Improving Knowledge Retention and Use in Construction Project Team Environments; A Soft Systems Methodology Approach

by

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Abstract

This study provides an understanding and identification of knowledge management challenges in project teams within a single organization. Identification of challenges has generated discussion and recommendations are put forward for improving the level of knowledge management within the organization. This information is useful to those who are involved in knowledge management in project environments in construction; equally, the methodology can be applied to other types of project teams.

The study provides interesting results, as multiple issues emerge based on how people view both their individual and collective actions on the project. Recommendations are considered as a business improvement project with a focus on culture change and process management rather than technology, which facilitates some of the changes.

The study was carried out between September 2005 and December 2007. An executive summary containing recommendations is available to senior management of the organization and is attached as Appendix A.

The benefits are the identification of what is needed to support overall organizational goals, individual and project team activities leading to improvements in processes. This information can be of importance for other construction project environments operating under similar circumstances.

To explore how knowledge management is used within the project team this thesis followed a soft systems methodology in order to understand the situation and provide recommendations for improvement. This methodology encourages debate and discussion helping to raise awareness as to how knowledge management can help the aims of the organization.

The research is a qualitative study of a single organization comprising departments in Germany and the UK. This includes project site offices in the UK covering a selection of personnel who have been involved in recent UK projects. Data collection has involved documentary review, questionnaires and semi-structured interviews, using the soft systems methodology to analyse and present discussion. Stakeholder interviews covered a range of advisors, managers, department heads, directors, engineers, commercial and site personnel.

The knowledge audit revealed that experience can be shared more effectively, knowledge was not being captured at project or organization level and that there was poor information and knowledge storage and retrieval means. Recommendations are put forward encouraging the active involvement of all departments to contribute and share ideas and project information allowing feedback on projects and organization work. The strategy for this change will be driven by the business objectives in order to become embedded in the day-to-day work of the organization. By following a strategy and valuing knowledge then the possibility of capture and reuse of knowledge is enhanced. This infrastructure helps to minimise the frustration that a knowledge worker can experience in an unsupported environment.
I declare that my thesis entitled Improving Knowledge Retention and Use in Construction Project Team Environments; A Soft Systems Methodology Approach for the degree of Doctor of Business Administration (DBA) of the University of Surrey, embodies the results of an original research programme undertaken by me. I have included specific references to any other work, by me or other sources, whether published or not.

Signature: Georgette Banham

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Date: 30/11/2009
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<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>BSI</td>
<td>British Standards Institute</td>
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<tr>
<td>CIT</td>
<td>Critical Incident Technique</td>
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<tr>
<td>CIRIA</td>
<td>Construction Industry Research and Information Association</td>
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<tr>
<td>COLA</td>
<td>Cross-Organizational Learning Approach</td>
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<td>CoPS</td>
<td>Complex Product Systems</td>
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<td>CoPs</td>
<td>Communities of Practice</td>
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<tr>
<td>DBA</td>
<td>Doctorate Business Administration</td>
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<tr>
<td>DOCMA</td>
<td>Document Management System based on Lotus Notes Database</td>
</tr>
<tr>
<td>ECIA</td>
<td>Engineering Construction Industry Association</td>
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<tr>
<td>E</td>
<td>Electronic</td>
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<td>FGD</td>
<td>Flue Gas Desulphurisation</td>
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<td>IMS</td>
<td>Integrated Management System</td>
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<td>IT</td>
<td>Information Technology</td>
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<td>KM</td>
<td>Knowledge Management</td>
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Thanks also go to my family and my husband for their continual support, motivation and encouragement.
Chapter One: Introduction

1.0 Introduction

The success of an organization and its project environment depends on the retention and use of its knowledge assets. However, projects often reflect the project individual’s own knowledge rather than the combined inputs of knowledge that resides elsewhere in the organization or of knowledge learned on prior projects. This is a problem of knowledge inefficiency that is currently experienced by the organization.

Global competition and calls for improvements to professional standards in the construction environment have prompted organizations to consider ways of increasing efficiency and maintaining competitive advantage.

The main trade and employers association for contractors working in the UK engineering construction industry outline what they believe to be some of the major issues from the industry. These are global challenges, overseas contractors, overseas workers and the preservation of UK standards and skills (ECIA 2005). Within media issued with the aim of communicating at site, project team and company level it is suggested that UK contractors need to show that they can compete with the rest of the world (ECIA 2005).

Knowledge, as a commodity, has been identified as one of the major competitive requirements, and if properly managed is said to reduce project time, improve quality as well as minimize “reinventing the wheel” (Love 2005).

A common rationale in the literature is that when a knowledge worker leaves, the organization loses vital knowledge and, in the worst case scenario, an aspect of its competitiveness (Hildreth 2000).

For an organization looking to keep at least on par with its competitors, the necessity to apply the best tacit and explicit knowledge should be at the forefront of its strategy.

This introductory chapter outlines the basis for the thesis and gives detail as to the structure that the thesis follows.

1.1 Rational

The need for the subsidiary to take responsibility for knowledge management and organizational learning is evident from the responsibility and input that the subsidiary has on UK based projects.

It has been said that failure in organizations such as Kidder Peabody and Metallgesellschaft was due, in part, to unmanaged organizational knowledge (Prusak 1997). Since one of these companies was a former parent company of the organization under study, it is interesting to note whether changes are present in the management of knowledge.
Subsidiaries are no longer viewed as passive receptors of knowledge but are themselves active agents in the process of capability development (Rugman 2001).

The literature review detailed in chapters 2 and 3 illustrate that recent studies of knowledge management in project settings have emphasized the difficulty of capturing project based learning and transfer of knowledge within the organization and to other projects.

Complex division of labour, many stages to the projects, fragmentation of expertise, and overcoming barriers involve intervention in the project, but despite intervention, there are still problems in the capture, transfer and use of knowledge within the project environment.

The company perceives that it faces loss of knowledge due to retiring members of staff and the use of contractors in key positions. Further challenges are related to re-organization of companies and the leaning out of business units and the start and finish of projects, which do not leave adequate time for reflection from one project to the next. This has led to the development of the research question.

In formulating the research question, the requirements of the subsidiary company and the findings from the initial literature review are considered, the main themes are:

- Why the area of knowledge transfer processes seems to be neglected

- To explore how the company can derive knowledge from team members thus making tacit knowledge explicit within the company and the project team

- To explore how project team members and non-project team members perceive their work in aiding the knowledge creation and learning of the organization, and the success of the project

- To explore knowledge strategy that allows project teams to avoid reinventing the wheel

Discussion with senior management has led to a focused research question that attempts to address the challenges of knowledge management that the company experiences within its project environments.

This challenge is that of project based knowledge management. The features that make a project – creation of temporary memberships of a team, one off activities and uniqueness, place the organization in a difficult position of knowing how to capture, organise and manage knowledge derived from past project experiences efficiently.

Via this practitioner thesis, the research question and study take a qualitative approach in order to focus and improve on this particular business problem that the organization experiences.
1.2 Aim of the study

The study will help to guide the organization develop and practice knowledge management within the project environment. An organizational learning strategy combined with knowledge management can be defined as a plan that will describe how the organization will manage its knowledge for the benefit of that organization. A good learning and knowledge management strategy should be closely aligned with the organization's overall strategy.

This will help to:

- Increase awareness of knowledge management in the organization
- Increase awareness of knowledge sharing and ways in which to share knowledge
- State where in the knowledge process the organization is now, where the organization wants to be, and how to get there

1.2.1 Research Question

The research question:

What is the role of knowledge within the project? How does knowledge management within the project help collaboration and project success?

1.2.2 Aims and Objectives

The following subset of questions has guided the study and data collection:

- Why the area of knowledge transfer processes seems to be neglected – Identifies why the organization is not doing more to retain knowledge.

- To explore how the company can derive knowledge from team members thus making tacit knowledge explicit within the company and the project team – discussing the role of knowledge management and the impact on the project.

- To explore how project team members and non-project team members perceive their work in aiding the knowledge creation and learning of the organization, and the success of the project – revealing assumptions made about knowledge management.

- To explore knowledge strategy that allows project teams to avoid reinventing the wheel – Looks at how knowledge management can be integrated in daily activities and recommendations.
1.3 Outline of Chapters

This chapter has explained the rationale, aims and objectives of this study.

Chapter two discusses the literature on knowledge and its management, starting from a generalised view leading to an organizational view. Areas covered in this chapter range from the philosophy of knowledge, to knowledge management systems, knowledge types, knowledge workers, knowledge intensive organizations, barriers to knowledge and strategy.

It is important to note at this stage that knowledge management is as is demonstrated by the literature review more than information and data – it is also a social issue that involves trust, obligation, and commitment between all (Erickson & Kellog, 2003 cited in (Palmer and Platt 2005).

The following chapter investigates the knowledge management literature from the construction industry and project team perspective.

The chapter describes that much of the literature shows that knowledge management can be implemented in any environment large or small resulting in positive benefits. The literature reviewed, however, does not extend its enquiry to those organizations where although the organization portrays that it is informed of and despite the abundance of current thinking and benefits of knowledge management, the reality of workloads mean that the capability of the organization to perform knowledge management is hindered. There does not seem to be reference to the fact that much organizational practice may not be consistent with suggestions and prescriptive literature (Easterby-Smith 2003). Further, there seems to be gaps in the literature as to how these organizations operating under these conditions can still benefit from knowledge management.

Building on other areas of research it has been suggested that there is a need for prescriptive literature to assist managers in assessing learning processes, knowledge management possibilities and the importance of human capital (Easterby-Smith 2003).

Using soft systems methodology to investigate some of the problems that the organization experiences in its project environments will assist learning processes to provide knowledge management possibilities with reasonable and culturally feasible changes to the way that the organization treats its project environment.

These attempts will provide immediate help to the organization and may provide other construction industry projects and organizations the ability to learn from the experiences obtained from this research.

Chapter four will explain the framework of the research and design strategies chosen.

This chapter explains how the research method of soft systems methodology is justified as it enables understanding through action, analysis and reflection, which in turn results in organization awareness, and learning.
Using soft systems methodology as a tool, the aim is to achieve a holistic view of the situation under consideration, obtaining views and perspectives of various participants involved with the longer-term aim of developing recommendations for improvements.

The following chapter, chapter five gives detail as to the fieldwork and the techniques used. This chapter explains how the research has been carried out using the techniques and methods discussed in chapter four. As far as possible, an exact description of how the research unfolded has been documented in this chapter. The next chapter discusses the findings from this research.

Chapter six presents the findings of the document analysis, questionnaires and interviews. The findings show wide gaps in both the awareness of knowledge management and the use of knowledge management in the organization compared to best practise. However, individual use of knowledge and its management is present and there is immense willingness to improve the organization knowledge and processes.

The absence of organizational knowledge strategy presents itself as conflict within the organization as there is a lack of understanding and procedure to follow which creates frustration for knowledge workers.

Chapter seven develops the rich picture for the overall situation and comprises of a discussion of the root definition and CATWOE analysis. This chapter illustrates the root definition, conceptual model and CATWOE analysis. These iterative elements are a part of the soft systems methodology that enables deeper understanding of the situation in question.

Chapters eight and nine present discussion of the preceding chapters and offer recommendations for improvements. Recommendations for future research are also discussed.

Chapter ten consists of the researcher's reflective diary highlighting personal lessons learnt as a result of the DBA programme.

Appendices consist of an executive summary, an understanding of the background to the organization giving a historical and cultural context that exists during the time that the study took place, consent letter and information memo to participants. A copy of the questionnaire has also been presented as an appendix.

1.4 Conclusion

This chapter has explained the rationale, aims and objectives of this study. The layouts of the chapters have been briefly discussed. Chapter two now takes the reader through a general literature review before proceeding to chapter three which takes the form of a focussed review of literature relevant to the construction project environment.
Chapter Two: Knowledge and its Management

2.0 Introduction

The success of an organization and its projects depends on the retention and use of its knowledge assets. Projects often reflect the project individual’s own knowledge rather than the combined inputs of knowledge that resides elsewhere in the organization or of knowledge learned on prior projects.

The literature on organizational learning, the learning organization, knowledge management and organizational knowledge is full with theories, viewpoints and research; it would be foolhardy to attempt to cover the full range of literature. The following is an attempt to cover the main themes to provide a general rationale for this research. This review touches on areas of project management, teamwork, knowledge management and organization learning in the construction industry environment.

Global competition and calls for improvements to professional standards in the construction environment have prompted organizations to consider ways of increasing efficiency and maintaining competitive advantage.

Industry reports such as The Latham Report (1994), The Egan Report (1998), and The Accelerating Change Report (2002) have identified the correct use of knowledge, as one of the major competitive requirements that will increase efficiency and effectiveness of the construction industry. The reports identify the use of partnering, collaboration, change and the use of best practice to improve industry practice.

As stated by Love et al, knowledge, properly managed, reduces project time, improves quality as well as minimizes “reinventing the wheel” (Love 2005).

The value of corporate knowledge is immense and the sharing and management of this knowledge within the organization demands to be applied with thoroughness.

In this second chapter, the review of knowledge and its different philosophical perspectives is presented. This is followed by a discussion of knowledge in the construction team project environment.

2.1 Understanding Knowledge – epistemological perspectives

Epistemology is the sphere of philosophy that investigates the beginnings, nature, and extent of knowledge. Epistemology looks at what knowledge is and questions how we know what we know (Patton 2002):p134).

When looking at the literature on epistemology there are many positions. Theories of knowledge stress its absolute character, and put emphasis on its dependence on people, cultures and objects.

Going back to Greek philosophy and at least since the time of Plato, the nature of knowledge has been questioned. As stated by Styhre (2004) in Plato's view
knowledge is an awareness of absolute, universal ideas or forms, existing independent of any subject trying to apprehend to them. In the dialogue, the Meno, Plato illustrates his theory of recollection, the idea that there is no new knowledge, there is merely a recollection of ideas the individual can learn and then experience (Styhre 2004).

However, how should knowledge in general be defined? Annas (2003) explains that in the Theaetetus Plato argues that, at a minimum, knowledge involves true belief. No one can know what is false. The dialogues are split into three sections: 1) Knowledge is perception; 2) Knowledge is true belief, and 3) Knowledge is justified true belief (Annas 2003).

Annas (2003) goes on to explain that though Aristotle puts more emphasis on logical and empirical methods for gathering knowledge, he still accepts the view that such knowledge is concerned with necessary and universal principles.

The two main epistemological positions that have grown out of this are empiricism, which is the deduction of factual knowledge from a posteriori premises, that is, premises that are knowable only by observation, and rationalism, which means to deduce factual means from a priori premises, that is, from premises that are somehow known to be “true” prior to observation.

This assumes that knowledge can be both experience based and can exist as a perception. Traditional epistemology (perception-based) knowledge is analysed as justified, true beliefs, and that knowledge is recognition of this truth. Pragmatic epistemology (experience-based) infers that knowledge is applied and defined through experience and heuristics.

A posteriori judgments are grounded upon experience and are consequently limited and uncertain in their application to specific cases. The connection of empiricism has led to a view of knowledge known as the reflection-correspondence theory (Turchin 1991). Knowledge results from reflection of external objects. Knowledge does not have a priori existence, like in Plato's conception, but is developed by observation, it is still absolute, in the sense that any piece of proposed knowledge either truly corresponds to a part of external reality, or not (Turchin 1991).

Kant makes a distinction between analytic and synthetic judgments, according to the information content (Kemerling 2002). Analytic judgments are purely explicative and can be deduced from the principle of non-contradiction (no assertion is both true and false). Synthetic judgments are preconditions for experience and are genuinely informative but require justification by reference to some outside principle. These distinctions were used by Kant to ask, whether a priori synthetic judgments are possible.

Early philosophical work has moulded the logic of recent literature and the concept of knowledge and its management in the present day.
2.1.1 Understanding Knowledge – the recent literature

The recent literature considers Charles Pierce (1839-1914), William James (1842 -1910) and John Dewey (1859 -1952) to be the founders of pragmatism. They argue against a priori beliefs. In Pierce's "logic of inquiry" (Goodman 1995) pragmatism involves a problem, reflection and belief tested through action, which in turn creates knowledge. Dewey illustrates this as two steps of reflection and then testing of observations or experiments. Reflective thinking contributes new ideas, which can then be investigated to create new solutions to difficulties faced. Easterby-Smith (2003) explains that Dewey points out that this is reflection on the problem and as such this can alter current procedures thus bringing knowledge to the organization (Easterby-Smith 2003).

Goodman (1995) explores Dewey’s thinking and states that problems lead to a state of confusion and conflict. Reflective thinking generates suggestions and ideas between the actual situation, the situation required and the circumstances relative to the current experience. Doubt motivates the ideas on which the problem is solved. For Dewey there are a number of assumptions that are crucial to pragmatic epistemology:

1. All knowledge is experimental
2. Whatever is the subject of knowledge is a result of experiment
3. The testing of ideas results in changes
4. The relationship between these changes constitutes the object of knowledge.
5. Whatever is designated knowledge represents a question that has been answered.

These assumptions lead to the assertion made by Dewey that in order to achieve knowledge and make use of knowledge that exists, action based on reflective thinking is required. Accordingly, to manage knowledge it is important to give time to experimentation and reflection. Many authors acknowledge the contribution of Dewey’s philosophical contribution to pragmatism in asserting that there cannot be a clear distinction between the observer and the observed (Easterby-Smith 2003).

Traditional perception based knowledge demands eternal truth. Since organizations have many valid truths that change over the course of time it is doubtful that companies can satisfy the criterion of eternal truth (Christensen 2003). The rationales for knowledge focus on pragmatic epistemology, where knowledge is something that is experienced and that can be used.

In Berger and Luckmann’s view, reality is socially constructed. Human social order is produced through interpersonal negotiations and implicit understandings that are built up via shared history and experience. A consensus of how things are to be perceived and what they mean is what sustains social order. They refer to “the reality of everyday life” to indicate the taken-for-granted sense of reality that is shared with others in a society, which already appears objectified. Berger and Luckmann (1971) propose a “sociology of knowledge,” they propose that “reality” is socially constructed by typifications. Externalisation and objectivation is a product of continuing dialectical process resulting in internalisation. By passing objectivations to others we socially construct knowledge (Brown 1979).
Nicolini cf (Dierkes, Berthoin et al. 2003) states “The relationship between knowledge and power is crucial, both because it challenges the existence of any universalistic foundation to knowledge and because learning is intimately bound up with the prediction of knowledge”. According to Nicolini (2003), a Foucauldian view of knowledge is power used to control and exert over another group. Knowledge is created and historically specific, as there are power shifts there are knowledge shifts. Foucault states that “individuals are the vehicles of power, not its point of application but that power is distributed… the individual is an effect of power” (Foucault 1980). New truth reorders knowledge and our systems and concepts that rest on this, as stated by Foucault in The Archaeology of knowledge “knowledge is defined by the possibilities of use and appropriation offered by discourse” (Foucault 2007).

In his theory of knowledge formation, Habermas theorises that human beings socially construct their knowledge and that the perspective that they generally use, governs their actions with respect to each other and their environment (Smyth 2004). He proposes three interests or perspectives, which he calls the technical, practical and emancipatory interests.

The next section elaborates on the ideas of learning, tacit and explicit distinctions and use of knowledge as a resource for the organization.

2.2 Understanding Organizational Knowledge and Knowledge Management

It is important to differentiate between organizational knowledge and knowledge management. The literature displays a high degree of categorization with respect to the notion of organizational learning, the learning organization, organizational knowledge and knowledge management. For knowledge management there does not appear to be a unique definition to which the literature can adhere, although many different definitions have been proposed (Davenport and Prusak 2000, Milton 2005, Gorelick 2004, Christensen 2003, Bukowitz & Williams 1999). Researchers in the area recognize this lack of clarity and understanding and recommend taking on a multi-paradigm view in order to better integrate understanding (Easterby-Smith 2003).

2.2.1 The Concept of Knowledge and Knowledge Management Systems

The concept of knowledge refers to everything, which is supposed to "exist" (including ideas, theories, everyday assumptions, language, incorporated routines and practices). The social construction of knowledge is conceived as an ongoing activity, performance and process; it is not the intentional outcome of any individual effort but the effect of everyday action and interaction. Stocks of knowledge appear as institutions, organizations, archives, texts, procedures and practices.

There are many definitions of knowledge. Much of the literature is in consensus that knowledge is a difficult term to define (Grant 1996; Davenport and Prusak 1998; Alvesson 2004; Milton 2005). Alvesson argues that the all embracing of many conceptualizations of knowledge makes for an ambiguous definition.

In order to aid definition an explanation of the differences between data, information and knowledge is proposed by much of the literature in order to set a distinction.
between the three terms. The literature illustrates general agreement that the terms are separate (Davenport and Prusak 1998; Aronson 2002; Alvesson 2004).

Figure 2.0 illustrates that data is agreed to be a record or collection of facts, measurement and statistics, whereas information is the processed data where inferences have been drawn from the data (Watson 1998; McFadden 1999). Knowledge is the information that has a contextual and relevant meaning. An ability to act upon the knowledge is an important factor of the term knowledge. Knowledge grows from the information that data and experiences can give us.

![Figure 2.0 Data, Information and Knowledge adapted from Information Technology for Management (Aronson 2002)](image)

Similarly, knowledge for Davenport and Prusak (1998) means a framework and a capacity to reason and make sense of information:

“Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knower. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms”.

The British Standards Institute Knowledge Management Vocabulary PD 7500 (BSI 2003) defines knowledge management as:

“The creation and subsequent management of an environment which encourages knowledge to be created, shared, learnt, enhanced, organized and utilized for the benefit of the organization and its customers.”

Knowledge management systems provide a means to assemble and act on the knowledge accumulated throughout an organization. Such knowledge may include the texts and images contained in patents, design methods, company practices, and competitor intelligence. Organizational knowledge is often tacit, rather than explicit, so these systems must also direct users to members of the organization with special expertise.

In other areas knowledge systems can refer to programs that lead the user to or have the ability to make decisions on the part of the user based on pre-computed information and data, artificial intelligence and expert systems are examples of these types of knowledge systems. Alternatively a knowledge management system has also been given the name to collaborative software programs that store data documents.
Concepts are best defined by how people use them (Sveiby 1996). In the knowledge management literature, there are two tracks of activities and two levels of involvement. The information technology track or the management of information track is involved with the construction of information management systems, artificial intelligence, re-engineering and groupware.

The management of people tends to concentrate on education, philosophy, psychology, sociology and the management of business methods. Here knowledge is a process to be explored and interpreted.

The two levels within these categories relate to the individual and the organization as Table 2.0 illustrates.

<table>
<thead>
<tr>
<th>Organizational and Knowledge Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track/Level</td>
</tr>
<tr>
<td>Organization Level</td>
</tr>
<tr>
<td>Individual Level</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Table 2.0 What is Knowledge Management? Karl-Erik Sveiby (Sveiby 1996)

Knowledge management can be explained as the explicit control and management of knowledge, whereas organizational knowledge is regarded as a key resource of competitive advantage being rooted in the resource based view of the organization (Penrose 1959; Easterby-Smith 2003).

During the 1990s, the focus on the study of the use of knowledge in organizations from a strategic business process perspective gave rise to the concepts of learning capabilities, and intellectual assets (Starbuck 1992; Nonaka and Takeuchi 1995; Spender 1996).

2.2.2 Tacit and Explicit Knowledge

Knowledge types are split into various groupings, for example tacit and explicit, personal and codified, individual and organizational, procedural and substantive, mature and immature (Polanyi 1966; Blacker 1993; Bohn 1994; Nonaka and Takeuchi 1995; Spender 1996).
Polanyi established the concept of tacit knowledge. Polyani's ideas on tacit knowledge are based on philosophical analysis rather than empirical investigation, it is suggested that it is difficult to put tacit knowledge into words and that successful transfer usually takes place through associations, observations and experience (Polanyi 1966).

Bohn (1994) discusses the different stages of knowledge from an immature to a mature level. He affirms that lower levels of knowledge need experts to organise, whereas higher levels may be automated and procedural requiring different methods of management.

Higher levels of knowledge maturity may be easier to place in explicit terms. However if the knowledge within the company is characterised by constant change then procedural methods of management may be harder to implement.

Bohn (1994) states that "the knowledge state of different process variables is important because it determines how to manage both the knowledge and the production process. The higher the stage of knowledge, the closer the process is to science and the more formally it can be managed. Conversely, "low stage processes, such as creative endeavours, do not do well under formal management methods, and should be treated more as art"(Bohn 1994).

Nonaka and Takeuchi (Nonaka and Takeuchi 1995; Dierkes, Berthoin et al. 2003) also gave attention to the concept of explicit and tacit knowledge. Like Polanyi they use the terms to define 'unable to be expressed' and 'able to be expressed'.

These original definitions have become blurred and tacit and explicit are often used to describe knowledge that has not been codified or knowledge that is recorded knowledge as illustrated in Table 2.1.

Davenport and Prusak (Davenport and Prusak 2000) provide an explanation of the dimensions of knowledge that range from the complex, inexpressible to the structured and explicit content.

<table>
<thead>
<tr>
<th>Tacit</th>
<th>Explicit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not teachable</td>
<td>Teachable</td>
</tr>
<tr>
<td>Not articulated</td>
<td>Articulated</td>
</tr>
<tr>
<td>Not observable in use</td>
<td>Observable in use</td>
</tr>
<tr>
<td>Rich</td>
<td>Schematic</td>
</tr>
<tr>
<td>Complex</td>
<td>Simple</td>
</tr>
<tr>
<td>Undocumented</td>
<td>Documented</td>
</tr>
</tbody>
</table>

Table 2.1 Dimensions of Knowledge (Davenport and Prusak 2000)
When looking at these frameworks, we need to ask how we can maximise advantage of all our intangible assets to achieve harmony. For Nonaka and Takeuchi, redundancy is an important condition for knowledge creation and that knowledge must be shared even where it is initially not needed. They argue that information sharing promotes tacit knowledge and members can use this information to offer new perspectives on their own and other's work.

Nonaka's knowledge spiral model illustrates the way in which tacit and explicit knowledge interacts to create knowledge in an organization. Nonaka (Nonaka and Takeuchi 1995) explains that social interaction such as sharing experience or socialisation creates tacit knowledge. This knowledge is transferred into a more communicable form or externalised into explicit knowledge. New knowledge is created from a combination of explicit knowledge. This explicit knowledge is transferred within the organization until it becomes tacit. Figure 2.1 has been adapted to illustrate how this could happen within a project environment.

![Figure 2.1 Framework for a learning organization - adapted Knowledge Spiral (Dierkes, Berthoin et al. 2003) Model](image)

The challenge with tacit knowledge management in a project environment is how to recognise, generate, share and manage the knowledge between team members (Bresnen 2005) and then how to transfer this knowledge to the organization.

2.2.3 Knowledge Based Organizational Theories

The literature emphasises that to manage knowledge, companies are to concentrate on how people interact rather than the actual technology that is used and that the environment must stimulate creativity. This is echoed by Sveiby in his intellectual capital framework (Sveiby 1997). The framework represents resources and investments of the organization. The framework has three elements: employee competence, internal structure and external structure.
Sveiby discusses his knowledge-based theory of the firm and indicates nine important knowledge strategy questions:

1. How to improve the transfer of competence between people?
2. How can the organization employees improve competence of others?
3. How can others improve the competence of employees?
4. How to transfer competence to tools and systems?
5. How to improve competence using tools and systems?
6. How to enable conversation to improve competence?
7. How can others’ competence improve our systems?
8. How can the organization systems improve others’ competence?
9. How can the organizations systems, tools, processes and products be effectively integrated?

The key point from the literature is to create an environment where people willingly transfer tacit knowledge. An ideal and the view taken by Sveiby (Sveiby 1996), which is similar to Bohn (Bohn 1994), is that as employee competence grows so there will be better performance and more innovation. As this competence grows, the internal and external structures needed by the organization to manage knowledge will be created. The internal structure is mainly the infrastructure of the organization. Items such as strategy, vision, information technology, patents and documented processes fall into this category. It does not include the human aspect of the organization. External structure consists of the values and relationships that the organization has with its stakeholders. External structure grows as solutions and productivity benefits clients and other stakeholders.

Milton (Milton 2005) states that

"Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the mind of the knower. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms".

Milton combines his people, process and technology perspective with the knowledge flow model to form a twelve-component framework for a knowledge management environment (Figure 2.2).
He argues that all the components are to be present for the system to work. A knowledge system addresses the triple aspects of people, process and technology. These systems operate within the corporate culture, which will support the process of knowledge re-use. Milton argues that companies should implement a mentality that wasting knowledge equals inefficiency. He goes on to state that knowledge roles are to be created in the team, to make sure that knowledge management is embedded within the project and its organization.

"Without knowledge management roles, knowledge management becomes 'everyone's job', and very quickly reverts to being nobody’s job'. (Milton 2005)

He states that this statement is not to be understood as meaning that only those with a knowledge management role should be responsible for knowledge management. Rather in the same way that every member of an organization is responsible for health and safety of others and has ethical and environmental responsibilities then it follows, then that everyone should be responsible for knowledge transfer and learning. This is equally true for knowledge that is our own or for others.

2.3 Knowledge Intensive Organizations

The terms knowledge, capital and labour refer to both inputs and outputs. By analogy, labelling a firm knowledge intensive implies that knowledge has more importance than other inputs (Sveiby 1997). However, this is not to say that the whole unit of the organization is knowledge intensive, but more that a larger part of the unit is knowledge intensive.

Some organizations are more knowledge intensive than others are; these organizations rely on professional knowledge or expertise to carry out their business. Research by
Windrum et al (Windrum 1997) identified design, architecture, and engineering services as knowledge intensive service sectors amongst others. Knowledge intensive sectors are often characterised by a high degree of tacit knowledge involving specialist knowledge and problem solving in project based environments.

Characteristics that are specific to knowledge intensive organizations include (Alvesson 2004):

1. highly qualified individuals using intellectual skills in work;
2. a high degree of autonomy and the downplaying of organizational hierarchy;
3. the need for extensive communication for coordination and problem solving;
4. distinctive client services;
5. subjective and uncertain quality assessment.

Organizations emphasize knowledge built in policies and procedures; however, knowledge largely is tacit and built into the cognitive skills of personnel and rooted in the work culture as shared collective understandings (Blacker, 1995 in Alvesson 2004).

