the importance for KM initiatives to be tailored to fit the specific needs of different firms. Further meetings have been planned in the next 6 months to discuss the progress of the two organisation's KM initiatives. An annual forum was also proposed, with members responsible for KM from various construction and non-construction firms to discuss KM ideas, the initiatives adopted within the various organisations, and to establish the applicability of best practice within the respective firms.

5.4   FURTHER RESEARCH

This section highlights areas of research that were identified as a result of the research, but could not be addressed during the EngD timescale. Table 5.2 represents each of these areas as a framework for further research.

Table 5.2: Framework for Further Research

Topic	Need for further research
Long term use of technology to support people-based KM	The importance of a focus on people-based KM is vital for the success of a KM initiative. However, as organisations grow and expand into new and more disperse geographic locations (and time zones) the demand for supporting technology will increase. As the use of KM-supporting technology becomes part of people's daily routine and they become more comfortable in using it, it will be important to understand how to maintain a focus on people-based KM despite widespread adoption of technology and the difficulties in facilitating face-to-face collaboration.
Measuring the effectiveness of KM-supporting technology	The need for the best suited technology will continue to be an important consideration and ongoing reviews of the KM-supporting capabilities of these technologies will be important. Although KPI metrics were developed during the research, they are still at an early stage of use. Further research is necessary to assess whether they provide adequate analysis of the performance of KM-supporting technology.
Locating the right knowledge	The introduction of MOSS during the research provided a powerful tool for capturing and storing knowledge. However, as these repositories of knowledge (image & document libraries, wikis, discussion forums etc.) grow and the amount of knowledge increases, the ability to search for and locate the right knowledge will be important. Research investigating the ability of technology to provide effective search results and the effect that this has on the successfulness of KM-supporting technology is therefore needed.
Utilising KM to move into new areas of expertise	The research highlighted the importance in providing people with the right tools and opportunities to facilitate simpler KM, in particular in setting up and establishing CoPs. Further research examining approaches for encouraging the creation of new areas of knowledge and the KM tools, which would be necessary to sustain this process would be useful.
Cross-CoP collaboration	Although the research examined CoP critical success factors and management best practice, many of the technical CoPs within RWB work on closely related areas of engineering. Further research examining techniques, which can be utilised to encourage successful collaboration across different CoPs would be useful in understanding approaches to knowledge sharing across CoPs.
Further examination of use of rewards / recognition	Although the importance of recognition for members of staff who contribute to KM initiatives was acknowledged during the research, further reward and recognition approaches need to be considered. In particular the integration of KM into the career development of staff needs further exploration.
Establishing the commercial benefit	Although the development and implementation of the overall KM framework within RWB resulted in the introduction of a number of KM improvement and development initiatives, the financial benefit of these changes was not measured. Further research would be useful in outlining a method for demonstrating the financial impact of improved KM on the firm and the commercial benefits that resulted.

5.5   RECOMMENDATIONS FOR INDUSTRY

The overall recommendation to the construction industry is to view a KM initiative as the sum of three parts and to encourage the adoption of balanced KM approaches, which are (1) focussed on people-based KM activities, (2) supported with the right technology, and (3) integrated into operational business processes.

Firms within the construction industry should use the framework outlined in this study as a model and actively tailor a range of specific KM activities (people-based, technology-based and process-based) to fit the needs of the business, the requirements of staff and the way in which the business operates on a daily basis. Key considerations for any organisation wishing to establish an effective KM initiative include the following:

- Construction organisations need to ensure that their KM initiatives are focussed on people; at the simplest level this should consist of establishing the right meetings to get the best suited people communicating and collaborating.

- From the outset any organisation developing, implementing or wishing to sustain a KM initiative needs a clear KM vision, which should be facilitated by developing and communicating a KM strategy (statement) and action plan.

- Successful KM should be facilitated through strong leadership, which needs to be demonstrated from the top of the organisation through to each one of the KM activities in place. KM leaders/champions need to raise awareness of KM, its importance to the business, and the benefits that can be realised. Leaders need to acknowledge that people involved in KM need to be continually stimulated and enthused to contribute to KM initiatives.

- KM initiatives require effective management, which includes providing KM activities with the appropriate resources (including funding), recognising successful KM projects, solutions and members of staff, and ensuring that the initiative is supporting the progression of the business. However, it is important for KM management to take a 'light touch' approach.

- Although an organisation's KM initiative should support the business's objectives, due to the importance of knowledge in contributing to the competitive advantage of construction organisations in particular, KM should become a core business objective in its own right.

- The organisation should not become too attached to any specific solution to KM (particularly in the case of KM-supporting technology). Changing business environments and the need to stay at the forefront of technical expertise mean that an organisation's KM initiative will need to evolve to support the changing requirements of the business. KM activities need to be constantly reviewed to assess whether they are supporting the progression of the business and its KM requirements; if they are not performing as needed an alternative solution may be necessary. The organisation needs to be prepared to move with the times, and in the case of KM-supporting technology, the solutions that are available are rapidly becoming more advanced and user-friendly.

5.6   LIMITATIONS OF THE RESEARCH

During the four years of research, numerous changes were brought about within RWB and a number of key conclusions were drawn. However, the research did experience some limitations, which were identified as follows:

- While every effort was made to gain an appropriate number of interview participants to ensure that the results were suitably representative of the sampled population, the specialist nature of the subject meant that this was difficult to achieve. In particular, during the investigation into CoP management best practice, interviews with further representatives from the construction industry (non-UK based) and with representatives from manufacturing and pharmaceutical industries would have better supported the research.

- The research was primarily focussed on the implementation and development of a KM initiative within RWB, which represents a small sector of the construction industry

(engineering design). Further to this, RWB (a subsidiary organisation of 'Ramboll') is on the verge of becoming a global business following the merger earlier in the year. However, it is in the early stages of this transformation, and as a result the demands on effective KM across disperse geographic locations will increase over the coming years. This may have influenced the research findings, and further reviews of KM performance as the firm expands will be important.

- The introduction of CoP management approaches and the development of a projects database specification all took place during the last year of the research. As a result, although long-term measurement of their effectiveness is important, it was not possible within the timeframe of this study.

- The focus of the research was on KM within one company. However, engineering best practice established within one organisation as a result of its own KM initiative, does not necessarily represent engineering best practice across the industry as it is based on the experiences of a limited number of staff (in this case 800 people). There is therefore a distinct need to understand how (construction) organisations can transfer knowledge across different firms to establish best practice from tens of thousands of people's experience.

- It was anticipated that the research carried out during Stage 4, examining the use of technology and process-based KM solutions to support people-based KM activities, would lead to a fourth paper. Although this could not be completed within the timeframe of the EngD programme, the paper has been drafted and will be submitted for publication in early 2009 (Appendix D).

5.7   SUMMARY

Knowledge is now widely recognised as a core organisational resource. This study forms part of an ongoing field of research examining the ability of KM practices to maximise the potential of this resource. Historically the tendency of organisations, particularly within the construction industry, has been to address KM on a reactive, *ad hoc* basis. This research presents a structured and balanced framework for KM and outlines the importance for organisations to adopt a strategic approach by focussing on people-based KM, and supporting it with technology and process-based KM activities. Rapid advancements in the understanding of the use of KM practices such as CoPs, as provided within this study, will enable businesses to quickly implement and realise specific KM solutions. This has become essential in a rapidly changing construction industry, which demands that organisations are able to quickly diversify and establish new areas of expertise in order to remain competitive and protect against downturns in the market.

Successful KM rests on a fine balance between the focus on people, supporting technology and integration within business processes. However, as companies become more global and find themselves operating on an increasingly virtual basis, they are likely to become more dependent on technology to sustain their KM initiatives. Maintaining the right KM balance across global organisations is therefore an important consideration and an area for further examination within the field of KM research.

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APPENDIX A ENSURING KM EFFECTIVENESS (PAPER 1)

Full Reference:

Abstract:

Purpose – The identification of a set of critical success factors, which ensure the effectiveness of knowledge management initiatives, with particular focus on the effect of people-orientated success factors.

Methodology/Approach – A comprehensive review of knowledge management literature, substantiated by ten qualitative interviews with leading academics and industrial representatives in the field of knowledge management in the construction industry.

Findings – The research suggests that organisations need to consider several key areas, in particular, the processes and practices undertaken to understand and define knowledge management, the implementation of dedicated champions, the integration of the initiative into the business, and effective communication of its benefits to members of staff. Each of these factors will have a direct bearing on the level of effectiveness reached by an organisation's knowledge management initiative.

Research Limitations/Implications – The industry-based interviewees were all strategic-level managers. This means that, in relation to the application of knowledge management initiatives, they adopt primarily managerial roles. Further interviews with the practitioners of these initiatives would be beneficial in reflecting the more 'hands-on' perspective of knowledge management implementation.

Originality/Value – A holistic overview of the best-practice for maximising the effectiveness of a knowledge management initiative by addressing the issues, which concern the people involved with its implementation.

Keywords:

1 INTRODUCTION

The aim of this study is to identify the critical factors that ensure the effectiveness of Knowledge Management (KM) initiatives before, during and after their implementation, within the context of UK-based construction organisations.

Despite the construction industry existing as one of the most people-reliant industrial sectors (Loosemore *et al.* 2003), the management of people within construction organisations remains a complex and difficult issue (Dainty *et al.* 2002). Nevertheless, UK construction organisations are increasingly becoming aware of the potential of the tacit knowledge held by their employees and the need to manage it (Carrillo and Chinowsky, 2006); an issue which has received widespread coverage in KM literature.

Although employees play a vital role in ensuring the successfulness of an organisation, the significance of people-related practices in providing effective KM solutions within construction firms, particularly in relation to rewards and encouragement for KM, has received a lack of coverage in the literature (Carrillo, 2004). This paper therefore considers the impact of employees on KM initiatives, with the aim of providing recommendations that can be applied generically across the industry.

The research includes a review of KM literature, which provided an understanding of KM issues in general, and the different types of factors that determine a KM initiative's success in particular. The research utilised ten qualitative interviews with key academics and professionals operating within the field of construction-orientated KM, which facilitated the collection of data relating to the different types of factors identified in the literature review. The analysis of the collected data has resulted in the formulation of a number of key conclusions, which take a high-level view of people-related KM issues.

2 KNOWLEDGE MANAGEMENT

Different authors have presented different definitions of KM. Davenport and Prusak (1998) suggest that KM is the process of capturing, distributing and effectively utilising knowledge. This is closely reflected by the definition given by Scarbrough *et al.* (1999), who describe KM as the process of creating, acquiring, capturing, sharing and using knowledge to enhance organisational learning and performance. Robinson *et al.* (2005) define KM as a method of exploiting, or transforming knowledge as an asset for organisational use to facilitate continuous improvement.

KM approaches are described throughout the literature by numerous different terms. Clarke and Rollo (2001), describe the different approaches adopted by various companies as 'KM initiatives', which incorporate the shared characteristic of a company's commitment to developing the production and flow of knowledge, and the dissemination and use of knowledge to create economic value. A KM 'initiative' denotes a holistic approach to managing knowledge. This is different from the term 'system', which is often used in KM literature to describe IT-orientated approaches to KM. 'KM initiative' is therefore the term utilised in this study to describe an organisation's approach to managing its knowledge that includes both human (soft) and system (hard) components.

The pressures placed on organisations to make better use of the knowledge available to them mean that the adoption of an effective KM initiative provides them with an attractive business solution. Gold *et al.* (2001) illustrate this point by explaining that a successful KM initiative enables an organisation to become more innovative, better coordinate its efforts, rapidly

commercialise new products, anticipate surprises, become more responsive to market change and reduce the redundancy of the knowledge and information available to it.

Many academics have identified the importance of people-focussed aspects of KM as the area for greatest potential. Numerous authors have identified the dependence of KM solutions on the staff and managers within an organisation, and the importance of their willingness and ability to act cooperatively and share their knowledge with that of others (Kamara *et al.* 2005; Fong, 2005). KM authors often refer to 'people'-related KM factors and solutions. Davenport and Prusak (1998) report that these factors relate to those personnel working within the firm, who share the requirement to create, share, search out, and use knowledge in their daily routines.

Swan *et al.* (1999b) state that despite the apparent enthusiasm from numerous recent publications for people and managerial solutions for KM, many articles continue to focus on IT-based methods. They also recommend that organisations must not neglect the human issues, and should aim to achieve a people-centred implementation of KM. This is a topic, which is also reported on by Smith & McLaughlin (2004), who suggest that during the development of KM solutions, people-related factors typically remain not acknowledged or discussible. Research into the specific factors that affect the willingness and cooperation of people to contribute to KM initiatives is limited (Swan *et al.* 1999).

Several authors who have focussed their work on the people-orientated aspects of KM have examined some consistent themes, including the effects of the behaviour, decision-making and actions demonstrated by members of an organisation towards its KM initiative (Coates, 2001; Fong, 2005; IRS Management Review, 2000; McKenzie *et al.* 2001; Smith & McLaughlin, 2004; Swan *et al.* 1999b). McKenzie *et al.* (2001) examined the conditions necessary for gaining commitment from employees to KM initiatives and state that:

> *"Organisations cannot assume that if they build a knowledge management system, people will embrace it wholeheartedly…Somehow we have to convince individuals to work in groups and voluntarily commit their energies to business objectives."*

Their key findings showed that gaining commitment requires support from senior management, the allocation of sufficient resources and funds, a dedicated champion, and recognition of the behavioural types of those involved. However, they state that the most important factor is ensuring that the staff members recognise the value of KM. IRS Management Review (2000) provides a number of recommendations for getting staff to share knowledge, stating that it is; *"often the most difficult aspect of KM to accomplish."* It suggests that in order to gain enthusiasm for KM, staff will want to see that their knowledge contributions have been acknowledged and rewarded, through financial or non-financial means. However, it continues by stating that some authors have advised against financial rewards, recommending intangible rewards instead, such as peer recognition, learning opportunities and greater autonomy. Similarly, Osterloh and Frey (2000) identify the importance of *intrinsic* and *extrinsic* motivation for obtaining KM contributions and outline the need for a different approach for each technique.

3   KM IN THE CONSTRUCTION INDUSTRY

The different definitions of KM in the literature result from the various perspectives and contexts that are specific to the authors (Carrillo, 2004; Egbu, 2004). Within construction, KM can be difficult to define precisely as there is not a general consensus on a single unified meaning of the concept (Egbu, 2004). However, Egbu (2004) explains that knowledge is an

important resource for construction organisations due to its ability to provide market leverage and contributions to organisational innovations and project success. The idea of knowledge as a competitive resource within project-orientated industries is a concept shared by numerous authors (Egbu, 2004; Egbu and Botteril, 2001; Nonaka and Takeuchi, 1995; Oltra, 2005). The potential benefits of effectively utilising their knowledge has meant that an increasing number of UK construction companies have identified the need to implement KM initiatives. However, the difficulties associated with understanding and managing organisational knowledge has meant that organisations experience numerous problems in successfully implementing and sustaining their initiatives (Egbu, 2004; Oltra, 2005). Al-Ghassani *et al.* (2004) also highlight the complexities of managing organisational knowledge and state that:

> *"Many unsuccessful knowledge management cases have been observed where rectifying or altering the system was difficult, time- consuming and expensive and failure resulted, in some cases, in the deterioration of the implementation of knowledge management…..Organizations' different cultures and different business goals make it impossible that one knowledge management system or tool would suit every organization and developing methods and strategies for implementing knowledge management needs the integration of several issues such as people, culture, and technology."*

Other reasons for KM failure given in the literature include (Carrillo, 2004; Carrillo and Chinowsky, 2006; Egbu, 2004; Oltra, 2005):

- An incoherent knowledge vision or lack of ownership of the knowledge vision;

- A lack of appreciation of knowledge as an important asset;

- A lack of an information sharing culture and climate;

- Inappropriate methods or tools for measuring and valuing knowledge;

- Inadequate standardised processes;

- Inflexible organisational structures;

- Time constraints or pressure on key staff and knowledge 'experts';

- Fear of the use and application of IT tools for KM (Technophobia);

- The 'knowledge is power syndrome' and failure to see the 'law of increasing returns' associated with knowledge creation; and

- A lack of a clear purpose, shared language and communication.

Integrating a KM initiative within an organisation and within the daily activities of its staff will require a change in the way that they work. Many authors have examined best-practice for implementing and managing change, presenting numerous models and recommendations. Mintzberg and Westly (1992) suggest that an organisation can implement change on a number of different levels, from a very broad and conceptual level, to a narrow and concrete level. They outline the importance of a holistic approach to change by considering the necessary lower-level changes such as structures, systems and people in order to effectively tackle high-level changes such as an organisation's culture and vision. Similarly, Kotter (1990) outlines the steps necessary to reach cultural change and describes this process in terms of eight different stages. The stages were deduced by identifying the most common causes of failure in a study of 100 companies in the process of initiating change:

- Establish a sense of urgency;

- Create a guiding coalition;

- Develop a vision and strategy;

- Communicate the change vision;

- Empower employees for broad-based action;

- Generate short-term wins;

- Consolidate gains and produce more change; and

- Anchor new approaches in the culture.

Research into the process of change within organisations, and the different factors that determine its success has also been carried out by Berenschot (ten Have *et al.* 2003). By examining a number of case studies Berenschot (ten Have *et al.* 2003) developed the seven forces model in order to facilitate an understanding of the key elements of a change process. The seven forces consist of:

- Necessity. The organisation needs to break the inertia and create a sense of urgency.

- Vision. People need to be able to see what they need to do.

- Success. By demonstrating early successes the organisation can create a sense of confirmation that improvements have been made.

- Spirit. A high level of commitment must be initiated and maintained.

- Structure. Organisational-level support is necessary.

- Capabilities. Employees require the knowledge, skills and empowerment to carry out new tasks.

- Systems. Performance should be recognised with the provision of information, reviews and rewards.