When looking at the management of knowledge a distinction is made between:

1. Use of existing knowledge.
2. Mobilisation of existing knowledge and creation of new knowledge.

In project work, the planning, and methodologies that in detail prescribe how things should be done are to a lesser extent in existence in knowledge intensive organization. Deetz (1997 cf Alvesson 2004) stresses that definitions and solutions should be communicated on a constant basis, in order to reinforce roles and responsibilities.

The literature relating to the management of change in organizations point out that key guarantors to successful change include commitment, involvement and shared perception (Vakola and Wilson 2004) this is aligned with knowledge intensive organizations.

From the literature our attention is drawn to the view of the 1980's that the organization is a resource based entity with capabilities and assets which could lead to strategic competitiveness (Penrose 1959). Drucker (Drucker 1998) predicted that the typical business would be knowledge based, an organization composed largely of specialists who direct and discipline their own performance through organised feedback. There is a distinction between corporate knowledge (the collective body) of experience and understanding of an organization's processes for managing both planned and unplanned situations, and corporate knowledge management, which is the process whereby knowledge workers are linked with knowledge sources and where knowledge is transferred and applied to different situations (Drucker 1998).
2.4 Rationalization of Knowledge Management for Business

The preceding sections imply that knowledge management systems and other management systems should be aligned so that reviews and performance targets are matched. Continuous improvement reviews must be aligned to management reviews and targets should be aligned to learning and action. Knowledge enables performance to increase and lessons learnt can create knowledge that is transferred throughout the organization. Knowledge is a resource that is capable of use in different situations and that can be used to increase performance (Drucker 1998). Failure to capture and transfer knowledge generated within one project, which is usually buried in unread reports and out of date filing systems or lost because people leave the organization, leads to wasted activity and impaired project performance (Carrillo et al, 2000).

Internal benchmarking can be used to audit and review business processes. By applying lessons learnt in other parts of the organization the value of knowledge can be measured.

A framework for deciding which knowledge to look at and how to manage that knowledge is illustrated in Table 2.2 Milton (2005) describes the four areas in two components: the level of in-house knowledge that currently exists and the level of in-house need for that knowledge. He states that where there is a high business need but the in-house level of that knowledge is low then your focus should be on rapid learning. Where the level of in-house knowledge is high then you should concentrate on best practice and standards. Conversely, where there is a low business need and the level of in-house knowledge is high then the organization should look at archiving the knowledge for future use. If the level of knowledge is low then it may be that the knowledge management interest may be low but this is also he states an area whereby innovation can occur.

<table>
<thead>
<tr>
<th>High value knowledge</th>
<th>New knowledge – need to learn fast</th>
<th>Core competence – need to establish best practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low value knowledge</td>
<td>The area where innovation may come from</td>
<td>Old competence – need to archive for future use</td>
</tr>
<tr>
<td>Knowledge that is low in the company</td>
<td>Knowledge that is high in the company</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.2 Types of knowledge (Milton, 2005)

By plotting organization knowledge on a matrix such as the above, the knowledge management strategy can be planned.

PAS 2001 (BSI, 2001) takes an engineering company as an example, and illustrates that the introduction of a shared system, accessible to engineers providing discussion areas and solutions to problems would encourage knowledge sharing, and save time freeing up time for the engineers to concentrate on other areas where knowledge does not exist. This also makes the company less reliable on the individual. The Publically Available Specification (PAS) from BSI recommends that organizations introduce knowledge management projects to functional areas where the knowledge management introduction is not organization wide. This is useful as it allows the organization to take a systematic approach. The PAS illustrates organizational
functions such as information technology, human resources, marketing, learning and education (training) and gives examples listed in Table 2.3

<table>
<thead>
<tr>
<th>Functional Area</th>
<th>KM Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Technology</td>
<td>Thin clients, centralised data, stakeholder analysis, macro platforms, content management systems, user directory services, and search and query functions, portal usage. Expansion of infrastructure to intranet, extranet and internet users.</td>
</tr>
<tr>
<td>Human Resources</td>
<td>Employee information portals, self-service personnel records, uniform policy communication over intranet, employee skills inventory, performance reviews evaluated for KM sharing and compensation linked.</td>
</tr>
<tr>
<td>Marketing</td>
<td>Story telling, example project information, video diaries, advertising cost savings and health and safety improvements due to KM strategies</td>
</tr>
<tr>
<td>Learning and Education</td>
<td>Dissemination of knowledge around specific topics via intranet home pages, discussion areas for communities of practice, new knowledge in form of presentations – verbal and online.</td>
</tr>
</tbody>
</table>

Table 2.3 KM applied to functional areas of an organization, source: PAS 2001, BSI

2.4.1 The Learning Organization

Senge (Senge 1990) identifies five disciplines that are essential for a learning organization. The fifth discipline deals with the organization and creation of an environment where improvement and forward thinking can be practiced.

Learning occurs in organizations as activities and are carried out by individuals however it is more difficult for the organization to learn as a whole from these activities (BSI 2005).

Senge (Senge 1990) puts forward that in a learning organization, leaders are designers, stewards and teachers. They are responsible for building organizations were people continually expand their capabilities to understand complexity, and clarify vision, that is they are responsible for learning and facilitating the making of informed decisions.

It has been suggested (Cummings and Worley 1993) that most of the literature on the learning organization is prescriptive. Categories that additionally characterise features of the learning organization include structure, information systems, human resource practices, organization culture and leadership.
A starting point in creating a learning organization is when the enterprise recognises the need for initiative and personal development, linked to the needs of the organization.

The four characteristics of organizational learning have been identified as (Garratt 1996):

- The encouragement of people at all levels to learn regularly and rigorously from their work.
- It has systems for capturing and moving the knowledge to where it is needed
- It values its learning
- Is able to transform itself to meet new competition

More recently Peter Drucker (Drucker 2001) advocates that knowledge will be a critical resource and knowledge workers will be a dominant group. He suggests that knowledge will travel very easily, will be available to everyone through formal education or other informal routes and could potentially be the cause of failure if not properly managed.

By participating in the process of research, staff members deepen their sensitivity to the perspectives and needs of the project and organization, thereby developing professionally. The learning that occurs is two fold and has been called “systemic praxis” Bawden and Packham (1998) referenced in (Patton 2002):

1. The inquiry can yield specific insights and findings that can change practice, and
2. those who participate in the inquiry learn to think more systematically about what they are doing and their own relationship to those with whom they work

2.4.2 Knowledge Workers

A knowledge worker has responsibility for self-management and self-development; and is a person who possesses valuable experience and expertise that is needed to perform a task (Alvesson 2004; Milton 2005). Complex tasks are focused upon rather than the division of work into simple procedures. Knowledge workers voluntarily offer contributions, are regarded as the type of worker that is naturally engaged, dynamic, challenge seeking and who must be encouraged to take time off work than to work more. (Drucker 2001; Westhuizen 2002; Christensen 2003; Love 2005).

Because of this, organizations need some kind of structure that ensures that both the individual and the organization are working towards the same goals. Spender (1996) believes that the kind of management needed can be described as a diffuse, non-bureaucratic management style. A common rationale in the literature is that when a knowledge worker leaves, the organization loses vital knowledge and, in the worst case scenario, an aspect of its competitiveness (Hildreth 2000). This then implies that senior management need to ensure that employees at every level are involved in transferring knowledge and that senior management use this knowledge when making strategic decisions. Consequently there is not a situation of management using knowledge to elicit power in a centralised manner, instead
knowledge work and problem solving are carried out by the majority of personnel (Alvesson 2004).

However, uncertainty and complexity are areas by which most knowledge workers work. Quality evaluations seldom take place, and often if a problem is solved it is not certain that a group of experts evaluating the job would agree on the quality/solution or that there would be consensus within the expert group (Alvesson 2004).

In the general knowledge management literature, knowledge management is portrayed as being crucial to the success of an organization. Methods for managing knowledge concentrate on the basic people, process and technology basis for any implementation of knowledge management. Both knowledge creation and the management have been heavily researched within organizations, in recent years the shift from the organization to the project team has occurred.

The literature highlights the importance of ensuring mobility and stakeholder intervention across the roles of knowledge workers. In this sense the knowledge worker concept is relevant to classify an individual working in a project team.

In the construction context, such mobility and stakeholder intervention would allow forms of interaction in which project manager, team leaders and organization managers can minimize risk to the project. The knowledge worker, the organization and team management can take the role of tutor and vice versa, in the process bringing forth new knowledge resources and knowledge to the current and future projects.

A significant part of the literature concentrates on the tacit and explicit forms of knowledge and the resulting reorganization or ‘life-cycle’ of knowledge between the individual and the organization or project team.

This has identified several tasks for knowledge intensive organizations. One feature of the discussions in this area is the characterization of knowledge management as something that enables someone (a knowledge worker) to use some piece of knowledge whether tacit or explicit more effectively. The discussion also seems to suggest ways by which the organizations could make their organizational knowledge more usable by a variety of knowledge workers. In this context project team members are the main carriers for experiences and knowledge from the day to day work of the project (Disterer, 2002).

2.5 Knowledge translation and barriers

Knowledge sharing involves making individual knowledge available to the wider group in order to achieve efficiency and quality practices.

In organizations where there are teams and networks, knowledge is seen as a communal possession that must be shared (Milton 2005). As companies expand and make changes to organization structure, the importance of managing knowledge internally takes on a translation problem. Businesses that were once organised along geographic lines are now restructured according to market segment or process. Within these organizations, people are widely dispersed and combine efforts in teams.
Raised awareness has helped organizations recognize that knowledge assets are a source of competitive advantage and that learning to better manage these assets has become a necessity. Yet even though more attention is being directed to best practices, these remain stubbornly immobile. In a survey of 431 US and European organizations conducted in 1997 by Ernst & Young, only 14 per cent of the respondents judged satisfactory the performance of their organization in transferring knowledge internally. The remaining 86 per cent found it lacking (Ruggles 1998).

Yanow (2004) theorizes about the kinds of knowing present in organizations where employees develop knowledge via interaction, proximity and exposure with clients and customers that could be valuable to the organization. This views knowledge as aggregated information with an added context. Often this context comes from the organization. The article theorizes about the nature and hardships of translating local knowledge concerning organizational practices and about the structural character of local versus “expert” knowledge from the parent company.

A survey of subsidiary managers and their immediate superiors from three large corporations found big gaps between expectations, perceptions and reality. Whereas the parent company expected 95 per cent of subsidiaries to be actively sharing knowledge and perceived that 89 per cent were actually doing so, in reality only 62 per cent were actively engaged in knowledge sharing activities (Gupta and Govindarajan 2000).

Five types of knowledge transfer are identified by the literature (Dixon 2000; Szulanski 2003; Milton 2005). These are transfer of knowledge within the team, near transfer to other teams, far transfer of non-routine tasks, strategic transfer of complex knowledge and expert transfer.

In a survey of more than 100 transfers Szulanski (Szulanski 2003) identifies that the receiver often does not have sufficient knowledge to receive knowledge, knowledge can be difficult to grasp; relations between staff e.g. lack of trust or respect do not promote a knowledge sharing environment.

In certain cases applications of best practices can not be made as the individuals themselves are not sure of causality (Szulanski 2003). Other barriers include:

- Knowledge ignorance of who knows what in the company
- Knowledge hoarding
- Knowledge closure or rejection of knowledge
- Knowledge modesty
- Resistance to change
- Lack of inquisitiveness
- Not attentive to problems (tasks are carried out on existing procedures)
- Time not available to change existing procedures

The dynamics in organizations of “passive knowledge” vs. “actionable knowledge” can be seen in organizations. Passive knowledge keeps ideas and knowledge that could have helped the project away from the project team. Problems appear later in
the project with negative effects, whereas actionable knowledge is discussed and shared with the project team resulting in possible prevention of problems with limited negative effects (Argyris 1990). In their case study paper on openness and cross-functional risk reductions Husoy et al argue that a deficient work culture concerning openness and work methods to manage risk, especially at the early stages of the project are of the most cost increasing and limiting factors in organizations (Husoy 2002).

Barriers like this can lead to what is known as the nut island effect. Levy (Levy 2001) studied performance of a water works company and found that a dedicated team faced with conflict and distracted top management could lead to behaviour labelled as the nut island effect.

The stages are:

1. Members of the team become task orientated and lose sight of the big picture
2. Team becomes isolated and ideas become limited to the team who start to create their own rules
3. These rules become the norm and the team and management believe that the operation is running smoothly
4. When problems occur the team finds ways of explaining away the inconsistencies
5. Self-deception – human nature rejects information that clashes with the reality one wishes to see.

It is the role of management to recognise when this is happening to prevent the situation taking effect. The danger is to not only the present project team but also where this becomes the culture of the organization the risk is that the behaviour can become embedded in future projects.

Senge (Senge 1990) describes the political side of organizational dynamics where data and information is either hidden as a result of culture or where there is an inability to use the information present:

“A political environment is one which “who” – is more important than “what” ... A non political climate demands “openness” – both the norm of speaking openly and honestly about important issues, and the capacity continually to challenge one’s own thinking” (Senge 1990).

2.6 Knowledge and strategy

The creation and diffusion of knowledge across professional and organizational boundaries has become an important issue in the field of engineering construction within the UK. The large investment made by organizations has pushed the issue up strategy priority lists. This is most obviously demonstrated by the appearance of the concepts of organizational learning, the learning organization and knowledge management in various research, and policy review and recommendation reports.

Although there are disagreements amongst theorists over an exact definition of
organizational learning, there is a growing acceptance of its role as a collective social strategic process through which organizational knowledge is created (Czarniawska 2003; Maier 2003)

Grant (Grant 1996) affirms that knowledge is linked to the individual and that companies must put in place schemes to gain maximum access to knowledge and distribution of this knowledge.

From a strategic point, any knowledge that resides with the employee rather than the company can weaken the company's position. The departure of key employee's and experts from the company, due to resignation, termination, transfer, secondment or retirement can mean that all too often an employees knowledge and experiences disappear at the same time. (Hildreth 2000; Dent and Montague 2003).

The increasing reliance on temporary and contract workers exacerbates "leakage" issues for companies. Dent and Montague (Dent and Montague 2003) suggest examples of continuity management strategies:

- Communities of practice used to share knowledge
- Mentoring between employees and shadowing to pass on skills
- Encouragement of teamwork
- Development of tools on the intranet that expert employees approaching retirement are encouraged to use
- Exit proformas used to ascertain if an individual owns processes and to confirm that the information has been transferred to other employees
- Retirees asked to act as mentors, sharing their knowledge with the employee due to take over their role in order to transfer knowledge
- Small groups of associated experts meeting for brainstorming sessions on a regular basis - shared knowledge will mean that if one member leaves the organization the group will still have the knowledge in the group or documented by minutes taken and used as a knowledge log.

Management techniques identified by total quality programmes (Crosby 1984), benchmarking techniques (Camp 1989) and re-engineering (Hammer and Champy 1993) have enhanced significantly the understanding of operational performance. Davenport and Prusak (Davenport and Prusak 1998) note that knowledge management was still in its infancy in 1998. The use of information generated from these measures is now possible with thanks to information systems e.g. intranets, data warehouses, decision support tools, enterprise resource planning systems and groupware (Szulanski 2003).

Pablos (2004) argues that multinational companies that choose a transnational strategy must achieve three objectives simultaneously: global efficiency, local sensibility and organizational learning. Many firms have a culture where knowledge hoarding is a key feature, which means a hindrance for the transfer of this knowledge to other organizational members as well as for its reuse and distribution.

Building an organizational culture that emphasises knowledge sharing is of benefit to the organization to release the strategic value of this resource. Pablos (2004)
states that human resource policies have an impact on creating this kind of environment.

This perspective can be seen to follow on from Grant’s (Grant 1996) three mechanisms of rules, sequencing and routines, which integrate knowledge. The focus is not on creating knowledge but on integrating the knowledge of the employees.

Expert knowledge is used to lay down rules, which act as a method of control ensuring that those employees who do not have the expert knowledge, can nevertheless act as though they possess this knowledge (Grant 1996). This is interpreted as a strategic use of knowledge in that it is integrated through mechanisms and structure to offer efficiency and application of individual knowledge at a collective level.

The knowledge management process framework (Bukowitz and Williams 1999), supports these strategic perspectives by following two activities that occur in organizations:

1. The day to day use of knowledge
2. Long term process of matching intellectual capital to strategic requirements

The framework is a simplified way of thinking about how organizations generate and maintain knowledge processes. The tactical side of the framework refers to how people gather and use information in their day-to-day work.

The strategic process of the framework involves the organization assessing the information it has already and building upon this to create value when making strategic decisions.

A team that works together on a series of projects can achieve increasing performance over time. They will gain experience, guidelines and heuristics for future jobs. Some knowledge will be crucial, some irrelevant, an important part of strategy planning is to define what knowledge is crucial to the business and where this knowledge resides or where the gap in this knowledge exists and how to mobilise the use of the knowledge. The use of organigraphs (rather than organization charts) derived from knowledge interviews can aid the understanding of how knowledge flows within the business and its processes.

Where knowledge resides can be used to discover the impact to the company of knowledge loss and its strategic use (Christensen 2003) Figure 2.5 illustrates the possession of knowledge.
The Strategic Perspective

| The Strategic Perspective | There is a risk of knowledge leaking out to competitors, as it resides with individual employees | There are fewer knowledge leaks to competitors, as knowledge is manifested more in the processes in the company rather than by individual employees |

The Internal Perspective

| The Internal Perspective | Private knowledge must be shared with other employees to prevent the wheel being re-invented | Knowledge is possessed (as a process) by the community in the company |

Knowledge is Individual

Knowledge is Collective

Table 2.4 Possession of Knowledge (Christensen 2003)

This non bureaucratic approach has been stated by Morgan (Morgan 1988):

"the traditional bureaucratic approach developed through the fragmentation of work processes; different functions were allocated to different people. With the new approach, integration is the rule. People are given multifunctional roles, thus creating the flexibility that allows self-organization to occur" (Morgan 1988).

This is echoed by Prusak (Prusak 1997) who states that in a business environment, an organization’s people tend to become knowledgeable over time. Tacitly, they absorb and socialise knowledge about the company and the industry. Knowledge becomes embedded into everyday tasks and routine.

2.7 Approaches to knowledge management

Nearly all of the literature advocate holistic based approaches covering the basics identified by O’Dell and Grayson: technology, culture, management and measurement (O’Dell and Grayson 1998; Alvesson 2004; Milton 2005).

Most companies according to Milton (2005) use an approach which manages the people who hold the knowledge. This is achieved by transferring gurus and importing experienced personnel into projects and teams. Traditionally this has the disadvantage of knowledge leaving the company, knowledge being used in one place at a time and the danger of knowledge becoming ‘fossilised’ and a ‘nut island’ effect taking over the team (Levy 2001).

Other approaches include partial and holistic methods. Partial methods include both technology and people or community led communities of practice combined with
document management. A holistic method addresses all dimensions of the 12-component framework that Milton suggests. This covers:

- Tacit and explicit knowledge
- Knowledge communication, capture, storage and retrieval
- People, process, technology and cultural aspects
- Learning before, during and after
- Project teams and communities of practice

Communities of practice (CoPs) are practical groups of people formed to manage knowledge by sharing what they know, learning from each other and providing a shared context for these interactions with a view to solving project based problems (Dent and Montague 2003; Milton 2005).

Examples of re-use of existing knowledge, experience and innovation include the use of tools to provide access to best practices and project histories. Pre-project reviews and initial start up project meetings ensure that existing knowledge residing in the organization is used while post project reviews are completed to reflect on the project and to document good practices and lessons learned logged (Kelleher 2001; BSI 2003; BSI 2003; Dent and Montague 2003; Love 2005; Milton 2005).

These tasks stem from frameworks explained by Drucker in 1954 (Drucker 1998) consisting of:

- The exploitation of knowledge
- The mobilisation and creation of knowledge
- The retaining and attracting of knowledge

The importance of performing a knowledge audit as a first step in developing a knowledge management strategy for an organization has been identified as crucial for evaluating where a company is in its knowledge pathway (Chauvel and Despres 2002; Love 2005). An essential output of the knowledge audit process is the knowledge map, which provides insights for improving business processes and systems.

The types of questions that a knowledge audit should ask include (Bukowitz and Williams 1999; Grey 1999):

- What type of knowledge is needed to do your work?
- Who provides it, where do you get it, how does it arrive?
- What do you do, how do you add value, what are the critical issues?
- What happens when you are finished?
- How can the knowledge flow be improved, what are the barriers?
- What would make your work easier?
- Whom do you go to when there is a problem?

Knowledge management processes need to be embedded into the daily working activities of every role rather than making it the responsibility of one (Love 2005) by focusing initial work on knowledge audits of the business, an organization can see
where knowledge could dovetail with day to day work. By creating a framework, this helps to create a process where knowledge is embedded into day-to-day processes.

The aim of the knowledge audit is to make explicit as much as possible. When using memories the organization is likely to lose knowledge as memories are unreliable; people forget, misremember, post rationalise, leave the company, retire or join the competition (Milton 2005).

If this is the first time there has been a knowledge audit in the organization, there may be no existing metrics to measure against. An audit that concludes that there is no attempt to capture the knowledge and experience of people leaving the organization, and makes recommendations to change; this is going to have far-reaching consequences. The audit will be able to demonstrate benefits to the organization.

The use of projects within the company present knowledge management challenges on a similar scale to that of knowledge management generally within the company. A project environment creates a situation whereby challenges of the project and its management of knowledge if managed effectively, can be used to reduce project time, improve quality and client satisfaction, and minimise "reinventing the wheel". The following section discusses the literature on knowledge management within the project, particularly the construction project environment.

Chourides et al (Chourides, Longbottom et al. 2003) states that for knowledge management to be successful, an organization must have a strategy and individuals must be persuaded to contribute to its formulation and implementation.

This is supported by a descriptive case study on EADS Military Aircraft (Mayrhofer and al 2005) which apart from facing the normal knowledge management challenges describes the need for a knowledge process and strategy in order to retain knowledge memory. This descriptive case study illustrates that there must be put in place processes and actions that allow the capture of knowledge.

Seeley and Dietrick (Seeley and Dietrick 1999) identify and emphasize six components which must be addressed when considering knowledge management:

1. Governance
2. Culture and Behaviour
3. Content management
4. Technology
5. Application
6. Dissemination
In their review of survey research in KM (Chauvel and Despres 2002) report from a research program which identified surveys that have been conducted in KM between 1997-2001. They found that the survey is typically used in knowledge management research to map and audit where the company stands in its maturity of knowledge management.

The knowledge map can help the company to identify where its knowledge resides, where bottlenecks for transfer exist and the next steps in the knowledge pathway.

Gorelick et al (2004) in Milton (Milton 2005) suggest that 'knowledge management is fundamentally a systematic approach for optimising the access, for individuals and teams within an organization, to relevant actionable advice, knowledge and experience from elsewhere'. One study supported by CIRIA (Dent and Montague, 2004) discovered that knowledge management systems have been developed very much on contingent, bespoke platforms. However, the level of emphasis on the various organizational and initiative sub-systems differed between the eleven participant companies, even though the fundamental problem is essentially the same - how to generate and capitalise on knowledge. The study showed that capture of tacit knowledge on a project-by-project basis proved to be a challenge.

This study affirms Christensen's view that a project environment where existing knowledge is reused can be used to create procedures for project teams to follow, whereas where knowledge is constantly created, this process is much harder to manage (Christensen 2003) as procedures are absent.

The report also points out that there is a scarcity of studies, which focus on what organizations do in practice to capture and transfer knowledge. This is unforeseen considering the importance of the project environment (Drucker 1998). However Chen (Chen & Chen 2005) found that between the years 1995 to 2004 the trend of organizational knowledge as a whole shifted to that of project knowledge.

Since then the literature, relating to the construction team and knowledge management has expanded. The central concept is one of organizational learning. The environment is one of a project-situated phenomenon. By following a pluralistic approach the literature review has considered organizational learning (Cook 1993) as well as learning being an individual activity (Argyris 1977; Simon 1991) both combined with knowledge management in project and organizational environments.

Knowledge workers differ from other types of workers in that they may resist following procedures, instead using their experience and skills to adjust to the particular needs of the situation. When there is change in the project, they respond and react to suit the project needs (Cortada 19898). As put by Charles Handy the challenge is one of how to ensure that this occurs while maintaining a learning and knowledge managing organization (Handy 1995).

The cultural perspective considers "...the capacity of an organization to learn how to do what it does, where what it learns is possessed not by individual members of the organization but by the aggregate itself. That is, when a group acquires the know-how associated with its ability to carry out its collective activities, that constitutes organizational learning" (Cook 1993).
Learning is seen to be problem solving, situated collective activities based on decisions that are made dependent on information that is fed by colleagues and individual experience, a phenomenon based on the environment it takes place in.

For organizational learning to take place there must also be individual learning. When organizational learning takes place this knowledge must be managed and made explicit for others to learn from and to prevent inefficiencies whether the knowledge is positive or negative.

Organizational learning and knowledge management is closely related, although distinctions are made in the multiple and extensive literature bases. Organizational knowledge, organizational learning and knowledge management is a multilevel process at both individual and group level (Brown 1991).

Following a pluralistic epistemology as suggested by Spender (Spender 1996) allows the combination of the different types and levels of knowledge that the organization makes use of and the investigation of the different knowledge interactions in place e.g. tacit, explicit, cultural, individual, collective, procedural, knowledge actions, and knowledge voids.

It has been proposed by Nelson that the where or what of knowledge in the company lays primarily in organizational routines (Nelson 1982). According to the conceptualization of the construction project environment, this is accepted as one off long term, fast changing and demanding environments where organizational routines are flexible. Consequently the nature of knowledge is a learning process that is adapted to an unstable position.
2.8 Conclusion

This chapter has discussed the literature on knowledge and its management, starting from a generalised view leading to an organizational view. Areas covered in this chapter range from the philosophy of knowledge, to knowledge management systems, knowledge types, knowledge workers, knowledge intensive organizations, barriers to knowledge and strategy. Different authors present different definitions of knowledge management and present different approaches to its creation, capture and usage.

<table>
<thead>
<tr>
<th>Main Concepts Identified</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doubt, confusion, testing of ideas lead to knowledge creation</td>
<td>Argyris (1977), Goodman (1995)</td>
</tr>
<tr>
<td>Knowledge shifts related to power shifts</td>
<td>Foucault (1980)</td>
</tr>
<tr>
<td>Knowledge as a competitive advantage</td>
<td>Penrose (1959)</td>
</tr>
<tr>
<td>Knowledge as a framework of experiences, contextual information and insight creating organizations routines.</td>
<td>Davenport and Prusak (1998)</td>
</tr>
<tr>
<td>Intellectual assets and capabilities as key resource of competitive advantage</td>
<td>Bukowitz and Williams (1999), Easterby-Smith (2003), Starbuck (1992), Nonaka and Takeuchi (1995)</td>
</tr>
<tr>
<td>Tacit and Explicit Knowledge</td>
<td>Polanyi (1966)</td>
</tr>
<tr>
<td>Different stage of knowledge – immature to mature</td>
<td>Bohn (1994)</td>
</tr>
<tr>
<td>Dimensions of knowledge</td>
<td>Davenport and Prusak (2000)</td>
</tr>
<tr>
<td>The learning organization, fifth discipline</td>
<td>Senge (1990)</td>
</tr>
<tr>
<td>Barriers to knowledge transfer</td>
<td>Szulanski (2003)</td>
</tr>
</tbody>
</table>

Table 2.5 Main concepts identified from literature review.

It is important to note at this stage that knowledge management is as is demonstrated by the main concepts covered in the literature review (Table 2.5) more than information and data – it is also a social issue that involves trust, obligation, and commitment between all (Erickson & Kellog, 2003 cited in (Palmer and Platt 2005). The main business drivers for knowledge management are identified throughout the chapter and summarised by Bair (2004) as:

- Knowledge sharing and competitive response
- Innovation
- Reducing or controlling costs
- Reducing loss of intellectual assets from employee turnover
- Increased need to operate globally
- Compliance

The following chapter investigates the knowledge management literature from the construction industry and project team perspective.
Chapter Three: Literature – Organizational Knowledge, Knowledge Management and the Construction Project Team

3.0 Introduction

The literature is crowded with recommendations for the creation of a learning organization and includes cultures, structures and the processes required to capture knowledge. In recent years, as a result of industry calls for various initiatives to increase the efficiency and effectiveness of the industry (The Latham Report, The Egan Report, The Accelerating Change Report) research literature has highlighted the need for changes in managerial culture and systems to support the knowledge based culture that has grown. The telecommunications industry of the 1990’s illustrated through growth from a hierarchy to a much more horizontal operating system how the process of change through strategic, tactical and operational modes, has to be monitored and stressed the importance of the capability to manage intellectual assets, knowledge and information in the process of change (Ledin 1990).

More recently, the literature has focussed on project learning and knowledge transfer within and between the team. Managing through project based work has become a standard for many companies and an integral part of business (Davenport and Prusak 1998).

3.1 The Construction Industry and the Project Team

Project teams are defined as a set of individuals who make up a temporary organization, who share collective responsibility for a shared outcome and detailed tasks under restricted time and budget (Disterer 2002, Milton 2005).

A team is defined by Cook et al (1994) as a type of group with complementary skills, competencies and knowledge, who are committed to a common purpose and set of performance goals and approach for which they will hold themselves mutually accountable. A team engages in collective work, which produces results, which are more than an individual’s efforts (Milton 2005).

A good team is characterised by (Hayes 2002):

- A clear sense of itself as a group
- Positive interaction with outsiders
- The cultivation of positive assumptions and beliefs
- Good communication

The construction industry has a number of key differentiators from many other industries.
The construction industry:

- Is large, comprising between 10% and 11% of the UK GDP, and employs over 1.4 million.
- Is highly disaggregated in terms of company size ranging from small and medium enterprises to large multinational enterprises.
- Is highly disaggregated in terms of activity (engineering, planning, development, architecture, and material / product suppliers).
- Is highly disaggregated in terms of clients ranging from homeowners, health, education, commerce and industry.
- Is highly project focused, with teams forming for projects and breaking up afterwards.

Construction project teams are temporary formal teams. Construction project teams can comprise people either from within the same organization or from different organizations (Male 1991).

Construction project teams have several layers of different skills that come together on each project to produce often-unique products. Designers, engineers and contractors who may use different means to convey the same information often work together on complex projects. Projects may also involve operational layers of client, project management, main contractors and subcontractors.

3.2 Construction Knowledge

The construction of a process plant has a high proportion of its development cost attributable to knowledge-based elements such as the design, assessment of cost alternatives of different subcontractors and components, advice on contractual aspects, risks, build ability of the plant, health and safety, and quality controls.

Knowledge created by the principle contractor while interacting with the client, engineers and subcontractors becomes deeply embedded within the socialisation process. The main capital for the organization is the intellectual assets and knowledge workers that are employed in the project team. As the plant is constructed and then commissioned, this knowledge is passed onto the operators. The stages of the project are illustrated in Figure 3.0.
Receive Enquiry from Client

Conceptual Design / Proposal Bid

Review by Client/ Preferred Tenderer?

No

Receipt of Order

Basic Engineering

Detailed Design and Procurement

Ordering of major equipment, HAZOP studies, Testing, Sizing, Enquiries, Planning of overall layout, Civil and Construction aspects

Sub-contractor bid analysis, enquiries and planning

Construction and Erection

Site Set-Up

Commissioning and Availability Testing

Handover

Alter Sales Care

This process can take anywhere up to five years and may or may not be realised as a receipt of order

Review or Discard

Figure 3.0 Flowchart illustrating typical stage gate framework processes - source: conversation with senior piping designer

The next section illustrates how knowledge underpins the construction project.

Knowledge within the project gives us the ability to take action (Milton 2005) however the project will normally pass through a number of stages e.g. scope - concept design - detailed design - construct - commission - operate. A problem of major construction projects is that different companies and teams may handle the different project stages.

Unless knowledge and learning are managed at every stage he argues, project actions will be hindered.
3.3 Construction Project Knowledge Management

Construction projects for the purpose of this research are regarded as complex product systems (CoPS). CoPS are defined as capital, engineering and information technology intensive business to business products that tend to be high in value and are of a one off nature for specialised markets (Hobday 1998).

There is a process of reuse of local knowledge through repeated designs and standardization of designs. Local knowledge is the knowledge that is developed by interaction among people that are specific to a local context - much of it is tacitly known (Hafner, 1999).

Project management takes place within an organizational context, the project is therefore not treated as separate from the organization, the organization structure has an effect on the design of the project management and the projects serve as building blocks in the creation and long term corporate strategy (Ayas 1996).

Objectives of the project are delivered by performing and coordinating a series of interrelated tasks. Knowledge management within the project can be broken down according to the work breakdown structure. Lessons can be captured and accessed at task level. Figure 3.1 illustrates the move from data to action and then the reuse of these actions in terms of current and future project management. Ayas (1996) identifies this learning from project to project as the key strategic variable for project management.

![Figure 3.1 Data, Information, Knowledge, and Project Management Cycle (adapted Milton, 2005)](image-url)
Knowledge management is raised amongst other issues as important for recognising the application of knowledge as a future differentiator in terms of company performance. In a study carried out by CIRIA (CIRIA 1999) a number of groups suggested means of building on the skills within their organization. The methods used in the study consisted of in-company and intra-company workshops, interviews and questionnaire surveys. Participants proposed that improved management of and access to knowledge would result in better decision making, reduced risks, continuous improvement which would lead to better service. Participants then suggested steps to achieve this.

Knowledge in the construction project can be classified into three categories (Whelton 2001):

- **Domain knowledge** - includes administrative information, planning information, standards, and technical rules. This information is generally available to all companies.
- **Organizational knowledge** - is company specific, and is the intellectual capital of the firm. Resides both informally, formally, tacitly and explicit. It also involves skills and relationships of those involved in business relationships.
- **Project knowledge** - this has the potential of usable knowledge, includes project records and documentation, experiences of problems and solutions.

In recent years, proprietary software solutions have appeared on the market in order to capture the information in these categories. Knowledge management systems provide a means to assemble and act on the knowledge accumulated throughout an organization. Such knowledge may include the texts and images contained in patents, design methods, best practices, competitor intelligence, and similar sources.

Professional services company Mott MacDonald say that knowledge management has dramatically cut the search time for documents and has had a major effect promoting collaboration and the sharing of expertise (Palmer and Platt 2005). However, it must be remembered, the project documentation is not provided for knowledge management, rather the documentation is created for the project and the tasks so project information must be transcribed into lessons learned (Disterer, 2002).

Organizational knowledge is often tacit, rather than explicit, so these systems must also direct users to members of the organization with special expertise. Access to an organization's knowledge is often provided via an intranet equipped with specialized search software.
3.4 Project Learning Difficulties

Often the sharing between the stages of a project and between the different companies is hampered by the habit or seemingly cost saving attitude of not appointing team members/companies until later in the program, even where their knowledge may have been useful earlier on in the design stages.

Knowledge shared can create positive aspects to the project team. If team members possess insufficient knowledge for a particular aspect they can turn to various sources to generate new knowledge, for example in survey of Hong Kong and UK Quantity Surveyors (QS's), team members fill knowledge gaps by consulting with professional references or other more senior QS's. This kind of knowledge sharing happens frequently in design situations, where team members may not have the necessary expertise or experience to generate the knowledge. Once the necessary knowledge has been created this should be made explicit so that team members can cascade existing knowledge to other projects or teams and re-use. Nonaka and Takeuchi suggest that this new knowledge is not used fully in organizations and needs to be encouraged (Nonaka and Takeuchi 1995). Studies from the construction industry (Fong 2005) consisting of case study research explored the underlying processes of knowledge creation. It was found that social networks were an important method for knowledge transfer, however these could as well as aid knowledge transfer and generation, hinder in that teams may resort to antecedent project approaches. The study found that inter-project transfer mainly occurred where team members took knowledge that they experienced from one project to another. This was observed in team meetings by reference to past projects, rather than reference to codified knowledge.

Addressing this question of what part social processes play in the transfer of knowledge has been investigated in construction projects by Bresnen (Bresnen et al. 2003), the qualitative study consisting of open-ended interviews and supporting documentation considered the introduction of a Regional Engineering Manager (REM) role. The aim of this was to improve performance by increasing coordination and providing support and development for engineers. The study found transfer of technical knowledge between sites and REM's tended to be largely by word of mouth, more formal processes such as the quality assurance procedures linked to the British Standards system developed by the Quality Assurance manager did not always find its way to the REM nor did it dovetail with other project review procedures. Accountabilities were also found to be vague within the organization, where it was then unsure who had responsibility for tasks. They found that communication and success depended on the skills of the person in the role rather than set procedures (Bresnen 2003).

The study detailed several factors, which enabled or inhibited the effective capture and diffusion of knowledge processes:

- Organizational structure and objectives
- Cultural context and climate for change
- Skills and capabilities
- Communications
- Technology
The overall findings reasserted the importance of social processes of project learning.

In project based environments where new ideas are created on temporary projects a method of selecting the new knowledge, agreeing where it is to be stored and how it is to be managed and then distributed to new projects needs to be of concern to the organization. However, it is often argued that the processes involved in delivering the final outcome of the project are similar, even though the project itself may have differences and the outcomes or product is different (Love 2005). The use of knowledge gained from successes and failures that have occurred in projects is vital for efficiency. The reuse of knowledge can be problematic where the project members leave to work on other projects, where project members are dispersed in different locations and where there is a lack of culture for knowledge retention.

Further limitations in managing project knowledge in the literature include (Bukowitz and Williams 1999; Whelton 2001):

- Construction knowledge often resides in the minds of the individuals working within the domain
- The intent behind decisions is often not recorded or documented. Ad hoc conversations, messages are difficult to record but contain much project related information
- People responsible for collecting project data may not understand the actual needs of those who may be using the data or those that may need to use the data at a later date
- Data is not usually managed at the time of creation, people are likely to leave the project before their input has been recorded
- Lessons learnt are not re used as information is overlooked. It is difficult to compile information and transfer to other projects
- Historical reports of projects do not include rich representation of data context so that it can be used with minimum or no consultation
- Projects are often under severe time limitations thus forcing immediate demands to be a priority rather than thoughts of future projects.

Research by Love et. al in 2003 (Love 2005) found that project reviews are rarely undertaken in the construction sector and where they are they are invariably used to place blame. The use of project reviews to place blame can hinder the very nature of the review as a blame culture may hinder openness and learning. Similarly, where small project based construction firms are in the position of survival, and the need to get on with the current or next job, motivation for developing and knowledge reuse is low. Findings from a case study involving seven construction companies found that small resource limited project firms will want to minimise their exposure to costs and risks of innovation which will not give a return until the medium to long term (Barret 2006).
In results published by Leseure and Brookes (2004), a majority of interviewees linked their knowledge management problems in project environments to discrete events in the evolution of their company’s environment. Significant events included downsizing and other large reorganization events, termination of a long-term relationship with a supplier, departure of an entire project team, high turnover, gaps in the age distribution of a department, and significant company growth (Leseure & Brookes 2004).

Knowledge management itself although popular in the literature is as a conscious practice still young and is not yet tied in to construction projects. This is illustrated by the pushing of awareness and advertising of the benefits of knowledge management for the construction project team. Findings from survey research conducted among 200 Hong Kong and UK quantity surveyors in early 2003 reveal that almost half of the respondents did not know about knowledge management.

Objectives of the knowledge management audit in Dent and Montague’s (Dent and Montague 2003) research concerning current KM practices in the participant companies were to:

1. Prioritise knowledge management issues and activities as a group benchmarking exercise

2. Identify current and future knowledge management tools and develop a detailed analysis of the characteristics and benefits of these tools and technologies.

The study suggests that time constraints and a lack of resources mean that post project reviews are not always carried out. Employees sometimes believe their priorities lie in starting the next project rather than reflecting on completed work.

Additionally the study finds that cultural problems occur where employees do not acknowledge that they will make the same mistakes as their predecessors, so do not recognise the need for a formal process of reusing existing knowledge (the processes to reuse existing knowledge are often in place but employees need incentives to complete tasks such as post project reviews).

There seems to be a common feeling that project information is relatively unique for many projects and therefore, project knowledge is essentially non-transferable (Dent and Montague 2003).

Difficulties exist in project-based organizations where there is no form of infrastructure for intra-project or inter-project information needs. Lack of management training in organization techniques within the firm, mean that survival is the first priority for the small firm and crisis management is usually the modus operandi (Watkins 1983) rather than a considered approach using the latest management techniques.

Confrontations and conflict are presented in greater frequency due to the complexities of the construction project. This presents a difficulty in creating a culture that aids knowledge sharing. The different knowledge types in the industry are illustrated in Table 3.0, although as Fong points out there are differentiations, the knowledge is
inseparable for the project completion. Any knowledge sharing is reliant on the understanding of the context of the knowledge itself (Fong 2005).

<table>
<thead>
<tr>
<th>Knowledge Type</th>
<th>Meaning</th>
<th>Explicit/Tacit knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sectoral Knowledge</td>
<td>Specialist knowledge of sectors</td>
<td>Mostly tacit (e.g. how to design and build)</td>
</tr>
<tr>
<td>Professional Knowledge</td>
<td>Knowledge and skills related to a particular profession e.g. architects, quantity surveyors, structural engineers, health &amp; safety, designers</td>
<td>Both explicit and tacit (e.g. knowledge in books/reports and professional judgement)</td>
</tr>
<tr>
<td>Company Specific Knowledge</td>
<td>Process and Procedural knowledge of a company e.g. project and organization management</td>
<td>Mostly explicit (e.g. company handbooks and manuals)</td>
</tr>
</tbody>
</table>

Table 3.0 Knowledge Types (Fong 2005)

A key finding of Leseure & Brooks (2004) measurement and benchmarking research of knowledge management in project environments was the differentiation between kernel and ephemeral knowledge. Kernel knowledge being the knowledge that is relevant from project to project across the organisation and ephemeral knowledge being that knowledge that is particular to a project.

The management of both types of knowledge has to be carefully managed. Kernel knowledge will require consistency and procedural processes whereas ephemeral knowledge will need a more flexible approach. Leseure & Brookes (2004) give the example of the supply chain as being a key source of ephemeral knowledge (in most cases, the ephemeral knowledge for a project team is the suppliers kernel knowledge). In this case, there is a need to extend the notion of a collaborative culture to relationships with suppliers. This would apply equally to the client relationship.

A study of the construction of the Channel Tunnel found that the perceived role and role significance of engineering consultants diverged heavily between the consultants themselves and the permanent staff (Hendrickson 1999). This may be due to a difference of knowledge types.

Similarly, studies of management consultancy projects illustrated that the outcomes of projects led to diverse assessments by the engineers themselves of the project outcome. Some felt that the projects were highly successful whereas others expressed negative verdicts (Alvesson 2004).
3.5 Building knowledge sharing cultures in construction project teams

Despite much literature and acknowledgement of knowledge sharing methods, the successful adoption of a knowledge sharing culture has presented a problem to project based companies (Dixon 2000; Szulanski 2003; Love 2005). It has been said that successful project management is based on both individual and collective competences; the sharing of knowledge and the importance of reflection, combined this can lead to project success (Love 2005). Namely, that the more knowledgeable the team are, the more likely they are to avoid mistakes, repeat good practice and avoid risk.

However, most construction companies are still at the stage of building their awareness of knowledge management (Palmer and Platt 2005).

Projects that are often one off, self contained, complex and in some cases with virtual teams make knowledge sharing difficult; combine this with project teams made up of differing professional disciplines mean that the building of a knowledge sharing culture is a hard task that the organization faces. However Grants (Grant 1996) view is that the level of co-ordination and organizational structure are imperative for integration.

A knowledge map for the project would help evaluate project knowledge bottlenecks. Often project team members are specialists in their own discipline, and are drawn in from other projects or projects that have just ended, they are also more frequently dispersed before the end of the project having spent effort on immediate deliverables rather than long term deliverables such as knowledge learned now to be reused on future projects (Fong 2005).

The Cross – Organizational Learning Approach (COLA) was developed to structure the gathering and sharing of tacit and explicit project knowledge. The process was primarily designed for collaborating arrangements but can be used across organizations or departments. COLA acknowledges that reviews should take place at various times in the project. COLA comprises pre workshop investigation and four workshop stages consisting of communication, observation, learning and application (Thomas 2003). Table 3.1 illustrates the process.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>Sharing successes, issues and opportunities</td>
</tr>
<tr>
<td>Observation</td>
<td>Identifying causes of successes and opportunities, seeking further</td>
</tr>
<tr>
<td></td>
<td>Opportunities for improvement</td>
</tr>
<tr>
<td>Learning</td>
<td>Developing what to do to enhance value for all, identifying who is</td>
</tr>
<tr>
<td></td>
<td>best placed to implement it</td>
</tr>
<tr>
<td>Application</td>
<td>Agreeing proposals to enhance value</td>
</tr>
<tr>
<td></td>
<td>Who is best placed to manage the processes</td>
</tr>
<tr>
<td></td>
<td>When to do it and</td>
</tr>
<tr>
<td></td>
<td>How to measure success</td>
</tr>
</tbody>
</table>

Table 3.1 COLA Stages (Thomas 2003)

After the workshop, the team must continue to track the impact and the effects of the improvements on value to their organizations.
Prior to the workshop, a questionnaire is sent out asking for opinions and responses to questions regarding the project. Once replies are received, the facilitator considers key areas to focus on during the workshop. This process ensures that learning takes place, that successes are repeated and mistakes are not repeated. However, the author points out that the success of COLA depends on the commitment of the whole team to share their learning in a no blame culture and on clear and decisive leadership.

Site managers are recognised as knowledge holders of complex information relating to the construction and day-to-day work on site. A study by Boyd and Egbu et al (Boyd 2004) involved 32 site managers from 12 construction small and medium enterprises, where story telling was used to debrief site managers and extract the knowledge that they hold to a wider audience. This method of story telling involved weekly debriefings in order that information was not lost over time and represented a continuous update.

Research by Taylor (2005) found that the use of the critical incident technique surfaces tacit knowledge by encouraging respondents to tell “stories” that are illustrative of good or poor performance in a particular area (Taylor, 2005). In her research, the use of the method helped to identify context specific details and allowed reflection to be undertaken by the respondents. Darshi De Saram et al (2004) recommend the further application of the critical incident technique in the construction industry to develop a maturity grid to assist project managers who want to improve construction coordination.

Information from both techniques above can be kept in a legacy archive or a project acquired knowledge base that is made available throughout the organization. The knowledge must be accessible to all and must be maintained and kept up to date (BSI 2001).

The BSI PAS2001 (2001) illustrates a knowledge management enabled IT infrastructure which is replicated in Figure 3.1 whereby data is centralised over the corporate global WAN rather than in separate offices. Where group IT strategy is implemented rather than separate local data strategies this can be achieved enabling the sharing and access to data and enforcing a knowledge sharing culture.
Collectivism refers to social networks in which individuals support each other. Many construction projects due to the diversity of skills and changing team members tend to be individualistic. Team based organization describes an organization that uses teams for core work, and the organization as the support structure.

Dent and Montague (Dent and Montague 2003) suggest that KM should support remote teams by enabling all remote individuals with access to the corporate network and email; senior management should visit remote teams on a regular basis to support them in terms of access to knowledge and help break down any “silo” mentality. They go on to say that supporting remote project teams and providing most employees with access to corporate and project, information is a key part of the corporate culture.

A team based organization must have intentional effort in order for the organization to support the team (Harris and Beyerlain 2005). Reflective activities must give thought as to what is required to support teams and how the organization can meet this.

The team-based organization recognises that a team helps to achieve success; however, the effectiveness is limited unless the environment or context of the organization is aligned with the team. Support systems for teams suggested by Harris and Beyerlain (Harris and Beyerlain 2005) enable better sharing and learning cultures as they design in lateral and horizontal interactions among and across team and organization members.

Team based organising overlaps with collaborative work systems, knowledge management and project based organizations. This is reflected in studies on knowledge in multidisciplinary project teams and boundary crossing (Love 2005).
Milton (2005) recommends methods such as peer assist, after action reviews, project review meetings, and retrospect in order to capture, use and learn from knowledge residing in the project and project peers. The knowledge re-use cycle in Figure 3.2 illustrates how knowledge from project team activities can via the above methods be reviewed and questioned. Lessons learnt can be validated and distilled leading to the adoption of best practices, which are then adopted as company standards and applied across the organization and the project environment.

Peer assists enable specific technical or commercial issues to be addressed, assistance and insight to be gained from other projects and exposure to potential new approaches, solutions or expertise (Dent and Montague 2003).

The frequency of the methods used to capture lessons should be linked with the frequency of performance as each time performance is assessed for example by retrospect and after action reviews, an opportunity is created to capture knowledge (Milton 2005).

The view of involving stakeholders reduces uncertainty by minimising assumptions concerning others views. This can highlight areas of potential conflict and aid in minimising any process inefficiency concerning undefined roles and responsibilities, unrealistic budgets and schedules, insufficient time for project definitions, re use of unrealistic “norms”, poor group dynamics, subjective decision making in conflict resolution. Oldfield (2001) in Whelton (2001) defines stakeholders as “Any individual or group with a vested interest in the project process or its outcomes”
Bounds et al. (Bounds. G 1994) suggest that using advantage points based on criteria reiterated by Harris and Beyerlaiin may support a strategy for achieving customer value. Collaboration creates a systems view for understanding the complexity of the project.

Project management requires keen analytical processes to identify stakeholders and to work with them to identify needs and expectations.

Project management is the organization, management, and control of all aspects of a specific project throughout its duration, from initial concept to final takeover. The final product should achieve the project owner’s objectives with respect to:

- Successfully fulfilling the predetermined scope, function, and quality requirements;
- Completion within the approved schedule; and
- Completion within the approved budget.

When project management is applied to a multi-project collection of work, we refer to this as program management. The principles of project management apply equally to program management. There has been a growing awareness of project management as a special skill and competency that is learned and applied, much the same as the traditional specializations of engineering or architecture.
Project management is quite different however, from the technical design, engineering, architecture or construction disciplines most readily associated with capital projects. Often, there are aspects of a project that fall outside the scope of these technical areas that need to be prudently managed in order to meet the broader project objectives. This has resulted in the evolution of project management as a separate and distinct function that is performed independently of, but in conjunction with, architects, specialty engineers, suppliers, and contractors (construction managers), each executing their respective project roles.

Traditional project management concentrates on planning, organization, directing and controlling resources to achieve specific goals on time and within budget (Disterer, 2002). Research by Kaulio (Kaulio, 2007) using the critical incident technique to interview project leaders in multi-project settings found that the most frequent issues project leaders deal with are to do with technical difficulties, dynamic leadership, group dynamics and relations with peers and client/supplier relationships. The advantage of this approach was that the incidents were able to be “unfolded” in order to give insight into the phenomenon being studied.

Following an empirical exploration of project managers’ ways of conceiving and accomplishing their work using an interview approach of 30 project managers in UK construction firms, Chen and Partington (Chen and Partington 2006) identified three different basic conceptions of project management work. These being project management as planning and controlling focused on the construction work process and individual subcontractors, organising and coordinating and being able to predict and manage potential problems, similar to the metaphor of a conductor managing the talents of different specialists to create a product that could not be created by any one single specialist.

The principles and techniques of project management are applied to a wide variety of projects involving strategic planning, new construction, major maintenance and repair work, renovations, relocations, and reorganizations. The more complex the situation or undertaking, the more appropriate the application of project management principles.

The advantage of creating a dedicated project team is that it can reduce dependencies, especially within the organization, as resources are allocated to the project. Where resources are shared then inevitable conflicts of resource pull will be felt between one project to another. The organization must build a network that is cooperative in order to accommodate shared resources such as the project administrative function, document controllers, and planners.

It is prudent to have reality checks ongoing during and after projects by performing project audits. The project audit includes:

1. Evaluate if the project delivered the expected benefits and expectations of all stakeholders. Was the project managed well?
2. Assess what was done wrong and what contributed to successes.
3. Identify changes to improve the delivery of future projects.
The Achieving Excellence suite of guides reflects recent practices and builds on experiences of the Achieving Excellence in Construction initiative. Post project reviews are carried out after the project and focuses on how well the project was managed. It must include the views of suppliers and specialists. It considers how well the project performed against key performance indicators such as cost and time predictability, safety, defects and client satisfaction. It also considers lessons learned from the team working; these lessons learned should be documented in the Lessons Learned Report and fed back to the organization. It is important to obtain views from members of the team including suppliers. This is a two way process. The guides give examples of government projects that have achieved savings in time and costs as a result of improved project management such as NHS Estates, Defence Estates, Highways Estates and the Environment Agency (OGC 2007). Furthermore, it is estimated that 90 percent of all projects are not seriously audited or reviewed, the most common reason being one of resource commitment. It has been observed that organizations that are leaders in their field are vigorously committed to continuous improvement and organizational learning (Grey and Larson 2003). However, as pointed out by Disterer (2002) most companies are investing heavily in innovative project work but investing nothing in evaluating and learning from it. At best, project team members keep the knowledge and experiences as individual knowledge, which they may use in the future (Disterer, 2002).

Good reasons for project reviews as a continuous process include the avoidance of lessons being forgotten over time and improving work in progress. This is particularly important where in large projects members of the team may move onto other projects. Any post project review should take place in a no blame environment and record all lessons learnt.

Project management provides for better information flow on the project as well as a degree of objectivity and perspective not otherwise available. The project remains organized under a single-point responsibility structure that facilitates a concerted and organized coordination, planning and control function. The benefits of a structured and formal project definition approach have been well documented by the Construction Industry Institute (CII) of the USA, where their studies of several thousand projects indicated an average savings of 39% on schedule and 20% on capital cost over projects that did not adopt a formal planning and definition approach (Bank 2006).

Project managers need to be able to engage effectively with stakeholders and hidden areas (Figure 3.4) of stakeholders in order to create project information on possible conflicts and problems that may arise (Boddy 1999; Bourne 2005; Smith 2006).

Invisible team members are often ignored but these team members can provide a source of influence and support to the project (Bourne 2005).
The context within the project exists must also be considered. Interactions between multiple projects or between the organization and the project are of importance where knowledge that is used in the set up of projects resides with the parent organization. In this situation there should be reuse of knowledge, where projects are run in parallel, there can be knowledge transfer between the projects (Kamara 2005; Smith 2006).

Studies on knowledge management in the manufacturing industry found that despite formal processes much knowledge transfer between projects is in informal organizational networks.

Additionally it found that to be successful companies needed to maintain knowledge and develop processes to facilitate the reuse of learning on projects (Brookes 2000). Knowledge needs human intervention in order to be successfully managed (Prusak 1997; Davenport and Prusak 1998; Dierkes, Berthoin et al. 2003). Disterer (2002) emphasises that companies that do not systematically secure knowledge gained in projects for later usage risk that some certain knowledge and useful experiences may get lost with the end of a project meaning that errors and problems may be repeated.
3.6 Measurement and Management

Traditionally, businesses have tended to measure performance using only financial measures (Stewart 2006). Knowledge management involves combining resources both tangible and intangible and processes with culture, skill and information. This makes the measurement of knowledge management activities difficult. Kaplan and Norton (1992) developed the balanced score card to measure both tangible and intangible performance but this is seen by some to be too general to be used alone to capture the specific needs of an organization (Hubbard 2000 cited in Stewart 2006).

However, by defining and measuring knowledge management activities we can illustrate the achievements of the knowledge programme. Knowledge management measurement:

- Demonstrates how knowledge management supports the organization in achieving its business objectives;
- Identifies how and where knowledge management programmes and activities add value throughout the organization;
- Shows the extent to which knowledge management strategies are being implemented;
- Highlights knowledge management deficits;
- Communicates knowledge management and gains buy in and support.

Table 3.2 illustrates some of the comments cited by construction companies that took part in case study interviews on the benefits that were measured and found in using knowledge management practices (Palmer and Platt 2005).

<table>
<thead>
<tr>
<th>Profitability/Productivity</th>
<th>Sales/ Marketing</th>
<th>Creativity/ Innovation</th>
<th>Staff Support/ Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased turnover</td>
<td>Improved client interaction</td>
<td>Good ideas</td>
<td>Supporting inexperience staff</td>
</tr>
<tr>
<td>Reduced stock holding</td>
<td>Add value</td>
<td>Innovation in processes or output</td>
<td>Fosters better working relationships</td>
</tr>
<tr>
<td>Reducing mistakes</td>
<td>Less time to market, differentiation from competitors</td>
<td>Learn from mistakes and transfer to new projects</td>
<td>Improved support allows better decision making by staff. Better monitoring and learning from H&amp;S incidents</td>
</tr>
<tr>
<td>Saving time, reducing repetition</td>
<td></td>
<td>Innovation.</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.2 Case study interviews Palmer and Platt 2005

Bassioni et al. (2005) use a framework of leadership as the main driver for change and improvement in organizations. Strategic plans are guided by focus on stakeholders and project concerns, once implemented on projects these result in project gains as the project concerns are at the forefront of the plan (Bassioni et al. 2005). For their research sixteen semi structured interviews were carried out to form a framework of driving factors which included risk management, supplier and partner relationships.
The concept of measurement and process improvement differs between organizations and the absence of frameworks makes the measurement process difficult to decipher.

Key performance indicators can provide meaningful metrics on knowledge management activities (Robinson et al. 2005). For instance, those that contribute to processes that increase efficiency, increased innovation, increased collaboration and timesavings should be measured in order to build and establish the organization as a learning one. Research based on a questionnaire survey by Robinson et. al (2005) found that a range of financial and non financial metrics are used to measure business performance and both large and small companies are combining various models to implement continuous improvement strategies.

Similarly, the six sigma framework provides a procedure for gathering information on activity improvement and has been shown in case study research to have the potential to improve processes in construction (Stewart & Spencer 2006), similar to the people, technology, process concept the advantage of six sigma is that it uses the people element to reach a practical solution.
3.7 Knowledge Management and Risk Management

The benefits of knowledge management aids risk management, which can provide significant benefits in terms of cost and success of the project. Giving knowledge of the risks of the project benefits all stakeholders such as senior management, strategic business and functional managers, project management team and the client (Merna 2003).

Figure 3.5 illustrates the network of stakeholders including top management, project sponsors, subcontractors, government agencies, other organizations and the client.

![Network of Stakeholders](image)

Figure 3.6 Network of Stakeholders (adapted from Leadership: Being an Effective Project Manager)

Qualitative risk assessment used to determine budgets and timescales should be reviewed to ensure that project programmes and budgets are realistic in terms of meeting objectives. Budgets should take account of resource provision.
The review should take account of:

- Its adequacy for the scope of works to be executed
- Any contingencies, allowances, provisional sums
- The reasons for their inclusion
- Their adequacy
- The adequacy of elements related to overheads, supervision, consultants fees

The programmes should ensure that all stakeholders both within the team and outside the team are involved. In order to ensure that:

- all the key activities have been identified
- the durations are realistic
- logic links and any constraints are correct

Experience shows that frequently the project programme is insufficient and fails to detail all areas of uncertainty (Smith 2006) and does not involve all stakeholders especially those invisible team members. The results of the reviews of the programme should form the basis for the risk log. The risk log will identify risks and contain knowledge extracted from experiences and assessments of potential impacts on the project. Risk logs may include the details of the projects constitution and structure, relationships between parties, management authority and approvals required, site specific safety procedures, risks arising from interfaces, potential for cost growth due to delays to approvals, contract default, familiarity of contractors, constraints on project due to resource shortages (Smith 2006).

Ongoing studies of 32 site managers from 12 construction small and medium enterprises using stories to recount previous events for debriefings – lessons learnt pertain to errors in absence of design info, poor adherence to health & safety procedures on site, late payment, theft and vandalism on site (Boyd 2004). The literature suggests that individuals playing different roles within the corporate structure are likely to use different mental models. The organizational literature refers to the need for the organizational actors to acquire a degree of flexibility in order to be able to step out from the mental models (e.g. defensive routines such as hoarding knowledge, keeping emails “just in case”) that guide their behaviors and actions.

Reviews of literature demonstrate that there is an awareness of the need to retain the human competence in the knowledge base (Keogh 1999). Darby and Zucker (Darby 2003) agree and identify ‘star’ scientists, they find that much of the knowledge remains tacit and that company success can be linked to the ability to retain knowledge worker services.

Dent and Montague (Dent and Montague 2003) recommend that in order to build a conducive learning environment the construction organization should establish a no blame culture with a supported learning cycle using technology as an enabler. In addition moving from a push to a pull culture where employees seek and share knowledge would enhance communication and risk mitigation.
3.8 Conclusion

In this review, the literature has identified an interest in the relationship between knowledge management and project management. Different authors present different definitions of and approaches to knowledge management. Successful knowledge management has been identified by many as enabling an organization to better coordinate its project activities and learning processes. Knowledge as a competitive resource is a concept shared by many.