Egbu and Botteril (2001) state that due to the project-orientated nature of construction organisations, cultural considerations are important for successful KM. He continues by stating that the short-term, task-focussed work can promote a culture, which inhibits continuous learning. Bresnen *et al.* (2003) state that the focus of KM literature has shifted towards the area of people and culture. Organisational culture is defined by Drucker *et al.* (1996) as the 'corporate glue' that binds employees to the objectives of the organisation. The importance of people and culture to KM is reported on by Kamara *et al.* (2005), who state that the transfer of project knowledge is dependant on the people involved and that the key issue is the relationship between 'individual knowledge' and 'shared organisational knowledge'; how much knowledge is retained by the individual and how much is held across the organisation.

The KM literature also points out the importance of effective communication in KM. Fong (2005) states that knowledge sharing relies on reaching a shared understanding of the underlying knowledge, not just in the content but also in the context of the knowledge, and for this reason communication is vital to capturing and sharing it. Despite the distinct need for people to communicate and share their knowledge, the literature suggests that this does not necessarily occur naturally and automatically, and that most firms do not make a conscious effort to foster the knowledge-orientated activities amongst their personnel (Davenport and

Prusak, 1998). In this case, openness, motivation and time pressures become important contributors to effective knowledge sharing (Fong, 2005).

Robinson *et al.* (2005) emphasise the need for employee recognition and encouragement from their peers, in order to stimulate knowledge sharing. They also identify the role of team leaders as key drivers for visibly recognising the achievements of employees, and that this recognition must be personal and meaningful. Oltra (2005) states that whatever approach is taken towards establishing a reward system for KM, there will be extremely complex dynamics involved, so 'quick-fix' solutions are not appropriate. Careful consideration is therefore needed from management over the roles played by different people, groups and departments across an organisation.

Despite the acknowledgement from academics that 'softer', people-orientated KM factors, including the use of incentives and rewards are important for ensuring the success of a KM initiative, Carrillo (2004) identifies the limited amount of research within this area of KM. Carrillo (2004) continues by suggesting that this is the main drive for the debate amongst academics over the most appropriate methods.

4 RESEARCH METHODOLOGY

The aim of the research is to determine people-orientated factors that ensure the effectiveness of KM initiatives within construction organisations. To meet this objective the findings from the research interviews were interrogated against the key factors, as identified by reviewing literature on the subject. This analysis provided the study with a number of key conclusions and recommendations.

An initial review of KM literature highlighted similarities, common issues, and any differences in views from previous authors. It also identified the following key areas that can affect the success of a KM initiative:

- Defining KM;

- Establishing the right focus for a KM initiative;

- Demonstrating the benefits of a KM initiative;

- Integrating KM initiatives with the organisation;

- Identifying potential financial and non-financial rewards;

- Creating the right environment for knowledge sharing; and

- Managing a KM initiative.

The research data was acquired through semi-structured interviews, which provided the best-suited medium for obtaining in-depth, detailed research material. To ensure highly detailed and meaningful information, leading experts within the subject of KM from both academia and industry were targeted for the interviews. The most suitable number of interviewees has been recommended as being *"as many as is necessary to find out what you need to know"* (Kvale, 1996). However, the most common number of interviews for a qualitative research study tends to be between five and twenty five, due to the time and resources available for a particular investigation and the law of diminishing returns (Kvale, 1996). A sample size of ten was deemed to be the most appropriate for the time constraints of this study, which provided a sufficient number for comparison and analysis of individual and group responses.

Using a preliminary literature review to develop theories and identify key issues, before testing and investigating themes further with qualitative interviews, is an approach utilised by Carrillo (2004) and Oltra (2005). Similarly, the research carried out by both authors was concerned with the people-orientated and HRM factors of KM respectively. Carrillo (2004) interviewed representatives from eleven organisations, while Oltra (2005) spoke to various participants from 3 organisations.

It was important that the research for this study examined best-practice and recommendations from both industry and academia. Although the research published by academics often represents the most up-to-date and cutting edge ideas, their papers are often theoretical and targeted for academic readers. Within industry, practitioners are applying similar concepts and solutions with varying levels of success. The sample group of ten was therefore divided into two groups; five academics and five industrial representatives. Analysing the information obtained from both groups will provide the link between theory and practice, and highlight areas of consensus that provide the greatest potential for construction organisations when implementing KM initiatives.

With a sample size of ten, the selection of the interviewees was an important consideration. Therefore the selection of experts was based on their contribution to key KM publications or, particularly in the case of some of the industrial participants, on their key contributions and influence in large construction firms implementing KM solutions. The interviewees consisted of:

- Four UK-based University Professors;

- A North American-based University Associate Professor;

- A Product Manager for one of the UK's leading KM software suppliers;

- A Collaborative Working Manager representing one of the UK's largest building contractors;

- A Knowledge Manager for a large UK Engineering consultancy;

- A Director for a leading UK Engineering consultancy; and

- A commercial and government consultant for KM solutions.

5   LIMITATIONS OF THE RESEARCH

Further interviews may have enabled more data for a more in-depth analysis of the key research findings, had more time been available for the research study. Although the majority of the interviews were carried out face-to-face, the geographic spread of the interviewees meant that for several interviews a telephone-based approach had to be utilised, which reduced the ability to explore responses in greater detail. The high-level positions occupied by the industry-based interviewees within their respective firms means that they are primarily involved with the management of KM initiatives. Further interviews with practitioners who are more concerned with participation in the initiatives would have been beneficial to the research. Although the interview themes had been carefully mapped out, an unstructured interview approach may have provided the research with additional areas of importance for KM initiatives, as identified by the interviewees themselves but not by the literature.

6 RESULTS AND DISCUSSION

Following the collection of the interview data, responses to the key areas of interest to the research have been analysed. This enabled an assessment of their importance in providing guidance and understanding on the issues concerned with the people-orientated aspects of KM. The following section provides a review of the main findings.

6.1 UNDERSTANDING KM

The research participants presented several differing definitions of KM. This is in keeping with the argument presented by Egbu (2004), who stated that KM is very difficult to define precisely due to a lack of general consensus in KM Literature. During the interviews a generic definition for KM was proposed as being:

> *"The processes associated with the creation of new knowledge, the sharing and transfer of new and existing knowledge, the capture, storage, exploitation and measurement of the impact of knowledge, in such a way that it benefits the unit of adoption, which can be the organisation."*

However, some of the respondents also spoke of the need for organisations to ensure that any generic definition adopted by an organisation is tailored to fit within their specific context and with their particular business objectives. The misunderstanding of the differences between knowledge, information and data was highlighted by the majority of the interviewees and concurs with Nonaka and Takeuchi (1995), who state that 'knowledge' and 'information' are often used interchangeably within KM literature. The interviewees suggested that this contributes to a lack of appreciation of best-suited KM approaches.

Although there were clear differences between the definitions given during the interviews, each version fitted within the boundaries of two perspectives proposed by Al-Ghassani *et al.* (2004); the *outcome perspective*, which examines the benefits an organisation gets from managing its knowledge, and the *process perspective*, which considers the process of controlling the creation, dissemination and utilisation of knowledge.

6.2 INTEGRATING KM WITH STAFF AND THE BUSINESS

As well as ensuring that organisations define KM in relation to their specific context, several interviewees stated that it is essential for a KM initiative to address the organisation's business objectives, type of work, culture, dynamics, policies and practices, and the required added value. Al-Ghassani *et al.* (2004) suggest that due to the differences between organisations' business objectives and cultures it is impossible for one KM system to suit every organisation, and that the key is to align the initiative with economic performance and strategy.

Although the study highlights the importance of the integration of KM initiatives with people's daily processes, several of the participants suggested that there is a danger of making the KM initiative too much a part of people's lives and therefore detracting from their actual jobs.

A theme, which was highlighted by several interviewees and KM authors, was the need for the KM initiative to integrate with existing organisational processes and systems. Fong (2005) raises this point by stating that the willingness of people to behave cooperatively and integrate

their knowledge with that of others is a key factor in ensuring knowledge is effectively created and exchanged.

However, the research identified two different opinions on the correct approach for integrating a KM system into an organisation's processes. While some of the interviewees recommended integration with policies and procedures, others suggested integration with daily and project activities. A key suggestion was that it is important to integrate KM with every-day activities rather than processes and procedures. The reason was cited as the need for KM to be intuitive and embedded, which means that its integration with policies and procedures, *"forcing someone to do something"*, is not necessarily effective.

6.3   NURTURING A KM CULTURE

Creating and sustaining the best-suited culture for knowledge sharing was identified by several of the interviewees as a key factor in ensuring KM successfulness. The importance of culture to KM is outlined by McKenzie *et al*. (2001) who state that a culture, which achieves a best-fit with an organisation's KM practices, is one where the employees do not feel any inhibitions about sharing knowledge. This is also a view held by Smith and Mcloughlin (2004) who suggest that it is vital for an organisation to develop an open and trusting culture. However, the interviewees indicated that the culture within UK construction organisations often inhibits effective knowledge sharing. They described a project-orientated industry, with teams that quickly become disperse, which was also cited as the main reason for the 'blame culture' that often exists. Dainty *et al.* (2002) also identify this issue and blame process fragmentation and the mutual interdependence of inter-functional teams for cultural problems within construction organisations.

6.4   ESTABLISHING KM CHAMPIONS AND TOP-LEVEL SUPPORT

During the interviews the need for someone to take responsibility for the management of the KM initiative, or a 'KM champion', was raised. The issue of who this person should be, and where they should be positioned within the company, prompted conflicting views from the interviewees. The general view however, was that ideally the knowledge champion should be someone at the top of the organisation, and if they are not, it is imperative that they have close collaboration and support from someone who is. McKenzie *et al.* (2001) recommend that all KM initiatives should be championed by someone within the organisation, who should take responsibility for convincing other members of staff of its benefits. They continue by stating that this person should be someone who is respected and with influence, as well as someone who appreciates the goals and objectives of the organisation. One common theme during the interviews was the importance of a core 'KM team' representing a cross-section of the organisation, which can support the KM champion and communicate the advantages of an initiative throughout the company.

Several respondents stated that it is important for the KM champion to take time at the start of the initiative to speak to as many people as possible across the organisation and to 'spread the word' as to the benefits of participating in the initiative. During the interviews the example of one successful KM champion who set aside six months to achieve this aim was given.

The necessity for top-level support was identified by every interviewee, with many suggesting that without top-level support a KM initiative will never work. However, as well as providing the authority to allocate the resources required, the respondents also highlighted a number of

other responsibilities, which top-level staff need to address. Several interviewees highlighted the need for top-level managers to communicate the benefits of the initiative to the organisation and to set an example by demonstrating that they are closely involved with the initiative. The extent to which senior-level support is necessary for KM is outlined by Coates (2001), who suggests that successful KM is purely down to effective management and a manager's ability to facilitate effective communication between members of staff.

The respondents stated that top-level staff must ensure the right culture of collaboration and trust is sustained within the organisation. Other important considerations for top-level staff included; ensuring the right systems and processes are in place to support the initiative; and an understanding of what is needed from the initiative, exactly what KM means for the firm, and that there will be an initial 'time lag' between the start of the initiative and when the benefits are seen.

6.5   ENCOURAGING STAFF BUY-IN

The need for employee buy-in was identified by several of the interviewees as being a critical component in ensuring the success of a KM initiative, with effective communication of the benefits cited as a key aspect. This has also been highlighted in the literature by several authors (Al-Ghassani *et al.* 2004; Carrillo, 2004; Egbu, 2004; IRS Management Review, 2000; McKenzie *et al.* 2001; Osterloh and Frey, 2000; Smith and Mcloughlin, 2004). Egbu (2004) summarises that;

> "The regular communication of benefits of knowledge management is important in sustaining the cooperation of project team members."

The majority of the participants suggested that these benefits should be communicated on a very individual basis or to small groups. It was suggested that the advantage of working with small groups is that these can then network out through the organisation, communicating the benefits of KM.

Al-Ghassani *et al.* (2004) cite the difficulties associated with communicating the benefits of KM as a key barrier to achieving successful KM. Despite the recognition by most respondents that there is a need to work with individuals and small groups, a conflicting argument was proposed by other participants, suggesting that it is very difficult to demonstrate the benefits, particularly to individuals. They concluded by stating that in some cases it may only be possible to communicate benefits of the initiative to the organisation as a whole, where one interviewee suggested that *"sometimes it is for the corporate good rather than the individual."* IRS Management Review (2000) outlines two critical factors in describing the benefits of KM; staff must be able to see that the new tools and practices will make their life easier, and the employees must be given time and space to pursue knowledge creation and sharing. Smith and McLaughlin (2004) suggest that an organisation should focus on three areas to achieve effective buy-in. Firstly, staff members need to become an integral part of the development of the KM vision. Secondly the employees should be motivated to want to make the most of their abilities, and thirdly that managers need to be able to appreciate the importance of facilitating effective face-to-face meetings.

'Real-life' examples of how people have used an initiative to successfully improve their work were identified as a key requirement for demonstrating benefits by a number of the interviewees. Carrillo (2004) also recommends this approach, suggesting that the benefits gained by other companies can be used to sell KM.

Providing rewards and incentives was cited as a critical aspect of ensuring the success of a KM initiative by the interviewees. However, there were several differing recommendations as to the most appropriate approach to take in relation to the use of financial and non-financial rewards. IRS Management Review (2000) states that many experts advise against financial rewards, due to the fact that they send out the wrong messages and have little impact on individual behaviour. The debate within KM literature on the subject of incentives and rewards (Carrillo, 2004) was reflected by the fact that some of the academic interviewees recommended financial rewards while the others suggested the use of non-financial rewards. However, all of the industrial representatives appeared to be in agreement by advising against the use of financial rewards completely, stating that they are problematic and recommending non-financial rewards as an equally viable option. During the interviews it was suggested that, regardless of the type of reward offered to the employees, *"if people feel they are gaining something in return for sharing their knowledge they are much more likely to do so."*

One academic's perspective was that employees should only be rewarded financially when they have contributed knowledge to the initiative, which has then been used by someone else. Further to this it was recommended that people who simply contribute any knowledge to the initiative should be rewarded non-financially. One of the industrial representatives suggested that being able to see that their knowledge has been used by someone else will act as an incentive for employees to continue to contribute to a KM initiative.

6.6 BALANCING PEOPLE AND IT

KM literature has highlighted the importance of both people and IT (Bresnen *et al.* 2003; Carrillo, 2004; Egbu, 2004; Matsumoto, 2006; Oltra, 2005; Robinson *et al.* 2005; Swan *et al.* 1999; Swan *et al*. 1999b), and there is now a general consensus amongst authors on the subject that a multifaceted approach of focussing on both people and IT is required (Carrillo, 2004; Egbu, 2004; Oltra, 2005; Robinson *et al*. 2005). This view was also represented by all but one of the interviewees. Of these, six suggested that the people-orientated aspect is key to the success of a KM initiative, where one participant suggested that the focus should be 90% about people and 10% about IT.

7 IMPLEMENTING AND MANAGING CHANGE

Although the research was carried out completely independently of any other work, the eight critical success factors for KM initiatives within construction organisations hold a number of similarities with Berenschot's seven forces model (ten Have *et al.* 2003). Figure 1 shows the findings from this research project mapped against the different elements of Berenschot's model.

	Eight critical success factors	Berenschot's seven forces model
1	Understand and define KM	Necessity (Creating sense of urgency)
2	Establish a fit with the needs of individuals and the business	Capabilities (Employees need to be capable of carrying out new tasks)
3	Integrate into organisation and daily lives of staff	Spirit (Employees care committed)
4	Implement KM champions and a supporting team	
5	Establish top-level support	Structure (Organisation-level support)
6	Demonstrate and communicate benefits and successes	Success (Demonstrating successes)
7	Determine suitability of financial and non-financial rewards	Systems (Rewarding performance)
8	Achieve a balance between people and IT	Vision (People can see what they need to do)

Figure 1: Comparisons to Berenshot's seven forces model

Although the implementation of champions and a supporting team is an additional point to the seven forces outlined in Berenschot's model (ten Have *et al.* 2003), this is an element included in Kotter's (1990) change process model. The link between the findings of this research and the elements necessary for implementing successful change indicates that the eight critical success factors outlined in the research serve as both guidance for ensuring that a KM initiative performs effectively, and also guidance for its successful introduction within an organisation.

8 CONCLUSIONS

The objective of this study was to consider the critical factors affecting the successfulness of a KM initiative within a construction organisation. The analysis of the data collected from the literature and interviews, conducted as part of the research, identified eight critical factors, which need to be considered before, during and after the implementation of a KM initiative, to ensure its effectiveness. These are as follows:

- Establish a high level of understanding and a clear definition of KM throughout the organisation.

- Ensure that the KM initiative fits with the needs of the individuals and the organisation's business objectives.

- Integrate the initiative seamlessly into the organisation and the daily lives of employees.

- Implement KM champions and a supporting team.

- Establish top-level support.

- Clearly demonstrate and communicate the benefits and initial successes of the initiative.

- Determine the suitability of financial and non-financial rewards.

- Achieve a balance between people and IT.

Although academics and industrial organisations have recognised the need for KM, there can be confusion over specific definitions of knowledge and KM within construction organisations. As a result there is the danger that KM initiatives can become misguided and

not serve their desired purpose. It is important for the whole organisation to understand what KM is and why it is important. The organisation should take a recognised and accepted generic definition, apply it to their specific context, and tailor it to accommodate specific business objectives. This will require support, agreement and communication from the top. To ensure an alignment with its business objectives and strategies, the organisation should consider the type of work they carry out, their culture, dynamics, politics and practices, as well as the added value that is required from the KM initiative.

It is important that the initiative becomes intuitive and embedded within people's every day lives, rather than appearing as an additional task that managers require them to complete. To ensure that this is the case the KM initiative should appear as a small change to their lives and should be implemented as part of existing daily or project activities. To be well-received, KM activities should only require small amounts of time and effort. However, this should be contributed on a regular basis. Although this can be enforced through policies and procedures, the initiative is likely to be seen as something that they are required to do rather than a useful aspect of their work. The policies and procedures approach should therefore be minimised.