Capture of knowledge and reflection is emphasised by Orange et al (1999) who identify the COLA process as a system of reflection. Disterer (2002) emphasise the capture of knowledge from projects as an important aspect of the knowledge management system.

This chapter has shown that much of the literature shows that knowledge management can be implemented in any environment large or small resulting in positive benefits. The literature reviewed, however, does extend its enquiry to those organizations where although the organization portrays that it is informed of and despite the abundance of current thinking and benefits of knowledge management, the reality of workloads mean that the capability of the organization to perform knowledge management is hindered. There does not seem to be reference to the fact that much organizational practice may not be consistent with suggestions and prescriptive literature (Easterby-Smith 2003). Further, there seems to be gaps in the literature as to how these organizations operating under these conditions can still benefit from knowledge management and achieve a state of reflection and learning.

Building on other areas of research it has been suggested that there is a need for prescriptive literature to assist managers in assessing learning processes, knowledge management possibilities and the importance of human capital (Easterby-Smith 2003).

Despite the reliance on formal project management systems in the organization, there is very little emphasis on knowledge management and the extraction of lessons learned within the project organization. The literature has highlighted that this is common across the construction industry and may in part be due to a lack of information sharing culture and climate, lack of appreciation of knowledge as an important advantage, and project time constraints.

Using soft systems methodology to investigate some of the problems that the organization experiences in its project environments will assist learning processes to provide knowledge management possibilities with reasonable and culturally feasible changes to the way that the organization treats its project environment with an emphasis on knowledge management.

Fennessy and Burstein (2000) found that the use of soft systems methodology in their case study research has been a way to explore a complex situation and has created an outcome of learning and reflection for the participants.
These attempts will provide immediate help to the organization and may provide other construction industry projects and organizations the ability to learn from the experiences obtained from this research.

The following chapter will explain the framework of the research and design strategies chosen.
Chapter Four: Framework of the Research

4.0 Introduction

Chapter one outlined the reasons for this research, while chapters two and three have highlighted the literature base, this chapter sets out the framework and reasons for selections made in the design of the research. The measures adopted to enable reliability; validity and triangulation are discussed in this chapter.

This chapter explains the framework used to answer the general research question:

What is the role of knowledge within the project? In addition, how does knowledge management within the project help collaboration and project success?

The objective of this research is to understand particular problems that the company is experiencing involving individuals, teams and use of its knowledge.

By exploring how knowledge management is currently used within the project team, the answers to four specific subset questions will be clearer:

- Why the area of knowledge transfer processes seems to be neglected – Identifies why the organization is not doing more to retain knowledge.

- To explore how the company can derive knowledge from team members thus making tacit knowledge explicit within the company and the project team – discussing the role of knowledge management and the impact on the project.

- To explore how project team members and non-project team members perceive their work in aiding the knowledge creation and learning of the organization, and the success of the project – revealing assumptions made about knowledge management.

- To explore knowledge strategy that allows project teams to avoid reinventing the wheel – Looks at how knowledge management can be integrated in daily activities and recommendations.

The benefits are the identification of what is needed to support overall organizational goals, individual and project team activities leading to improvements in processes. This information is of importance for other construction project environments operating under similar circumstances.

Given that the above is the motivation for this research and that the researcher is under the employment of the organization it follows that an approach is needed that allows both the investigation of knowledge and a structure that allows a problem to be solved allowing organizational development (Patton 2002).
4.1 The Research Process

The research process undertaken in this study is based on the need for an investigation into a setting within the organization with an intention to improve, and identify strengths and weaknesses in the setting. The assumption is made that the organization will be in a position to use the information to improve what they are doing. Capital for the organization in this case is the intellectual asset and knowledge workers that are employed. It is how to use the capital that the study seeks to explore and illustrate to the company in order that strategy can take advantage of current thinking in this area.

4.1.1 Purposes of Research

The research process consists of developing an understanding of social reality experienced by the subjects of the study in accordance with their own motivations and intentions. Managerial decisions and agreements often reach gridlock because of the fundamentally different sets of assumptions about the definition of the real problem. Assumptions are the properties of stakeholders - that is, any individual, group, or organization.

The research is considered more of a formative evaluation rather than one of pure action research by the researcher based on the assumptions and constraints on the research namely the time available for the research to be carried out and the limited resources of both the researcher and the organization. The two areas of formative evaluation and action research fall on the same continuum of theory to action but are distinguished by the purpose of the research (Patton 2002). The following table illustrates the differences between the two.

<table>
<thead>
<tr>
<th>Type of Research</th>
<th>Purpose</th>
<th>Focus of Research</th>
<th>Desired Results</th>
<th>Desired level of generalization</th>
<th>Key assumptions</th>
<th>Publication Made</th>
<th>Standard for Judging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formative Evaluation</td>
<td>Improve an intervention: a program, policy, company or product</td>
<td>Strengths and weaknesses of the specific program, policy, product or settings being studied</td>
<td>Recommendations for improvement</td>
<td>Limited to specific setting studied</td>
<td>People can and will use information to improve what they are doing</td>
<td>Oral Briefings; Limited distribution to other similar evaluators</td>
<td>Usefulness to and actual use by intended users in the setting studied</td>
</tr>
<tr>
<td>Action Research</td>
<td>Solve problems in a program, organization or community</td>
<td>Organization and community problems</td>
<td>Immediate action; solving problems as quickly as possible</td>
<td>Here and now</td>
<td>People in a setting can solve problems by studying themselves</td>
<td>Interpersonal interactions among research participants; informal unpublished</td>
<td>Feelings on the process among participants, feasibility of the solution generated</td>
</tr>
</tbody>
</table>

Table 4.0 Adapted from A Typology of Research Purposes (Patton 2002)
4.1.2 Framework of the Study

Mitroff and Linstone (Vidgen 2002) identify three perspectives: the technical, organizational and personal perspective. These are essential in bridging the gap between analysis and action. The adapted figure below illustrates the Nonaka SECI cycle within the project environment.

As part of unbounded systems thinking, Mitroff and Linstone (Vidgen 2002) present a problem-solving methodology called the multiple perspective theory. This approach includes three different paradigms of thinking:

1. T - the technical perspective;
2. O - the organizational or societal perspective;
3. P - the personal or individual perspective.

Mitroff and Linstone believe that each requires the user to distinguish how we are looking from what we are looking at because of the different sets of underlying assumptions and values found within each perspective. Multiple perspective theory provides a holistic view in solving real world problems (Nor Hasliza 2004).

The multiple perspective theory has been used by Nor Hasliza (2004) as a tool to analyze knowledge management literature from the three perspectives.

Within the framework of organizational learning and knowledge management, research the techniques of Soft Systems Methodology follows a similar trend of thought in that methodology is used to present different views of the situation from a holistic perspective.

The literature review has highlighted the field of organizational learning and the
exploration of ways to design organizations so that they fulfil their function effectively. Organizational learning is focused originally on the practice of five core disciplines of systems thinking, team learning, shared vision, mental models and personal mastery.

It is important to state here that SSM is a methodology used to understand the situation and not a manner in which to frame the situation as a system. Systems’ thinking enables complexity to be discussed and understood rather than trying to map the processes to a system. The soft systems methodology (SSM) is used as a method to comprehend the underlying processes and to highlight the related issues.

However, initially the view taken was that a grounded theory approach would be suitable for analysis. Grounded theory is intended as a methodology for developing theory that is grounded in data which are systematically gathered and analysed (Goulding 2002). Grounded theory is a rigorous method and time consuming with the need for the constant transcribing, coding and comparing of data until saturation of data is achieved.

For the novice researcher there is a danger that the principles of grounded theory are not fully understood which could lead to a muddling of methodology. Soft systems methodology and grounded theory both seek to discover underlying assumptions and contexts of the situations. Both methods allow self-reflection and analysis. In this respect, both methods are suitable for analysis.

In a pre study the use of grounded theory and soft systems methodology were compared. It was found that for the novice researcher under time pressure the use of rich pictures, which are easier to create, and present allowed analysis and feedback to occur in a faster manner. Whereas the use of grounded theory on the data collected proved problematic and time consuming. Considering the experience of the researcher and the time pressures involved in this research it was viewed that a method that allowed a rigorous yet quick analysis was required. For this reason soft systems methodology was favoured in this instance.

Soft systems methodology provides a framework for iterative enquiry and learning about the organization (Maqsood et al, 2003). The method encourages group learning and this is strengthened by the participation and joint ownership of the problem solving process.

The choice of Soft Systems Methodology (SSM) for this research is matched to the interpretative qualitative approach which views social reality as a world built of meaningful interpretations, which are changeable depending on circumstance, time and view.

As identified by the literature by participating in the process of the research itself, staff members deepen their sensitivity to the perspectives and needs of the project and organization, thereby developing professionally. The learning that occurs is two fold and has been called “systemic praxis” Bawden and Packham (1998) referenced in (Patton 2002):
1. The inquiry can yield specific insights and findings that can change practice, and
2. those who participate in the inquiry learn to think more systematically about what they are doing and their own relationship to those with whom they work.

Soft systems methodology involves the participation of staff members thus; the methodology provides a well-defined framework on the continuum of theory to action to help address problems from a multiple perspective holistic approach (Maqsood et al 2003, Nor Hasliza 2004).

4.1.3 Qualitative and Quantitative Choices

Epistemology is the study of knowledge and science and the methods used to study. "The epistemological presuppositions underlying the research determine the way in which we construct our research question" (Thiertart et al 2001).

Through research we can ask ourselves what it is we are trying to find out, in what way are we going to find this out and how we can confirm this knowledge in future research. Consideration, along objective and subjective factors will enhance the design of our research strategy, making our understanding as researchers better.

The aim of the researcher is to uncover and understand behaviour by interpreting actions (Riley, Wood et al. 2000). A qualitative study will attempt to learn about the setting. With regard to data collection, the source of data collection consists of company documentation, and the views and experiences of the participants themselves. Sampling will therefore be purposive and questionnaires and interviews will be the main instruments of data collection.

Different perspectives of reality and knowledge give rise to two main paradigms of positivism and interpretatism (although there are many other frameworks). In this circumstance, a paradigm is a generally accepted model of how ideas relate to one another to form a conceptual framework.

In the interpretivist paradigm, the researchers goal is to gain a holistic overview of the context of meanings (Miles and Huberman 1994). The main task of this is to find out how people act and take action in their everyday situations within the context of their reality.

Patton (Patton 2002) states that "in real world practice, methods can be separated from the epistemology out of which they have emerged." He goes on to state "The methods of qualitative inquiry now stand on their own as reasonable ways to find out what is happening in programs and other human settings" in order to contribute to practical knowledge and solve pragmatic problems.

However as pointed out by Thiertart (Thiertart and al 2001) the association of qualitative methods and interpretatism and quantitative methods with positivism represents an over simplification of epistemological positioning. Although qualitative approaches are more likely to be guided by constructivist logic in more general terms, research approaches are not attached to a particular paradigm (Thiertart and al 2001).
Ackroyd (in Thiertart, 2001) states that once established, methods no longer belong to the discipline or the paradigm in which they were engendered, but rather become procedures whose use is left to the discretion of the researcher. Merging of methods add to increasing the validity of the research.

Miles and Huberman (Miles and Huberman 1994) recommend linkage of qualitative and quantitative data giving the following illustration Figure 4.1 of how the two kinds of data collection can deepen findings of research.

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>(exploration; document analysis)</td>
<td>(perceptions; questionnaire)</td>
<td>(deepen findings; interview)</td>
</tr>
</tbody>
</table>

Table 4.1 Qualitative and quantitative links

Rossman and Wilson 1984, 1991 give three reasons for linking the two types of data (cited in Miles and Huberman, 1994:p41).

a) To enable confirmation or corroboration of each via triangulation
b) To elaborate, providing richer detail
c) To initiate new lines of thinking

Miles and Huberman (1994) specify a second level of linkage whereby qualitative information from interviews is compared to numerical data from the questionnaire.

This study uses both qualitative explorations of data via document analysis, then quantitative data from questionnaires giving descriptive statistics, which are then explored in interviews in order to deepen the findings. This is analysed using soft systems methodology.

4.1.4 Soft Systems Methodology

It is feasible to conduct formative evaluation research from a systems thinking perspective using soft systems methodology. Although soft systems methodology is aligned within action research the principles can be used in formative evaluation research.

Soft Systems Methodology (SSM) was developed by Peter Checkland University of Lancaster. It is based upon systems theory, systems theory attempts to study the whole picture; the relation of component parts to each other, and to the wider picture - it can therefore be said to be a 'holistic problem investigation tool'.

SSM has been compared with organizational models of theory of action, organizational and action learning perspectives proposed by Argyris and Schön. Barnden and Darke (Barnden and Darke 2000) attempted to identify if SSM could be used for the purposes for undertaking organizational learning. The paper concludes that the intention to improve the problematic situation takes the organization from a status of theory in use to taking deliberate actions for improvement by considering the
changes that are culturally feasible for the organization. From their study, it is concluded that the process of SSM enables organizational learning to occur. The study recommends that to verify this, the process of doing SSM in a real life problematic situation can be undertaken.

Theory of action is the learning that is demonstrated by an organization in the manner in which it carries out its performance of its tasks. Argyris and Schön (Argyris 1990) call these theories of action. Organizations have espoused theories and theories in use, espoused theories being what the organization says it does compared with theories in use being what they actually do. The use of soft systems methodology provides an interpretative manner in which to explore the situation in place. Fennessy and Burstein (2000) state that the major advantage in applying soft systems methodology to knowledge management research is that it includes explicit modelling of the context of the research which is essential to do when talking about knowledge as opposed to information management.

4.1.5 Quality of findings

"When research is intended to have policy implication, when findings are to aid business decisions – wrong conclusions may have costly consequences. Validations reduces the risk of making decisions based on misleading research" (Krippendorff 2004). Two definitions of validity and reliability are set out in Figure 4.1

Yin (Yin 2003) recommends tests that are applicable to establishing the quality of empirical research. These include reliability, internal validity and external validity.

<table>
<thead>
<tr>
<th>Validity</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>By validity, I mean truth: interpreted as the extent to which an account accurately represents the social phenomena to which it refers. (Hammersley, 1990:57)</td>
<td>Reliability refers to the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions. (Hammersley, 1992:67)</td>
</tr>
</tbody>
</table>

*Figure 4.1 Definitions of Validity and Reliability, source: Doing Qualitative Research, Silverman, 2000:175*

4.1.5.1 Reliability

As set out above reliability is indicated by agreement of results among duplication of research. In asking ourselves whether our research is reliable we can look at whether the research question is clear, has data been checked for bias, do multiple observers accounts converge, has peer review or corroboration been used.

For this study, the literature raised questions combined with a real problem experienced by the organization. Secondary data through company documentation formed the beginnings of questions leading to a general questionnaire while interviews clarified the views so far. Validation of evidence through rich pictures ensured accuracy after interviews.
Feedback has taken place both during data collection, this is a logical source of corroboration of the questionnaires and after analysis where the feedback is able to be better laid out and contain more evidence in order to provide an easier overview for the participants.

Reliability ensures that the research is consistent and reliable. The research has been documented so that a latter researcher can replicate the study and expect to find the same findings given the same situation in place. Yin (Yin 2003) recommends auditing as many steps as possible in order to satisfy this test. Chapter 5 details the method undertaken with systematic descriptions so that other researchers can replicate the study.

The research is part of a practitioner doctorate based in the place of work, for this reason this raises questions of possible bias. To minimise this possibility the researcher made effort not to put across affirmative or negative views on the research. This was also recognised to be a possible element during feedback that the feedback itself may change respondents’ perspectives (Miles and Huberman 1994).

In summary reliability refers to the consistency of the research on different occasions. For this study to be replicated the researcher has detailed the method and procedure of the research to demonstrate reliability.

4.1.5.2 Validity

In order to arrive at valid findings the researcher must think critically about data analysis. As suggested by Silverman (2000) these areas are as follows:

a) The refutability principle – problem of anecdotalism
b) The constant comparative method – testing of alternative data
c) Comprehensive data treatment – all cases of data are analysed
d) Deviant case analysis – the above seeks out deviant data to account for
e) Using appropriate tabulations – ensuring method behind the tabulations.

Internal Validity

Do the findings make sense to the setting in which the study takes place? Is the data rich and meaningful, were the conclusions considered accurate by the setting? Are the types of questions that the researcher has been concerned with when looking at internal validity.

Internal validity deals with inferences made where an event cannot be observed. In this research, crosschecks were made with company documentation, other projects and with existing literature. This has considered whether the inference is correct and whether rival explanations have been considered (Yin 2003). The temptation to take easy conclusions is avoided and alternative directions are tested in order to refute findings.

Findings are based on the sample of internal documents, questionnaires and interviews completed by employees and contractors working on projects within the
organization. This has contributed to the internal validity of the research; however, it questions the external validity.

**External Validity**
Are the findings transferable to other settings – how far can they be generalised. – are the original sample fully described to permit adequate comparisons, do the findings include enough description for readers to assess the transferability of the study, does the report suggest settings where the findings could be tested further.

This deals with whether the research is generalizable beyond the research boundary. In this research, the goal is to provide a practicable solution to a problem that the organization is experiencing via a practitioner doctorate study. However the methods used and the findings can be accepted where there are similar situations (Yin 2003).

Purposive sampling aids the generalizability of the research by allowing the comparison and grounds to be compared and expanded to other similar cases. By thinking critically about the sample, we can include new samples after the research.

The type of research undertaken is a formative evaluation, which serves to improve a specific setting that is, studied (Patton, 2002). Formative evaluations can serve to empower groups through evaluation participation and continuous improvement thus generating generalizable knowledge within the industry regarding lessons learnt and better practices (Patton, 2002: 220).

Future research may in addition therefore include replication in other construction organizations partnered with either the project and the organization or external. This would achieve different independent data sources to consider alongside the existing data set. Publication and dissemination of findings may be through staff publications, industry communications and journals.

**4.1.5.4 Application**

Application is concerned with whether the research is of use to the organization. This research enhances the level of understanding of the situation facing the organization and illustrates through both recommendations and discussion how to improve its use of knowledge. The recommendations provided give the organization the ability to act on the situation and improve its level of knowledge reuse.

**4.1.6 Triangulation**

Different kinds of triangulation can contribute to validity. Triangulation tests not only for consistency but for inconsistency which helps to raise different perspectives on research (Patton 2002). Different perspectives can help to elaborate findings (Miles and Huberman 1994).

Methods of triangulation can be described as by data source, by method, by researcher and by theory as distinguished by Denzin. Data type can be added to this list (Miles and Huberman 1994).
The aim of triangulation is the collection of data using various sources that have different elements that can add to the research.

Validation meetings containing people who know the context of their work and/or from outside the context aid triangulation to agree what has been done and what is still to be done (McNiff, Lomax et al. 2003). Multiple perspectives or theories can be looked at giving different viewpoints and discussion points to be considered.

The view taken is that there is no fixed point in the situation and that this situation is constantly changing and evolving thus to recreate research that would give exact results would be difficult. However, the use of different sources and methods of data collection combined with the use of a method such as SSM that allows triangulation with colleague review and learning to show different worldviews has been chosen with this in mind in order to validate the research.

4.2 Approaches to Data Collection

The qualitative approach has both benefits and limitations on the data collected because of the small sample. However, because of the background of the researcher, the organization was prepared to allow document analysis, questionnaires and follow up interviews. The researcher was in addition able to develop rapport with the interviewees to allow access to data that without this relationship may not have been accessible.

4.2.1 Study Population

The population consists of all staff within the subsidiary organization, and those from the parent company that are or have been directly involved with UK construction projects. The group includes managers and staff with engineering, accounting, technical, health and safety or administrative backgrounds, and includes contract-employed staff of long and short-term duration. The group will also include contractor employees employed by the organization.

It is important to minimize the time that participants are to spend contributing to the research as project time and man hours are under constant pressure within the organization and accounted for on an hour-by-hour basis. It is an assumption that some individuals are more willing to take part than others may be and that the use of rich pictures will enable the quick review and comment that may not otherwise be able to take place with more formal procedures that may take up more time than is available.

4.2.2 Samples

Having acknowledged the social and human interaction factors, which act as players in the problem to be researched. It is recognised that the process of alternating between action and reflection and then refining methods in light of new understanding
will benefit business practices. We must be aware of this interaction in order that we can bring together action, reflection, theory and practice (Brydon-Miller et al, 2003). For this reason, a multi source approach is appropriate.

There are challenges associated with sampling namely the time and resources available to the researcher. However, it is important that the sample is representative and for these reasons, the type of sampling used is purposive.

Purposive sampling also known as relevance sampling is where the sample is chosen because they are information rich and illuminative. The sampling aims at selecting all textual units that contribute to answering the research questions and in depth study (Miles and Huberman 1994; Patton 2002). The choice of sample is aimed at gaining insight about the phenomenon, not empirical generalization from a sample to a population (Patton 2002). Qualitative samples tend to be purposive rather than random (Kuzel, 1992; Morse, 1989 cited in (Miles and Huberman 1994). This type of sampling allows us to choose a case because it illustrates a process in which we are interested (Silverman, 2000: 104).

The data collection and fieldwork strategy falls within the qualitative data approach – interviews capture direct quotations about people’s personal perspectives and experiences and careful document review gives insight to the situation (Patton 2002). However it is accepted that the choice of sampling places limits upon the conclusions that can be drawn from the research (Miles and Huberman 1994)

The resulting units of text are not meant to be representative of a population of texts, rather, they are the population of relevant texts available to the researcher and from which the sample was drawn (Krippendorff 2004).

Chain sampling (snowball) is used to get a wide range of information. Chain sampling can be described as when one sample of interest generates another, for example from sampling people who know other people who know information of interest or from information from documents or questionnaires that generate interest elsewhere to follow up with interviews.

The boundary is the context of the organization and the research will not consult the clients or subcontractors of the organization. This boundary restricts the sample size. The research does not seek statistical generalisations rather it seeks to understand the situation. Confidence in the findings can be taken that considering that the organization is a small one, the sample size represents the majority of personnel involved in the UK projects who are able to offer rich information. Patton (Patton 2002) argues that the validity of such research is more to do with information richness than with sample size.

The main units of analysis are:

1. The individuals working on the projects, selected management and other relevant personnel.
2. Documents of the company for example minutes of meetings, memo’s, project timetables, contract terms, project news, and general correspondence.
3. The project itself and the organization structure.
Each unit of analysis will imply a different kind of data collection, a different focus for the analysis of the data and a different level at which findings can be made (Patton, 2002).

### 4.2.3 Data Collection Stages

In order to bring together multiple sources, techniques of data collection to be used will include looking at official documents of the organization (although this will be subject to access limitations) questionnaire, and interviews. Using multiple data sources will increase the validity and robustness of the research.

Prior to the start of data collection, authority from the organization for access to documents would be obtained. Individual authorisation obtained from each individual taking part in the interviews and questionnaires would take place before commencement of the survey or the interview. Results of the study are available via the form of an executive summary.

Document analysis will consist of looking at procedures, minutes of meetings, brochures, project plans, and site and project team documentation for recent past and current UK projects. Challenges associated with document analysis include getting access to the documents, understanding why the documents were produced, determining the accuracy of the documents and linking with other sources of data collection.

Following document analysis a questionnaire survey will be sent out to the population that will consist of all staff within the subsidiary organization, and those from the parent company that are directly involved with UK construction projects, including those that are identified from documentation. Questions for the survey will be those that are identified for further analysis from literature, and the document analysis stage.

The interview process includes preparing the guide, pilot interviews, refinement as per feedback from the pilot interviews, preparation for data analysis and analysis. The interview approach will use the technique of critical incident questioning - whereby respondents are asked questions to reflect on critical incidents within the project. Techniques for data collection, regarding critical incidents can be done in many ways such as focus groups, interviews, discussions and by questionnaire; (Edvardsson 1992) suggests a basic model of cause, course and result. Olsen’s method was to ask for any unusual or unsatisfactory incidents in banks. Olsen (Johnston and Branley 2006) categorised the incidents based on what he interpreted to be the core problem. The use of a traditional questionnaire to collect data on critical incident can also be used to obtain the information needed.

A telephone interview guide will be prepared in order to allow the same line of questioning in each interview but at the same time, allowing for the flexibility needed depending on the respondent reactions and responses. This qualitative interviewing style will capture the views and experiences of individuals in their terminology. Questions will be opinion, experience and knowledge based.
4.2.3.1 Critical Incident Technique

Combination of critical incident technique (CIT) with soft systems methodology allows the development of knowledge by providing a rich collection of data to deal with questions of how and why does the organization function in this manner. The critical incident technique is used to obtain information from interviewees.

The critical incident technique is a set of procedures used for collecting observations that have critical significance. These observations are used to solve practical problems and to make recommendations for improvement.

A critical incident is one that makes a significant contribution either positively or negatively to an activity. Typically, respondents are asked questions or to describe an experience they have had.

CIT is a flexible method that usually relies on five major areas. The first is determining and reviewing the incident, then fact-finding, which involves collecting the details of the incident from the participants. When all of the facts are collected, the next step is to identify the issues. Afterwards a decision can be made on how to resolve the issues based on various possible solutions.

CIT was first used by John C. Flanagan (Flanagan, 1954) as part of his work with the United States Army Air Forces during World War II, where Flanagan conducted a series of studies focused on differentiating effective and ineffective work behaviors.

CIT can help individuals better understand their roles and help them understand their interactions with others. CIT is in this respect used as an interview technique where the informants are encouraged to tell about organizational incidents instead of answering direct questions. The idea is that the strengths and weakness of the organizational performance are displayed during unusual procedures (critical incidents). Using CIT avoids the informant stereotype opinions about management, and working procedures but the organizational performance is able to be analyzed by assessing the responses.

There are both advantages and disadvantages to using this method, as discussed below. However, the method is a sound one in which to use as an interview basis for this research (Darshi De Saram et al, 2004).

The use of CIT has the following advantages:

- Flexible method that can be used to improve multi-user systems.
- Data is collected from the respondent's perspective and in his or her own words.
- Does not force the respondents into any given framework.
- Identifies even rare events that might be missed by other methods which only focus on common and everyday events.
- Useful when problems occur but the cause and severity are not known.
- Inexpensive and provides rich information suited to a soft systems method
- Emphasizes the features that are particularly vulnerable
- Can be applied using questionnaires or interviews.
However, the disadvantages include:

A first problem comes from the type of the reported incidents. The critical incident technique will rely on events being remembered by users and will also require the accurate and truthful reporting of them. Since critical incidents often rely on memory, incidents may be imprecise or may even go unreported. The method has a built-in bias towards incidents that happened recently, since these are easier to recall.

- More common events could be missed.
- Respondents may not be accustomed to or willing to take the time to tell (or write) a complete story when describing a critical incident.

4.3 Analysis

Analysis Strategy is a holistic perspective – the whole phenomenon under study is understood as being complex and that is more than the sum of its parts; focused on complex interdependencies. The main unit of analysis is the organization and its project teams within. Each unit of analysis within implies a different kind of data collection, a different focus for the analysis of the data and a different level at which findings can be made.

Miles and Huberman (Miles and Huberman 1994) define analysis as consisting of three flows of activity. These are data reduction, data display and data drawing (Miles and Huberman 1994). The authors explain the activities:

Data reduction takes place throughout the research when the researcher narrows down the area of study, chooses the research question and decides which data to collect and which collection methods to use.

Data display involves displaying the data in an organised form so that others can follow the data.

Conclusion drawing is the drawing and verification with others via feedback, or can be verified with the researcher themselves via cross-referencing back to the data.

This study uses Miles and Huberman flows of activity in the analysis of the data. The use of SSM guides the data display activity with presentation of the data, whereas data drawing and verification is achieved by using SSM to obtain views and perspectives, which validate the findings.

Through the guidance of SSM, this study uses indigenous typologies as a form of qualitative analysis. This is analyst generated typology constructed and then taken back to the participants for review – an inductive analysis (Patton 2002).

Soft systems methodology (SSM) is used to analyse any situation, in its idealised form, is described as a logical sequence of seven steps. The sequence is not imposed on the researcher, thus the methodology is flexible in the need for iteration and in
considering unstructured situations. The sequence of methods follows the framework:

1) Identifying the issues concerned,
2) Analysis of situations, and
3) Build up of rich pictures of the problematic situation,
4) Creation of root definition and CATWOE analysis,
5) Conceptual models of the ideal situation
6) Comparison of models with perceived reality
7) Deciding what is culturally and economically feasible to take action on.

In the first stages, the situation or problem is identified in an unstructured form as a situation to be explored. The rich picture is used to discover information and knowledge rather than to stick to factual or hard data because those consulted generally have valid tacit knowledge to offer that is difficult to explicate in means that are more conventional. The rich pictures gives the researcher a powerful means to explain the situation using information gleaned from various sources. The picture displays relationships and representation of the situation in a manner for people to grasp and comment upon quickly.

The root definition offers a summary of the situation aim. The root definition is not necessarily everything a situation achieves but is a defined concept of what the situation aims to achieve.

A root definition is tested against a group of elements known by the mnemonic CATWOE that defines a checklist for:

- Customer (beneficiary or victims of the situation)
- Actors (those directly affecting the situation, those that have inputs)
- Transformation process (what is happening in terms of inputs being transformed into outputs in this situation)
- Weltanschauung (worldview of participants that make the process meaningful)
- Owner (the entity most affected by the particular situation or with power to stop the process), and
- Environment (what is given outside the situation but that can still affect the situation).

The root definition is expressed in statements, which incorporate the points of view that make the activities of the situation meaningful. The CATWOE analysis provides a framework that ensures that all points of view and interest are considered in the knowledge enquiry process.

Developing an account of what is desirable and culturally capable to achieve the transformation described in the root definition can be illustrated as an activity model or chart. Validation is achieved by taking the models back to the owners of the situation for discussion.

Specific recommendations and implementation plans to improve the situation can include organizational changes, implementations, procedure or policy changes. The
final stage is the action taken or proposed to take to reflect on the information and make changes as per recommendations made.

Checkland (Checkland and Poulter 2006) recommends that simultaneously the cultural, social and political enquiries that take place be composed of three analyses:

1. of the intervention itself, clarifying the roles of researcher, and owners of the problem.
2. of the social system in terms of roles, norms and values within the situation
3. of the political system within the situation

Analysis one identifies the changing roles and perceptions of the situation that arise from carrying out the study itself.

Analysis two is the investigation between all roles, norms and values. In addition to the formal roles, informal roles are considered in the models.

Analysis three identifies how power is distributed and how this affects the situation.

The proposed transformation is judged by three criteria of efficacy, efficiency and effectiveness. For example does the recommendation for change meet the intended outcome, can the outcome be achieved with the resources available and be worthwhile and will this help the project success or longer term aim of the organization.

4.4 Ethical Considerations

Consent comprising of senior management within the parent and the subsidiary was obtained prior to the commencement of the study.

The permission of individual participants was obtained at the time they were approached to participate in the study and then again when followed up.

In order to keep anonymity the names of the ultimate parent, the parent and the subsidiary have not been documented. Names of participants are not used nor job titles where this can lead to a participant being identified.

4.5 Conclusion

This chapter has explained how the research method of soft systems methodology is justified as it enables understanding through action, analysis and reflection, which in turn results in organization awareness, and learning.

Using soft systems methodology as a tool, the aim is to achieve a holistic view of the situation under consideration, obtaining views and perspectives of various participants involved with the longer-term aim of developing an understanding of knowledge management in the construction project environment and recommendations for improvements to knowledge management in the project environment.

The following chapter gives detail as to the fieldwork and the techniques used.
Chapter Five: Research Methods and Techniques

5.0 Introduction

The key issue addressed by this study relates to knowledge management. The knowledge of the research method framework and techniques used in the study will be of practical interest where the prime motivation involved is understanding the environment within which the actions are taking place (Smyth 2004). This chapter details the manner in which the research has been carried out.

A personal journal consisting of written notes and electronic files has been kept during the study. This has been cross-referenced as part of reflection and in ensuring that this chapter is as complete as possible.

5.1 The Research Process

The study consisted of four stages and was carried out as part of the DBA programme sponsored by the organization.

The first stage consisted of a meeting with a director within the organization to agree the problem that the organization was experiencing. From this, a general research area of knowledge management was identified, with specific questions that the organization wanted to probe.

As the researcher is employed by the organization and as, the doctorate is a practitioner degree the research question is one that is aimed at benefiting the organization with information towards a practical problem that is being experienced at the time of the research.

The second stage consisted of a literature review of the general area. This literature review started as a broad review and then became more focussed.

The third stage consisted of data collection via document analysis, questionnaire and interview. Agreement from senior management was obtained prior to the start of document analysis (Appendix C). Using the document analysis element a pre-study was undertaken in order to decide on the methodology of grounded theory or soft systems methodology. Once the methodology had been chosen the document analysis was undertaken. From the documentation analysis a questionnaire was derived with questions centred on themes identified and listed in the summary sheet (Appendix H). These questions had been agreed with senior management and then piloted with a small group of ten respondents. Amendments were then made as a result of the pilot. Amendments concerned wording and the type of data that the questions collected. For example, did the questions give data that would be relevant to the study?

A list of questionnaire participants from the UK and Germany were drawn from project documentation and agreed with senior management. This list was sent to
senior management in Germany with a covering mail explaining the aim of the study. The covering letter was signed by a Director in the UK (Appendix D).

The questionnaire was then submitted to participants via email (Appendix E). Replies were collated via the QuestionPro system. Questionnaire results were analysed and interviews arranged with those participants that were available to be interviewed. Interviews aimed to validate and probe deeper into the questionnaire findings. Consent was obtained verbally using a consent form read out to the participants (Appendix F).

The fourth stage of the study consisted of analysis and this stage overlapped the other stages. Miles and Huberman (1994) definition of analysis consisting of data reduction, data display and data drawing was used within each stage. Comments on the rich pictures were sought from interviewees and colleagues in order to validate findings and cross reference with participants.

Figure 5.0 Stages of Research Process

This section has given a brief overview as to the stages of the research; the following sections give more detail as to each element in the stages.
5.2 Literature review method

The review of literature on knowledge and its management began with a search of various university library catalogues. The review includes published books, journal articles, dissertation studies and papers presented at conferences.

The literature search has been carried out using a systematic literature review approach as described in Figure 5.1 (Hart 2003; Sign 2004).

<table>
<thead>
<tr>
<th>Phase One: Published Books</th>
<th>- text books, library catalogue, dictionaries - initial mapping of the topic area, a search of the vocabulary of concepts, provisional list of key work/ authors, extract relevant items from bibliographies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase Two: Journal Articles</td>
<td>- review journals, citation indexes - identification of articles, reports, analyse bibliographies, detailed search of sources</td>
</tr>
<tr>
<td>Phase Three: Theses and Conference Papers</td>
<td>- work in progress, articles, theses and papers - conference proceedings, identify book and articles not already found, any other relevant material</td>
</tr>
</tbody>
</table>

Figure 5.1 Phases of the literature search adapted from Hart 2000 & Sign 2004.

The literature review of management research and soft systems methodology has additionally helped shape the data collection methodology by providing a knowledge base with regard to methodology and the various techniques available to approach problems.

To focus the review, six search terms initially were used. These were knowledge, knowledge management, organizational learning, construction project knowledge, project knowledge management and project team knowledge.

However, the literature review has been treated as a working document, with constant rework and review, material has been primarily selected and organised to highlight important issues in order to show how the literature links to this study. It was recognised that the researcher could miss important information if searching by keyword and in this case, phase two and three of the literature review revealed further literature sources that were relevant.

The literature on knowledge, knowledge management and organizational learning is large whereas literature on construction project knowledge was quite concentrated. Project knowledge management literature had overlaps with construction knowledge, project knowledge and team working, the reviews in this area helped to focus the study and the design of the methodology.

The search omitted terms relating to competitive advantage, corporate strategy and engineering management as these sources do not directly inform issues of knowledge management within the project team. However, some resources containing organizational change were followed up as change is related to learning. Sources mentioning knowledge management systems and software were excluded where articles were found to be more of a technical nature.
Journalistic commentary was avoided unless this added to the depth of understanding of the researcher. However, journalistic commentary has been included where this reviewed experiences of project knowledge in construction firms and the benefits of collaboration.

Different sources have been used to complement one another to reduce bias in the sample of studies. Literature covered all years of publication available to the researcher up to the present date. Project knowledge literature and construction project knowledge literature being sparser prior to 1995.

It was felt that important information may be missed if searching solely by keyword so references were followed up where appropriate using a snowballing effect of literature review. Additional keywords were also added to the searches where new areas of interest occurred such as team working, nut island effect, group psychology, and collaboration.

5.3 Research Design

The literature review provided a sound foundation for the design and method. The literature review supported the investigation through the conceptual framework where it provided reference points following the data analysis in subsequent chapters.

Figure 5.2 Design concept: Project Learning
Project complexities (archetypes) exist which hinder the success of the project. These areas are often experienced repeatedly on projects resulting in ad hoc actions. Ad hoc actions in certain situations are welcomed as knowledge workers adapt to the environment and constraints placed upon them. When these complexities are repeated, learning takes place that allows these constraints and actions against them to be repeatable thus the complexities become managed and the actions are then optimised for the project. These actions within the project team form project learning which in turn becomes organizational knowledge, which is seen as a key resource to the firm. Knowledge management is required in order to control, integrate and share this resource so that for each new project the optimised method of control is the manner of operation rather than ad hoc management.

The use of soft systems methodology provides a framework for thinking and analysis of the situation itself and aided thinking in the manner in which the process of the study could be carried out. Thus, SSM was used both for content and for process of the study.

Table 5.0 illustrates the main concepts used to construct Figure 5.2 as discussed above.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>KM, OK, LO, OL Multi Paradigm</td>
<td>Easterby-Smith, 2003</td>
</tr>
<tr>
<td>CMMI</td>
<td>Software Engineering Institute, 2002</td>
</tr>
<tr>
<td>Systems Thinking</td>
<td>Checkland &amp; Poulter, 2006</td>
</tr>
<tr>
<td>Project Archetypes</td>
<td>Szulanski, 2003</td>
</tr>
</tbody>
</table>

Table 5.0 Concepts used in construction of Figure 5.2

Soft systems methodology (SSM) is described here as a logical sequence of seven steps, however the sequence is not imposed on the researcher, thus the methodology is flexible in the need for iteration and in considering unstructured situations. The sequence of methods followed the framework:

1) Identifying the issues concerned,
2) Analysis of situations, and
3) Build up of rich pictures of the problematic situation,
4) Creation of root definition and CATWOE analysis,
5) Conceptual models of the ideal situation,
6) Comparison of models with perceived reality
7) Deciding what is culturally and economically feasible to take action on.

After the literature review had been carried out the first stage of SSM, relating to content was started. To start analysis one was carried out alongside identifying the issues concerned. This is an analysis of the intervention of the study itself defining roles of client, practitioner and owner. By carrying out analysis one this helped to think about the aims of the study, the requirements of the study, who would use the information obtained and who to approach for the study.

Analysis two is the investigation between all roles, norms and values. In addition to the formal roles, informal roles are considered in the models.
Analysis three identifies how power is distributed and how this affects the situation.

The analysis of the social and political aspects of the situation helps to consider the feasible changes that can be made and thus recommended in order to achieve an ideal situation. A summary of analysis one, two and three is available as Appendix 6.

Identification of the issues concerned required collecting data from documents of the projects and the submission to participants of an electronic questionnaire.

Follow up interviews took place and respondents were asked unstructured questions about their involvement in the project, project reviews, learning and expectations.

The stages involved the development of a rich picture to give an illustration of the problematic situation. The objective of this is to learn about the different perceptions of the problem. During the stages, there was much iteration and participants were involved in helping to develop the picture. This took place over the phone and face to face looking at the rich pictures. Most of this discussion due to the tight timetables of the participants consisted of “snatched” moments during the normal course of the workday in order to validate the rich pictures. This then was developed using a software program with brainstorming templates.

During the interviews, respondents were asked probing questions regarding lessons learnt and asked about any critical incidents. All respondents offered suggestions on what could be done to improve the situation of learning from projects. Interview notes were taken while respondents answered questions.

The use of rich pictures proved to be a good manner in which to enable understanding. Feedback was quickly undertaken and comments made both on the research project and on the situation illustrated.

Data collected has been analysed using the NVIVO software program trial version. The trial version was used due to cost of the package and availability to the researcher. Using this package full texts of documents, interviews and open text comments have been brought together. This involved the researcher reading and re-reading data, annotating it and identifying areas of interest.

Using the NVIVO software assisted in the management and organization of the raw data files and text. Using keywords, data could be queried and sorted into groups. NVIVO enabled a rapid perspective on the text that could then be followed up manually by annotating and marking specific points in the text (Bazeley 2007). This aided in identifying local language used by participants when putting together rich pictures, root definitions and conceptual models for improvement. Using local terms allows participants to provide feedback more easily (Patton 2002; Bazeley 2007). Indigenous typologies are categories that come out of the language of the situation – the language already exists and the data is categorised according to this pre existing framework (Patton 2002).

Manually, interview notes, open comment text and discussion notes were highlighted with comments and then sorted to reflect general concepts and categories. These were then checked to see whether connections could be made or patterns identified.
Data analysis occurred early while still collecting data and was viewed as an iterative and continuous process. Such overlapping improves both the analysis and the data collection (Miles and Huberman 1994; Patton 2002).

In order to illustrate excerpts of raw data have been included in subsequent chapters, in the form of extended quotations, alongside accounts of the interviews. This was also used with participants later to allow validity checks between the data and the researchers account. Themes that have emerged have been taken back to participants for further discussion and validation. As the software was a trial version, a limited functionality was available so manual sorting of topics and themes also took place alongside using the software program.

As part of the process, a CATWOE description was developed of what the situation aims to do. Using the CATWOE, root definitions were developed. The root definition defines the main purpose of the situation but not necessarily the only purpose. Iterations of the root definition took place when discussed with the participants and the researcher achieved a best fit. Consideration of the best fit was made in reference that the root definition is not the only purpose of the situation. Root definitions provided a means by which to express the aims of the situation. The root definition then provides the means by which the ideal situation can be envisaged. Root definitions were changed and adapted as discussed with participants to accommodate different views.

5.4 Data Collection Method

The methods chosen for data collection were considered with the following areas in mind; informed consent, the right to withdraw, sensitivity, representation, practicality and validation.

Data collection was flexible in that it was viewed that the research question and the collected information may have evolved depending on the information collected and openings available in the organization.

Data collection consisted of document analysis, questionnaire, interview and discussion.

5.4.1 Internal Secondary Data

Secondary data has been looked at after and during the literature review process in order to help define the problem more clearly and to help in designing the primary data collection techniques.

The benefit of secondary data is that it is low cost and less effort. The documents were readily accessible and were useful for evaluating primary data. However the data obtained constitutes a record of project information and is not designed for the benefit of the researcher (Thiertart and al 2001). This data does however enable one to consider past actions that have had influences on decision making within the projects.
Document sources can pose questions of bias on the part of those who compiled the document. Researchers must consider the context in which the document was created and its purpose and then subjectively interpret it. Assumptions are made as to the correctness and validity of documents.

Care was taken to consider contamination of documents e.g. double archiving systems that separate "head office" files from "local files". Double sourcing of documents has been carried out in these cases to help with validity, looking at both electronically held data and manual hard copy filing systems.

Document analysis began with document collection and review; this consisted of looking at procedures, minutes of meetings, brochures, and project plans, site and project team documentation. These documents were sorted into groupings where appropriate and used in the development of the rich pictures and root definitions.

Challenges associated with document analysis include time-consuming sifting through the documents, understanding why the documents were produced, and determining the accuracy of the documents and linking with other sources of data collection (Miller, 1997). The challenges in this study included the time involved sorting through documents and making sense of writings and obtaining responses to particular documents that were missing or misfiled. In many cases personnel had left the company thus it was not feasible to ask the original author queries that had arisen over events that documents related to.

Documents were analysed from three contracts available at the time of analysis. Either documents were in the process of archiving (April 2006) or were ongoing projects undertaking the commissioning stage.

Observations have been split into administration of documents and content of documents. Administration refers to general filing considerations whereas content refers to the analysis of the content and specifics of the documents. Common themes have been extracted from the documents resulting in a rich picture of the problem.

5.4.2 Questionnaire

The questionnaire has been formed using the analysis of the documents relating to the three contracts that have been included as part of this study. From the document analysis, general questions were shaped that would answer or investigate areas that were identified to be pertinent to answering the research questions.

The aims and objectives of the study have also had an impact on the choice of questions included. The aim of the questionnaire was to provide evidence that supported and clarified the findings of the document analysis stage and to enlighten the research.

Questions were shaped from either original questions or those that have been used in relevant research for similar knowledge management audits within organizations.
When preparing the questionnaire the following points were taken into consideration:

1. A review of the basic objectives of the study?
2. A visualization of the relevant information that the questionnaire should produce
3. A category of questions relating to the research questions
4. How easy it is for the respondent to give the information
5. That the sequence of questions did not create bias
6. Pilot study results

Questions had been identified from the literature review and from the document analysis, which would help to answer an interpretation of how the company could best derive strategy and form a knowledge map of where the company exists in its knowledge management growth.

Questions were structured around seven categories. These categories were mainly taken from the literature and with a view of supporting the documentary evidence:

1. Basic background of respondents (Questions 1-8)
2. Reflection time in projects (Questions 9-14)
3. Knowledge management practices used (Question 15)
4. Respondents views and knowledge of and on knowledge management policies /effect on project success (Questions 16 - 24)
5. Collaboration within the organization project team (Question 25)
6. Collaboration between the project team and others external to the organization (Question 26)
7. Respondents views on project structure (Question 27)

The questionnaire ended with an open-ended question (Q28) allowing respondents to raise any comment that they felt relevant.

Questions were used in order to separate groups of people in order to compare results and should the need for follow up interviews have been required so that two different sets of questions could be asked of the groups. These questions allowed the separation of the respondents into two groups, which allowed for frequency analysis and segmentation.

Multiple-choice questions that consisted of four or more categories were used in order to ask the respondent to select one answer or more answers from a possible list.

For this type of question, it was important to consider including an "other" category because there may have been other avenues, which the researcher may had overlooked.

The rating scale questions used requires the respondent to rate a statement along a continuum. Rating scales (rather than the staple or semantic differential) are often used to measure the direction and intensity of feelings, opinions and attitudes.

The open-ended question seeks to explore the qualitative, in-depth aspects of a particular topic or issue. It gives a person the chance to respond in detail. The open-
ended question was seen as important and one that could be used in follow up interviews or discussions.

Where “other” is added to a multiple-choice question a branching instruction was used to find out “what other” the respondent had in mind.

Demographic questions were used to identify characteristics such as gender, which company worked for, experience, and job role. Demographic questions help to classify the difference between UK and German respondents or those that have worked on a construction site and those that have not. Demographic data can help to construct a more accurate picture of the group of persons that are responding.

Pre-testing of the questionnaire on a small sample enabled the wording to be corrected and understanding of questions to be tested, the length of time taken to complete and a sample analysis could be trialled, which led to modification of the questionnaire from the initial pre-study. However, a change in management, modification of the organizational structure, and changes of personnel – made access conditions more difficult and the sending out of the survey was delayed. Respondents’ availability also decreased with the start up of three large contracts, and key respondents in some cases had left the organization.

During the testing of the Formic software, which was the software to be used for the main study questionnaire, it was found that technical problems existed. These consisted of respondent returns being duplicated due to errors on the server that the Formic software resided on. In order to correct these errors, the server had to be reset. Administrative shortages meant that the reset of the server took time and in some cases took days to be completed. Access to the software was also only available at one machine which meant that the researcher could not easily gain access at the required times. Further an upgrade to the software to correct the technical errors had been planned which would have meant that the project would need to be reinstated after the upgrade. Because of these problems, an online questionnaire-hosting program was used instead. The online software used is Question Pro. The pre study questions were replicated on this new software in order to make sure that the results and problems experienced beforehand did not re-occur.

After approval by both the parent company and the sponsoring company, the questionnaire was electronically sent to recipient e-mail in-boxes during July, August and September 2006. Respondents were presented with text explaining and introducing the questionnaire and were then asked to click on a link taking them to the questionnaire site.

The questionnaire consisted of 28 questions, consisting of multiple choice, yes or no and likert scale questioning. An online internet site was used to present the questionnaire, which was then delivered to respondents via the corporate e-mail to personnel who have at some point been involved with projects that involved the UK company as the Principal Contractor. This consisted of seven UK projects over a period of 7 years including three current projects.
Respondents were identified and chosen for receipt of the questionnaire from project organigrams and telephone lists provided by the project documentation used in the document analysis stage and from current available documents to the researcher.

Overall, lists of 188 names were extracted from the documentation, out of which 4 specifically refused to participate, 164 viewed the questionnaire and out of the 140 who started, 53 actually completed the survey giving a drop out after starting of 87 people. Therefore, the survey generated an overall completion rate of 37.86%. The average time taken to complete the survey was 23 minutes. Respondents were divided into two groups these being Group 1 associated with GmbH and Group 2 being associated with the UK side of the organization. The results from these two groups are presented in the form of charts and tables.

As each respondent started or completed a questionnaire a report was sent to the researcher with individual responses, this was then reviewed individually and collated.

The very act of sending out the questionnaire and highlighting knowledge management resulted in comments from respondents, which showed a willingness to learn, improve project performance and embrace knowledge management practices.

5.4.3 Interviews

Stakeholder interviews involved personnel who conduct day-to-day activities of the organization. A previous project had involved a range of managers from different areas and while this gathered many opinions about what is required, it did not reflect the actual needs within the organization nor peer review and analysis. For this reason stakeholder interviews covered the broadest possible participants from the organization and the methodology of SSM employed. Where managers were involved they were interviewed as individuals exploring work patterns as well as managers of others thus giving both operational and managerial viewpoints.

The interview approach used the technique of critical incident questioning. Techniques for data collection, regarding critical incidents can be done in many ways Olsen’s method was to ask for any unusual or unsatisfactory incidents in banks. Olsen (Johnston and Branley 2006) categorised the incidents based on what he interpreted to be the core problem. The interviews in this study used Olsen’s approach to categorise the findings and to generate further questions.

Six interviews were carried out 8 months after the completion of the questionnaire.

The interview participants consisted of the following job roles:

Site Accountant (previously a Management Accountant at the Head Office)
Commercial Contracts Manager
Deputy Site Manager
Quantity Surveyor
Piping Engineer
Senior Electrical Engineer
At the start of each interview, the results of the surveys were reported back, providing an opportunity for the findings to be discussed. This aided validation of the findings.

Interviews were seen as the best way of following up the questionnaire survey that was used, this is in contrast to Fong (Fong 2005) who stated that interviews were not done in a study involving multi disciplinary project teams as it was considered to be too early and difficult to discuss knowledge management in depth – questionnaire survey was used instead in this instance. The opposite was found in this study where respondents had much to say about their perceptions and experiences in the project team and use of knowledge. The combination of an initial survey to assess perceptions and then interviews to probe resulted in a rich data collection in this instance.

The semi structured interview approach was used and attempts to establish rapport with the participant were taken at the start of every interview. In some cases, interviews were conducted there and then on the first call to the interviewee if they had the time available. In other cases a date and time was arranged for the interviewer to call back when more convenient. The interview is understood as an interaction and the interviewer should be sensitive to the respondent’s reactions in this respect the interviewer made it clear that if the interviewee did not have the time immediately then an appointment could be made or if the interview had already started then the interviewee could pause if workload dictated this. In all interviews, the time allotted for the interview was overrun. This was seen to be beneficial to the research as it was clear that interviewees had much to say about the topic. Attempts were however made to keep to the general subject rather than be totally outside of the interview. Appendix G provides the general interview guideline used. The interview guideline used gave enough time to answer questions, to allow the follow up and probing of answers and allowed the interviewer to empathise in an appropriate manner.

Semi structured interviews involved senior management, project management and project practitioner in order to gain perceptions of project learning practices at different points of the organization (Love 2005). The semi structured interview attempts to establish rapport with the participant, the ordering of questions was seen as less important using a movement from general to particular questioning. The researcher was then free to probe / prompt discussion of interesting issues that arose following interaction. Questions were therefore open ended rather than closed and were neutral rather than leading.

Although an attempt was made to use the critical incident technique, this was used as a guide as respondents quite often during the course of the interviews would talk more generally rather than focussing on an incident. The critical incident technique was used in part however for rich data to be collected from the interview whereby areas for improvement could be identified. Where possible when interviewees discussed events the researcher asked the interviewee to describe an event, what led up to it, and what happened as a result, and how it could have been improved or what was good about the event.

Prior to the start of interviews, the researcher felt that more knowledge of the project environment and sense of project management would aid the interview process if the researcher undertook some background knowledge. In order to carry this out, during
the course of normal day duties in the researchers job role on the sites itself observations about the construction project management process and difficulties faced where noted and generally chatted about with colleagues in order to glean more information. The researcher also undertook practitioner qualification in a formally recognised method of project management, PRINCE2. This gave the confidence to be able to picture the issues that were spoken about in the interviews and to be able to prompt discussion.

The phone interview is a benefit as it eliminated travel costs and allowed for contacting of interviewees at times that are convenient for both the interviewee and researcher. Short phone discussions were also used to discuss the rich pictures, which were sent by email after establishing the discussion with the recipient while the recipient was on the phone to the researcher.

The phone interview was found to shorten the data collection period than the face-to-face interviews were estimated to take; the phone was used to follow up interviews.

It was found that some of the interviewees were distracted with colleagues entering the office, background noise and work e-mail coming in on the computer. Despite distractions, the use of phone interviews was very useful as to have to travel to the various locations would have meant time and travel costs. The advantage of phone interviews is that they can be used in combination with other methods (Ratner 2003). For this research, the phone interview has been used in conjunction with the online survey and document analysis.

The initial interview protocol had been tested with two respondents. Transcriptions of these first two interviews were found to be satisfactory, however during subsequent interviews it was found that interviewees had much information to offer so the interview was adapted to allow the free flow of information.

The procedure used for the phone interview was as follows:

1. Review of the document analysis and questionnaire results to determine types of question to be asked, whether open ended or closed, the users that were to be contacted.

2. Develop the guideline for the interview. In the phone interview, the guideline contains prompts to be used, note taking, and transition statements for the interviewer in order to be able to allow the interview to flow (Appendix G).

3. The guideline was then pilot tested and feedback incorporated for the interview over the phone.

4. Participants were then contacted on the phone in order to see if they would participate and what times best suited them. An ethics statement / interview consent form was used to read to the participants in order to reassure participants that the interview followed formal protocols (Appendix F) and interviewees were assured of anonymity.

5. When interviews began, several minutes were taken to establish rapport with the participant using a conversational and pleasant tone of voice. Results of the
questionnaire and brief reminder of the study were then given to the participant. The most important questions were asked first in case the interviewee had to cut short the interview due to other commitments. Participants described an event, what led up to it, and what happened as a result where appropriate. Participants were encouraged to talk about any event, as critical incidents can be minor or major events that led to negative or positive consequences.

6. Detailed notes were taken of all the phone interviews and immediately after the interview, these notes were reviewed and put into Nvivo and Word and manually coded in order to capture the essence of the interviews.

Some of the difficulties that arose included keeping the participant focused on the interview questions and knowing when to close out responses to one question and when to move to the next. Interviews typically lasted between 30 minutes to 1 hour depending on work schedules. Writing notes at the same time as listening and responding, being clear with questions and ensuring that bias did not creep in when asking questions were challenges that were faced.

It was found that when there was an interruption the interviewee was very keen to arrange a call-back to continue which showed a good interest in the questions being asked or the topic.

Ideally, more time would have been available for the interviews and more personnel interviewed. Much of what was said in the interviews reflected the findings from document analysis and the questionnaire however; the interviews gave a richer source of information to the background of the earlier findings.

The use of a guideline helped to structure the interview even though this was a loose guideline. This guideline was of benefit when collating the findings and processing the information.

5.5 Analysis

Analysis occurred throughout the fieldwork. When looking at the documents of the organization a summary sheet was used to record analysis.

All documents reviewed were kept for reference on storage disks. Files were sorted so that files that were not to be reviewed such as excel files, AutoCAD drawings, project plans were excluded. A folder structure was created that divided the documents by project name; any documents that were of particular interest were stored in this directory structure for quick reference. Initially handwritten notes were taken for the documents to identify the following:

- Type and date of document
- Internal or external document – any responses
- Main theme of document
- Author and Job title
- Selection of items from document text that gives insight into situation
- Physical qualities such as handwritten notes/ mark ups/ post it notes attached
A summary table was then created with headings in order to record salient points from each document. These headings included whether the document was an internal or external communication, the salient points in the text, significance and theme or aspect that the significance related to in terms of the literature review. Each document that was reviewed was recorded in this manner in the summary table.

An example of the summary sheet is included as Appendix H.

After the initial review of the documents, the analysis consisted of sorting the documents for common themes and aspects. Out of this, a rich picture was drawn representing the salient points and common themes and aspects that were evident in the documents. This was discussed with colleagues for feedback. From this rich picture and the literature review, the questionnaire was designed and distributed. The analysis of the questionnaire took place once all replies had been received.

Since the purpose of this data is to describe and summarise the views of participants with a view to providing deeper probing via interviews descriptive statistics have been used. Descriptive statistics are a method of displaying in summary what the data shows. Descriptive statistics include the mean, median, mode and standard deviation. However, since there are qualitative characteristics of the questions and responses which tend to lend themselves less to statistical manipulation, percentages are shown, as these are more meaningful.

QuestionPro generated descriptive statistics from the questionnaire. For this reason the researcher has been careful to look at each response individually rather than taking an overview. By looking at the data responses individually, it has helped to take a view of the data, which has put the researcher closer to the responses than would have been achievable by looking at an overview.

Questionnaire statistics were reviewed and general trends and and responses were analysed using the descriptive and qualitative responses. Using soft systems methodology, these generated rich pictures, which then helped to form the guideline for the interviews.

The extraction of critical incidents used both manual and NVIVO software. To extract incidents from the interviews, transcripts were noted and extracted to the software. Criteria for extraction of incidents followed Flanagan's (1954) criteria: (a) the incident must comprise an action reported and judged to be critical by the participant and (b) the behavior must be relevant to the general aim of the research, which, here were the project activities. Each incident was extracted and coded for three features: (a) what the event's context was, (b) what happened that was helpful, and (c) the incident's effect. Each incident was given a descriptor to capture the meaning of that reference, to describe the helpful, facilitative area of action.

Participants were asked to review the rich picture; to determine the accuracy. All participants stated that the rich picture represented their experiences accurately. The analysis of the interviews focussed on three areas. These areas arose from the interviews, and were cross-referenced with the results from the questionnaire and the literature review. These three themes formed part of the root definitions, which
were then tested against CATWOE. Activity models were then suggested to form recommendations.

5.6 Validation

Data has been translated into diagrams, and documented as to what it is thought the data may represent or what can be inferred from them. Constant evolution of the situation under review has aided the analysis and validity with review and peer meetings with colleagues who have validated the researchers view points and conclusions.

Validation meetings took place with those that were interviewed and then again, separately with those that took part in the questionnaire but not the interviews. This gave a wide viewpoint and validation from different sources of participants.

Data collected from document analysis was validated through a focus group of context specific participants (data controllers), where common problems were identified and discussed.

The approach of the questionnaire allowed a wider group to be involved in the process and follow up interviews allowed the rich picture to be shared and discussions of the current situation to take place. Participants had not previously been asked for their views on this subject or in this manner before. Therefore this was a new approach for the organization for example there is no routine questionnaires that are sent out on different subject matters, round table discussions are not the norm, neither is there a staff magazine produced which could have been used for requests on views.

Using SSM in this way allowed a way of modelling organizational activity as it is and gave a presentable, quick manner of dissemination of the information so far collected.

The document analysis, questionnaire, interviews and small focus groups (consisting of between 1 and 3 people) allowed validation to take place using participants involved in the situation. On occasion during the validation sessions, items were raised whereby participants did not fully agree and this resulted in debate of individual viewpoints and ideas on how specific practices could change in their own areas and within the organization.

Discussion of the root definition with participants led to many iterations of the definition before arriving at one, which considered all elements of the CATWOE analysis from the situation rather than the researcher viewpoint.

The conceptual models being seen as ideal situations but not necessarily those that would be implemented unless they had the commitment from senior management in terms of resources.

5.7 Manner of recommendations and outcomes

The conceptual models and recommendations for feasible changes have been made in the form of tables and diagrams’ illustrating the ideal situation and what is needed to
achieve this. The executive summary gives details to the organization of the study and its recommendations.