A designated manager for the KM initiative, or 'KM champion', is vital for ensuring its success. The KM champion should be supported by a team of 'sub-champions', who can support the KM initiative at all levels of the organisation. Ideally the KM champion should be someone at a strategic level within the organisation, as they have the authority, responsibility and accountability for providing the required resources and processes. If they do not occupy a senior position they will require the close collaboration and support from someone who does. It is important for the KM champion to be given time from the outset to speak to people across the organisation to communicate the benefits of the initiative. This study has indicated that it is important for KM champions and senior managers to understand the necessity for this initial period, which will ensure that the benefits and importance of the initiative are communicated across the business.

Top-level support for the KM initiative is extremely important in order to provide it with the necessary resources, implement the right processes, set an example, and communicate the benefits. Although KM literature has identified the need for top-level support (Carrillo, 2004; Coates, 2001; Egbu, 2004; McKenzie et al. 2001), this study has shown that this support will only be effective when top-level managers understand explicitly what the KM initiative is, what it will require from the organisation and how it should support the business.

To ensure employee buy-in to the initiative, its benefits must be clearly communicated to them. When communicating the benefits, KM champions and managers need to consider the cases of specific individuals or small groups, and assess how KM can improve their daily activities and work. People can be profiled to determine what they want from the KM initiative, how they are likely to respond to it and whether additional training, coaching or pressure will be required. Real-life examples of how the initiative has been used to improve someone's work should be communicated to employees. Although the KM literature consistently identifies the need for employee buy-in (Carrillo, 2004; Egbu, 2004; Fong, 2005; Robinson et al. 2005), this study suggests that there is a danger of encouraging employees to over-contribute to a KM initiative, and as a result become a distraction from their actual job roles. Employees therefore need to be aware of what is required from them, while senior managers should establish suitable levels of contribution.

Rewards can be very useful in encouraging participation in a KM initiative. However, non-financial rewards are more likely to appeal to construction professionals than financial rewards. KM needs to become a regular part of people's everyday work. Rewards for regular

everyday activities are soon likely to lose their appeal, although regular recognition and encouragement is important. Employees who use the initiative to improve their own work, or contribute knowledge that proves useful for someone else should be rewarded for doing so. It is also important that they can see where and how their contributions have been useful. While recognition from colleagues, the organisation and the wider industry are key motivators, awards and days-out have been used by construction organisations to good effect. KM literature identifies the debate, which exists between academics over the use of financial and non-financial rewards. Although this was reflected in the responses from academics during the research, those respondents representing industry were in agreement that financial rewards should not be used to encourage KM involvement.

Careful consideration should also be given to determining the necessary roles of both the people involved and any IT solutions. The research indicated that although the initiative should be primarily focussed on people, IT support is important. To achieve the right balance an organisation should strive to sustain its people-orientated KM practices, while also ensuring that the right technology is in place.

It is important to recognise that the research is focussed on KM initiatives within construction organisations in the UK and the USA. The KM initiatives discussed are probably influenced to some extent by cultural characteristics such as the project and team-based nature of the work, the competitiveness of construction markets, and the traditions and practices within the two countries. As a result these research findings may have some limitations in their application to other countries and industries; hence, careful consideration of any cultural differences (which could affect, in particular, the integration of KM initiatives with the way people work and the organisation's goals, and the adoption of rewards for KM) would be appropriate in these cases.

The research findings have shown that the people involved with the implementation and management of a KM initiative play a vital role in determining its effectiveness within a construction organisation. Although the research has been focussed on construction-related KM, there are distinct similarities between the findings and the change management models outlined by Berenschot (ten Have *et al.* 2003) and Kotter (1990). This suggests that the eight critical success factors may serve as a more generic set of guidelines for the implementation of KM initiatives within organisations outside of the construction industry. By considering the eight critical success factors identified in this study, managers and practitioners can have confidence in adopting a holistic approach towards their involvement in an organisation's KM practices.

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APPENDIX B   CRITICAL SUCCESS FACTORS FOR COPS (PAPER 2)

Full Reference:

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Abstract:

Knowledge management has received considerable interest within the construction industry in recent years. In particular, organisations and academics have highlighted the potential benefits to be gained from successfully implementing people-orientated knowledge management solutions, of which Communities of Practice have become a recognised, and in many cases, a successful and preferred technique.

The aim of this research is to identify the critical success factors for technical Communities of Practice within an engineering design consultancy. To achieve this, a series of interviews were carried out with key members of staff involved in Communities of Practice within a leading engineering design consultancy. This provided the research with both strategic and operational perspectives. The interview findings were then compared with the key recommendations outlined in related Knowledge Management literature. The sponsoring company has carried the research forward and is looking to implement the critical success factors identified through this study to further enhance the effectiveness of its Communities of Practice.

Based on the findings from the interviews and the Knowledge Management literature reviewed, the research proposes a series of methods necessary for ensuring that an organisation can maximise the potential of its Communities of Practice. The results suggest that the effective use of Communities of Practice can support the business on both a strategic and project level.

Keywords:

Knowledge Management, Communities of Practice, engineering consultancy, Task Groups.

1 INTRODUCTION

Knowledge is increasingly being recognised by commercial organisations as a source of competitive advantage (Edvinsson 2000, Johannessen and Olsen 2003). In recent years Knowledge Management (KM) has received a large degree of interest from many academics and practitioners, who have proposed numerous KM approaches and solutions.

Although two different approaches to KM; people-orientated and technology-orientated, have been used in the past, there is now a general consensus amongst academics and practitioners that a holistic approach is needed with both people and technology-based aspects considered together. Many authors are of the opinion that the people-focussed aspects of KM are of primary importance, although to be effective and sustainable these will require the support of technology-based solutions (Carrillo 2004, Pan and Scarbrough 1998). Communities of Practice (CoPs) represent a primarily people-based KM solution which has received widespread coverage in KM literature.

This paper examines the factors, which determine the effectiveness of CoPs within a 600-strong multi-disciplinary engineering design consultancy. The research includes a review of KM literature and a number of qualitative interviews with members of staff responsible for CoPs within the case study organisation. The analysis of the data collected has resulted in the formulation of a number of conclusions, taking a high-level view of the necessary conditions and requirements for CoPs to successfully support an engineering design consultancy.

2 KNOWLEDGE MANAGEMENT IN CONSTRUCTION

The recent interest in KM within the construction industry has resulted in a large amount of literature on the subject. The following review enables an understanding of similarities and differences in the statements made by previous KM authors.

Many UK construction organisations have acknowledged the potential of the knowledge held by their staff and the need to manage it (Carrillo and Chinowsky 2006, Robinson et el. 2001). However, managing this knowledge is a complex issue, the solutions for which must be tailored to fit each individual organisation (Al-Ghassani *et al*. 2004). Davenport and Prusak (1998) describe KM as a process of capturing, distributing and effectively utilising knowledge, while Robinson *et al*. (2005) define KM as a method of exploiting, or transforming knowledge as an asset for organisational use to facilitate continuous improvement.

The necessity for organisations to consider the use of various KM approaches can be explained by the existence of different types of knowledge. Nonaka and Takeuchi (1995) describe two kinds of knowledge. The first is explicit knowledge, which can be articulated through formal language and can be transmitted across individuals formally and easily. The second is tacit knowledge, which exists as personal knowledge embedded in an individual's experiences. This type is hard to formalise, and difficult to communicate or share with others.

Despite the complexities involved with the transfer of tacit knowledge, KM techniques such as CoPs provide a viable solution (Verburg and Andriessen 2006). Indeed, following a survey of large construction organisations, Carrillo *et al*. (2002) stated that CoPs were the most widely used KM technique. KM authors also suggest that large international construction companies have the greatest need for, and benefit most from CoPs (Egbu and Robinson 2005). Verburg and Andriesson (2006) also state that CoPs have found particular interest due to the failure of computerised systems to support KM.

3 COMMUNITIES OF PRACTICE (CoPS)

Wenger *et al*. (2002) define CoPs as:

> *"Groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis."*

Similar definitions are proposed by Davenport and Prusak (1998) and Lesser and Fontaine (2004), who describe CoPs as self-organising groups that establish a regular system of interchange, which are initiated by employees who communicate with one another because they share common work practices, interests or aims. Although 'Communities of Practice' has become a well-used term within the literature, they are also referred to as 'knowledge communities', 'knowledge networks', 'learning communities', 'communities of interest' and 'thematic groups' (Al-Ghassani *et al*. 2005).

The literature highlights the fact that there are numerous different forms of CoPs, which vary between different organisations and conditions. Although Wenger *et al*. (2002) state that CoP size, lifespan, distribution, formality and intent can all vary, they describe four types of communities commonly found in organisations as being:

- *Helping communities*, focused on solving everyday problems and sharing ideas;

- *Best-practice communities*, concerned with the development of best-practices;

- *Knowledge-stewarding communities*, concerned with distributing knowledge; and

- *Innovation communities*, fostering the development of unexpected ideas and innovations.

Saint-Onge and Wallace (2003) describe several generic CoP characteristics, which also serve to outline the basic requirements of a CoP:

- CoPs should be self-managed, providing solutions based on experience.

- CoPs should create knowledge that supports the organisation and establish their own norms and guidelines.

- CoPs should be a resource for their members, where each member supports the others.

- Organisations should recognise the importance of CoPs and collaboration.

3.1 COMMUNITY MEMBERS

Saint-Onge and Wallace (2003) state that member commitment is vital for CoP success. They suggest that although CoP membership can be less permanent in the early stages, once the CoP establishes a strategic purpose the members will see a direct impact on their ability to perform, and are more likely to stay involved. The literature identifies CoP coordinators as being particularly important for CoP success, stating that they should identify important issues, plan and facilitate events, link members, manage CoP/organisational interfaces, help to build a knowledge base, and assess CoP progress (Wenger *et al*. 2002, Wenger 2000).

3.2 BENEFITS OF CoPS

The value added by CoPs is a topic, which continues to be debated (Saint-Onge and Wallace 2003). Wenger *et al*. (2002) suggest that it is important for the value of CoPs in stewarding

knowledge to be fully understood, and that organisations should set the right expectations and acknowledge that CoPs are not the means to replace teams or business units. The literature commonly divides CoP benefits into organisational benefits, community benefits and individual benefits (Wenger *et al.* 2002, Saint-Onge and Wallace 2003, Fontaine and Millen 2004, Frost and Schoen 2004). These are described in Table 1. Indeed, these benefits could also serve as success metrics; a CoP could be assessed through its ability to deliver the three sets of benefits.

Table 1: CoP Benefits

Individual Benefits	Community Benefits	Organisational Benefits
Establishes a network of contacts	Establishes trust between members	Increases opportunities for technology and innovation
Provides a sense of community and enhances job satisfaction	Improves collaboration and access to expertise	Enables faster problem-solving and quality of decision-making
Enhances reputation and a professional sense of identity	Enhances power sharing and influence within the business	Aids employee recruitment, development and retention
Expands skills, expertise and confidence in approaching problems	Develops a common language, methods and models around specific competencies	Enhances strategy, efficiency, cost savings, and authority with clients
Supports daily work activities and team contributions	Shares knowledge and retains expertise	Improves speed of service and quality assurance

3.3 MANAGING AND SUSTAINING CoPS

CoP management techniques have become a key topic within the literature. De Laat and Broer (2004) suggest that many CoPs are formed naturally from networks, which are established spontaneously. Saint-Onge and Wallace (2003) support this viewpoint, stating that:

> *"Early analysis of knowledge-based organisations identified groups of employees getting together to solve work-related problems, without management directive or involvement."*

However, many authors suggest that management support for CoPs is a crucial element. Wenger *et al.* (2002) state that although management is necessary for CoP success, CoPs can be resistant to over supervision and as a result cannot be measured and managed in conventional ways. They suggest that although management methods may seem informal in the early stages, they will need to become more rigorous over time as investments increase.

The difficulties associated in determining the best-suited management methods for CoPs are well documented (Lesser and Fontaine 2004). KM authors have suggested that formal management approaches can be at odds with the informality of CoPs, and that the correct balance is needed to prevent the creation of discrete, isolated and inward-looking CoPs, which may inhibit organisation-wide knowledge sharing (Quintas 2005, Hislop 2004). Sheehan *et al.* (2005) suggest that organisations, which are formal and hierarchical can be detrimental to CoPs, as they may be perceived to be less business critical than project teams.

Middle and senior managers play an important role in fostering CoP success. They need to visibly value CoPs, provide resources, recognise the efforts made by CoP members, promote CoPs as 'industry best-practice', and ensure that CoP objectives are aligned with those of the business (Frost and Schoen 2005, Saint-Onge and Wallace 2003, Wenger *et al.* 2002).

3.4   CRITICAL SUCCESS FACTORS

The importance for effective CoPs is illustrated by Gold *et al*. (2001), who explain that successful KM initiatives enable organisations to become more innovative, better coordinate their efforts, rapidly commercialise new products, anticipate surprises, become more responsive to market change and reduce the redundancy of the knowledge and information available to them. Several authors have examined the specific issues that contribute to CoP effectiveness and have proposed a number of critical success factors. Vestal and Lopez (2004) identify the following nine key factors necessary for CoP success:

- A clear and compelling business case for all involved.

- A dedicated and skilled facilitator or leader.

- A comprehensive knowledge map outlining the required focus of the CoP.

- An outlined and easy-to-follow knowledge sharing process.

- A supporting technology to facilitate knowledge exchange, retrieval and collaboration.

- Communication and training plans for members and others outside of the CoP.

- An updated and dynamic roster of CoP members.

- Metrics of success to show business results.

- A recognition plan for CoP participants.

Lee and Neff (2004) examined the impact of supporting technology. They state that face-to-face contact is essential, and suggest that technology can, at best, support CoPs in-between such events. They also state that although technology is important, it cannot launch and/or sustain an effective CoP on its own.

Wenger *et al*. (2002) state that due to the voluntary nature of CoPs, their ability to attract and engage members by generating excitement, relevance, and value will determine their level of success. They continue by identifying seven critical success factors for CoPs:

- Design CoPs for evolution and recognise that a CoP's focus is likely to change.

- Include both inside and outside perspectives to determine the right direction for a CoP.

- Establish a coordinator, core group of attendees, and a suitable level of participation.

- Develop both public and private community spaces allowing for meetings and websites, as well as one-on-one networking of community members.

- Regularly discuss CoP value. Although early value may be provided by tackling current problems, as the CoP 'grows' the development of knowledge becomes more important.

- Combine familiarity and excitement.

- Create a rhythm for the community by holding regular events at the right frequency.

Despite the CoP best-practice guidance outlined in the literature, authors are calling for further research and understanding of the conditions necessary for successful CoPs. While Verburg and Andriesson (2006) state that little is yet known about their useful way of working and what would constitute useful success conditions, Soekijad *et al*. (2004) state that despite the attention form organisations, academic interest in CoPs is still limited.

4 CASE STUDY

The sponsoring organisation is a multi-disciplinary engineering design consultancy with thirteen offices based both in the UK and internationally. As well as structural engineering (its core business) it also offers a number of other disciplines including; building services, fire, façade, and geotechnical engineering, bridge design, infrastructure and public health, environmental assessment, and sustainable and renewable projects.

Task Groups (TGs) are the organisation's equivalent to a CoP, and are made up of groups of employees who volunteer to address issues for a particular area of the business. There are 33 TGs in total covering a wide range of subjects, which involve approximately 200 members of staff. TGs can address topics that are raised by the company's management meetings, by anyone within the organisation through a feedback system on the company intranet, or topics communicated to them informally. Following the resolution of an issue by the TG, its members then determine how to disseminate that information. The organisation is primarily interested in improving the 18 TGs that are focussed on technical aspects, which are therefore the focus of this research. TGs have always been fundamental to the organisation's culture and it has previously implemented improvements, based on extensive research examining how the organisation can enhance the way in which it supports TGs (Matsumoto 2006). The company wishes to build on its previous research, and continue to drive TG best-practice.

5 METHODOLOGY

The aim of the research was to identify the critical success factors necessary for CoP effectiveness within an engineering design consultancy. To achieve this, a set of semi-structured interviews with the 18 technical TG chairs, and a focus group with three company directors who are responsible for KM issues were carried out. This provided the research with both operational and strategic TG perspectives. The interview and focus group findings were then compared with the key recommendations outlined in the literature. The purpose of a case study methodology was to facilitate access to staff who could explain the importance of CoPs to the organisation, and the factors that affect CoP success.

Based on the critical success factors identified by Wenger *et al*. (2002), Vestal and Lopez (2004), and Lee and Neff (2004), the TG chair interview topics were as follows:

- How TG objectives are determined and how the organisation provides support for TGs;

- How regularly face-to-face TG meetings/events are held, and who the TG members are;

- How the TG chairs feel their TGs support the business;

- How the TGs disseminate the knowledge generated within their meetings, and how they communicate this across the business;

- How technology is used to support the TGs; and

- How TG success is measured and recognised.

Each of the six areas was discussed in turn with the TG chairs, who presented their views and ideas. Each interview lasted approximately 45 minutes and was supplemented by information available on the company intranet, internal (TG) reports, and copies of presentations made by the TGs to various members of the organisation. During the focus group the directors were

presented with the key TG topics identified by the TG chairs during the earlier interviews, and their views and reactions were recorded. The two sets of data enabled an understanding of the factors that the members of staff involved with CoPs considered as critical to their success.

6 FINDINGS FROM THE TG CHAIR INTERVIEWS

The TG chairs stated that they determine their own objectives and deliverables. Although the majority were focussed on current project issues and tackling short-term objectives, which they felt was valuable to the business, they recognised the need for a constant alignment of longer-term objectives with the organisation's strategic direction. They acknowledged that in order to achieve this, they needed closer involvement with senior managers and an improved communication process. They stated that up-to-date objectives would ensure that TGs continue to integrate effectively with the expanding organisation, and do not become peripheral groups.

The regularity of TG meetings varied. While a few met on a monthly basis, several met once or twice a year. It was interesting to note that the TGs that met regularly were those that were directly linked to the organisation's strategic business plan, and as a result had chairs and senior managers who were more closely involved. The chairs were very enthusiastic about their TGs, but cited a high project workload as the reason for spending less time than they would like to on TGs. Because TG meetings were normally carried out over lunch breaks and were seen as informal events the chairs stated that it can be difficult to come away from their projects to work on TGs. Several suggested that allocating specific office hours to TG work rather than lunch breaks would encourage greater commitment from members, and that a greater allocation of TG budgets would enable them to commit more resources to TG work.

The chairs recognised the importance of commitment from TG members. Several stated that they required new volunteer members. While some stated they would simply benefit from more people to tackle the TG workload, irrespective of experience, other TGs required people with high levels of skill and experience to maintain the high levels of quality on TG projects.

Because many TGs were focussed on current project issues, some were only active for short periods of time when a related issue was raised on a project. The chairs were concerned that the periods of inactivity may result in a lack of long-term support for, and awareness of TGs. Wenger *et al.* (2002) provide guidance on this issue by suggesting that during periods of decreased activity, CoPs should focus on idea sharing forums and tool-building projects.

The chairs identified the necessity to further enhance the dissemination of TG findings. This aspect was examined in the previous TG research project (Matsumoto 2006), which resulted in the compilation of a form for TGs to document objectives and deliverables, and a TG reporting schedule. Although the form and schedule had been utilised by the TGs, the chairs were in agreement that these needed to be kept updated. There were two main meetings for the TGs to present and discuss their work outside of the group; a monthly management meeting, and a lunch time meeting for presentations to the whole organisation. Although only a few TGs had presented at both meetings, the chairs demonstrated a desire to regularly report on their work, and stated that this would create a greater awareness and recognition of TG successes. They stated that a clear reporting process would enable them to keep the organisation updated on TG work on a regular basis.

The chairs were in general agreement that TGs should make greater use of the existing technology available to them. Some TGs had utilised the company Intranet and videoconferencing, however this was not done on a regular basis. One chair stated that several

experts in the subject area of their TG were located at one of the international offices, but had not been involved with the TG via videoconferencing due to the *ad hoc* nature of the TG meeting regularity. The chairs acknowledged that the company is implementing an Enterprise Content Management (ECM) IT system to help it build on its KM capabilities, and that this will provide the TGs with valuable collaboration and knowledge-disseminating tools.

Although the chairs did not feel pressurised to deliver tangible outputs, the TGs that were tackling issues closely related to the business plan were under more pressure to deliver, with one TG included in a regular auditing process. The chairs also stated that greater awareness of TG deliverables would create more opportunities for the business to identify TG successes.

7 FINDINGS FROM THE COMPANY DIRECTOR FOCUS GROUP

The key TG chair findings were presented to the directors to gain an understanding of how they felt TGs supported the business, and any solutions or recommendations they had for enhancing the effectiveness of the TGs.

The directors explained that the company has made on-going efforts for a number of years to support TGs, and that they were keen to understand how management approaches can be improved to maximise the potential of TGs. Although many TG successes were acknowledged, they recognised that more TG benefits could be realised across the business. The directors acknowledged that TG findings should be disseminated across the business more widely to enable a better understanding and awareness of TGs. They identified the implementation of the new ECM system as a facilitator of this. The directors also stated that for effective KM, face-to-face contact including TG meetings and presentations, are equally as important as an IT system for collaboration and communication.

The directors recognised the importance of sufficient time for TGs, although they highlighted the importance for TGs to present a business case to justify the necessity for additional resources. They added that closer collaboration with TG chairs would enhance the communication of TG objectives, and therefore anticipated TG deliverables, making it easier to assess the necessity for allocating specific office hours rather than lunch breaks to TGs.

The directors acknowledged the efforts made during the previous research project (Matsumoto 2006), and the necessity to sustain the use of the TG form and reporting schedule. They suggested that although it is important for most TGs to meet regularly, some may only need to meet once or twice a year. They identified the potential of the monthly technical meeting for TGs to disseminate their findings, which was also highlighted by Matsumoto (2006), and stated that it would provide valuable feedback for TG projects. The directors were keen to monitor TG outputs and suggested that a six-monthly or annual 'TG review' meeting should be set up to enable them to assess TG deliverables.

The interview and focus group responses emphasised a number of CoP requirements, the analysis of which revealed interesting parallels between TG chair and director view points.

8 CONCLUSIONS

The research objective was to consider the critical success factors for technical CoPs within an engineering design consultancy. An analysis of the data collected identified several key considerations, which need to be made by those involved with the management and day-to-day operation of CoPs within an engineering design consultancy. The two sets of responses

confirmed the importance of the CoP success factors identified in the literature, and highlighted a number of methods for their application. These are as follows:

8.1 CONSIDER CoP MEMBER REQUIREMENTS

The enthusiasm and commitment from CoP members, and leaders in particular, is vital for CoP success within any organisation. The requirement for CoP members who have a wealth of experience as well as those who are inexperienced must be carefully considered. The necessity for CoPs within project-orientated organisations to tackle complex project issues means that highly-skilled and experienced employees should be identified as potential CoP members.

8.2 ESTABLISH BOTH SHORT AND LONG-TERM CoP OBJECTIVES

While short-term objectives may concern current (project) issues, which can be effectively established by the CoPs themselves, long-term and more strategic objectives are also necessary in order to sustain CoP effectiveness, requiring high-level input. Because CoPs within project-orientated organisations tackle very complex problems, the specifics of CoP projects do not need to be reviewed at a strategic level. However, regular middle-management support and guidance for CoP projects is vital.

8.3 ESTABLISH REGULAR CoP MEETINGS AND EVENTS

Although CoPs should determine their own meeting regularity based on what they hope to achieve, this should be communicated and agreed at a high level within the business. By doing so, the regularity of meetings can be encouraged and maintained, the profile of a CoP can be raised, and support for it sustained. To build and sustain an organisation's knowledge base, regular CoP meetings should be held even during periods of reduced activity.

8.4 PROVIDE SPECIFIC TIME ALLOCATIONS FOR CoPS

Allocating specific 'office hours' for CoPs within project-based organisations can help to ensure that members, and in particular CoP leaders, can commit to CoP work. It also provides visual recognition that CoPs are a valuable organisational resource. Aligning CoP objectives with the organisation's strategic direction can provide justification for these time allocations.

8.5 FACILITATE REGULAR COMMUNICATION OF CoP WORK

It is important to provide CoPs with clear processes and opportunities for communicating their work. This can help raise CoP awareness within the company, and enhance high-level support and the subsequent allocation of resources. By ensuring that activities are regularly communicated outside of the CoP, there is more incentive for CoPs to ensure that objectives are kept up-to-date and deliverables are monitored.

8.6 CONSIDER THE USE OF SUPPORTING TECHNOLOGY

Although technology may be necessary to support the collaborative features of CoPs and the dissemination of their findings, the most important aspect of CoPs is the face-to-face element.

The research has highlighted the necessity for both operational and strategic perspectives to achieve a balance in the composition of CoPs, their objectives, activities and deliverables. The findings highlight a number of critical success factors for CoPs within an engineering design consultancy, and best-practice approaches for their implementation. Further research will be carried-out with the sponsoring company to assess the application of the findings outlined in this study to its CoPs. The research will examine CoP best-practice within other technical-orientated organisations, both within the construction industry and external to it.

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APPENDIX C MANAGEMENT BEST PRACTICE FOR CoPS (PAPER 3)

Full Reference:

Abstract:

Communities of practice (CoPs) have generated an increasing amount of interest in recent years, both within knowledge management (KM) literature and the construction industry. However, there is an ongoing debate as to the most appropriate way to provide organizational support for CoPs and whether they can be managed effectively for increased organizational benefit. The aim of the research presented in this paper was to identify CoP management best practice and to implement the findings within a sponsoring organization. A key objective was to examine actual CoP management practices rather than managerial intentions – an area of research that, at present, is lacking within KM literature. A review of KM and CoP literature was combined with semi-structured interviews with experts from seven case study organizations, both within the construction industry and external to it. A number of best practices were implemented within a sponsoring organization including providing 'strategic guidance' rather than direct management, establishing senior-level sponsors and/or steering groups, ensuring clarity and alignment of CoP objectives, ensuring effective selection of CoP leaders, securing dedicated CoP resources, integrating CoPs with existing business processes, supporting face-to-face collaboration, and non-obtrusive monitoring of CoP performance. Although a number of key conclusions were established, further research will be necessary to determine the long-term impact of CoP management practices.

Keywords:

1   INTRODUCTION

An initial review of literature on communities of practice (CoPs) examined the contributions made by previous research studies, and any similarities or differences in the conclusions and recommendations made by CoP authors. The key topics identified were then examined in further detail by incorporating them into the interview questions.

In recent years, knowledge management (KM) has become an increasingly important consideration for construction organizations (Ribeiro, 2000; Carrillo, 2004; Robinson *et al*. 2005; Carrillo and Chinowsky, 2006). This has resulted from recognition within project based industries that knowledge is a vital organizational and project resource (Egbu, 2004; Nonaka and Takeuchi, 1995; Pan and Scarbrough, 1998). The effective mobilization of knowledge is particularly important for construction firms due to the difficulty in sourcing expertise quickly and the need to provide clients with confidence of an organization's competence in specific areas of work (Carrillo, 2004). Koch (2002) states that the 'one of a kind' nature of construction projects necessitates the ability of construction firms to effectively reuse and mobilize existing knowledge of different project elements. He suggests that, as a result, KM is likely to take a central role in future competitive strategies for construction organizations.

2   KNOWLEDGE MANAGEMENT IN CONSTRUCTION

The existence of both tacit and explicit knowledge has long been acknowledged among academics and practitioners following the work carried out by Nonaka and Takeuchi (1995). Explicit knowledge can be articulated through formal language, including grammatical statements, mathematical expressions, specifications and manuals, which can be transmitted between individuals formally and easily. Tacit knowledge exists as personal knowledge, embedded in an individual's experiences, which involves intangible factors such as personal belief and perspectives making it hard to formalize and difficult to communicate or share with others. For example, tacit knowledge held by a consulting engineer may concern a specific domain such as the design of oil refineries, developed from years of work in this field. Similarly, tacit knowledge held by a contractor may be knowledge of which construction methods are most appropriate for a specific situation. Construction firms are extremely knowledge-intensive and can be characterized by their use of a high degree of tacit knowledge, resulting from the need for high levels of problem solving and technical ability (Anumba *et al*. 2005; Robinson *et al*. 2005). Tacit knowledge is therefore particularly important in producing innovative projects, which incorporate design and construction solutions that cannot be met by establishhed answers (Robinson *et al*. 2005). Despite the difficulty associated with the transfer of tacit knowledge, it has been well documented that CoPs present a suitable KM solution (McDermott, 2000; Lesser and Storck, 2001; Carrillo *et al*. 2002; Wenger *et al*. 2002; Ardichvili *et al*. 2006; Grisham, 2006; Verburg and Andriessen, 2006; Garavan *et al*. 2007). Wenger *et al*. (2002) go as far as to suggest that CoPs are the best suited tool for codifying knowledge, due to their ability to combine both tacit and explicit aspects.

However, within the construction industry, KM is at an early stage of development, with the majority of firms still focused on understanding, clarifying and tackling KM (Carrillo *et al*. 2002). Construction organizations are therefore interested in finding out which KM practices are being adopted by other firms, both within construction and other industry sectors, in order to benchmark their efforts and improve performance (Carrillo, 2004). In particular, firms within the energy (including oil and gas), manufacturing, IT and software, pharmaceuticals, chemical and financial sectors have been involved in KM for a much longer period than

construction (Ribeiro, 2000; Teleos, 2007) and have proved the effectiveness of their initiatives through the demonstration of benefits including increased revenue, shorter design and production times, improved customer and staff satisfaction, and market leadership. Carrillo (2004) highlights the need for construction organizations to identify KM best practice from outside the construction industry and suggests that further research is needed in this area. CoPs in particular have attracted an increasing amount of interest from construction firms that are keen to mirror the benefits outlined above (Carrillo *et al.* 2002; Koch, 2002; Egbu and Robinson, 2005; Poole and Sheehan, 2005; Grisham, 2006).

3 COMMUNITIES OF PRACTICE AND THEIR MANAGEMENT

Communities of practice are defined by Wenger *et al.* (2002) as 'groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis'. As a result of increased interest in CoPs across KM literature and within the construction industry, firms are actively seeking to maximize the potential of their CoPs by leveraging them to better support organizational performance. However, there is a lack of understanding as to the most appropriate management approaches to adopt and the impact that this has on those involved. This paper therefore presents a review of CoP literature, identifies best practice through an analysis of CoP management approaches taken by seven case study firms, and examines the applicability of these approaches within a sponsoring organization.

Although early literature on KM suggested that technology-orientated KM solutions were the way forward, more recently, the focus has shifted towards the adoption of holistic approaches, focused on people-based KM practices and supported by technology (Pan and Scarbrough, 1998; Carrillo, 2004; Bishop *et al.* 2008a). CoPs have become a key people-orientated KM solution for many organizations that have been recognized as being world-leaders in the field of KM.

3.1 NATURALLY FORMING VS INTENTIONALLY CREATED

Despite a number of research studies examining the use of CoPs (Wenger 2000; Wenger *et al.* 2002; Lesser and Fontaine, 2004), there is an ongoing debate over their manageability and the impact this has on their ability to support organizational performance. Swan *et al.* (2002) highlight the fact that although recommendations regarding management intervention in the operation of CoPs have become more common within KM literature, these debates have tended to focus on managerial intentions rather than actual practices, risking their legitimacy. Whereas some authors are of the view that CoPs are naturally forming, self-organizing groups (Gongla and Rizzuto, 2001; Lesser and Storck, 2001) that are resistant to management (Venters and Wood, 2007), others consider CoPs to be an integral part of the business, which should be set up intentionally and managed by the organization (Gongla and Rizzuto, 2001; Dubé *et al.* 2005). As a result there has been a call for further research to examine the impact that CoPs have on an organization in order to establish a better understanding of how businesses can accommodate and contribute to CoP development (Gongla and Rizzuto, 2001; Roberts, 2006; Loyarte and Rivera, 2007).

3.2   CoP MANAGEMENT

Management of CoPs is a controversial and complex issue (Swan *et al*. 2002) with no one-size-fits-all solution (Gongla and Rizzuto, 2001). This is due in part to the fact that each community has its own unique culture, strengths and challenges. There is an argument that because CoPs emerge as a result of the interest of its members in a particular subject area, rather than to perform a specific task, the focus of the organization should be to recognize and support CoPs rather than to create and manage them (Brown and Duguid, 1991). However, recent literature suggests that there is an increased awareness that CoPs can be managed and leveraged for competitive advantage by creating knowledge resources for teams and business units, creating opportunities to capture and consolidate knowledge across business units, and supporting business strategy (Swan *et al*. 2002; Wenger *et al*. 2002; Saint-Onge and Wallace, 2003; Roberts, 2006; Garavan *et al*. 2007).

Loyarte and Rivera (2007) suggest that although the management of CoPs is a necessity, it should take the form of 'light-touch support'. Roberts (2006) supports this view by stating that organizations should facilitate the spontaneous emergence of CoPs while avoiding excessive managerial pressure. Wenger *et al.* (2002) outline the importance of aligning the focus and objectives of a CoP with those of the organization by suggesting that where CoP topics lack strategic relevance to the organization, the community will be marginalized and have limited influence. However, Brown and Duguid (1991) state that the reorganization of CoP work by managers can disrupt highly functional communities.

As a result of the fact that CoPs may be resistant to over-supervision, management cannot be applied in conventional ways (Wenger *et al*. 2002). It has been proposed that CoP management should focus on creating and promoting the right conditions, time and space for CoPs (Ardichvili *et al*. 2006). To achieve this, the organization needs to establish the right communication channels and regular interactions with CoPs to keep track of their activities and progress (Gongla and Rizzuto, 2001). This suggests that management approaches should be concerned with establishing the right processes and environment to encourage a CoP culture that better supports the business and enhances the perception that CoPs are a valuable resource.

3.3   ORGANIZATIONAL SUPPORT

Achieving the right balance between CoP leadership and organizational support is important. It has been suggested that in the early stages of CoP development, leadership is extremely valuable to the CoP whereas organizational support is less important. However, in the later stages of CoP evolution, this balance is reversed as a result of increased organizational expectation of the value provided by CoPs (Gongla and Rizzuto, 2001).

Cothrel and Williams (1999) highlight the fact that corporate efforts often tend to focus less on the dynamics of CoPs and more on the expected results. This relates to an area of disagreement within the literature surrounding the difference between CoPs and teams, and emphasizes the need for this study to examine CoP practice rather than theory. The literature proposes that although CoPs may move from one state to the other (Gongla and Rizzuto, 2001), they are not the means to replace business units (Wenger *et al*. 2002).

CoP funding is an important aspect of the organizational support necessary for CoPs. The application of this funding should be considered at three different levels – individual participation in CoPs, budgets for projects, and funding for CoP infrastructure, including funding for CoP coordinators. Further to this, many organizations distinguish between more

formal CoPs, which are well funded, have dedicated staff and are accountable for knowledge products or services, and less formal CoPs, which are unfunded and receive less scrutiny over the value that they generate (Wenger *et al*. 2002).

3.4 COP LEADERS

Guidance from CoP leaders or coordinators may ultimately determine CoP effectiveness, to the extent that even in a constraining environment with a lack of organizational support, a well-suited leader can still bring CoP success (Ardichvili *et al*. 2006; Dubé *et al*. 2005). A CoP leader needs to perform both management and leadership activities and should bring drive, vision and enthusiasm to the CoP. They also need to work in close collaboration with middle and senior managers (Wenger *et al*. 2002; Saint-Onge and Wallace,2003; Frost and Schoen, 2004; Garavan *et al*. 2007).