In the UK, the company currently holds 9001 and 14001 certificates from BSI for specific activities; the scope of certification includes “contract management sales and procurement for process plant projects managed by GmbH and the UK companies”.

Because of learning processes and discussions within the UK external to this project, but with shared project management involving the researcher it has been decided to embark on an integrated service improvement programme that will address the following best practice standards that are applicable to all the processes within the company’s control:

- BS EN ISO 9001:2008 – Quality Management System
- BS EN ISO 14001 – Environmental Management System
- OHSAS 18001:2007 – Health and Safety Management System

The proposed company buyout has prompted a project titled “change” within GmbH of which a topic for discussion is the collaboration concept with the UK. The executive summary in some respects provides the evidence and clarification as to why the company should adopt certain standards and best practises within the organization.

5.8 Limitations and Strengths of study

The nature of this research focuses on a specific, localised problem, and the organization itself is relatively small so the findings are also based on a small sample. However, this is presented from a range of viewpoints from the organization.

The assumption is that each new data source gives a new insight and this could change the findings of a research project however in carrying out the interviews an element of repetitiveness was shown in the issues that arose.

The findings are based on perception of interviewees and respondents to the questionnaire. Document analysis is based on documents written for purposes other than for research and is subject to the researcher’s interpretation. This perception and interpretation may therefore not reflect reality.

Interpretative researchers can never be sure that they have captured the worldview of what has been studied, nor that they give the correct meanings or interpretations or real meanings of the data.

In hindsight, the timing of the questionnaire could have been better placed. It was not a particularly good time to administer the questionnaire due to it falling in the main summer holiday season. Due to time limitations on the research project, it was decided to follow up non-responses in the September in order to catch those respondents who may have overlooked the mail in their inbox.
Corporate email may have helped a better response rate as from a known source, although a better response may have occurred if the questionnaire had been mailed in hard copy or if the researcher had followed up the questionnaire with a telephone call to the respondents. This was viewed as potentially intrusive, bearing in mind that a reminder email had already been distributed.

Out of those that did respond, the average time taken to complete the questionnaire was calculated as 23 minutes; this may have contributed to drop outs of respondents due to boredom, loss of interest or interruption. Some respondents did re-enter the questionnaire two or three times and pick up where they had stopped possibly showing that they were interested in the subject matter and felt that the questions were of relevance to their work.

Where respondents have entered a negative value in response to certain questions a limitation of the questionnaire is that the design does not allow a matrix extraction that would have allowed a further question to seek out information as to why the negative response was given. Again, had there not been a time constraint this element could have been followed up with further interviews. In addition, face-to-face interviews may have allowed responses to be investigated further.

The study has primarily focussed on UK based projects. Future research would benefit from exploring other projects that do not involve the UK subsidiary or that are from different parts of the group organization. Further interviews with other external contractors, and other engineering organizations would have provided more data for inclusion and a more in depth study along the lines of case studies per organization, however time and access restrictions did not allow for this.

In addition, the study consisted of participants from the UK and Germany so it is a possibility that findings were country and/or culture specific. Although this limitation is mitigated by the international nature of participants and in that many points raised by participants relate to that, found in the literature review.

A significant strength of the study is the actual participation, self-reflection, learning and awareness that have resulted from this study in relation to participants. The use of the soft systems methodology has highlighted areas where personnel within the project and support project staff can improve processes and knowledge practices. This has been achieved in a short time using a simple yet structured method of discussion and thinking. This method can be developed and facilitated in the construction project environment to encourage its use within this and other organizations and its projects in a more formal manner to aid programme management and project/site managers.

5.9 Conclusion

This chapter has explained how the research has been carried out using the techniques and methods discussed in chapter 4. As far as possible, an exact description of how the research unfolded has been documented in this chapter. The next chapter discusses the findings from this research.
Chapter Six: Research Findings

6.0 Introduction

This chapter concentrates on the findings from the fieldwork data collection of document analysis, questionnaires and interviews. This is presented in relation to the specific research questions. Elements of the soft systems methodology such as the cultural, political and social enquiry and rich pictures contribute to the findings, as does the literature review and are included in the presentation.

6.0.1 Cultural, Political and Social Enquiry

The initial stages of the study consisted of an enquiry into the cultural, political and social aspects of the situation.

Soft systems methodology recommends an enquiry into the cultural, political and social situation in order to understand the environment into which proposed changes are made in order that the changes recommended are feasible for the environment itself.

Analysis 1 identifies the changing roles and perceptions of the situation that arise from carrying out the study itself and enables the various roles to be considered when carrying out the various stages of the study to ensure that all stakeholders’ viewpoints are considered. Analysis 2 is the investigation between all roles, norms and values. In addition to the formal roles, informal roles are considered. Analysis 3 identifies how power is distributed.

Background to Analysis 2 and 3 are given in a descriptive manner in Appendix B.

6.0.2 Document Analysis

Documents were analysed from three projects available at the time of analysis. Two of these projects existed in archive while the third was at the time of analysis (April 2006) an ongoing project undertaking the commissioning stage.

Observations are split into administration of documents and content of documents. Administration refers to general filing considerations whereas content refers to the analysis of the content and specifics of the documents. Common themes were extracted from the documents resulting in a rich picture of the problem situation used to answer the research questions.
6.0.3 Questionnaire

The aim of the questionnaire was to provide evidence that supported and clarified the findings of the document analysis stage or to raise issues that were not originally identified that might help to answer the research questions.

Questions had been identified from the literature review and from the document analysis, which would help to answer an interpretation of how the company could best derive strategy and form a knowledge map of where the company exists in its knowledge management growth.

After approval by both the parent company and the sponsoring company, the questionnaire was electronically sent to recipient e-mail inboxes during July, August and September 2006.

The questionnaire consisted of 28 questions, consisting of multiple choice, yes or no and likert scale questioning. An online internet site was used to host the questionnaire, which was then delivered to respondents via the corporate e-mail to personnel from the UK, and GmbH who have at some point been involved with projects that involved the UK as the Principal Contractor.

Respondents were presented with text explaining and introducing the questionnaire and were then asked to click on a link taking them to the questionnaire site.

Respondents were identified and chosen for receipt of the questionnaire from project organigrams and telephone lists provided by the project documentation used in the document analysis stage. These respondents had since moved on to new projects thus the sample projects now grew to a total of seven projects.

Overall, lists of 188 names were extracted from the documentation, out of which 4 specifically refused to participate, 164 viewed the questionnaire and out of the 140 who started, 53 actually completed the survey giving a drop out as Table 6.0 illustrates after starting of 87 people. Therefore, the survey generated an overall completion rate of 37.86%. The average time taken to complete the survey was 23 minutes. Respondents were divided into two groups these being Group 1 associated with GmbH and Group 2 being associated with the UK side of the organization. Although out of the 53 completions one respondent failed to answer the grouping question. In addition, not all questions were completed. This was a limitation of the questionnaire whereby the grouping question and other questions should have been made a required field to complete preventing such inconsistencies in the quantitative data totals presented in the tables. However, this does not distract from the qualitative information that the questionnaire provides.
Survey Statistics

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viewed</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Started</td>
<td>140</td>
<td>39</td>
</tr>
<tr>
<td>Completed</td>
<td>53</td>
<td>37</td>
</tr>
<tr>
<td>Completion Rate</td>
<td>37.86%</td>
<td>94.87%</td>
</tr>
<tr>
<td>Drop Outs (After Starting)</td>
<td>87</td>
<td>2</td>
</tr>
</tbody>
</table>

Average time taken to complete survey: 23 minute(s)

Table 6.0 Survey Response Statistics

The questionnaires completed were divided as follows between the following segments of job type where respondents stated their job title:


Respondents identified which organization they worked for in order for a comparison to be made between the different organization groups. Group 1 referring to GmbH, numbered 39 whereas Group 2 referring to UK respondents numbered 15 respondents giving 54 respondents in total who answered this question.

Responses revealed that the respondents had a vast number of years of experience between them. The average number of years worked for the organization was over 10 years. Individual responses varied between 2 months and 34 years.
Have you worked in a construction site environment during any of your project time with this company?

### Frequency Analysis

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>35</td>
<td>63.64%</td>
</tr>
<tr>
<td>No</td>
<td>20</td>
<td>36.36%</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Grouping / Segmentation Analysis - Data

<table>
<thead>
<tr>
<th>Answer</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>No</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>15</td>
</tr>
</tbody>
</table>

### Grouping / Segmentation Analysis - Charts and Graphs

<table>
<thead>
<tr>
<th>Answer</th>
<th>20%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Group 1</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Group 2</td>
</tr>
</tbody>
</table>

Table 6.1 Frequency and segmentation of those who have worked in a construction site environment

In response to the number of engineering construction, projects worked on the responses varied between 1 and 100 projects.

Table 6.1 shows that more than half (64%) of respondents had worked in a construction site environment during their project time with the company. The others had not worked on site meaning that they normally would be based in the UK or German headquarters.

### 6.0.4 Interviews

While the initial survey provided a perspective of the situation the interviews allowed deeper insight into the situation. The combination of an initial survey to assess perceptions and then interviews to probe resulted in rich data collection. Although interviews were carried out with UK personnel, these personnel all had experience either working in GmbH offices and/or on site or head office both from within the project team and as project support.

The six interviews were carried out eight to ten months after the completion of the questionnaire. At the start of each interview, the results of the surveys were reported back, providing an opportunity for findings to be validated.
The semi-structured interview approach was used and attempts to establish rapport with the participant were taken at the start of every interview. Mostly interviews were conducted there and then on the first call to the interviewee if they had the time available. In other cases a date and time was arranged for the interviewer to call back when more convenient. In all interviews, the time allotted for the interview overrun. This was of benefit to the research as it was clear that interviewees had much to say about the topic.

Although many respondents were unaware of knowledge management or project review there were instances where respondents could report on project learning that had been carried forward to new projects. However, this was performed on an individual tacit basis rather than because of project reflection processes. Interview themes centred around two main themes. These being project management and coordination and project review and learning. These themes are discussed in relation to the research questions. This concurs with research carried out by CIRIA (1999) whereby participants proposed that improved management and access to knowledge would result in better coordination of projects.

6.1 Findings in relation to Question 1

Question 1 has asked why the area of knowledge transfer processes seems to be neglected. In answer to the question, knowledge transfer processes are found to be neglected from the perception of the organization members. However, this perception is one of knowledge transfer from a group perception. When looking at individual knowledge management, we can see that individual knowledge strategies are used in varying degrees. This is in agreement with the findings of Fong (2005) who found that inter project transfer of knowledge mainly was a result of one to one transfer of knowledge rather than project transfer processes.

What is lacking is the organization infrastructure to support these individual strategies in order for the knowledge to be owned by the organization and used by the group members. There appeared to be neither project organization in place nor procedures in place. Where procedures were in place site teams rather than the project or organization structure issued them and were worked on alongside any organization, procedure, which took second place to the site procedure if any, existed. This resulted in duplicate work, conflict and incomplete processes.

The findings from this research show that the assumption of complexity in the project environment is one that is shared by all project members. There appears to be a neglect of knowledge transfer and management due to a lack of organization project structure that captures and coordinates the management of knowledge within the project. This finding corresponds with those of Bresnen (2003) whereby the lack of several factors such as organization structure, skills, communication and culture for change are identified as factors that would inhibit effective diffusion of knowledge.

6.1.1 Documentary Analysis

The findings from the documentary analysis showed that there were many occasions of documents which were misfiled or not logically filed as expected, additionally the
filing system seemed to change style throughout projects and from project to project. There was no set format for filing and inconsistencies in filing orders. This lack of a logical sequence to the filing system made it hard to follow where a document existed. Comments from document controllers verified that often documents would be put back in the wrong location or that documents did not have a specific location.

It was found that comments were in instances written on documents but not initialled, therefore leaving ambiguity as to who has made the comment.

Documents indicating a requirement for responses were not linked; it was not clear from searches where these responses were held in the filing system or if they existed.

There were many instances of personal documents/photos mixed in with business information, documentation from other projects mixed with another project's documentation, archive boxes marked as for example Project X also contained Project Y documentation.

Documents did not conform to a common standard and in many cases did not indicate an owner, version number or date.

These findings are in agreement with Bukowitz & Williams (1999) and Whelton (2001) who state that documentation systems are often implemented and operated by those that do not understand the actual need of the users. Often the intent behind decisions is not recorded so the system becomes one that is not used or lacks the content of knowledge where lessons can be learned.

The documents illustrated mostly lack of communication between project members and the lack of follow up sessions unless instigated by a particular stakeholder. Different locations of work also carry different expectations, generally it is seen that the head office is unaware of the complexities and pressure of the project, whereas the head offices have the view that the project team and site team are unaware of the overall picture and other project individual complexities.

There appeared to be a blame culture and point scoring attitude within both the project team and other sub contractors, this was also found in research by Love (2005) and found to hinder the sharing of knowledge. Expectations as to norms and values are illustrated by the feeling of them and us relationships between both the UK and Germany and by the Site team and the head offices. These roles are not static and can change depending on pressure and stress experienced at the time. The placement of power is seen to be held by Germany or the head office involved. There is often confusion as to who should make the decision and whether this decision will be over ruled elsewhere at a later date. This quite often is reflected in motivated employees feeling that their input to a particular stage of a project is not considered worthwhile. Many examples where work has been carried out and then overruled only to be recovered at a later date when a problem has arisen have been raised by individuals on site teams in different projects in the documents that were viewed – this point was also raised by one interviewee when talking about another colleague's work that he knew off that had been treated in a similar way. Barret (2006) found that this happens where companies desire to limit their exposure to costs to the detriment of long-term learning. This was mostly found to happen in smaller companies under severe time and budget limits and where training in management skills lacked.
The expectation that any change ultimately depends on the degree to which senior management cares about the issue and then the time available to senior management to oversee that the issue is looked at is an accepted value in the company. Individuals do not feel empowered to make change happen at lower levels. It is accepted that even where procedures are in place that these are not followed giving rise to mistrust and lack of respect of procedures and roles.

Mis-communication between project members and between the project team and the client and its representatives was apparent by the number of documents that indicated that information was missing or requested again after being issued. Documentation illustrated that project team members were concerned as to why advice given by various parties had not been followed up or implemented – the documentation shows iteration by parties asking why this advice has not been implemented or put on file – for the most, these documents did not have corresponding replies especially if they were generated internally. Monitoring systems to evaluate, review and learn are not in place leading to a misbalance in the motivation to learn and prevent mistakes occurring again. There is plenty of mistrust and disregard for information that is held both individually and electronically, individuals preferring to repeat learning experiences in order to make sure that information is correct and justified. This in turn creates annoyance for those that feel that their information could have been used rather than consulting outside sources.

Roles within the companies are varied and quite often overlap and are shared due to constraints of resource. The documentary analysis showed that between projects different roles existed or combined different responsibilities illustrating an inconsistency in the project organization between projects. This also was shown to prove confusing for project members who were in some instances unsure of who should deal with a matter where the job role existed in one project but not another.

There could be found no illustration or explanation of any particular project methodology in use, this was verified later in interviews by interviewees indicating that they were unaware of any project methodology in use.

Finally pre and post project reviews were not documented, although documents during the projects indicate that external project consultants had suggested that these reviews should take place, there were no follow up documents to suggest that the recommendations had been taken on board.

A rich picture of the findings of the document analysis illustrates these points. The rich picture is an attempt to picture everything that might be relevant to a situation including the process and activities that may be occurring. This rich picture was constructed by combining the salient points and themes that were uncovered by the document analysis. The picture also includes representations of roles that are regarded within the situation and the behaviour and conflicts that might be present. Once assembled the rich picture was then discussed with document controllers and those that had input to the document structures.

From these discussions there was general agreement that the document management system is struggling to cope with the project split in three locations and the lack of
structure itself to the method of document control. All document controllers stressed the need for a uniform method that is used from project to project which they saw would ease the pressure on the document controller. Procedures for document control were felt not followed creating further confusion. This finding echoes that of Watkins (1983) who found that difficulties exist in project-based organizations where there is no form of infrastructure for intra-project or inter-project information needs. Lack of management training in organization techniques within the firm, mean that survival is the first priority for the small firm and crisis management is usually the modus operandi (Watkins 1983) rather than a considered approach using the latest management techniques.

![Figure 6.0 Rich Picture Document Analysis](image)

There appears to be a general mood of conflict and blame coming out of the documentation with many problems and challenging issues to be dealt with.
6.1.2 Descriptive Data

The questionnaire addressed the knowledge practices that the organization members used. Table 6.2 shows a summary of the options chosen. Other items listed by respondents included: Association Memberships, Google, Bookshelf, Pool Information, Kelly’s Directory and informal discussions.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Percent</th>
<th>20%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Before project review</td>
<td>25</td>
<td>12.76%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. During project review</td>
<td>37</td>
<td>18.88%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. After action project review</td>
<td>18</td>
<td>9.18%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Networking</td>
<td>23</td>
<td>11.73%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Yellow pages</td>
<td>7</td>
<td>3.57%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Intranet</td>
<td>16</td>
<td>8.16%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Communities of Practice</td>
<td>7</td>
<td>3.57%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Sharing of best practices</td>
<td>15</td>
<td>7.65%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Document Management Systems</td>
<td>23</td>
<td>11.73%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Collaboration Tools</td>
<td>6</td>
<td>3.06%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Peer Assist</td>
<td>6</td>
<td>3.06%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Knowledge Centres</td>
<td>6</td>
<td>3.06%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Other</td>
<td>7</td>
<td>3.57%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>196</strong></td>
<td><strong>100%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key Analytics**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.311</td>
<td></td>
</tr>
<tr>
<td>Confidence Interval @ 95%</td>
<td>[4.814 - 5.809]</td>
<td>n = 196</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>3.555</td>
<td></td>
</tr>
<tr>
<td>Standard Error</td>
<td>0.254</td>
<td></td>
</tr>
</tbody>
</table>

31.63% chose the following options:
- During project review
- Before project review

Least chosen options
- Collaboration Tools 3.06%

Table 6.2 shows that before project review, during project review, networking and document management systems were the most used by respondents. Out of these 32% of respondents chose the during project review and before project review.

To a lesser extent after action project review, intranet and sharing of best practices featured as used by respondents. The least chosen options were collaboration tools, knowledge centres and peer assist.
Open text comments indicated that respondents would appreciate help from the organization in using knowledge management tools as they saw this being of benefit to the tasks they had to complete under pressure.

The next question asked if respondents thought that the overall Group should amend project review procedures to ensure discussion and capture of knowledge.

<table>
<thead>
<tr>
<th>Frequency Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer</strong></td>
</tr>
<tr>
<td>1. Yes</td>
</tr>
<tr>
<td>2. No</td>
</tr>
<tr>
<td>3. Procedures already ensure this</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
</tr>
<tr>
<td>Confidence Interval @ 95%</td>
</tr>
<tr>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Standard Error</td>
</tr>
</tbody>
</table>

**Key Facts**
- 98.18% chose the following options:
  - Yes
  - Procedures already ensure this
- Least chosen option 1.82%:
  - No

Table 6.3 Responses to should the group amend project review procedures

There responses show mixed thoughts, whereas 78% in Group 1 responded that procedures should be amended, 20% indicated that procedures were already in place to ensure discussion and capture of knowledge. Group 2 gave a similar response as shown in Table 6.4

<table>
<thead>
<tr>
<th>Grouping / Segmentation Analysis - Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Answer</strong></td>
</tr>
<tr>
<td>1 Yes</td>
</tr>
<tr>
<td>2 No</td>
</tr>
<tr>
<td>3 Procedures already ensure this</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Table 6.4 Segmentation analysis to should we amend project review procedures

The next question asked if "best practices" should be made available to ALL staff via some form of communication (e.g. over the IT network or via forums)?
Do you think that "best practices" should be made available to ALL staff via some form of communication (e.g. over the IT network or via forums)?

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>49</td>
<td>90.74%</td>
</tr>
<tr>
<td>No</td>
<td>5</td>
<td>9.26%</td>
</tr>
</tbody>
</table>

**Table 6.5 Frequency analysis to should best practices be made available to all?**

The responses illustrated in Table 6.5 indicate a majority agreement that best practices should be made available to all. Both groups indicated that this should be the case.

The next question asked, “Which of the following groups is responsible for the knowledge management practices in use in the organization?”

<table>
<thead>
<tr>
<th>Answer</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Resources</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Information Technology</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Knowledge Management Unit</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Project Team</td>
<td>28</td>
<td>4</td>
</tr>
<tr>
<td>Individuals</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Research Department</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Don’t know</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>

**Table 6.6 Which departments are responsible for knowledge management**

The range of responses to this question indicates that respondents either viewed knowledge management to be everyone’s role and not one particular department’s responsibility or that there was uncertainty of who has responsibility. Out of the options 58% of respondents chose the project team and individuals options. The least
chosen option overall with 5% was the option of human resources. Table 6.6 illustrates the group segmentation.

Respondents were invited to provide a feelings score for five statements relating to knowledge management and its different attributes. In each case, they were asked to choose from a 5-point likert scale of Strongly Agree to Strongly Disagree. The question “Effective knowledge management requires a 'holistic' approach, which considers the different aspects of knowledge management. Please indicate your feelings to the following statements” was posed to respondents.

<table>
<thead>
<tr>
<th>Overall Matrix Scorecard</th>
<th>Question</th>
<th>Count</th>
<th>Score</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>54</td>
<td>1.519</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2</td>
<td>51</td>
<td>1.843</td>
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</tr>
<tr>
<td></td>
<td>3</td>
<td>54</td>
<td>1.611</td>
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<td></td>
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</tr>
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<td>1.574</td>
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<td></td>
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<tr>
<td></td>
<td>5</td>
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<td>1.944</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Average</td>
<td>1.698</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 6.7 Effective knowledge management requirements**

The responses indicated strong agreement that in an ideal situation a holistic approach covering the five areas of appropriate resources, capturing processes, communication mechanisms, attitude and record management should be adopted. These areas correspond to the three elements of people, process and technology. Table 6.7 illustrates the overall score matrix and grouping analysis. This corresponds with Milton’s (2005) people, process and technology 12 point framework.
### Overall Matrix Scorecard

<table>
<thead>
<tr>
<th>Question</th>
<th>Count</th>
<th>Score</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Good cooperation between members of the Lentjes Group</td>
<td>54</td>
<td>4.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Good cooperation between project members</td>
<td>55</td>
<td>4.345</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Good cooperation between project members and others (e.g. subcontractors)</td>
<td>55</td>
<td>4.109</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Clear roles and responsibilities</td>
<td>55</td>
<td>4.127</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Strict change control/request procedures</td>
<td>54</td>
<td>3.981</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Clear and concise contractual terms for all</td>
<td>55</td>
<td>3.873</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Appropriate project procurement systems</td>
<td>55</td>
<td>3.962</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Appropriate project review systems</td>
<td>55</td>
<td>3.927</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Ongoing project reflection systems</td>
<td>55</td>
<td>3.927</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Good project organisation</td>
<td>54</td>
<td>4.204</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Clear project communication</td>
<td>55</td>
<td>4.255</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Timely, valuable information from different parties</td>
<td>55</td>
<td>4.036</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Accurate initial cost estimates</td>
<td>55</td>
<td>3.945</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Emphasis on past experience</td>
<td>55</td>
<td>3.927</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td>4.046</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Grouping Analysis

<table>
<thead>
<tr>
<th>Question</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Good cooperation between members of the Lentjes Group</td>
<td>40</td>
<td>3.775</td>
</tr>
<tr>
<td>2. Good cooperation between project members</td>
<td>41</td>
<td>4.293</td>
</tr>
<tr>
<td>3. Good cooperation between project members and others (e.g. subcontractors)</td>
<td>41</td>
<td>4.000</td>
</tr>
<tr>
<td>4. Clear roles and responsibilities</td>
<td>41</td>
<td>4.000</td>
</tr>
<tr>
<td>5. Strict change control/request procedures</td>
<td>40</td>
<td>3.800</td>
</tr>
<tr>
<td>6. Clear and concise contractual terms for all</td>
<td>41</td>
<td>3.683</td>
</tr>
<tr>
<td>7. Appropriate project procurement systems</td>
<td>41</td>
<td>3.902</td>
</tr>
<tr>
<td>8. Appropriate project review systems</td>
<td>41</td>
<td>3.829</td>
</tr>
<tr>
<td>9. Ongoing project reflection systems</td>
<td>41</td>
<td>3.854</td>
</tr>
<tr>
<td>10. Good project organisation</td>
<td>41</td>
<td>4.098</td>
</tr>
<tr>
<td>11. Clear project communication</td>
<td>41</td>
<td>4.171</td>
</tr>
<tr>
<td>12. Timely, valuable information from different parties</td>
<td>41</td>
<td>3.951</td>
</tr>
<tr>
<td>13. Accurate initial cost estimates</td>
<td>41</td>
<td>3.854</td>
</tr>
<tr>
<td>14. Emphasis on past experience</td>
<td>41</td>
<td>3.732</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td>3.924</td>
</tr>
</tbody>
</table>

Table 6.8 Factors important to project success

Using the same likert scale respondents were asked to provide how they felt to the following question: Generally, to what extents do you personally agree or disagree
that the following factors are important to project success. Respondents were then
given a list of statements. Table 6.8 shows a summary of responses. The responses
indicated again strong agreement that in an ideal situation there were many items that
were important to project success. These areas correspond to best practice.

The least chosen options for all statements were disagree or strongly disagree.

Respondents were asked if in terms of meeting project budgets, quality and time if the
statements in the above question were 100% vital to the project success. Between
87% and 91% of respondents felt that this was the case for all three elements of the
project.

Project members see knowledge management, collaboration and co-operation as very
important to project success and efficiency. Research Palmer and Platt (2005) say
that knowledge management has dramatically cut the search time for documents and
has had a major effect promoting collaboration and the sharing of expertise in the
engineering company they studied (Palmer and Platt 2005).

However, the findings from this research found that there is no consistent approach to
these areas and overall knowledge management is not fostered in the organization.
There is no knowledge management strategy within the organization and it is the
recommendation of this report that this area is reviewed by the organization. This is
in agreement with Disterer (2002) who states that most companies are investing
heavily in innovative project work but investing nothing in evaluating and learning
from it. At best, project team members keep the knowledge and experiences as
individual knowledge, which they may use in the future.

The absence of a clear dedicated knowledge management structure means that the
organization does not derive as much benefit from its knowledge as it should.

Conflict in project management decisions arises due to lack of communication of tacit
and explicit knowledge, time to review past decisions and respect of individuals (lack
of understanding as to why past and present decisions were made in the manner
made).

6.1.3 Qualitative Analysis

The interview analysis found the theme of project management and coordination to be
one in which all respondents raised issues. Respondents viewed project management
as the structure in which the project is controlled. This structure seemed to lack
clarity in the interviews and respondents identified that they felt that such a structure
needed strengthening in all projects. Respondents identified that communication is
hindered by various lack of structures and understandings between the project site
teams and project management and between head offices.

This is illustrated below by comments made during interviews.

"It does seem as if when problems appear that information does not go on to the next
design. You will probably find that some of the problems at Project A – that Project
X already had them. Not for sure – would be interesting to see. What was the
meeting that we had recently intended to be a getting together of brains – not all were invited but at least a meeting was attempted – exactly the right thing to do – unfortunate it was not taken seriously by all, there was no commitment or structure to the meeting and the time was wasted.”

“people carry on in their own little worlds – we know what we need to do, but no one prepared to make the changes so we keep on repeating mistakes, that mentality follows all the way through the job and it reflects on rest of project. We keep being told that departments are not talking to each other that no one knows – who knows but it makes us at the site look stupid in front of others”

“there was a breakdown in communication between project team and site team and correct route of information between the council, the client and us. I’m sure this could happen again but I guess the underlying problem was the misunderstandings between the teams, but you could see it coming.”

This reflects the findings from Kamara (2005) & Smith (2006). They state that there should be reuse of knowledge, where projects are run in parallel; there can be knowledge transfer between the projects. However, their studies on knowledge management in the manufacturing industry found that despite formal processes much knowledge transfer between projects is in informal organizational networks. As Disterer (2002) and the participants have illustrated the lack of knowledge management and sharing of lessons learned means that repeat mistakes are inevitable.

Further comments reflect the project coordination aspects that were identified.

“I would have a project task force based in the UK at conceptual design stage either at local office or at site and stay until end of project. Everyone sits in the same room.”

“total uncertainty for planning as we do not get the information in time or the drawings issued.”

“Makes scheduling difficult, no planning of resources and all this happened on the last project too”

“Project management needs to improve in my opinion”

“Someone with enough authority should be on the site. Is evolving but not quick enough or sometimes in the right direction. Everything takes twice as long.”

“Should be able to make decisions on site without questioning within authorities. But now all strangled with different management everywhere.”

“No one actually coordinates this”

“No method of project management”

“better leader – recognises that UK contractors should be working in the UK”
"If it were a UK job, I would expect to come to site with the manual of how to do it — post this formality should be ironed out between company level and UK — operations manager with an overview of responsibility for all the sites. That would have been. If you do that then complies with regulations — e.g. CDM, & H&S, electrical procedures required to run a job in UK"

"There could be a procedure for post or during project review but what use if no one knows. At the end of this project everyone is going to leave so would have to be during. I bet no one knows for sure about a procedure. The project management manager should ensure that project learning occurs — it needs coordination. Too busy sorting out problems though."

According to one interviewee “sharing of experience is important and has a direct impact on the project, but we do not set time for this”

"There should be a project close out meeting and I also think there should be a more significant level of kick off meeting to discuss the whole project — not a gradual ramp up of project personnel. They all have good ideas and should be included. Key areas to be talked about beforehand should help the project be run on a smoother basis.”

"There is plenty of shop floor discussion of what we do well and not do well I just don’t think it gets to the people who can do anything about it."

With regard to procedural knowledge and management of procedures there appeared to be a distinct lack of procedures for personnel to follow, as indicated in the following comments from various interviewees.

"Talking about admin procedures there are none or not that I am aware of — there used to be or are out of date. I think a lot of my colleagues feel that there is very little guidance in how the company operates generally I mean there are particular tasks procedures but basic knowledge or operations are harder and even if there is a procedure then the procedure is not implemented and audits prove this."

"That knowledge is getting embedding in the agency — for example the document is.... — owned by the agent if they exist — sometimes not in existence. Here I don’t have access to even an acceptance letter that the business owns, it’s cribbed of someone else."