Muller (2006) recommends that CoP leaders should have an established reputation, lead by example and provide a consistent vision of CoP aims and objectives. He suggests that despite widespread observation of CoP leaders, there has been little interest in the impact of leadership on CoPs – an area that this study examines in further detail. The importance of well-suited leaders is such that those who are too busy to commit sufficient time to CoPs may need to be replaced (Dubé *et al*. 2005). Ardichvili *et al.* (2006) suggest that CoP leaders should be elected, while Gongla and Rizzuto (2001) state that it is important to recognize that leaders will require different skills and competencies at different stages in the life of a CoP. The talented candidates who demonstrate the characteristics outlined above are likely to be people who are in demand within the organization. In relation to this, Gongla and Rizzuto (2001) state that further research is necessary in order to understand how CoPs can create the right environment that will attract and sustain the best-suited members. It will therefore be important for this study to examine how the benefits of this role can be communicated across the business.

In addition to CoP leaders, a central CoPsupporting team should be considered. This team would be responsible for raising awareness of CoPs, supporting their development and integrating them with the broader knowledge systems that exist within the business (Wenger *et al*. 2002).

3.5 FACE-TO-FACE VS VIRTUAL COLLABORATION

A key managerial consideration is the adoption of face-to-face and virtual CoP collaborations. Although many authors have cited face-to-face meetings as being critical to CoP success (Lesser and Storck, 2001; Venters and Wood, 2007), some have suggested that face-to-face collaboration can become a slow, costly and time-consuming activity when CoP members are geographically dispersed (Dubé *et al*. 2005). New collaborative technologies have been identified as a possible solution with e-mail, discussion groups and chat rooms cited as well-suited tools (Lesser and Storck, 2001; Dubé *et al*. 2005). Within recent KM literature, virtual CoPs are now the most recognized strategy for integrating the human side of KM. However, effectiveness can be encouraged by basing their formation on existing face-to-face communities or semi-formal groups (Ardichvili *et al*. 2006).

Several authors have suggested that the technological challenge lies in designing the social side of collaborative technology and that whatever technology is adopted, people must be comfortable using it (Cross *et al*. 2006; Loyarte and Rivera, 2007). Moving from a traditional CoP format to a virtual CoP is not an easy process (Dubé *et al*. 2005) and particular consideration must be given to the use of technology at the right stages of CoP development

(Gongla and Rizzuto, 2001). Although smaller firms may wish to sustain a culture of face-to-face collaboration, the use of technology to support this type of collaboration as the business grows will require a culture change in itself.

3.6   IMPLEMENTING CHANGE

The introduction of CoP management practices will represent a change in CoP culture. There is extensive literature available on best practice for implementing and managing organizational change, with many authors recommending a holistic approach, which considers the impact of change at the different levels within an organization (Bishop *et al.* 2008a). Kotter (1990) and Berenschot (Ten Have *et al.* 2003) identify several critical success factors for achieving successful cultural change. They state that it is vital to:

- Create the right vision;

- Establish quick-wins and demonstrate successes;

- Establish a high level of commitment and senior level support;

- Empower people and ensure that they have the appropriate skills and capabilities;

- Implement the right systems and processes; and

- Seek to anchor new approaches within organizational culture.

Huy and Mintzberg (2003) outline three distinct types of change:

1. 'Dramatic change' is driven from the top-down. Although this approach can be effective, it can also be misguided and resisted.

2. 'Systematic change' is generated laterally and is more focused and structured. However, it can be overly formalized and, as a result, stifle initiatives within the organization.

3. 'Organic change' is driven from the bottom-up. Although this is the most natural approach, it can be splintered and anarchical.

Any necessary change in the way CoPs operate will need ongoing support from the CoP members. It will therefore be important to understand the requirements of those directly involved with CoPs, prior to the initiation of a drive for cultural change.

3.7   MOTIVATION

A consistent CoP management theme is the willingness of people to contribute to CoPs. Indeed, the engagement and involvement of CoP members may be the single most important factor that contributes to the success of a CoP (Cross *et al.* 2006). The need for organizational recognition of the value of CoPs and the necessity for CoP activity to contribute to career progression and professional development are emphasized within the literature (Lesser and Storck, 2001; Ardichvilli *et al.* 2006; Bettoni and Braun, 2003; Dubé *et al.* 2005). In relation to CoP activity, a study by Cothrel and Williams (1999) concluded that it was the industries characterized by rapid change that tend to be more active, where people are compelled to seek out others with more experience in order to tackle new complex products.

The importance for encouragement of interest and commitment from CoP members suggests that the way in which management intervention is perceived will be critical. CoP management

needs to acknowledge the value of CoPs and should be seen as something that is there to help and support CoPs, indicating a need for unobtrusive approaches.

4   AREAS OF UNCERTAINTY

The literature review identified several key areas requiring further research. These areas formed the basis for the interview questions and included the following:

- The appropriate level of managerial intervention in the operation of CoPs within different organizations;

- How CoP objectives are determined and aligned with business strategy;

- The way in which CoP leaders and members are attracted and established;

- How to facilitate and sustain effective CoP collaboration;

- How commitment and enthusiasm for CoPs can be sustained; and

- How to identify and recognize CoP value and successes.

5   RESEARCH APPROACH

The research approach consisted of three stages. The first stage was concerned with the identification of areas of uncertainty surrounding the management of CoPs within the literature. The second stage consisted of a review of these areas through interviews with CoP experts from seven case study organizations, which led to the collation of CoP management best practices. The third stage utilised an action research approach, which involved the application of CoP management best practices within a sponsoring organization (not one of the case studies), with a view to bringing about change and improvements to the way in which its CoPs operate. This facilitated a test of the robustness and applicability of the different practices within an industrial setting and enabled the research to develop further knowledge and theory of CoP management best practice based on the action taken.

The semi-structured interviews provided the best suited medium for obtaining in-depth, detailed research material. The organizations were selected based on their identification within KM literature as leaders in KM and CoPs, which had advocated distinct business benefits as a result of their KM initiatives. A sample size of seven case study organizations was deemed to be the most appropriate for the time constraints of this study, which provided a sufficient number for analysis and comparison with the literature review findings.

The sample provided a balanced mix of three construction organizations and four non-construction organizations, enabling sufficient comparisons of the various CoP management approaches. One member of staff from each organization was interviewed for the research (Table 1), although two members of staff from organization E were interviewed as their roles were interrelated. The interviewees selected were all members of staff responsible for the coordination and management of CoPs. This gave the research the required strategic perspective in order to understand key CoP management factors. However, all of the interviewees had also been participants of various CoPs, which provided the research with an added operational element. The key points outlined by the interviewees were then transcribed to facilitate the identification of emerging themes and CoP management best practice.

6 SUMMARY OF INTERVIEW FINDINGS

The following section investigates the areas of uncertainty identified within the literature, by examining the key recommendations made by the representatives of the seven case study organizations. The interviewees highlighted a number of areas that they considered critical in ensuring effective CoP management. These areas formed the basis of the CoP management best practices for implementation within the sponsoring organization.

6.1 THE OPERATION OF CoPS WITHIN THE ORGANIZATION

The number of CoPs that existed within each of the organizations ranged from eight to more than 10,000, which were orientated around either specific subjects or particular job roles. It was the firms outside the construction industry that had the largest numbers of CoPs; the largest number of CoPs for any of the construction firms was 21. When outlining the purpose of their CoPs and what they brought to the business, two key themes were consistently highlighted – to support and connect people, and to link different regions and areas (in several cases on a global scale). Although establishing support for and focusing on people was clearly a key aspiration of all the organizations, it was those outside the construction industry that highlighted it as a core objective. In terms of managerial support for CoPs, all the firms had either a central 'steering group' or 'management sponsors' for CoPs (organization E had both). Interviewee F (see Table 1) described the focus of its central 'KM team' as providing guidance and support rather than management for CoPs, which was primarily concerned with empowering CoPs to give them ownership of their tasks and activities. Interviewees D and F stated that it was important to recognize that different CoPs operate in different ways, while E stated that there was no one-size-fits all solution.

6.2 CoP OBJECTIVES

Within most of the organizations, CoP members determined their own objectives as they are seen as the experts in their respective fields. However, five of the respondents stated that CoP objectives may be further aligned with the needs of the business through guidance from the steering group or management sponsor. Interviewees A and B described workshops that had been held to determine CoP objectives and stated that they had been key in revisiting and reassessing old objectives. All of the respondents identified the importance of senior-level involvement in providing a strategic perspective and the necessary resources. Interviewees C and D stated that specific senior members of staff may be targeted for CoP involvement based on their expertise, while C stated that this process is the responsibility of the CoP itself.

Table 1: Case Study Organisations

Organisation		Interviewee Position	Description of Organisation	Turnover (2007)			
				$1-10bn	$10-50bn	$50-100bn	$100+ bn
Construction	A	**Knowledge Manager** and central coordinator for CoPs	One of the UK's leading homebuilding and construction companies		✓		
	B	**Project and Contracts Manager** responsible for the overall coordination of CoPs	One of the UK's leading construction companies	✓			
	C	**Resource Planner** involved with supporting the operation of a number of CoPs	UK construction subsidiary of one of the world's leading homebuilding organisations	✓			
Non-construction	D	**Engineering Excellence Network (CoP) Leader**	One of the world's largest energy companies				✓
	E	Two members of the **Knowledge Management Team**, responsible for the development of KM-supporting software and supporting the overall operation of CoPs	One of the world's leading oilfield services providers		✓		
	F	**Software Architect** involved with setting-up and running CoPs	One of the worlds leading IT systems providers			✓	
	G	**Knowledge Leader** responsible for overall KM and coordinating CoPs	One of the worlds leading tax, transaction and advisory services firms		✓		

6.3 CoP MEMBERS AND LEADERS

The need for best-suited leaders was highlighted by all of the respondents. Being enthusiastic and committed, having good teamwork and leadership skills, demonstrating expertise, experience and a particular interest in the subject area were cited as being key requirements for a CoP leader. Several of the respondents highlighted the need for 'leaders' rather than 'managers', and that the best approach to be taken in driving a CoP forward was to 'lead by example'. The necessity for a good CoP leader was emphasized by interviewees D, F and G, who stated that the position is often a full-time job role within their firms. Although all of the respondents stated that CoP leaders are volunteers, the selection processes varied. While some of the organization's CoP leaders were simply the keenest, most enthusiastic people, other firms used more formal processes. Interviewee E stated that having volunteered for the position, candidates are then elected into it by the CoP members. Interviewee D stated that CoP leadership positions are advertised internally as a normal job role. The four respondents from firms outside the construction industry highlighted the importance for the CoP leader role to be linked to career development and progression, while three interviewees also cited this as a key requirement of the CoP members. In terms of who can join CoPs, membership

within most of the organizations was open to anyone, with interviewee A stating that it is important to have a balance of experienced and inexperienced staff.

6.4   SUSTAINED COLLABORATION

The necessity for face-to-face collaboration was identified as being key to CoP effectiveness by five of the interviewees (both construction and non construction based), who stated that this type of contact encouraged stronger relationships and trust between members. However, organizations E and F (representing two of the largest firms) stated that although face-to-face collaboration is important, in many cases it is not feasible due to the wide geographic spread of CoP members. They stated that in these cases, technology such as video- and teleconferencing, instant messaging and social networking software should be utilized to support face-to-face collaboration. Interviewee F stated that if used correctly, these technologies can be as good as face-to-face collaboration and that most of their CoPs operate on a virtual basis.

Interviewee F stated that when an organization has thousands of CoPs, which work virtually and autonomously, managing them is about providing them with the right tools and processes to 'help them to help themselves'. He stated that the chief executive officer of the organization once asserted that you cannot authoritatively direct every individual in a company of several hundred thousand, there are simply too many of them, each working in their own context. In terms of resources, the five non construction- based respondents stated that funding is readily available for CoPs and that this can be obtained through applications to the management sponsor or steering group. Time for CoPs was also highlighted as a key requirement by five of the interviewees, including all three based in construction firms. Interviewees A, B, C and D all stated that specific 'work' time is allocated to CoPs. A and B stated that the amount of time is determined by the management sponsor and steering group, respectively, while D stated that as CoPs become more formal, the core group of members may be allocated 10% of their time for CoP work. They also stated that CoP involvement should be part of the job description for people who are involved in a CoP, but are not part of the core group of members. The necessity for allocated time was outlined by interviewee C, who stated that 'without it, project work will always come first'. E stated that although CoP time is seen as something separate to 'work time', the two are becoming more integrated as a result of an improved focus on supporting members' daily work lives.

6.5   ENTHUSIASM AND COMMITMENT

Within most of the case study organizations (the construction-based firms in particular) it was seen as being very important that people were able to recognize the value in contributing to CoPs, not only in supporting their own daily work activities and self development, but also in making a contribution towards the progression of the business. While interviewee E suggested that leaders have a key role to play in encouraging interest and activity, C stated that both leaders and members are rotated on an 18 month basis to maintain interest and focus. Interviewees A and D suggested that where CoPs have become completely inactive or ineffective, they may be disbanded by senior management. E stated that the 'KM team' may step in to help an inactive CoP by introducing new leaders or improving communication channels. Interviewee F stated that it is important for senior managers to empower CoP members to encourage activity and recognize their efforts.

6.6 OUTPUTS AND SUCCESSES

There was no single, formal reporting mechanism covering all CoPs within organizations A, B, D and F. However, within organizations B, C and D, the steering groups or management sponsors were responsible for keeping track of CoP activity. Interviewees A and F stated that CoPs or CoP leaders can be set annual targets or goals, while A also stated that informal outputs such as the number of collaborations, meetings and connections made by the CoP may be monitored. Interviewee D stated that CoP outputs are highly respected within the business, as CoP members are regarded as the experts in their respective fields.

All the respondents identified the importance of recognizing CoP successes. Interviewees A, B, D and F stated that awards are given to members who have achieved success with their CoPs. A, D and F described annual awards programmes and F also mentioned trips abroad and financial rewards. Interviewees D, E and G stated that CoP members who have achieved success are identified through the company intranet or monthly newsletters. D and F highlighted the need to recognize CoP achievements through the career progression of CoP members, and that successful members are often progressed into high-level positions with responsibilities for setting-up and managing other CoPs. This reflected the level of skill necessary to effectively manage CoPs.

6.7 FUTURE CHANGES

Interviewees D and E suggested that within their organizations, CoPs will continue to develop and evolve and that although old CoPs may die out, new CoPs will form. A, C and D stated that CoPs and members will continue to be rotated to ensure that their focus and enthusiasm is sustained. A, B and D stated that senior involvement and support for CoPs will continue to be important, while F stated that locating the right people to be involved will be key. E suggested that management intervention must continue to be based on 'light-touch' approaches driven from the bottom-up, while A identified the need to continually integrate CoPs within the business. Interviewees E, F and G emphasized the need to focus on people and the fact that technology will continue to improve virtual collaboration and the way CoPs are supported. E suggested that in the future people will become more comfortable with this type of technology, which will facilitate further support for CoPs.

7 SUMMARY OF CoP MANAGEMENT BEST PRACTICE

The interviewees proposed a number of solutions for the management of CoPs, which addressed the areas of uncertainty in the literature. These formed the basis for the following set of CoP management best practices.

- Utilize a strategic guidance approach rather than direct management.

- Establish senior-level management sponsors and/or steering groups.

- Objectives determined by CoP members and aligned with the business strategy through close collaboration with management sponsors/ steering groups.

- Selection of CoP leaders based on ability, experience, commitment and recognition from CoP members.

- Secure dedicated CoP 'work time' and funding.

- Integrate CoPs with existing business processes and establish the right CoP culture at an early stage of development.

- Support face-to-face collaboration with effective communication channels and the best-suited technology to empower CoP members.

- Monitor CoP performance through non-intrusive means and provide both strategic and operational-level feedback.

8 SPONSORING ORGANIZATION OVERVIEW

The sponsoring organization is a multidisciplinary engineering design consultancy with 16 offices both in the UK and around the world. As well as structural engineering (its core business) it offers a number of other disciplines including building services, fire, facade and geotechnical engineering, bridge design, infrastructure and public health, environmental assessment, and sustainable and renewable projects.

Task groups (TGs) are the organization's equivalent to CoPs and consist of groups of between five and 10 staff who volunteer to address issues for a particular area of the business. There are 30 TGs in total covering a wide range of subjects, involving approximately 200 members of staff. Following the resolution of an issue by the TG, its members then determine how to disseminate the outcome. The organization is primarily interested in improving the 18 TGs that are focused on technical aspects, which are therefore the focus of this research.

TGs have always been fundamental to the organization's culture and it has previously invested in research to examine how it can enhance the way in which it supports TGs (Matsumoto, 2006; Bishop *et al.* 2008b). This study continues on from research carried out by Bishop *et al.* (2008b) who identified a number of critical success factors for TGs and highlighted the need for an examination of CoP best practice within firms external to the construction industry.

Until now, TGs have operated in parallel to other work activities and, as a result, managerial and organizational intervention in TG activity has been minimal. However, the organization has recognized that to achieve the full potential of TGs, further change in the way they are supported and managed by the business is necessary. In order to understand what action needs to be taken, the sponsoring organization has acknowledged the need to benchmark its efforts against other firms and to examine how these companies have effectively utilized CoPs for increased organizational performance. The aim of the research is to ensure that TGs continue to be a core aspect of its culture and something that staff enjoy contributing to, while also ensuring that they make ongoing contributions to organizational performance and development. The sponsoring organization was therefore fully supportive of the research project and keen to implement its findings.

9 IMPLEMENTATION OF CoP MANAGEMENT

Utilizing an action research approach, each of the above practices was implemented within the sponsoring organization through the introduction of a number of CoP management initiatives, as set out below.