Another states:

"Not necessarily gaps but more vagueness' — procedures cannot cover everything — for example I understand what to do but nothing has been said about the 5 to 6 months backlog and like the thing is because nothing is written down we are all floundering because one person happened to know, he showed us and we know now but what if he was not here — he’s an external contractor and put in a system from another company that he was familiar with within 5 minutes. Not even seen procedures screen shots for our own supposed system."
Moreover:

"Most of the procedures are written from their own world - even when I write them - more vagueness, but everyone is writing them, there should be a central department doing this not every Tom, Dick and Harry, it wastes so much time and we have to keep on doing it afresh and no one bothers to follow because they have no authority."

"I don't know really who has control - I report to different people and sometimes their views clash - I am the middleman, so I tend to wait a while which normally means delays until they reach an agreement as to which way to go. Happens so much, it's hard"

"If you come now it's just me and one other staff person here - there was a big lull but now more work than ever. All employees have gone - not one staff on some sites. The whole organization view is of core employees being with agency staff who have no idea how things work. More fire fighting being done in everything - civils/site/mechanical/QS - everyone brand new even though we are years old. If you get someone to listen to you that we need strategy I'll take my hat off"

In addition:

"No two people think the same way. Classic e.g. with canteen - why maybe we should already have an agreement single source and cabins - we always have the same problems with cabins, don't seem to learn from them.

"Where we going to put them - contractors - these things should already be planned for the project but no - we swing into main works - no procedure for site setup. A metal cabin with no power, no power, sit and wait oh yes here is the civil contractor. Guess what we need power! Just keeps on being repeated. We need to be slicker than this... Makes us look stupid as we never know what is happening or when."

"Everyone is third parties - we are too fragmented"

"The procedure itself is a key which contains a lot of knowledge from site based pointed view and yet the project teams not just the site teams were reluctant to embrace the guidance given even though it was proven it was a workable system until cornered by the client, because the client was asking where the controls are, and now some of it is adopted but still not fully implemented - there is a significant mistrust because it is local rather than group. The procedure itself has not been realigned with the Group philosophy. If the procedure had been produced in conjunction with Germany's site execution there may have been less mistrust."

"I have asked for barely basic processes and it is not there - not explicit enough or a nonsense or not based on the correct relationships. All I can imagine is that some are just winging it - but that is not the way is it? You're playing catch up all the time and implementing things".

"New guys phone.... direct and do not use my knowledge - sharing knowledge does not happen here - why not use the knowledge that already exists why pay for it. Or is it political? I've told them before to ring me rather than pay for it".
6.2 Findings in relation to Question 2

Question 2 asked how the company could derive knowledge from team members making tacit knowledge explicit within the company and the project team.

The data findings illustrated that the company is at the beginning of its knowledge management strategy.

6.2.1 Documentary Analysis

The organization via business processes should embed knowledge management practices so that knowledge management becomes an every day part of working. Formal time to reflect establishes the importance of reflection and learning. Examples given of knowledge management practices include peer assist, after action reviews, project reviews, project learning logs, intranets, better use of technology, retrospect’s, increased collaboration and definition of processes and guidelines.

However, the findings from the documentary analysis indicated that there appeared to be no linking or formal referencing or post/lessons learnt review documentation area in project filing systems. Organigrams of site staff were not available or not updated where appropriate and project administration documents were missing or not filed under the project filing system.

Much of the knowledge from documents seemed to be hazy indicating that there is much interaction between people, that knowledge is specific and much of it is tacitly known. This knowledge is the perfecting of execution strategies and working with experienced companies in the supply chain. The front end engineering and design phase is often characterised by low volumes of information with many options investigated and information discarded. The handover to the next phase is generally via documents and individual experience. Documents often become divorced from the application system that created them and potentially important information becomes lost or duplicated. This concurs with the view of Hafner (1999) that knowledge is developed by interaction among people that are specific to a local context - much of it is tacitly known (Hafner1999).

Engineering, procurement and construction phases are characterised by a quickly expanding set of information. The emphasis is on high data integrity. The project is likely to be geographically distributed and involve numerous contractors. Problems occur with duplication of data and multiple sources of data. Often it is difficult for members in one part of the organization to know what information exists elsewhere. Information tends to be dispersed and members in one group rarely communicate with those in other groups unless a problem arises. This puts the organization at a disadvantage as individuals who might profit from sharing ideas and experience tend to be unaware of one another's efforts. The confusion over documents is presented in the project or when compiling manuals. It is not infrequent to go outside the organization to seek expertise.

Where expertise from outside the organization is gained this is often forgotten or not acted upon – the act of obtaining the information is more than often a fire fighting
exercise. Users of the document system stated that in certain cases it was easier and quicker to obtain a drawing from a supplier or another department than to retrieve from the system.

There is evidence of a lack of knowledge management within the documents, project pre and post reviews are either not performed or the documents relating to these meetings are archived elsewhere external to the document storage area. There seems to be a sense of organised communication in some areas but conflicts in others.

Quality evaluations seldom take place, and often if a problem is solved it is not certain that this solution will follow through the project or be taken to the next project. There seems to be no area where lessons learnt are stored whereby group of experts evaluating the job would agree on the quality/solution or that there would be consensus within the expert group that a particular solution is the way forward.

Team members tend to discuss project (content, relationships and methods) problems informally rather than formally but ideas / actions are not implemented due to lack of resources (time, labour, and cost). This can contribute to a “nut island effect” in the projects illustrated by some of the comments received in the interviews undertaken.

6.2.2 Descriptive Data

The descriptive findings indicated that more than half of the respondents (63%) spent time reflecting on project work at a regular basis throughout the project. The least chosen option was at the end of the project. When reflecting on time spent sharing thoughts with other team members, again the most popular answer was on a regular basis throughout the project.

Do you have planned time for reflection on the work you do on projects?

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>30</td>
<td>54.55%</td>
</tr>
<tr>
<td>No</td>
<td>25</td>
<td>45.45%</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 6.9 Frequency analysis of planned reflection

Respondents were asked if they have planned time for reflection on projects. Table 6.9 presents the frequency of the responses. Differences were apparent between the
two group’s responses illustrated in Table 6.10 Group 1 responding by 70% that they did have time for planned reflection compared to Group 2 responding by 86% that they did not have time for planned reflection. This corresponds with Love (2005) who states that project reflection is rarely carried out and where it is may be hindered by a blame culture represented by power challenges between the two groups.

<table>
<thead>
<tr>
<th>Grouping / Segmentation Analysis - Data</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
<td>Count</td>
<td>Percent</td>
</tr>
<tr>
<td>Yes</td>
<td>29</td>
<td>70.73%</td>
</tr>
<tr>
<td>No</td>
<td>12</td>
<td>29.27%</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>100%</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Grouping / Segmentation Analysis - Charts and Graphs</th>
<th>20%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
<th>100%</th>
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<tbody>
<tr>
<td>Answer</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td>70.73%</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>13.33%</td>
<td>29.27%</td>
<td>86.67%</td>
<td></td>
</tr>
</tbody>
</table>

*Table 6.10 Segmentation analysis of planned reflection
Please choose whether the hours you stated in the above question relate to:

<table>
<thead>
<tr>
<th>Frequency Analysis</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A regular basis throughout the project</td>
<td>13</td>
<td>31.71%</td>
</tr>
<tr>
<td>At the end of the project</td>
<td>4</td>
<td>9.76%</td>
</tr>
<tr>
<td>Both of the above options</td>
<td>11</td>
<td>28.33%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>13</td>
<td>31.71%</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>100%</td>
</tr>
</tbody>
</table>

Key Analytics

<table>
<thead>
<tr>
<th>Mean</th>
<th>2.585</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence Interval @ 95%</td>
<td>[2.204 - 2.966]</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.245</td>
</tr>
<tr>
<td>Standard Error</td>
<td>0.194</td>
</tr>
</tbody>
</table>

**Key Facts**

63.41% chose the following options:
- A regular basis throughout the project
- Not applicable

Least chosen option 9.76%:
- At the end of the project

Table 6.11 Frequency analysis of stages across project that reflection takes place

If respondents indicated that they did spend time on project reflection, they were then asked in the next question how many hours approximately they spend per month on reflection activities. The answers ranged from 2 to 30 hours per month. These related mainly to Group 1, whereas Group 2 mainly replied that this was not applicable.
Respondents were then asked at what stage these hours were across the project timescale. Table 6.12 is a summary of the results.

Table 6.12 illustrates that both a regular basis and at the end of the project were the most popular answers for Group 1.

### Table 6.12 Segmentation analysis of stages across project that reflection occurs

<table>
<thead>
<tr>
<th>Answer</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A regular basis throughout the project</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>2 At the end of the project</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>3 Both of the above options</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>4 Not applicable</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>9</td>
</tr>
</tbody>
</table>

### Table 6.12 Segmentation analysis of stages across project that reflection occurs

<table>
<thead>
<tr>
<th>Answer</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A regular basis throughout the project</td>
<td>20%</td>
<td>40%</td>
</tr>
<tr>
<td>2 At the end of the project</td>
<td>22.22%</td>
<td>13.33%</td>
</tr>
<tr>
<td>3 Both of the above options</td>
<td>30.30%</td>
<td>0.00%</td>
</tr>
<tr>
<td>4 Not applicable</td>
<td>18.18%</td>
<td>77.78%</td>
</tr>
</tbody>
</table>

Respondents in the following question were asked if they have planned time to share thoughts with other team members.

**Do you have planned time to share thoughts with other team members?**

### Table 6.13 Frequency analysis of planned time to share thoughts

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yes</td>
<td>32</td>
<td>58.18%</td>
</tr>
<tr>
<td>2. No</td>
<td>23</td>
<td>41.82%</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 6.13 shows a summary of responses. Again, respondents indicating that they did have planned time were asked how many hours per month are approximately spent on this activity. Answers ranged from 2 to 30 hours per month.

Over half of respondents did have planned time to share thoughts with other team members, although there were differences between the two groups.
Respondents were then asked at what stage these hours were across the project timescale. Table 6.14 illustrates a summary of the responses.

Please choose whether the hours you stated in the above question relate to:

<table>
<thead>
<tr>
<th>Frequency Analysis</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A regular basis throughout the project</td>
<td>16</td>
<td>37.21%</td>
</tr>
<tr>
<td>2. At the end of the project</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>3. Both of the above options</td>
<td>14</td>
<td>32.56%</td>
</tr>
<tr>
<td>4. Not applicable</td>
<td>13</td>
<td>30.23%</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key Analytics</th>
<th></th>
<th><strong>Key Facts</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.558</td>
<td>69.77% chose the following options:</td>
</tr>
<tr>
<td>Confidence Interval @ 95%</td>
<td>[2.176 - 2.940]</td>
<td>A regular basis throughout the project</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.278</td>
<td>Both of the above options</td>
</tr>
<tr>
<td>Standard Error</td>
<td>0.195</td>
<td></td>
</tr>
</tbody>
</table>

Overall 70% chose the options of a regular basis throughout the project or both of the above options.

Table 6.15 illustrates the segmentation analysis of the time spent by the two groups. Time spent by Group 1 was divided by a regular basis throughout the project and at the end of the project. Group 2 stated that this was not applicable or stated a regular basis throughout the project.
Table 6.15 Segmentation analysis of spread of planned time spent sharing thoughts

### 6.2.3 Qualitative Analysis

Project review and learning featured as an important element arising from the interviews. Respondents identified that project review is an important element that the organization could improve to make tacit project knowledge explicit.

For example one interviewee reported on planning schedules that were taken from a previous project and worked on as a lump sum rather than separately therefore making the exercise a once only activity – the learning from the previous project that this saves on time and administrative costs was carried forward.

"Call off schedules were bought of from project X and worked on lump sum instead of separate orders so I only did the exercise once – knowing that all work done save on admin and it works so much better this was for about six suppliers."

However, another stated that some practices that were good had not been replicated in future projects and that in other projects they had been replicated displaying an inconsistent approach.

"Project X's lack of communication and non sharing of information is not on this project though that was much retained to certain individuals, this has been dropped and does not exist here. More people know about things – oh by the way I heard this conversation and heard of this problem. In the past only kept to engineer and site
manager now here its very much a weekly meeting all round (everybody no exclusions of personnel) so everyone knows what's going - open forum. No blame culture open forum. Awareness – not 3rd or 4th hand – from one to one person – it is so so good – a complete different way of handling. We are resolving as a group now and that's a good bonus for moral. I remember we used to do on Project Z. Not sure why not carried forward from Project Z. I don't know it seems to have got lost. Even on Project A worked up as next level up and we would talk about it”

Other were quite forceful in their views on project learning:

“Not enough - never learn from our mistakes – if anyone says we do they are lying even going to right to the start of the job it is always manic – people know what happens and what happens it happens again – its standard straight forwards – it makes us look like idiots.”

“we tend to skirt around the issues, quick to criticise but nothing constructive and then gets forgotten”

“There is not a lot of base documentation we are probably all making the same mistakes- in fact I know we are because the last project made the same mistake to another, can’t remember its name now but remember sitting in a meeting and them saying it happened last time”

“There is no structured way of sharing lessons learned and no formal project review or closure, as a result of this knowledge is lost - saying oh yeah this happened on so and so – why oh why did they not say earlier – could have saved millions”

In another interview, a respondent commented that project reviews were unheard of:

“Now that’s a good idea. Of course we need project review as otherwise we don’t get anywhere – I’ve never been party to a project review though – why?”

Another interviewee commented that learning was lost due to a difference of views:

“We did not learn from this use of design. I do not think they could see the benefits of the system. It helped enormously on the project but then cost cutting meant that it was not used again. It was a good system and it is a shame the people in authority could not see this”

The above comments are indicative of a complex situation that is difficult to manage despite the best intentions from the team players and stakeholders. The rich picture attempts to put this into context for the organization.
The rich picture above depicts the situation that is currently experienced and that has been interpreted by the researcher and validated by the interview participants. The company has many gaps in the documentation of business and project processes. Personnel often are unaware of their duties and rely on mentoring to "settle into a job." Some documented business processes exist but many of these are out of date or simply not followed in the day-to-day operations.

The organization is relatively small despite large value contracts and relies on verbal and mail communication heavily.

Planning and review activities are not undertaken consistently for operational activities or infrastructure requirements planning.
Knowledge management best practice is not followed – the organization viewing itself as “too small” to benefit from this or many where unaware of best practice.

No formal or informal structures are in place for knowledge capture and reuse. The organization suffers from knowledge loss and wasted time spent in “recreating the wheel”. This is acknowledged by the organization members who express a desire to learn and re-use knowledge if given a structure to achieve this.

It was viewed by some respondents who had worked across many projects that project management standards vary from project to project depending on the skill of the project and site management teams. Project standards are not in place in the organization. Awareness of project standards is limited, with many members unsure of project conventions that may be in place at organization level.

Awareness of the procedures and access to documented procedures is limited. Documentation of procedures differs amongst areas in the group or has been confused by personnel working on the same project but for different organizations.

6.3 Findings in relation to Question 3

Question 3 looked at how project team members and non-project team members perceive their work in aiding the knowledge creation and learning of the organization, and the success of the project.

Data collection has explored the perception that team members have of their work and the influence of knowledge. Project members consider knowledge to be of importance to the overall success of the project and future projects.

Although many respondents were unaware of knowledge management or project review there were instances were respondents could report on project learning that had been carried forward to new projects. However, this had been performed on an individual tacit basis rather than because of project reflection processes. Interview themes centred around two main themes. These being project management and coordination and then project review and learning.

The findings show that knowledge management practices for the project depends on the individual project manager in place and the coordination that they personally view as important. If a project manager changes mid project the change in tactic is clearly seen by team members in the way that the project is run and where emphasis is put. In some instances, changes of project managers improved knowledge sharing and collaboration however, for others this was not the case. Organization wise it was felt that knowledge management is an area that can be improved with little effort but that this needed to be coordinated centrally and with the input of both project team and the wider organization.

This finding is in agreement with work by Hendrickson (1999) and Alvesson (2004). They found that different perspectives of roles and role significance led to differing views of responsibility for knowledge and coordination. This demonstrates the need for organization responsibility for collaboration and knowledge sharing in knowledge intensive organizations.
6.3.1 Descriptive Data

Respondents were asked if they thought that there should be formal time allocated for reflection (project knowledge review) activities. Table 6.16 shows a summary of responses.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Frequency Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>49</td>
<td>90.74%</td>
</tr>
<tr>
<td>No</td>
<td>5</td>
<td>9.26%</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 6.16 Responses to whether there should be formal time allocated for reflection activities?

The answers indicate strong agreement for formal time to be allocated for reflection activities. Formal time would correspond to respondents having a cost code to book time against in this situation. This indicates that the respondents viewed reflection activities important in order to contribute to learning.

Looking at the collaborative work of respondents questioning required respondents to think generally about the level of cooperation among colleagues and to indicate using a likert scale the level of agreement on a number of statements.
Thinking generally about the level of cooperation among colleagues in your own organisation when working on projects, to what extent do you agree or disagree that they:

<table>
<thead>
<tr>
<th>Overall Matrix Scorecard</th>
<th>Count</th>
<th>Score</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are keen to help each other achieve project goals</td>
<td>54</td>
<td>2.222</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Mutually collaborate with each other</td>
<td>54</td>
<td>2.148</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3. Wilfully contribute useful opinions to each other</td>
<td>53</td>
<td>2.340</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Actively assist each other in solving difficult problems</td>
<td>52</td>
<td>2.212</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5. Are cooperative with each other</td>
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<td>2.187</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>54</strong></td>
<td><strong>2.218</strong></td>
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<table>
<thead>
<tr>
<th>Grouping Analysis</th>
<th></th>
<th></th>
<th>Group 1</th>
<th></th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Are keen to help each other achieve project goals</td>
<td>40</td>
<td>2.225</td>
<td>15</td>
<td>2.200</td>
<td></td>
</tr>
<tr>
<td>2. Mutually collaborate with each other</td>
<td>40</td>
<td>2.075</td>
<td>15</td>
<td>2.333</td>
<td></td>
</tr>
<tr>
<td>3. Wilfully contribute useful opinions to each other</td>
<td>39</td>
<td>2.282</td>
<td>15</td>
<td>2.467</td>
<td></td>
</tr>
<tr>
<td>4. Actively assist each other in solving difficult problems</td>
<td>36</td>
<td>2.250</td>
<td>15</td>
<td>2.133</td>
<td></td>
</tr>
<tr>
<td>5. Are cooperative with each other</td>
<td>40</td>
<td>2.150</td>
<td>15</td>
<td>2.200</td>
<td></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>40</strong></td>
<td><strong>2.196</strong></td>
<td>15</td>
<td><strong>2.200</strong></td>
<td><strong>2.267</strong></td>
</tr>
</tbody>
</table>

Table 6.17 Overall matrix and grouping analysis of overall cooperation within organization
1. Are keen to help each other achieve project goals

<table>
<thead>
<tr>
<th>Frequency Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
</tr>
<tr>
<td>1. Strongly Agree</td>
</tr>
<tr>
<td>2. Agree</td>
</tr>
<tr>
<td>3. Neutral</td>
</tr>
<tr>
<td>4. Disagree</td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 6.18 Frequency analysis – Are keen to help each other achieve project goals

Mutually collaborate with each other

<table>
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<tr>
<th>Frequency Analysis</th>
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</thead>
<tbody>
<tr>
<td>Answer</td>
</tr>
<tr>
<td>1. Strongly Agree</td>
</tr>
<tr>
<td>2. Agree</td>
</tr>
<tr>
<td>3. Neutral</td>
</tr>
<tr>
<td>4. Disagree</td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 6.19 Frequency analysis - Mutually collaborate with each other

Wilfully contribute useful opinions to each other

<table>
<thead>
<tr>
<th>Frequency Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
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<tr>
<td>1. Strongly Agree</td>
</tr>
<tr>
<td>2. Agree</td>
</tr>
<tr>
<td>3. Neutral</td>
</tr>
<tr>
<td>4. Disagree</td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 6.20 Frequency analysis - Wilfully contribute useful opinions to each other
Actively assist each other in solving difficult problems

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</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
</tr>
<tr>
<td>1. Strongly Agree</td>
</tr>
<tr>
<td>2. Agree</td>
</tr>
<tr>
<td>3. Neutral</td>
</tr>
<tr>
<td>4. Disagree</td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 6.21 Frequency analysis - Actively assist each other in solving difficult problems

Are cooperative with each other

<table>
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<tr>
<th>Frequency Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
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<tr>
<td>1. Strongly Agree</td>
</tr>
<tr>
<td>2. Agree</td>
</tr>
<tr>
<td>3. Neutral</td>
</tr>
<tr>
<td>4. Disagree</td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 6.22 Frequency analysis - Are cooperative with each other

The responses were 78% in agreement or neutral agreement that there is level of cooperation between colleagues.

The least chosen options were disagree and strongly disagree.

Respondents were then asked to consider collaboration with others external to the organization. The question was stated as follows, thinking about the level of cooperation between your own organization and other firms working on projects, to what extent do you agree or disagree that our own organization's colleagues. Lists of statements were presented as illustrated in Table 6.22. Table 6.22 illustrates the overall matrix scorecard and grouping analysis. Tables 6.23 to 6.28 illustrate the frequency analysis of responses.
### Overall Matrix Scorecard

<table>
<thead>
<tr>
<th>Question</th>
<th>Count</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are keen to help other firms achieve project goals</td>
<td>52</td>
<td>2.481</td>
</tr>
<tr>
<td>2. Mutually collaborate with other firms</td>
<td>51</td>
<td>2.373</td>
</tr>
<tr>
<td>3. Wilfully contribute useful opinions to other firms</td>
<td>51</td>
<td>2.471</td>
</tr>
<tr>
<td>4. Actively assist other firms in solving difficult problems</td>
<td>52</td>
<td>2.519</td>
</tr>
<tr>
<td>5. Are cooperative with other firms</td>
<td>52</td>
<td>2.385</td>
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### Grouping Analysis

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<th>Group 1</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Are keen to help other firms achieve project goals</td>
<td>38</td>
<td>38</td>
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<tr>
<td>2. Mutually collaborate with other firms</td>
<td>37</td>
<td>37</td>
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<tr>
<td>3. Wilfully contribute useful opinions to other firms</td>
<td>37</td>
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</tr>
<tr>
<td>4. Actively assist other firms in solving difficult problems</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>5. Are cooperative with other firms</td>
<td>38</td>
<td>38</td>
</tr>
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<td><strong>Average</strong></td>
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<td>37.86</td>
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Table 6.23 Matrix scorecard and grouping analysis for cooperation between organizations

1. Are keen to help other firms achieve project goals

### Frequency Analysis

<table>
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<tr>
<th>Answer</th>
<th>Count</th>
<th>Percent</th>
<th>20%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
<th>100%</th>
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</thead>
<tbody>
<tr>
<td>1. Strongly Agree</td>
<td>4</td>
<td>7.69%</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>2. Agree</td>
<td>23</td>
<td>44.23%</td>
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<td></td>
<td></td>
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<tr>
<td>3. Neutral</td>
<td>21</td>
<td>40.38%</td>
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<tr>
<td>4. Disagree</td>
<td>4</td>
<td>7.69%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
<td>0</td>
<td>0.00%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>52</td>
<td>100%</td>
<td></td>
<td></td>
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</table>

Table 6.24 Frequency analysis - Keen to help other firms
2. Mutually collaborate with other firms

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
</tr>
<tr>
<td>1. Strongly Agree</td>
</tr>
<tr>
<td>2. Agree</td>
</tr>
<tr>
<td>3. Neutral</td>
</tr>
<tr>
<td>4. Disagree</td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 6.25 Frequency analysis - Mutually collaborate with other firms

3. Wilfully contribute useful opinions to other firms

<table>
<thead>
<tr>
<th>Frequency Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
</tr>
<tr>
<td>1. Strongly Agree</td>
</tr>
<tr>
<td>2. Agree</td>
</tr>
<tr>
<td>3. Neutral</td>
</tr>
<tr>
<td>4. Disagree</td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 6.26 Frequency analysis - Wilfully contribute useful opinions

4. Actively assist other firms in solving difficult problems

<table>
<thead>
<tr>
<th>Frequency Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
</tr>
<tr>
<td>1. Strongly Agree</td>
</tr>
<tr>
<td>2. Agree</td>
</tr>
<tr>
<td>3. Neutral</td>
</tr>
<tr>
<td>4. Disagree</td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 6.27 Frequency analysis - Actively assist other firms in solving difficult problems
5. Are cooperative with other firms

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Strongly Agree</td>
<td>3</td>
<td>5.77%</td>
</tr>
<tr>
<td>2. Agree</td>
<td>28</td>
<td>53.85%</td>
</tr>
<tr>
<td>3. Neutral</td>
<td>19</td>
<td>36.54%</td>
</tr>
<tr>
<td>4. Disagree</td>
<td>2</td>
<td>3.85%</td>
</tr>
<tr>
<td>5. Strongly Disagree</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 6.28 Are cooperative with other firms

The responses indicated general agreement or neutrality of over 80% over levels of cooperation.

A further question asked respondents how effectively they rate particular aspects within the project environment.

<table>
<thead>
<tr>
<th>Question</th>
<th>Count</th>
<th>Score</th>
<th>Not Effective</th>
<th>Fairly Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Extremely Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Communication of project issues in your most recent project</td>
<td>53</td>
<td>2.623</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Issue management on this project</td>
<td>51</td>
<td>2.706</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>3. Resolving of issues before escalation to the next management level was necessary</td>
<td>51</td>
<td>2.804</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Resolving of issues if escalation was required</td>
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<td>2.712</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>5. Issues able to be resolved without affecting the project schedule or budget</td>
<td>52</td>
<td>2.481</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. The organisation structure that was established</td>
<td>52</td>
<td>2.673</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>7. The understanding by the project team of their specific roles and responsibilities</td>
<td>52</td>
<td>2.904</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8. How well your expectations were met regarding the extent of your role involvement in the project</td>
<td>51</td>
<td>2.902</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>9. Practices that provide high quality results identified in order that they are adopted as best practice</td>
<td>52</td>
<td>2.519</td>
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</tbody>
</table>

Table 6.29 Overall matrix scorecard rating of overall project environment
- Communication of project issues in your most recent project

### Table 6.30 Rating of communication of project issues in your most recent project

<table>
<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Percent</th>
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### Grouping / Segmentation Analysis - Data

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Table 6.30 Rating of communication of project issues in your most recent project

- Issue management on this project

### Table 6.31 Rating of issue management on this project

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<thead>
<tr>
<th>Answer</th>
<th>Count</th>
<th>Percent</th>
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<th>40%</th>
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### Grouping / Segmentation Analysis - Data

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<td><strong>Total</strong></td>
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Table 6.31 Rating of issue management on this project
• Resolving of issues before escalation to the next management level was necessary

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<tbody>
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<td><strong>Answer</strong></td>
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<td>2. Fairly Effective</td>
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Table 6.32 Rating of resolving of issues before escalation to the next management level was necessary

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</tr>
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Table 6.33 Rating of resolving of issues if escalation was required.

• Resolving of issues if escalation was required

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<td>3. Effective</td>
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<tr>
<td>4. Very Effective</td>
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<td>5. Extremely Effective</td>
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<td><strong>Answer</strong></td>
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<tr>
<td>3 Effective</td>
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<tr>
<td>4 Very Effective</td>
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<tr>
<td>5 Extremely Effective</td>
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• Issues able to be resolved without effecting the project schedule or budget

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<td>5. Extremely Effective</td>
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<td>Total</td>
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Table 6.34 Rating of issues able to be resolved without effecting the project schedule or budget

• The organization structure that was established

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<tbody>
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<td>Answer</td>
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</tr>
<tr>
<td>3. Effective</td>
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<tr>
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</tr>
<tr>
<td>5. Extremely Effective</td>
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Table 6.35 Rating of the organization structure that was established.
• The understanding by the project team of their specific roles and responsibilities

### Frequency Analysis

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Table 6.36 Rating of the understanding of roles and responsibilities

• How well your expectations were met regarding the extent of your role involvement in the project

### Frequency Analysis

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<td><strong>37</strong></td>
<td><strong>15</strong></td>
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Table 6.37 Rating of how well expectations were met regarding role in the project
- Practices that provide high quality results identified in order that they are adopted as best practice

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</table>

Table 6.38 Overall rating of practices that provide high quality results identified

The responses indicated general agreement over levels of cooperation, responses ranged from between 67% to 81% effective, fairly effective or very effective.

For all statements, the least chosen option was extremely effective.

The last question invited open text comments; these are incorporated in the rich picture.
The picture provides a summary of the situation that the questionnaire responses illustrate. This is based upon the researcher's interpretation of the situation by looking at the qualitative data presented by the questionnaire, combined with open text comments made by the respondents.

![Figure 6.2 Rich picture questionnaire](image)

The rich picture illustrates the view of respondents and illustrates that projects are complex environments and the lack of knowledge management and organization makes this situation problematic. Knowledge management in a project related environment is a difficult issue when individuals are moved from project to project however; this is seen to be an important issue to tackle in order to enable project success and organizational learning. A lack of training in the project environment hinders team building and understanding of methods. It was viewed that the limited amount of reflection led to performance issues and rework resulting in project delays. The support from the organization is crucial to the project environment success as the current working of differing systems hinders harmonisation and the efficient management at organization, project and site levels.
It was found that inter-company relations might be improved by way of procedures, guidelines, awareness programs and social activities. There are differences in the way that knowledge management is used between the parent company and the subsidiary. There are also differences in procedures between the two companies working on the same projects. This creates conflict and confusion. The site environment creates a third procedural element to fuse the two segments which then creates delays as there are different expectations as to who is carrying out which roles and who has responsibility.

It was viewed that strong involvement of top-level management deteriorated quality and project execution, more decisions should be made at the site level, but within the boundaries of pre agreed project and organization work packages. It was thought that because of confusion levels of cooperation differed according to levels of hierarchy in the organization.

One respondent when followed up to discuss the picture felt that this was all nice to do and nice to have but the reality was they felt that no change would come across to the organization unless senior management were on board and then only if these issues were raised to ultimately improve the organizations bottom line.

Findings were in agreement with the literature. The organization is in the very early stage of its knowledge awareness (Palmer & Platt 2005). Participants viewed their actions and learning capabilities to be of importance for project success but this needs to be directed for project transfer and organizational long term learning (Love 2005).
6.4 Findings in relation to Question 4

Question 4 looked to explore knowledge strategy that allows project teams to avoid reinventing the wheel. This question has been answered by analysis of the findings to the preceding questions and the literature review.