9.1 COMPANY DIRECTORS AS KM CHAMPIONS

Within the sponsoring organization, two directors were established as leaders of KM, one of which was at board level. To ensure that they had a good understanding of CoPs and the value

that they offer to the business, regular meetings were held between the two directors and other senior-level members of staff involved with TGs. This ensured that the focus was on supporting the people involved and providing guidance and support for TGs through 'light-touch' management approaches. The directors gave several presentations on KM and TGs to the whole business, creating widespread awareness and interest, while also demonstrating the senior-level support and commitment for CoPs within the firm.

9.2   STEERING GROUP

Historically, an 'engineering excellence' meeting has been held on a monthly basis, attended by 10–15 senior members of staff (including at least one director) to examine and discuss various engineering related issues and topics within the organization. The group has now been given the responsibility of acting as a steering group for TGs. Each month, members from two TGs are given the opportunity to present their projects, activities and progress at the meeting according to dedicated presentation slots set out in an annual schedule. This has been key in providing high-level strategic guidance, feedback and direction, and also in recognizing the efforts made by the TGs. The high-level position of the meeting and its engineering focus has also further integrated TGs and improved their communication channels across the business.

9.3   TG DETAILS SHEETS

None of the TGs within the case study organization had set out specific goals or objectives and as a result many had lost their focus (Bishop *et al*. 2008b). To address this issue, a 'details sheet' template was compiled and communicated to the TGs. This was aimed at helping them to map out key areas of focus and their needs. Each details sheet included a list of the TG members, short- and long-term objectives, the resources required and any anticipated deliverables. These were then stored in a central location (on a TG intranet page) which could be viewed by anyone within the organization. This gave the TGs a better understanding of the direction that they needed to move in as a group and provided other staff external to the TGs with key information, enabling them to get in touch with the right experts should they need to highlight a related topic. The details sheets were intended to be a 'live' document, which the TGs could use and update at every meeting. They were filled out by every TG and regularly used within management meetings to review TG projects and assess the need for follow-up actions.

9.4   ANNUAL TG FUNDING

An annual budget has now been allocated to TGs, each of which is encouraged to submit a funding proposal for particular CoP projects or an estimation of the time required to complete activities. This has meant that the time taken by members to complete TG-related tasks outside of their project work is still recognized as being productive time, rather than as a 'spare time' activity. A percentage of the budget wasalso intended for rewarding the TGs; an area that the board has opened up to the TG members for suggestions on how successes should be recognized.

9.5   NEW TG CHAIRS

Several TGs had chairs who were very senior and some of the busiest people within the businesses. As a result they were unable to spend sufficient time leading and organizing their TGs. Although these staff continued to be involved with TGs, leadership responsibility was passed on to another member of the TG to encourage renewed enthusiasm and commitment.

The new TG chairs were nominated for the position by colleagues within the TG, which ensured that they were well respected and trusted by the TG members. The most successful replacements were those who were not only committed and enthusiastic, but who were 'up-and-coming future senior managers' and 'keen to make a name for themselves'.

9.6   BEST-SUITED TECHNOLOGY

Following the compilation of an initial central HTML TG intranet page, the case study organization has now created an intranet page for each TG using Microsoft SharePoint 2007 (Figure 1). This software actively supports collaboration through discussion boards and 'wiki-type' encyclopedias, as well as helping the TGs to manage and coordinate meetings, documents and images. Each page is controlled by the TGs themselves, giving them ownership of their intranet space. The pages can be used and updated during TG meetings, reducing administration time and enabling better capture of knowledge. The TG pages have also replaced the details sheets by enabling the chairs to better track their goals, objectives, activities and deliverables. The technology has been a powerful tool for raising awareness of TGs by enabling anyone to view TG pages, get involved in online discussions or locate the people involved.
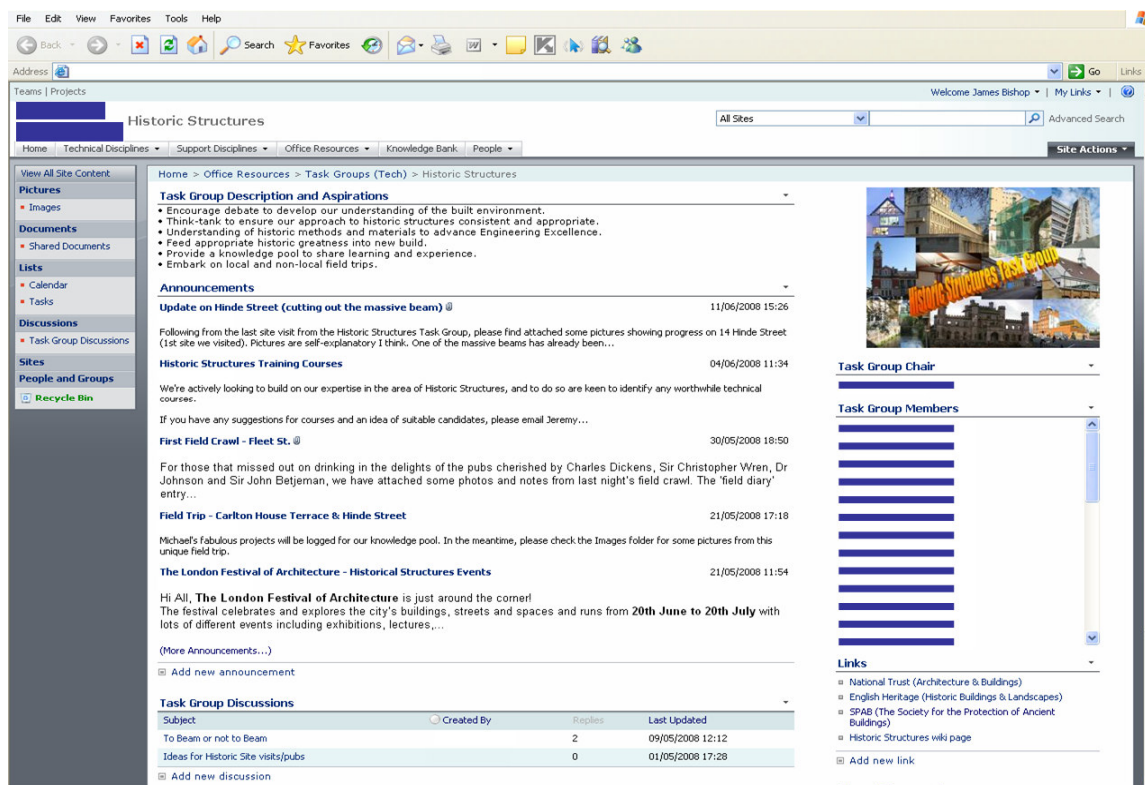

Figure 1: Example of Task Group Page

9.7   HEALTH-CHECK WORKSHOPS

Five 'health-check' workshops were held to review and discuss TG aims and objectives. Each workshop was chaired by a director and attended by between five and 10 TG chairs. The purpose of the workshops was to provide a forum where the TG chairs could present their ideas and objectives to other likeminded colleagues and take on board interesting insights and feedback that resulted. They also provided the chairs with strategic guidance and demonstrated recognition for the importance of TGs. A direct result of the workshops was the

changeover of several new TG chairs and a merging of two TGs. The workshops were well received, with further sessions being called for by the TG chairs and directors. As a result, it is planned that they will become an annual event.

10 REFLECTION

The CoP management best practices and the corresponding initiatives implemented within the sponsoring organization are outlined in Table 2.

The environment, time and space for CoPs, created through the introduction of the steering group, funding and supporting technology were key in enhancing CoP development, as cited by Ardichvili *et al*. (2006). However, although several authors have suggested that CoPs should be set up intentionally (Gongla and Rizzuto, 2001; Dubé *et al*. 2005), these initiatives provided the tools which made the formation of CoPs easier, rather than intentional. For example, the steering group provided a forum where CoPs could present their work in the knowledge that they would be provided with constructive feedback and strategic guidance, rather than being critically reviewed. This was important in aligning CoP objectives with those of the business, enhancing CoP ownership with members, and in maintaining enthusiasm and commitment. Although the importance of a CoP steering group was only briefly highlighted within CoP literature (Wenger *et al*. 2002), it proved to be one of the strongest initiatives implemented, providing strategic support, management sponsors, alignment of objectives, support for selection of CoP leaders, resources, cultural support, communication channels and non-intrusive monitoring.

The presence of skilled CoP leaders, who were trusted and respected by the CoP members, was critical to success, as indicated by Dubé *et al*. (2005) and Ardichvili *et al*. (2006). This meant that although the selection process was an important consideration, the CoP members needed to have the final say on the appointed candidate. The appointment of 'up-and coming future senior managers' as CoP leaders within the sponsoring organization and the dedicated resources both enhanced commitment and sent out the right message as to the importance of the leadership role. Although it has been suggested within CoP literature that organizational support becomes an important factor in the later stages of CoP development (Gongla and Rizzuto, 2001), the research showed that it is vital for the organization (management) to take responsibility from the outset for demonstrating the value of CoPs to the business.

For busy employees who commit their time to CoPs, funding is essential not only in providing them with the necessary resources but also in visually acknowledging their efforts and the value of CoPs to the business. This is particularly true of construction firms, where the reluctance to allocate time for CoPs outside of project work often results in minimal CoP activity. The sponsoring organization has given the responsibility of applying for funding to the CoPs themselves, ensuring that they are able to meet their own distinct resource requirements.

The research indicated that the larger organizations relied on a well established CoP culture and management efforts focused on empowering CoP leaders and members. However, the small to medium sized firms appeared to have achieved success by actively encouraging the right culture through support based more on a one-to-one basis with CoPs, although further research examining a larger sample of organizations would be useful in supporting these findings. The sponsoring organization was at the stage where it was seeking to establish the right culture and needed to implement the best-suited processes and technologies to ensure that, in the future, CoPs will utilize these tools as a matter of course. To ensure that CoP members were comfortable with the use of Microsoft SharePoint pages, the roll-out of this

tool was coordinated among a number of groups with one-to- one follow-up training sessions. Although the technology introduced was a critical enabler of CoP collaboration, supporting the perspectives of Lesser and Storck (2001) and Venters and Wood (2007), it was used primarily as a tool for supporting follow-up actions to face-to-face meetings, which have continued to be a core CoP practice, despite the difficulties identified by Dubé *et al*. (2005).

Table 2: CoP Management Best Practices and Corresponding Initiatives

CoP Management Best Practice	Initiatives Implemented Within Sponsoring Organisation						
	Details Sheets	KM Champions	TG Funding	New TG Chairs	Steering Group	Workshops	Technology
Strategic guidance		✓	✓	✓	✓	✓	
Management sponsors / steering groups		✓			✓		
Determine & align objectives	✓	✓		✓	✓	✓	✓
Appropriate selection process for CoP leaders				✓		✓	
CoP 'work time' & funding			✓	✓	✓		
Integrate CoPs & establish right culture		✓	✓	✓	✓		
Effective communication channels & technology		✓			✓	✓	✓
Non-intrusive monitoring of CoP performance	✓				✓	✓	✓

11 SUCCESS OF CoP MANAGEMENT PRACTICES

Gold *et al*. (2001) describe six key outcomes that indicate a successful KM initiative. These are outlined below, with an assessment of how these outcomes were accounted for as a result of the introduction of CoP management practices within the sponsoring organization.

11.1 ENABLES THE ORGANIZATION TO BECOME MORE INNOVATIVE

The improved clarity and effectiveness of the communication and reporting channels and readily available information on who's involved with which TG, has facilitated better collaboration across TGs, with members from a greater geographic spread now involved. Key project issues are better communicated to TGs, the solutions to which are being better communicated back into the business.

11.2 ENABLES THE ORGANIZATION TO BETTER COORDINATE ITS EFFORTS

The introduction of the SharePoint pages has meant a reduction in administration time for TG members by enabling them to store minutes electronically and have online agendas (all TGs have now published their latest minutes and agendas), which can be viewed and altered in a

central location during meetings. The steering group now accesses these pages on a monthly basis to review TG issues and progress.

11.3 ENABLES THE ORGANIZATION TO RAPIDLY COMMERCIALIZE NEW PRODUCTS

Following the introduction of TG funding, several funding proposals have been received and are currently under review. These include proposals to investigate new materials and design techniques for use in upcoming projects, which would not have been explored otherwise unless done in the engineer's spare time.

11.4 ENABLES THE ORGANIZATION TO ANTICIPATE SURPRISES

The initial details sheets and five workshops facilitated a review of TG objectives and encouraged TGs to take a longer-term perspective. As a result, the TGs are now tackling issues that are not only immediately relevant to their respective areas of expertise, but also those that will be significant in the future.

11.5 ENABLES THE ORGANIZATION TO BECOME MORE RESPONSIVE TO MARKET CHANGE

It is now easier for people to set up, establish and create awareness of TGs. As a result, TG chairs are able to address new areas of interest more quickly and have been getting immediate responses to various issues from members of staff across the company through discussion forums and wiki-type pages. Following the implementation of the practices outlined in Table 2, several new TGs have been formed including flood risk, seismic design, polluted soil and water, and design TGs.

11.6 ENABLES THE ORGANIZATION TO REDUCE THE REDUNDANCY OF KNOWLEDGE AND INFORMATION

The TGs are capturing more knowledge and information than ever before through improved TG meetings, presentations, reporting and their SharePoint pages. Monthly SharePoint statistics have been collected, detailing the total number of visits to all pages, the number of times people click on or open different documents and applications, and the people who access the pages the most. These figures have shown a steady increase since the introduction of the new CoP initiatives.

12 CONCLUSIONS

The aim of the research study was to identify a set of CoP management best practices and examine the implementation of these within a multidisciplinary engineering design consultancy. The provision of a set of practical examples has addressed a gap in CoP literature concerning the application of actual CoP management practices. This was achieved by combining a review of CoP literature and the analysis of seven case study interviews, with an implementation of the findings within a sponsoring organization.

CoP literature questioned the ability to effectively manage CoPs, without compromising the sustained commitment and enthusiasm of CoP members. However, the research has demonstrated that it is possible to achieve a balance, by adopting a nonintrusive 'light-touch, strategic guidance' approach. It also proved that CoP management approaches, which have been successfully adopted by firms outside the construction industry, are suitable for implementation within an engineering design consultancy. Construction firms should therefore strive to provide their CoPs with greater flexibility and freedom, to enable them to react faster to changes and future challenges within the industry.

The research outlined the need for effective integration of CoPs with existing organizational processes and systems. This addressed an area of uncertainty within the literature surrounding the difference between CoPs and teams. Although CoPs should be seen as different to teams, they should be empowered to tackle their work in a similar way. This relates to the allocation of the best-suited tools, processes, resources (including time) and communication channels, which also provides recognition of the value of CoPs to the business. Establishing the right CoP culture at an early stage is important in sustaining long-term effectiveness and ensures that changes in the way CoPs operate ultimately becomes an organic process.

The research has outlined that virtual collaboration tools will become increasingly important as firms expand and as the standard of the technology and its social capabilities improves. Despite the doubts highlighted within the literature as to the longevity of face-to-face collaboration, the research has outlined the importance for virtual tools to support ongoing face-to-face communication. Regardless of the supporting tools and technologies adopted, it is vital that they are tailored to fit the needs of the business as well as those of the CoP members.

The members of staff involved in CoPs will ultimately determine success. Key roles including KM champions, CoP leaders and CoP members therefore need to be filled with the best-suited people. Each of these roles should become a recognized aspect of people's jobs and should contribute to professional development and career progression. This emphasizes their importance and recognizes the skills required. Although these roles should be voluntary, an appropriate selection process for CoP leaders needs to be in place with key input from the CoP members.

Despite the initial success of the implementation of CoP management best practices within the sponsoring organization, further research is needed in order to determine their long-term effectiveness. Further to this, due to the need for CoP management practices to fit the needs of the organization and its CoPs, those implemented within the sponsoring organization require further comparison with approaches that have been tailored and adopted by other construction-based firms.

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APPENDIX D   USING TECHNOLOGY TO SUPPORT A BALANCED KM INITIATIVE (PAPER 4)

Full Reference:

Abstract:

In an increasingly competitive construction industry, the role of innovation has become a key factor for firms wishing to sustain their competitive advantage. Indeed, over the last decade an emphasis on innovation has replaced efficiency and quality as the main source of competitive advantage, and a pre-requisite for success and survival for numerous organisations. It is this requirement for construction firms to become more innovative and maximise the use of their resources that renders *knowledge* as a key organisational asset.

There is now a general consensus across the industry and academia that knowledge is a vital organisational and project resource. However, construction firms have experienced difficulties in implementing effective Knowledge Management (KM) initiatives, with only a handful of firms realising KM success. KM literature highlights the need for balanced KM approaches incorporating people, process and technology-orientated solutions. The aim of this paper was therefore to examine the successful approach taken by a multi disciplinary engineering design consultancy, in implementing KM-supporting technology to sustain its people-orientated KM practices, and integrate KM within its business processes.

Utilising a case study methodology the research highlighted a number of factors which need to be considered during the implementation of KM-supporting technology. These include the need for it to; incorporate capabilities, which reflect a number of overall KM critical success factors; be focussed on people-orientated KM; be tailored to fit the specific requirements of the business; be supported at senior level; be allocated appropriate resources and management; achieve staff buy-in; and be integrated sufficiently to become part of the way people work on a daily basis.

Although the research highlighted the effectiveness of the case study organisation's approach, it acknowledged that there is no one-size-fits-all solution. It also highlighted the need for further research examining the long-term use of KM-supporting technology and effective measurement criteria.

Keywords:

1   INTRODUCTION

The current economic climate necessitates that construction firms are able to react faster to business opportunities and stay ahead of the competition. The ability of an organisation to innovate and make the most of 'what it knows' may make the difference between its success and failure. Knowledge has long been identified as a valuable organisational asset and source of competitive advantage, with many firms both within the construction industry and external to it striving to manage knowledge effectively. However, managing knowledge has proved to be a difficult process, with many organisations experiencing numerous problems in successfully implementing and sustaining Knowledge Management (KM) initiatives. Further to this, KM literature has highlighted the need for an improved understanding of the components necessary to realise a balanced KM initiative and the factors, which will determine its success. By adopting a case study methodology, this study examines the approach taken within an engineering design consultancy to support its people-focussed KM initiative with technology.

2   INNOVATION AND KNOWLEDGE MANAGEMENT

The importance and role of innovation in the overall construction process and necessity for firms to become more innovative in reaction to an increasingly competitive construction industry has been well documented (Egbu, 2004; Robinson *et al.* 2005; Bolwijin and Kumpe, 1990). Several authors have even suggested that innovation has been seen to replace efficiency and quality as the main source of competitive advantage for such firms (Bolwijin and Kumpe, 1990; Egbu, 2004).

Egbu (2004) suggests that the ability to innovate depends largely on the way in which an organisation uses and exploits the resources available to it. Further to this he suggests that it is the requirement for construction firms to become more innovative and to maximise the use of their resources that renders 'knowledge' as a strong organisational asset suggesting that *"few would argue that an organisation's capacity to innovate depends to a very considerable extent upon the knowledge and expertise possessed by its staff."* Edvinsson (2000) illustrates this fact by asserting that knowledge is fast overtaking capital and labour as the key economic resource in advanced economics, while Johannessen and Olsen (2003) state that an organisation's capacity to create and sustain competitive advantages lies in what it knows, not what it owns. Knowledge as a competitive advantage is a topic, which has been highlighted by many authors, who are in agreement that there is now a general acceptance in competitive business environments and project based industries that knowledge is a core organisational and project resource, providing market leverage and contributing to project success (Egbu, 2000; 2004; Nonaka and Takeuchi, 1995; Pan and Scarbrough, 1998; Tseng, 2008).

Knowledge is defined by Nonaka and Takeuchi (1995) as *"a dynamic human process of justifying personal belief toward the 'truth'."* However, they continue by describing two distinct types of knowledge as being; *tacit* and *explicit*. Explicit knowledge is defined as that, which can be articulated through formal language, including grammatical statements, mathematical expressions, specifications and manuals. This kind of knowledge can be shared by individuals formally and easily and is often referred to as *hard* knowledge. Tacit knowledge is described as that, which exists as personal knowledge, embedded in an individual's mind and is often defined as *soft* knowledge. This type of knowledge is influenced by factors such as personal belief and perspectives, making it hard to formalise and difficult to communicate or share with others. Tacit knowledge in particular has been highlighted as being particularly important for construction firms, due to the need for high

levels of problem solving and technical ability (Anumba *et al*. 2005; Robinson *et al*. 2005). Robinson *et al*. (2005) emphasise this point by stating that tacit knowledge is key in producing innovative projects, which incorporate design and construction solutions that cannot be met by established answers.

Alternative definitions of KM have been presented by various authors. Davenport and Prusak (1998) state that KM is "*the process of capturing, distributing and effectively utilising knowledge.*" This is similar to the definition proposed by Scarbrough *et al*. (1999), who describe KM as the process of "*creating, acquiring, capturing, sharing and using knowledge to enhance organisational learning and performance.*" Robinson *et al*. (2005) describe KM as a method of "*exploiting or transforming knowledge as an asset for organisational use, to facilitate continuous* improvement." The existence of the two different types of knowledge and definitions has generated considerable interest within KM literature and within the construction industry as to the best methods of sharing this knowledge, with firms such as Amec, Arup, Balfour Beatty, Bovis Lend Lease, Cyril Sweet, Taylor Woodrow, Turner Townsend and Wates Construction investing in KM (Carrillo, 2004).

KM research has focussed on two distinct KM strategies; codification (IT) and personalisation (people) (Robinson *et al.* 2005). Codification strategies use IT-tools to capture and leverage explicit knowledge, whereas personalisation strategies focus on non-IT-tools or human interactive systems to leverage tacit knowledge. Carrillo and Chinowsky (2006) explain the link between these two approaches and Nonaka and Takeuchi's (1995) distinction between tacit and explicit knowledge, by suggesting that:

> "*Explicit knowledge is that which could be documented and therefore physically stored in either paper or electronic format. For the construction industry these include standard operating procedures, best practice guides, etc. Explicit knowledge thus lends itself to an IT-centric strategy. Tacit knowledge is that which is stored in people's heads and is acquired through experience. This is much more difficult to document. For construction this covers the know-how of experienced staff, e.g. team leaders. Tacit knowledge is better shared using communication channels.*"

Early discussions within KM literature tended to focus on the use of IT-orientated solutions, which in 1998 were the focus of almost 70% of articles (Oltra, 2005). Although the limitations of approaches focussed too narrowly on IT have long been emphasised and the key importance of cultural and people-orientated aspects has been widely recognised (Bresnen *et al.* 2003; Oltra, 2005), IT is highlighted as being essential to an organisation that wishes to manage its knowledge assets (Egbu and Botterill, 2001; Tseng, 2008). Research projects that have examined balanced approaches to KM (people, process and technology-based KM practices) have concluded that a multifaceted approach focusing on all aspects of KM is vital (Bishop 2008b; Carrillo, 2004b; Pan and Scarbrough, 1998). In this respect, this paper utilises the term 'KM initiative' to denote a balanced KM strategy.

With respect to technology, Tseng (2008) states that the value of IT to KM is in enabling the expansion and universalisation of the scope of knowledge and in increasing the speed of transferability. Tseng (2008) also suggests that advancements in IT and the internet have greatly enhanced the value of knowledge assets. Lin and Huang (2008) highlight the importance of ensuring that the users of such technology perceive it to be useful, and suggest that the effectiveness of a KM technology is dependent on the extent to which a knowledge sharing culture already exists. Further to this, they state that the users need to feel that utilising the technology is beneficial to them on a personal level. In terms of the specific technologies used, several authors identify the need for it to serve different purposes such as

authoring, indexing, classifying, storing, contextualising and retrieving information, as well as for collaboration and the application of both tacit and explicit knowledge (Lindvall et al. 2003; Tseng, 2008).

The difficulties associated with understanding and managing organisational knowledge has meant that many organisations experience problems in successfully implementing and sustaining their initiatives (Egbu, 2004; Oltra, 2005; Tseng, 2008). Several have identified specific barriers to the adoption of effective KM initiatives (Egbu, 2004; Oltra, 2005; Carrillo *et al*. 2000), described as:

- An incoherent knowledge vision / lack of ownership of the knowledge vision;

- No appreciation / lack of appreciation of knowledge as an important asset;

- A lack of an information sharing culture and climate;

- A lack of / or inappropriate methods / tools for measuring and valuing knowledge;

- A lack of / inadequate standardised processes;

- Rigid /inflexible organisational structures;

- Time constraints and pressure on key staff / knowledge 'experts';

- Fear of the use and application of IT tools for KM (Technophobia);

- The 'knowledge is power syndrome' and failure to see the 'law of increasing returns' associated with knowledge creation, that shared knowledge stays with the giver while enriching the receiver; and

- A lack of a clear purpose and shared language and meaning of knowledge management.

Bishop et al. (2008b) support the idea of a balanced approach to KM but identify the necessity to focus on people-orientated KM solutions and provide support for these with the best suited technology and processes. However, Tseng (2008) states that few studies have explored the role and effect of IT on KM initiatives. Within the literature, although the barriers to the implementation of effective KM initiatives are understood, there is not a comparable degree of clarity on the success factors for balanced KM. The aim of this study was therefore to examine the successful balanced approach taken by a multi disciplinary engineering design consultancy, in implementing KM-supporting technology to a) sustain its people-orientated KM practices, and b) integrate KM within its business processes.

3   METHODOLOGY

In order to establish a best practice approach for the use of technology to support a balanced KM initiative, it was necessary to examine the successful application of KM-supporting technology within a construction organisation. This demanded the use of a case study methodology, which can be defined as being an empirical inquiry that investigates a contemporary phenomenon within its real life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (Yin, 1984). As within this study, the most common use of the term associates the case study with a location, such as an organisation, and focuses on the intensive examination of the setting (Bryman, 2004).

In relation to data collection, ethnographic research methods were utilised. Ethnography, a term which is also used interchangeably with 'participant observation' and 'fieldwork'

(Delamont, 2004), refers to the extended involvement of the researcher in the social life of those he or she studies, in order to observe people, talk with them and form an understanding of what they are doing, thinking and saying (Bryman, 2004; Delamont, 2004). This entailed observation of, and involvement in the daily operation of the business to facilitate the identification of KM best practice.

4   CASE STUDY ORGANISATION

Ramboll Whitbybird (RWB) is a multidisciplinary engineering design consultancy specialising in a wide range of engineering services. As well as structural engineering (its core business) it also offers a number of other disciplines including; building services, fire, façade, and geotechnical engineering, bridge design, infrastructure and public health, environmental assessment, and sustainable and renewable projects. Over the past eight years, it has invested in extensive research to maximise the potential of the knowledge held by its staff in order to encourage innovative design solutions, recreate project successes and avoid the repetition of mistakes (Bishop et al, 2007; Bishop et al, 2008a; Bishop et al. 2008b; Matsumoto, 2006).

During the last year RWB has invested in a technology platform to enable it to better manage its data, information and knowledge across the business, as the company grows and becomes more geographically dispersed. Rapid advancements in KM-supporting technology and their capabilities made the choice of the best-suited tool for RWB a critical consideration. Following the review of several KM-supporting technology platforms, Microsoft Office SharePoint Server (MOSS) was identified as being well-suited to RWB's KM needs.

As a result of the KM research carried out to date by RWB, its people-orientated KM practices were prioritised for development and improvement. In particular, the firm's Task Groups (TG), which are its equivalent of Communities of Practice (CoPs), have become a core element of its KM framework, and over the last year it has achieved a number of successes in improving their effectiveness (Bishop et al. 2008b). However, the research had highlighted the need for a balanced approach for KM, which was focussed on people, integrated within the business and supported with technology. In this case, MOSS, which also exists as RWB's intranet platform, supports KM within RWB on a number of levels, and for numerous business processes and activities. The focus of this study however, was to examine the approach taken towards the initial implementation of MOSS to support RWB's overall KM strategy, and the ways in which it was utilised to support the organisation's TGs.

5   FINDINGS

Although one of the key features of MOSS is as a document management tool, RWB has initiated a carefully thought out implementation, development and management strategy for MOSS to maximise its potential as a more balanced KM tool. Indeed, a document or information management tool is not capable of managing tacit knowledge (Quintas, 2005), and for this reason it was important to utilise the collaborative capabilities of MOSS to facilitate both tacit and explicit KM.

5.1   IMPLEMENTING MOSS AS A KM-SUPPORTING TECHNOLOGY

RWB is acutely aware of the necessity for a balanced approach to KM, and has adopted an overall KM strategy and action plan, which accounts for the KM critical success factors identified by Bishop et al. (2007). To ensure that MOSS supported RWB's KM strategy, its

implementation was based on these critical success factors. This ensured that the introduction of the technology was undertaken in a structured manner, which incorporated change management principles while also accounting for the requirements necessary to achieve an effective and balanced KM initiative. The following section outlines the actions taken in order to address each of the critical success factors.

1. Understand and define KM across the organisation

It was essential that MOSS was implemented and communicated across the business as a KM-supporting technology. Further to this it was important from the outset that MOSS was developed with knowledge capture, sharing and dissemination as its core attributes. Although the system comes as an 'off-the-shelf' solution, it was selected partly due to the fact that MOSS is very adaptable and could be 'tailored' to suit RWB's KM requirements, and as such the company invested substantially in further development of the technology. In order to ensure that the development of the system was in line with RWB's aspirations, the compilation of an initial brief and specification for MOSS was an important stage. The brief outlined the need for MOSS to "*retain and enhance RWBs ability to create, capture, process, retrieve and disseminate data, information and knowledge….and enhance RWB's reputation of expertise in using effective Knowledge Management initiatives and systems.*" Further to this, the brief acknowledged that MOSS had specific requirements, which needed to be met by the business in order to facilitate effective KM, including:

- Full commitment from management, assignment of sufficient funds at project start-up, and extensive communication to ensure buy-in from staff;

- Assignment of staff with sufficient resources to plan, design and implement the new system;

- Training, which takes into account the system functionality as well as the business change;

- An innovative view and application of the technology, which is aligned with business objectives;

- Consider the role of CoPs and level of managerial involvement in CoPs; and

- Utilise appropriate measurement criteria.

2. Establish a fit with the needs of individuals and the business

The process of 'tailoring' MOSS to suit the requirements of the people using it was vital, not only in ensuring efficiency but also to ensure that people were comfortable using it, found it useful, and therefore 'bought-in' to the technology. To achieve this, a strategic-level MOSS 'steering group' was set up consisting of 10 RWB directors. This group was responsible for the overall management of the system and also for determining the best ways in which it could support the advancement of the business. On an operational level, three 'user groups' were established for different areas of the business; Task Groups, disciplines and projects. User group meetings were held on a monthly basis with the MOSS development team in attendance. This meant that with each iteration of the framework for MOSS, the end users of the system could provide feedback on its usefulness for them. Early involvement of the end users in the design of MOSS was also important in facilitating ownership.

3. Integrate within the organisation and daily lives of staff

The introduction of MOSS represented a big change within the business and to the way people worked on a day-to-day basis. As a result it was important to implement the system in

a 'step-change' manner, introducing a number of small changes over a longer period of time. The different areas of the MOSS system were only opened up across the company for everyone to use after development of each area was complete, the user group feedback was positive, and key individuals had been trained. The design of the system, based on the brief, was such that it was intended to become part of the way people work on a daily basis in order to reduce unproductive time and to make their work lives easier. To support this and further integrate MOSS within core business processes, it was also tied in with RWB's Quality Assurance (QA) procedures.

4. Implement KM champions and a supporting team, and establish top-level support

Senior level-involvement was essential not only in ensuring that the implementation of MOSS had the right resources and management, but also in demonstrating the importance of MOSS to the rest of the business. Although this was initially achieved by setting up the steering group, it was strengthened by establishing one of the steering group members as a 'MOSS champion', responsible for spreading the word as to the benefits and importance of MOSS across the business.

5. Demonstrate and communicate benefits and successes

The steering group members took a very visible approach to communicating the benefits and successes of MOSS by giving a number of presentations across the company. The development team also played an important role by visiting all regional offices to do further introductory presentations. Training was an important aspect in demonstrating the capabilities and benefits of the technology. Initial training sessions were held with groups of employees including directors, team leaders, personal assistants, and engineers. Follow-up one-to-one training sessions were then held for those who requested them, and were also intended for further tailoring of the system to suit the needs of different groups of employees.

6. Determine suitability of financial and non-financial rewards

Financial rewards have never been part of RWB's culture as they could potentially inhibit the open and collaborative nature of the firm, and were therefore rejected for MOSS. However, senior managers actively recognise successes within the business by publicising them through email and other internal communication tools. MOSS has been highlighted within several internal RWB newsletters and has been consistently highlighted by senior managers at management meetings and internal presentations. Recognition of the importance of MOSS to the business has also been evident through the ongoing commitment of funding and resources for MOSS-based initiatives.

7. Achieve a balance between people and IT

The brief for MOSS outlined the importance for the technology to be a supporter of people-based KM activities. People-based KM is at the core of RWB's KM strategy, with CoPs in particular proving to be an effective people-orientated KM practice. In that respect, MOSS has been communicated across RWB as a *supporter* of KM, rather than as a KM solution in its own right. Since the introduction of MOSS, people have continued to be the focus of RWB's KM efforts; however, RWB has acknowledged that as it continues to expand, the role of MOSS will become more important.

5.2 SETTING UP COLLABORATIVE WORK SPACES FOR TASK GROUPS

Task Groups (TGs) have existed within RWB for many years and have become a central aspect of the organisation's culture. As a result of recent development and improvement initiatives for TGs, they now function as a core KM practice for RWB. While TGs, particularly over the last year, have proved to be effective, as the company has expanded and its geographic spread increased the demand for technology to support the traditionally face-to-face based approach to TGs has grown. RWB's KM strategy acknowledges the need for people-based KM practices to be integrated within business processes and supported with the best-suited technology. As a result, MOSS was identified as being an important tool in supporting the ongoing operation of TGs.

To support TGs, MOSS was utilised to set up collaborative intranet-based sites for each group, which were accessible to anyone across the company (Figure 1). The benefit of these sites to the TGs and to the organisation as a whole was that they would provide capabilities for the capture, storage and dissemination of both tacit and explicit knowledge. In relation to tacit KM (and tacit to explicit knowledge conversion), each site included a discussion forum to enable the TG members, and anyone else within the firm with relevant knowledge or interest, to discuss issues, ideas or experiences related to TG topics or projects. It was intended that the discussion forums would replace the necessity for some email traffic to encourage knowledge capture, which may otherwise have been lost or not shared effectively through an email discussion. 'Wiki'-type pages were also created for each site (Figure 2), providing an area for TG members to document experiences, guidance and recommendations on numerous areas of expertise relevant to their TG colleagues. TG members can also highlight important issues or topics of interest through an 'announcements' function, which is aggregated through to RWB's intranet home page, and can also be linked to email. The need for people to continue to be at the core of knowledge sharing within RWB, meant that wherever possible the MOSS pages were designed to facilitate face-to-face collaboration by providing the names of experts and links to contact details.

With respect to the capture of explicit knowledge, the TG sites utilised two functions; document and image libraries (Figure 3). These enabled TG members to capture any relevant documentation and images, particularly in the case of best practice guidance documents. As well as storing all related documentation in one location, the added advantage of capturing documents within MOSS is that the process encourages validity and collaboration. Each document can be 'checked out' by one of the TG members, while he or she edits it. Anyone else who opens the document will see a 'read only' version indicating that someone is working on it, until it has been checked back in. This meant that there was only ever one 'current' version, avoiding the problem of people working on and saving their own separate copies. Images and documents can be linked into discussions, announcements and wiki entries on the TG sites to further enhance knowledge sharing and collaboration.
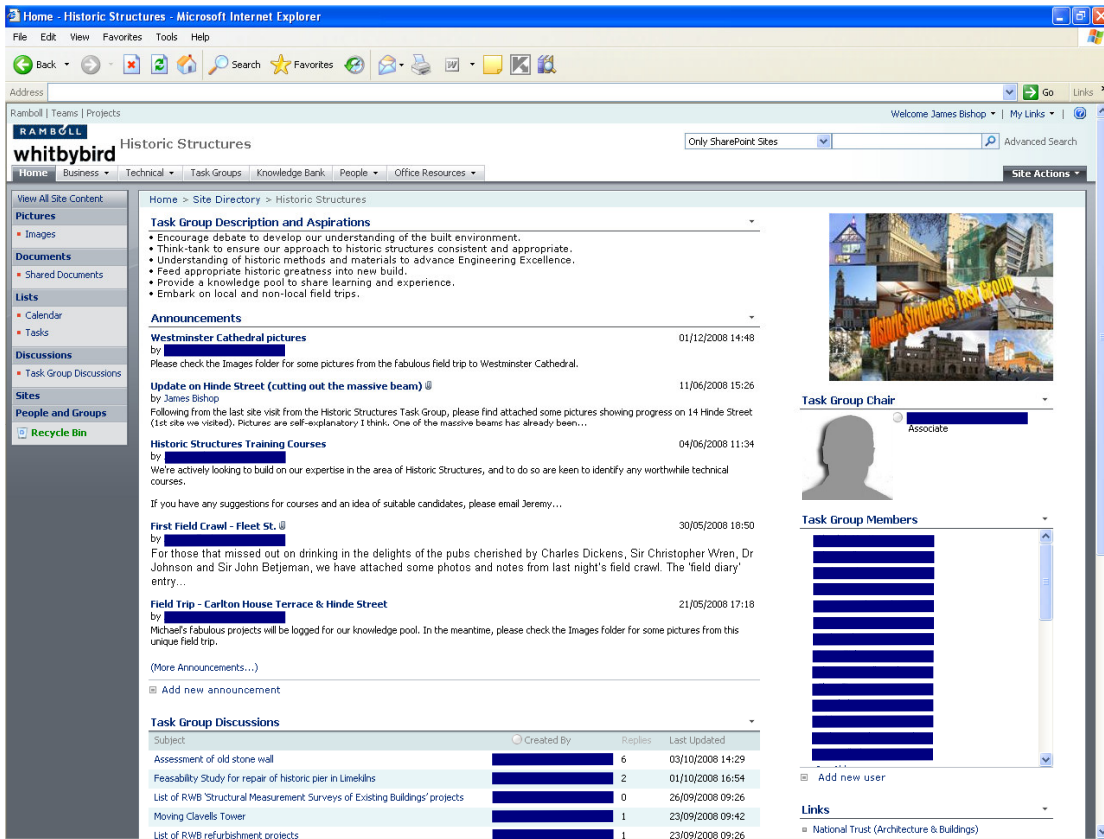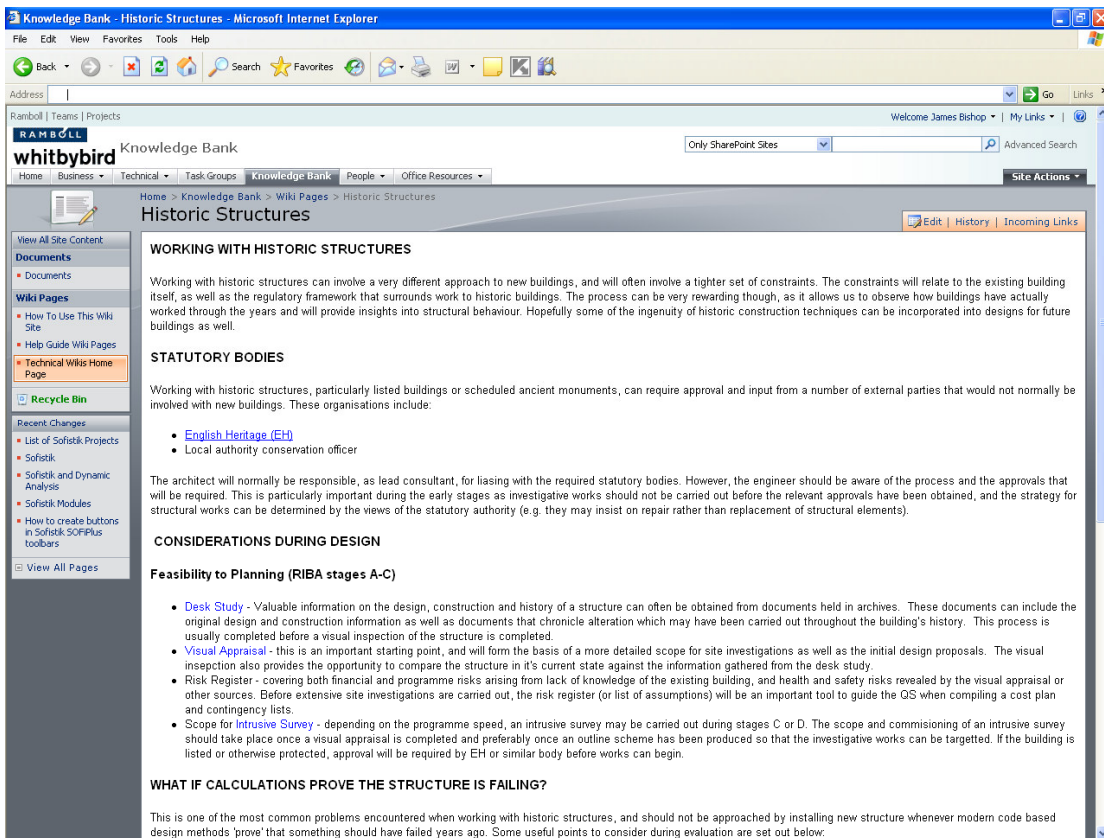
Figure 1: Example of Task Group MOSS site

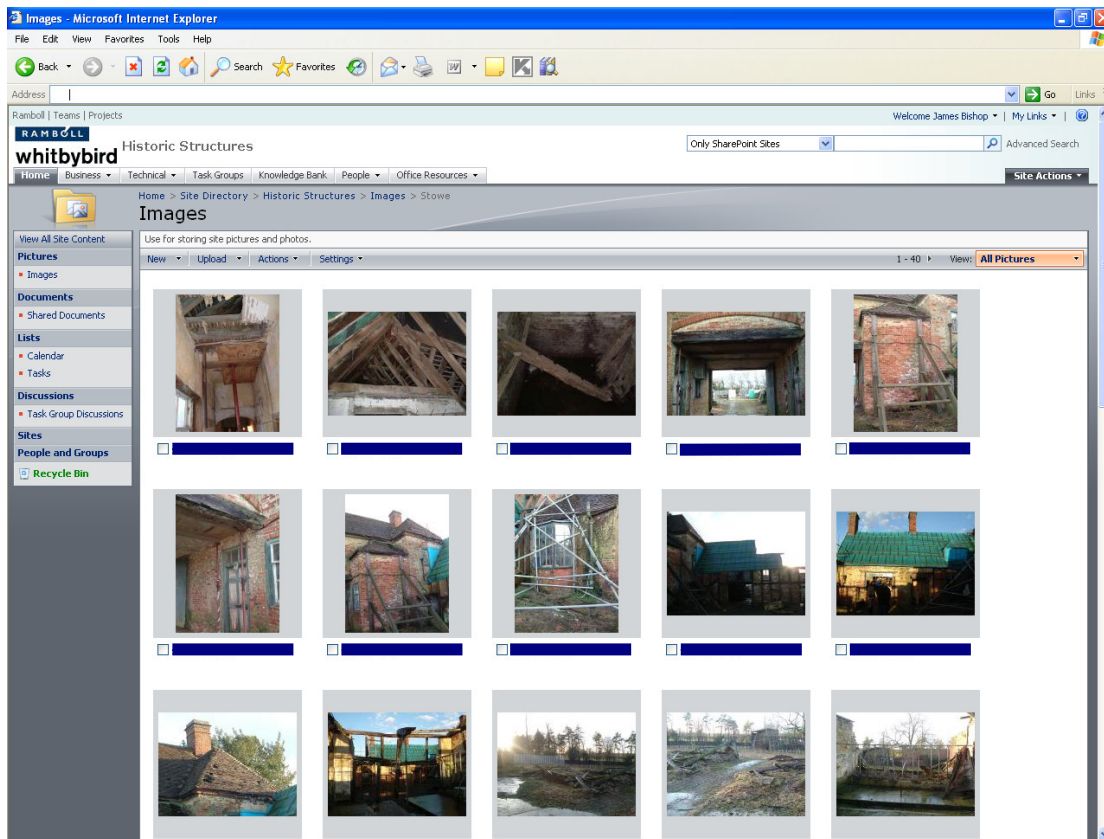**Figure 2: Example of Task Group 'Wiki' page**

Figure 3: Example of Task Group Image Library

As a core aspect of RWB's KM strategy, TGs were positioned as a central area on the MOSS system (the 'TG home page'), providing links to each individual TG site. This emphasised the importance of TGs to the business, while also facilitating easy access to the TG sites for any member of RWB staff (within 2 'clicks'). The formation of a 'TG site user group' was essential in designing the template for the TG sites. By liaising with members of the user group, which consisted of TG members and chairs, the MOSS development team ensured that the sites would be best-suited to the needs of the TGs. Following the development of the template, individual MOSS sites were created for every TG. In line with the introduction of the sites, a rigorous MOSS training programme for every TG chair and at least one other TG member was implemented. Ownership of the TG sites was then handed over to the respective TGs, enabling the members to keep the data, information and knowledge captured within their sites updated. Initially, the TGs were required to upload a minimum amount of information, including the names of the chair and members and its aims and objectives, before the sites were made visible across the company.

Following the implementation of the TG MOSS sites, the TGs experienced several main benefits from their use. The key advantage has been improved accessibility to data, information and knowledge in specific areas of expertise, not just for TG members but for RWB employees across the world. Following the introduction of MOSS within RWB, several new TGs have formed. By setting up MOSS sites from the outset the TGs found the process of establishing their TG, communicating aims and objectives, and raising awareness of their new group far easier. Further to this, it had become more straightforward to become associated as a member of a TG. For TG meetings, administration time was reduced by storing meeting agendas and minutes on their sites and using them as 'live' documents,

updating them during their TG meetings. For senior managers, measuring TG performance also became a simpler process as TG tasks and activities could be monitored through MOSS.

6 CONCLUSIONS

Although the technology used in this case has proved to be an effective tool, particularly for CoPs, it is important that technology is seen as a supporter of KM. People and people-orientated KM solutions such as CoPs should be the core focus of any KM initiative. However, where large firms become geographically dispersed, technology is important in sustaining the effectiveness of people-orientated KM.

The development of any KM-supporting technology needs careful consideration as there is no one-size fits all solution. Prior to the implementation of KM-supporting technology, the organisation needs to establish a KM strategy and action plan to ensure a clear understanding of KM across the business. KM-supporting technologies will require careful selection and a level of 'tailoring' to ensure that they fit with the KM requirements of the business, its individuals and the way in which it operates on a day-to-day basis. Early involvement of end-users in the design and development of the technology is essential in ensuring it is best-suited for their needs and in providing ownership. Empowering employees to take ownership of KM-supporting technology is an important step, not only in gaining sustained buy-in from staff, but also in ensuring the validity of the data, information and knowledge captured. This de-centralised approach encourages experts within the organisation to collaborate with like-minded colleagues and drive knowledge sharing within their specialist areas.

It is important for the organisation to provide the technology with the right resources. This includes providing the right approach to technical support, training and further development of the technology following its initial implementation. Support from senior management also demonstrates the value of KM, and the technology itself to the business. The culture of the organisation is likely to have an effect on the successfulness of KM-supporting technology. Within RWB, the organisation's open, collaborative, team-orientated culture and the existence of CoPs, meant that its staff were already proactively sharing knowledge and have 'bought into' the technology. In this case success was based on the ability of the technology to suit the needs of the end-user and the effectiveness of change management approaches applied during its implementation. The impact of change was lessened by the introduction of a system that was Microsoft-based and therefore had a familiar feel to it. The fact that the KM-supporting technology solution had been partly designed by the end-users was also a key factor.

The use of MOSS to support people-orientated KM has proved to be an effective solution for the case study organisation. As well as empowering CoPs to take greater control of their actions, the use of MOSS has created a greater awareness of CoP practices across the business and encouraged sustained collaboration and knowledge exchange. Further research examining the long-term use of (people-based) KM-supporting technology would be useful in determining patterns of sustained usage and the continued effectiveness of such tools. An examination of the use of MOSS to support KM within other firms would also be beneficial in providing a comparison with the findings established within this study.

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APPENDIX E   RWB KM STRATEGY STATEMENT

RWB KM Strategy

RAMBØLL
whitbybird

Page 1 of 1

job title	RWB KM Strategy	job no.	
date		file ref.	
prepared by	J Bishop / I Matsumoto	circulation	

KM Strategy Statement

As a successful and rapidly expanding company, we are continuously looking to improve the way we work and do business. To enable us to do so we need to ensure that we retain our key assets and qualities. These include;

- Our ability to innovate by reusing knowledge gained on projects, which in turn enables us to avoid starting from scratch, streamline our processes, and facilitate better risk control;
- Engineering excellence, through learning from and building on our experiences, and the use of cutting-edge techniques and technologies; and
- Our unique culture of a 'one Ramboll Whitbybird' across our different offices, focussed on our people and face-to-face collaboration.

Knowledge Management is all about people and helping us to do our jobs better. In particular it's about;

- Building on our own expertise, skills and abilities;
- Learning from our experiences;
- Creating networks with experts and champions;
- Supporting our projects and teams;
- Enhancing our reputations and professional identities; and
- Developing our careers.

Historically RWB has had a strong knowledge sharing culture facilitated through; the company's flat structure; presentations (at Project Delivery, Friday mornings, and technical highlights); Task Groups; Management Meetings; and the intranet. As the business moves forward, we need to sustain this culture and enhance our knowledge sharing activities.

Because knowledge management is all about maximising the potential of the expertise, experience and interpretations held by RWB people, knowledge management initiatives should be **focussed on people-based solutions (soft systems), and supported by the appropriate technology (hard systems) and processes.**

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APPENDIX F   RWB KM ACTION PLAN

RWB Knowledge Management

RAMBØLL
whitbybird

job title	Knowledge Management Action Plan	job no.	
date		file ref.	
prepared by	James Bishop / I Matsumoto	circulation	

Knowledge Management Action Plan

1. **Designate at least one Operations Board Director as a Knowledge Management Champion.**
   - A designated director as a 'Knowledge Management Champion' is vital in order to:
     - o Provide the initiative with the necessary processes and resources;
     - o Constantly communicate the benefits and progress of the initiative to the business;
     - o Encourage buy-in;
     - o Set an example to the rest of the organisation, by supporting and adopting the initiative; and
     - o Monitor and maintain a collaborative culture, which will support the knowledge management initiative.
   - To drive the initiative in the right direction and realise its full potential for the company, top-level managers must understand:
     - o What the initiative is;
     - o What it requires;
     - o How it should support the business; and
     - o That there will be an initial 'time-lag' at the start before the benefits are seen.
2. **Establish a Supporting Team for the Initiative**
   - This has been strongly recommended in academia and industry.
   - The team should represent a cross-section of the organisation to ensure that the importance and benefits of the knowledge management initiative are communicated at all levels.
3. **Align the Knowledge Management Initiative with Ramboll Whitbybird's Business Objectives,**
   - The initiative should be primarily concerned with the knowledge and expertise of whitbybird staff, and therefore should focus on people-orientated knowledge sharing activities rather than on IT.
     - o It is essential to establish a balance between people and IT.
     - o The role of IT should be as a supporter or enabler of the people-orientated knowledge sharing activities.
   - When developing the initiative, Ramboll Whitbybird needs to consider how it relates to/affects:
     - o Engineering;
     - o Culture;

o Company dynamics;
o Policies and practices;
o The expected added value to be provided by the knowledge management initiative and what will constitute its success; and
o The needs of engineers and support staff.
- The initiative needs to be intuitive and embedded with the everyday lives of Ramboll Whitbybird staff.
- The knowledge management initiative needs to be introduced as a small change to what engineers and support staff already do – employees should contribute small amounts of time and effort on a regular basis.

4. **Establish a Clear Definition of Knowledge Management and a High Level of Understanding Throughout the Organisation.**
   - Many construction firms are implementing knowledge management systems, which subsequently fail due to a misunderstanding of how they should support the business and how to implement them.
   - Ramboll Whitbybird needs to establish an understanding, across the organisation, of:
     o What knowledge management is;
     o Why it is important for the company; and
     o How it will help the business.
   - In both industry and academia there is a lack of understanding of the difference between knowledge, information and data.
     o By simply storing information and data the system does not constitute a knowledge management initiative.
     o It is important that Ramboll Whitbybird staff understand and appreciate that knowledge is formed through their own interpretations, experiences and expertise, and that it is these that should be captured by the initiative.

5. **Clearly Demonstrate/Communicate the Benefits and Initial Successes of the Initiative and Determine the Suitability of Rewards.**
   - It is important to make Ramboll Whitbybird employees aware of exactly what is required from them, which will ensure against over-contributing of knowledge to the initiative.
   - It is most effective to approach individuals and small groups when communicating the benefits of the initiative.
     o Need to consider how the initiative will improve their daily lives/work activities.
   - Regular recognition and encouragement from peers/managers/team leaders for contributing to the knowledge management initiative is very important.
   - It is extremely beneficial to provide 'real life' success stories (initial successes of the initiative).
   - Financial rewards are seen as being unsuitable for rewarding knowledge management in construction organisations.
   - People need to see that what they are contributing is being used. This will motivate them to contribute further knowledge.
   - The contributions of 'useful knowledge' (which has been reused to improve someone else's work) should be recognised in particular.