It was found that knowledge management strategy that built knowledge management around business processes would ensure that knowledge is not a product that is ignored but one that the organization can use to its advantage. By building processes, that capture knowledge the organization could prevent reinventing of the wheel and the associated resource loss.

The organization has still to commit significant resources to the work of knowledge management and the areas it can benefit. Having not yet made any formal business cases to justify investments or plans to implement or review a knowledge management strategy has put the organization in a situation where the risk and reality of knowledge loss and inefficiency knowledge use is present.

A first step for the organization would be to identify the processes in use. From all forms of data collection, it was understood that business processes for this particular organization would benefit from being made explicit and defined with an emphasis on clarity and awareness.

From the literature, examples of re-use of existing knowledge, experience and innovation include the use of tools to provide access to best practices and project histories. Pre-project reviews and initial start up project meetings ensure that existing knowledge residing in the organization is used while post project reviews are completed to reflect on the project and to document good practices and lessons learned logged (Kelleher 2001; BSI 2003; BSI 2003; Dent and Montague 2003; Love 2005; Milton 2005).

The importance of performing a knowledge audit as a first step in developing a knowledge management strategy for an organization has been identified as crucial for evaluating where a company is in its knowledge pathway (Chauvel and Despres 2002; Love 2005). An essential output of the knowledge audit process is the knowledge map, which provides insights for improving business processes and systems.

The types of questions that a knowledge audit should ask include (Bukowitz and Williams 1999; Grey 1999):

- What type of knowledge is needed to do your work?
- Who provides it, where do you get it, how does it arrive?
- What do you do, how do you add value, what are the critical issues?
- What happens when you are finished?
- How can the knowledge flow be improved, what are the barriers?
- What would make your work easier?
- Whom do you go to when there is a problem?
Knowledge management processes need to be embedded into the daily working activities of every role rather than making it the responsibility of one (Love 2005) by focusing initial work on knowledge audits of the business, an organization can see where knowledge could dovetail with day to day work. By creating a framework, this helps to create a process where knowledge is embedded into day-to-day processes.

The aim of the knowledge audit is to make explicit as much as possible. As this is the first time there has been a knowledge audit in the organization, there are no existing metrics to measure against.

The use of projects within the company present knowledge management challenges on a similar scale to that of knowledge management generally within the company. A project environment creates a situation whereby challenges of the project and its management of knowledge if managed effectively, can be used to reduce project time, improve quality and client satisfaction, and minimise "reinventing the wheel". The following section discusses the literature on knowledge management within the project, particularly the construction project environment.

In addition, the descriptive findings show that project collaboration and cooperation was identified as an area where the organization could improve both internally and externally with contractors. It was seen that project team members encountered difficulties in working in the current environment for both operational and managerial aspects and this was seen to create friction and conflict in the teams.

Better definition of processes, procedures, best practice and a greater awareness of knowledge management practices that can be combined with both internal and external collaboration and partnering would be of benefit to the organization.

6.5 Conclusion

Chapter 6 has presented the findings of the documentary analysis, questionnaires and interviews. The findings show wide gaps in both the awareness of knowledge management and the use of knowledge management in the organization compared to best practise and the literature. However, individual use of knowledge and its management is present and there is immense willingness to improve the organization knowledge and processes. The participation of respondents via the questionnaire survey and interview has provoked discussion and reflection, which has resulted in self-reflection and learning of the project interactions themselves and an increased awareness of knowledge management.

The absence of organizational knowledge strategy presents itself as conflict within the organization as there is a lack of understanding and procedure to follow which creates frustration for knowledge workers. Participants have gained an understanding of this and have demonstrated a willingness to improve the situation in their day-to-day tasks.

The following chapter develops the rich picture for the overall situation and comprises of a discussion of the root definition and CATWOE analysis. The discussion chapter then draws upon the literature review and the findings of the study.
Chapter Seven: Root Definition, and CATWOE Analysis

7.0 Introduction

The build up of the rich pictures of the problematic situation has been achieved via data collection, which is a part of data analysis (Miles and Huberman 1994), in this chapter the creation of the root definition and CATWOE analysis is achieved.

7.1 Rich picture of the problematic situation

The rich picture below illustrates the problematic situation that the organization is experiencing in a holistic view. This rich picture encompasses the previous rich pictures however it is difficult to assemble the richest picture covering all elements involved in the situation therefore consideration has been given to those areas that will benefit the organization the most. Many of the problems that the organization experiences are also evident in the literature. These include areas such as barriers to knowledge sharing and management difficulties in project and organizational settings. The problems experienced are not new ones but problems that have been experienced and documented elsewhere.

Figure 7.0 Rich picture of the problematic situation
The rich picture illustrates that the presence of friction and conflict within the situation is attributed to a lack of knowledge structure that the knowledge workers in the situation require in order to be efficient. The challenges found included frustration caused by repetitive mistakes which caused losses on projects and blame both within the project team and the different subgroups of the organization.

There were also difficulties for staff to find information in the organization, which led to staff creating their own documents in order to save time on searching. This caused a mismatch of documents and many templates in place with no consistency. Linked to this was the difficulty of knowing who has what experience in the organization, a lack of role responsibility and job descriptions hindered the process of locating expertise.

Due to poor communication staff were also unaware of what is happening elsewhere in the organization, this is resulting in poor morale. The shortage of processes and guidelines is resulting in confusion and conflict where subgroups are creating their own processes which are often in conflict with the hidden authorized processes.

7.2 Root Definition

The root definition of the situation is derived from the analysis of the data collected and is defined as the ideal goal of the situation:

A project owned and operated by the company and project participants to complete stated project aims in order to comply with the contract awarded to the company by the client, by means of efficient, quality and timely project execution and operation, (complying with relevant legislative standards), in order to fulfil contractual liabilities with the client. The project takes place within the company environment and must be undertaken with available resources enabling a learning environment from project to project. Project success in terms of project team, client satisfaction and operating profit is to be achieved using existing knowledge and innovation.

The model in Figure 7.1 shows that the process that the project follows is one with many stages crossing many departments in the organization. The model illustrates the flow of the stages that a typical contract would follow.
Figure 7.1 Model illustrating project process from internal discussions.

It is useful to express the root definition in terms of PQR where P is what to do; Q is how to do and R why to achieve. The above root definition can then be expressed as:

P to meet contractual obligations
Q by carrying out harmonized project execution and site management
R contributing to knowledge growth and long term success of the organization

The creation of the root definition and CATWOE elements help to identify the goals of the business and to define the strategy for the knowledge management programme.

7.3 CATWOE

The elements, which are present for the activity in the root definition, are known by the mnemonic CATWOE. The mnemonic stands for C, the customers who are affected by the activities that take place. A, the activity actors involved in the situation, T, the transformation process based on W, the worldview of why this is
being carried out. O is the owners of the process who have the ability to stop the process and E refers to the environment.

The CATWOE model is thus:

Customer: Directors internal and external affected by the process

Actors: Project Manager, Project Team, Project Support personnel

Transformation: processes and technology, construction, project and site management collaboration and co-operation using knowledge management strategies.

Weltanschauung: To be able to meet contractual requirements as per the contract with the client, to provide services to the industry and shareholders with efficiency.

Owner: Client, Project Manager, Senior Management

Environment: Competition, quality, cost, time, legislative requirements and culture of organizations and sub contractors.

In terms of performance, it is useful to think of three criteria of efficacy, efficiency and effectiveness. For example, the root definition can be thought in the following way using the three criteria.

Efficacy 1 Demonstrable project knowledge base, project success, harmony within project and organization support

Efficiency 2 Project on budget and time

Effectiveness 3 Reduced litigation, further business, project success, and knowledge base that is used and updated regularly.

The above criteria give a measure of what the performance criterion is to be.

7.4 Conclusion

This chapter has illustrated the root definition, conceptual model and CATWOE analysis. These iterative elements are a part of the soft systems methodology that enables deeper understanding of the situation in question.

The approach is used to present perceptions of the situation in order to compare and make recommendations for procedural change using the model as a source of requirements for development.
Chapter Eight: Discussion and Improvements

8.1 Introduction

The conceptual model of the ideal situation is now presented in this chapter as Figure 8.0; this allows us to begin the process of comparing models of perceived reality and the activity models required in order for improvements to be made.

The main recommendation made is for the organization to introduce the concept of knowledge management formally and embed knowledge management in the structure of business processes that can be tracked in day-to-day operations.

This chapter brings together the results and analysis detailed in the preceding chapters.

8.2 Discussion

Although knowledge management can be applied to every department within the organization, the study has focused on the project environment. The more projects completed the more experience the organization has from encountering and solving problems. The study has shown that knowledge management is lacking in the environment and that the organization would benefit from its use.

Earlier the rich picture illustrated the problematic situation that the organization is experiencing in a holistic view. This rich picture encompassed the previous rich pictures. Many of the problems that the organization experiences are dealt with in Figure 8.0, the model attempts to illustrate the ideal situation. This follows Spender (1996) and the pluralistic approach combining the different knowledge interactions that may exist.

The model illustrates that the goals of knowledge efficiency are to enable faster decision making, to reuse ideas, documents and skill. By avoiding duplication, work can be streamlined and money saved. By not spending time reinventing the wheel, effort can be placed elsewhere. By using project review and spending time on reflection, the organization can learn from its mistakes and can learn which practices are good. In order to do this there must be a culture of trust and openness. By learning and identifying what can be improved the organization makes a better success of the next project.

Standard processes and procedures encourage predictable and known outcomes. This creates consistency and moral of staff is improved as staff are able to recognize and learn what is expected in certain situations without confusion. Processes should be clear and communicated rather than hidden and ambiguous. Processes that are compatible across the organization ensure consistency.
Knowledge management is complex and cannot be implemented overnight – knowledge management should be looked at as a strategy that can be taken in small steps to provide both immediate and future benefits. Participants viewed the project environment as a complex one where the transfer of knowledge proved to be a challenge. This is in agreement with Dent & Montague (2004) who found in their study that tacit knowledge transfer on a project-by-project basis has still to be dealt with in project organizations.

Hoarding and the lack of sharing of knowledge can put the organization at risk when employees leave or are unavailable. By creating a culture of knowledge sharing, creating knowledge databases and project histories the ability for the organization to own the knowledge is increased this puts less reliance on tacit knowledge, this view corresponds to that of Grant (1996).

Although knowledge workers work independently and make decisions and choices based on their expertise and skills, knowledge workers require structure in which to operate and establish knowledge. Knowledge workers thrive on collaboration and communication. Lack of knowledge strategy creates frustration for knowledge workers, which effects efficiency and moral. There exists an enthusiastic participation of a wide group of professionals, which reflect high commitment and
interest in improving practice. Fong (2005) identifies that shared understanding and collaboration is vital for the transfer of knowledge.

Procedures in the organization differ from office to office, when working on joint projects this puts the project and the knowledge workers in conflict regarding responsibilities, practices and actions. Project team conflicts can be seen in many areas where knowledge strategy and processes could be implemented to eradicate this conflict and frustration. The organization should create harmonised processes across the project environments that are put in place after consultation with the various stakeholders. Consultations should consider differences in perceptions between the offices so that decisions are made with clear justifications. These differences in perception should be explored further within the UK and GmbH offices including site offices. The implication of these different perceptions may be related to knowledge and power (Foucault 1980) and this should be investigated to ensure that power perceptions do not hinder the transfer of knowledge.

As the organization has limited resources, it should take care to evaluate the aims and most pressing needs and develop a strategy that focuses on optimum resource allocation. The strategy can then be expanded as and when the needs of the business dictate. The organization should as a starting point follow the recommendations below, which correspond, to the intellectual capital framework (Sveiby 1997) and the people, process and technology framework (Milton 2005):

- Define processes, procedures and guidelines and advertise and enforce

- Create awareness programs for knowledge management concepts

- Make all relevant project information accessible to all participating members across all departments regardless of office or location.

- Have details of staff and their skills in a central database, allowing the organization to have a searchable who’s who and knows what in as much detail as possible

- Produce guidance documents drawing on the construction and project experience, other sites involved in similar activities can benefit from previous experience – good or bad

- A well managed programme of knowledge handover that starts at the tendering stage and continues to a period after practical completion

- Use the range of guidance material, formal regulations and standard and make available, and advertise the existence of these so that personnel are aware that these are in existence.

The recommendations represent resources and investments of the organization covering three elements of employee competence, internal structure and external structure (Sveiby 1997).
The seven steps needed for a knowledge management programme follow (Bukowitz & Williams 1999). Of these steps, the first few are considered in this study. It is the recommendation of this study that the organization continues with the programme.

- Understand the organizations current knowledge
- Decide what is required from the knowledge management programme
- Draw up a strategy
- Enable a knowledge sharing culture
- Manage the knowledge content
- Use enabling technology
- Measure and review the results

The programme is iterative and involves constant review of the business needs as knowledge becomes embedded in the structure of the business.

Knowledge must therefore be aligned to the business strategy of the organization, the overall aim is the wish to run more smoothly and cost effectively. From this study, it has shown that by focusing on project data, staff skills, supplier knowledge and ensuring consistency and coordination of business processes and procedures the first steps towards a knowledge management programme can be taken.

Strategy should focus on how to organise the knowledge, set up communication and how to measure performance. The culture of the organization should focus on allowing time for knowledge management practices, changing attitudes so that knowledge is shared within a no blame culture. The emphasis should be on supporting each other rather than trying to hinder or point blame at each other. Cooperation and understanding is the focus and should be encouraged at all levels throughout the organization. This is in agreement with the four characteristics of a learning organization identified by Garratt (1996).

Capture of key documents would include for example project reports, project progress meeting minutes, accounting information, project team de-briefing, project reviews, presentation information, induction and training information, staff skills, expertise and experience. An understanding of departments should be available in order that the organization can realise how each department fits into the programme.

Although technology is not seen as an aid to knowledge management in isolation, enabling technologies are one part of the scenario, it is therefore useful to look at the technology in use and make comments on usage within the organization currently.

The organization should look at the existing technology within the organization that can support the programme. The table illustrates that there are many tools that currently exist in the organization that can be part of the knowledge management
programme. Using the existing technology can save money and accelerate the programme. Staff will also be familiar with the concepts that the technology can provide. The study identified an agreement by participants of the importance of knowledge sharing and combined with the familiarity of technology the willingness to use such technology based knowledge practices would be increased. Fong (2005) identifies that willingness to cooperative is an important factor in knowledge sharing. In addition to existing technology, new technology or new uses of technology can be considered. For instance many discussions in the organization take place using e-mail, technologies such as team spaces, portals and wikis can be used instead allowing greater access and search facilities. Using such support systems enables better sharing and learning cultures (Harris & Beyerlain 2005).

The following table lists some of the existing technologies that can aid knowledge management processes and the current use within the organization.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Use</th>
<th>In Use Currently</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>Rapid distribution of documents and drawings allows greater and increased consultation</td>
<td>Yes – fully in use by all, archiving not seamless.</td>
</tr>
<tr>
<td>Document Management</td>
<td>Better visibility of documentation, improved information security, reduced costs of distribution, better accountability, improved searching and version control giving greater confidence.</td>
<td>A review of the systems in place is needed with one system for all and a system that meets objectives of stakeholders.</td>
</tr>
<tr>
<td>Conferencing and web cameras</td>
<td>Aids consultation between project participants, and is an important tool for communication.</td>
<td>Not in use fully. Web cameras in use in some places but not an organization wide initiative.</td>
</tr>
<tr>
<td>Project Databases</td>
<td>Access to previous / current project information in a searchable form</td>
<td>Yes – but not available company wide to all, does not contain all project information, seen as a hindrance rather than enabler by most. Does not meet stakeholder expectations.</td>
</tr>
<tr>
<td>Intranet and Extranet</td>
<td>Effective communication, consultation, sharing of information throughout company. Access to relevant information project information, regardless of locations, for both internal and external members of the project</td>
<td>Not in use although is in place. No priority or understanding of its usage and importance. Requires awareness and increased implementation.</td>
</tr>
<tr>
<td>Company Website</td>
<td>Provision of information on company and current projects, for staff, potential customers and any interested parties</td>
<td>Yes but not updated, nor importance given to as a method of communication to external stakeholders.</td>
</tr>
</tbody>
</table>

Table 8.0 Technologies currently in use across organization
Many variations of knowledge management practices exist, the following are the recommended actions in order to achieve the model illustrated in Figure 8.0 Desirable Improvements. These knowledge processes should be embedded in to the working procedures and guidelines across the organization. These steps however small are ones that would make differences to overall improvement of the project and organizational situation.

1. Each project adds to the long-term strategy of improvement. A manner in which to identify improvement enables the organization to learn from experience. As part of the project management controls project review must be undertaken. This project review can take the form of learning during and after actions and project closure as recommended by Love (2005).

After action, reviews can be undertaken after any significant task or phase during the project. These reviews are focussed meetings whereby discussion takes place regarding what was supposed to happen, what actually happened based on fact, why a difference occurred (if it did) and the lessons learnt.

After action reviews can be used to record small tasks or large. The importance is that learning takes place, which then is transferred within the project or to the next project.

After action reviews originated from the US Army and are a proven method of capturing lessons and actions.

At the end of each project, a method for learning after the project must be integrated into the project management process. One way of doing this is for one person either the project co-ordinator or the project manager to report back on what was achieved. Alternatively and the recommendation is for a holistic approach would involve the team discussing lessons learnt. This follows on from the post project review and will ask how we can avoid the problems in the future, how can future projects benefit from good and bad lessons learnt from this project. Retrospect’s must be held at the end of each major phase of the project in order to learn during the project, and to apply to other projects at different stages. Retrospect’s can aid in reviewing business processes and must be considered within improvement plans. Where there is a history of team disbandment and personnel leaving before the end of the project then interviews can take place with individuals and then put together to gain common themes. The inclusion of as many stakeholders as possible must be the aim in order to generate a full review (Brookes 2000, Disterer 2002, Walker 2003, Milton 2005, Palmer and Platt 2005).

The end project report for instance gives detail as to whether the project has performed against planned cost and schedule. The report describes the impact of approved changes, and the quality of work carried out. The report should contain a summary of achievements, any changes that were approved and their effect on the project plan, an analysis of change issues and the overall effect of changes to the plan and costs.
Post Project reviews including lessons learned workshops and post decision reviews need to be implemented in order to understand in detail why specific projects were more successful than others. Increasing knowledge visibility enables knowledge to become embedded in reflection practices and transfer to future projects. The suggestion of review is one that is highlighted by Milton (2005).

Risk management is an area that is dependent on knowledge management. Knowledge management processes can help risk assessments and contingency planning. Project review can enhance processes by ensuring widespread knowledge and integration of business processes, this ensures that risks are considered and processes are incorporated that manage risk.

2. Idea management is the collection and development of ideas that can deliver value to the organization. Ideas are based on individual experience and knowledge and thus should be captured. Knowledge management aids idea management by sharing ideas and providing ways of collecting and evaluating ideas and suggestions. Ideas need to be collated and reviewed to ascertain whether they can generate results or changes in processes.

3. The implementation of a lessons learnt log that is available to all personnel. This log should be updated regularly throughout the project phases. A lessons learnt log is illustrated below. This log could be kept project specific and then at the end of the project amalgamated into the organization knowledge database.

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Lesson Learnt</th>
<th>Action</th>
<th>Responsibility or Owner</th>
<th>Process Update</th>
</tr>
</thead>
</table>

*Figure 8.1 Lessons Learnt Log adapted from continuous improvement record, BSI*

Lessons can be applied when considering for example new contracts as part of contract review and for application in risk management. Lessons learnt need to be actionable lessons rather than statements of what went wrong or what was a success. Project activity creates lessons learned which are then reviewed and applied. As they are applied, they are refined and adopted as business processes and procedures.

The lessons learnt logs need to be stored in an area where they are accessible by as many as possible for example; the organization intranet would enable ease of access. These processes match the SECI framework (Nonaka and Takeuchi 1995) by encouraging the SECI lifecycle.
4. Organization and project roles should be clearly defined. Job descriptions should be defined for all project and organization roles. This information should be communicated to all. This increases visibility of personnel and structure of responsibility. Organization and project charts can help to communicate the structure of the project and organization.

5. Communication of news to be implemented via newsletter. The advantage of a newsletter either paper or electronic is to offer a method to communicate regularly with personnel and create an atmosphere of cohesion despite geographical location. The newsletter can broadcast that organizational procedures are in place and provide the necessary awareness of the benefits of knowledge sharing. Some personnel are likely to gain motivation and satisfaction by inclusion in the newsletter and recognition of activities. Team working can also be rewarded in this way.

6. Project management integration should be increased. Project methodology should be followed on each project and the methodology should be communicated so that an understanding of phases and protocols is in place. If there is no standard methodology used then this area should be reviewed with the aim of adopting a standard organization project methodology that would ensure consistency across projects with set authorisation levels and responsibilities. All project managers would be trained to this methodology. By following a project methodology this would clarify authority levels and establish roles and responsibilities that are clear throughout the organization. Husoy et al (2002) state that a lack of work methods can increase costs and is a limiting factor for knowledge efficiency.

7. Business processes should be developed and adopted regardless of location. Agreement must be reached as to local business processes and these should be adopted by the project. Clear definitions will help to relieve ambiguity. Current Integrated Management System (IMS) improvements should be agreed upon at Director level across the group and mandated for project work.

8. Knowledge management processes should be seamless and integrated into business processes so that they are part of day-to-day activities. Knowledge management then becomes “the way we work” rather than extra workload. This corresponds to the tactical day-to-day work basis that Bukowitz & Williams (1999) suggest for knowledge strategy.

9. Employ regional engineering or knowledge managers or similar in a position where knowledge transfer and project coordination can be improved by improving support between sites and head offices. Knowledge managers (or another title to suit) are responsible for knowledge, lessons learnt and facilitating review meetings. As part of this role, they would ensure
consistency and coordination between individuals, departments, teams and projects.

10. Increase the awareness of knowledge management via communication of the benefits of knowledge sharing and learning for individual, project and organization. Currently awareness of knowledge management is confused with information management, respondents were unsure as to who had the responsibility for knowledge management. This matches with Nonaka and Takeuchi view who identify that knowledge and information are terms that are confused and that knowledge is difficult to define (Grant 1996, Alvesson 2004, Milton 2005).

11. Tacit knowledge of personnel whether contract or staff is at risk of leaving the organization. By performing knowledge interviews with key members of staff, the expertise of these staff can be mapped out and knowledge transfer plans created. The process of knowledge interviews and knowledge profiles will result in learning and knowledge transfer to the organization and to other individuals involved in the process. In this manner the risk of knowledge can be ascertained and plans can be made for knowledge transfer and learning.

12. Checklists from the knowledge interviews can be created from areas that personnel currently perform tacitly. This is then made explicit and formalised, reviewed and adopted as procedure. In this manner, new entrants do not have to recreate working methods where previously the tacit knowledge of the individual was used.

13. Following on from knowledge interviews are exit interviews in order to ascertain personnel views and knowledge that may not have been gained from the initial knowledge interview. This would enable knowledge to be captured before it leaves the organization. Exit interviews should be carried out for each knowledge worker leaving the organization as part of the human resources function. Dent and Montague (2003) recommend such management continuity strategies.

The above activities require support from both staff and management. Long term investment in knowledge management can help to achieve improved document control, project knowledge, improved risk management, improved communication and learning within the organization that is fed back to the day to day work. With continual monitoring and review, the impact on the organization and the success of the knowledge management program can be assessed.
The following activity table lists the above activities with a brief description.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processes to be identified, reviewed and refined and communicated to all. Processes should be organization wide.</td>
<td>This would prevent the current situation of hidden processes and the associated frustration.</td>
</tr>
<tr>
<td>Peer assist</td>
<td>Relevant people both internal and external are invited to offer views and experience. This is an effective way of bringing tacit knowledge out.</td>
</tr>
<tr>
<td>After action reviews</td>
<td>Mechanism for learning during project activity, are focussed review meetings, short in duration, can promote clear objective setting, what actually happened rather than opinion, lessons learnt. Can be held in project review meetings.</td>
</tr>
<tr>
<td>Knowledge engineers and managers</td>
<td>Roles accountable within the team, can access knowledge, capture, document and share, ensuring that processes adhered to.</td>
</tr>
<tr>
<td>Knowledge histories</td>
<td>The keeping of a lessons learnt and actions log that is applied to each new project phase.</td>
</tr>
<tr>
<td>Retrospect's</td>
<td>Capturing knowledge at the end of the project, this goes into greater depth and is offered to the next project.</td>
</tr>
<tr>
<td>Develop better integration of departments</td>
<td>Departments to be aware of each others work and constraints.</td>
</tr>
<tr>
<td>Job descriptions and organization charts</td>
<td>Full and complete documentation in this area related to the project and the wider organization.</td>
</tr>
<tr>
<td>Increase IT knowledge and use</td>
<td>Ensure that IT facilities in place to support strategy and personnel. IT facilities and department to work together rather than as separate entities.</td>
</tr>
<tr>
<td>Increase support office knowledge of project and site work</td>
<td>Run awareness forums – departments to work together rather than separate entities.</td>
</tr>
<tr>
<td>Improve collaboration with other organizations</td>
<td>Hold project review sessions externally.</td>
</tr>
<tr>
<td>Allow formal time for reflection processes</td>
<td>Embed reflection and action as an integral part of the business.</td>
</tr>
<tr>
<td>Involve all levels of management and make aware knowledge management benefits for the organization</td>
<td>Involve the business so that knowledge efficiency is the norm.</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>This activity would enable best practice awareness within the organization.</td>
</tr>
<tr>
<td>Centralised documentation on projects</td>
<td>Currently documents dispersed, and procedures are not known for handling.</td>
</tr>
</tbody>
</table>

Table 8.1 Activities for improvement
8.4 Conclusion

This chapter has discussed in summary the analysis that has taken place and the findings from the previous chapters. It has shown that the organization is lacking in knowledge management practices in a group environment. Knowledge management takes place individually but this must be aligned to the business operations in the project environment. Infrastructure that would support group knowledge management is not in place and there are many areas covering process, technology and culture where the organization can take first steps towards a knowledge strategy.

Many of the recommendations are ones that can be implemented in a short manner of time. Where possible the creation of a small-centralized knowledge management team focussed on tool maintenance, community and cultural development and communication of knowledge management would be of benefit for coordinating knowledge activities. The programme of knowledge capture and transfer starts at the tendering stage and continues to handover. For the organization knowledge capture and transfer is a continuous cycle.

Of special interest to the project environment are the project review reports and the methodology used in this study. This type of report generates knowledge assets and enables learning to take place, which can be used on future projects. Considering that the organization is a project based environment this process should be mandatory as part of the project management process.

The methodology has realised self-reflection, learning and awareness by participants. The use of the soft systems methodology has highlighted areas where personnel within the project and support project staff can improve processes and knowledge practices. This method can be developed and facilitated in the construction project environment to encourage its use within this and other organizations and its projects in a more formal manner to aid business improvement.
Chapter Nine: Conclusions

9.0 Introduction

What is the role of knowledge within the project? In addition, how does knowledge management within the project help collaboration and project success?

The objective of this research is to understand particular problems that the company is experiencing involving individuals, teams and use of its knowledge.

It was seen that by exploring how knowledge management is used within the project team, the answers to four specific sub questions would be clearer:

- Why the area of knowledge transfer processes seems to be neglected – Identifies why the organization is not doing more to retain knowledge.
- To explore how the company can derive knowledge from team members thus making tacit knowledge explicit within the company and the project team – discussing the role of knowledge management and the impact on the project.
- To explore how project team members and non-project team members perceive their work in aiding the knowledge creation and learning of the organization, and the success of the project – revealing assumptions made about knowledge management.
- To explore knowledge strategy that allows project teams to avoid reinventing the wheel – Looks at how knowledge management can be integrated in daily activities and recommendations.

The following section takes each question in turn and presents a summary of the findings.

9.1 Review of Questions

Question 1 has been answered by a review of the literature and the carrying out of primary research. In answer to the question, knowledge transfer processes are found to be neglected from the perception of the organization members. However, this perception is one of knowledge from a group perception. When looking at individual knowledge management, we can see that individual knowledge strategies are used in varying degrees. What is lacking is the infrastructure to support these individual strategies in order for the knowledge to be owned by the organization and used by the group members.

The conclusions from this research show that the assumption of complexity in the project environment is one that is shared by all project members. Project members see knowledge management, collaboration and co-operation as very important to
project success and efficiency. However, there is no consistent approach to these areas and overall knowledge management is not fostered in the organization. There is no knowledge management strategy within the organization and it is the recommendation of this report that this area is reviewed by the organization.

The absence of a clear dedicated knowledge management structure means that the organization does not derive as much benefit from its knowledge as it should.

Conflict in project management decisions arises due to lack of communication of tacit and explicit knowledge, time to review past decisions and respect of individuals (lack of understanding as to why past and present decisions were made in the manner made).

Question 2 has been answered by a review of the literature and the carrying out of interviews and a review of best practice documentation available in the domain.

Team members tend to discuss project (content, relationships and methods) problems informally rather than formally but ideas/actions are not implemented due to lack of resources (time, labour, and cost). This can contribute to a "nut island effect" in the projects illustrated by some of the comments received in the interviews undertaken.

The organization via business processes should embed knowledge management practices so that knowledge management becomes an every day part of working. Formal time to reflection should be allocated establishing the importance of reflection and learning. Examples given of knowledge management practices include peer assist, after action reviews, project reviews, project learning logs, intranets, better use of technology, retrospect's, increased collaboration and definition of processes and guidelines.

Knowledge management is more than information and data – it is also a social issue that involves trust, obligation, and commitment between all. As referred to in the literature review programmes such as Investors in People or International Standards can help to make links between collaboration and knowledge management concepts, this can be further aligned with standardisation schemes such as proposed integrated management systems.

Question 3 has been answered by carrying out an investigation based on soft system methodology.

Data collection has explored the perception that team members have of their work and the influence of knowledge. Project members consider knowledge to be of importance to the overall success of the project and future projects.

It was viewed that more time should be given to reflection, learning and collaboration. Communication of these views was presented in the rich pictures derived from the data collection.

Although many respondents were unaware of knowledge management or project review there were instances were respondents could report on project learning that had been carried forward to new projects. However, this was performed on an
individual tacit basis rather than because of project reflection processes. Interview themes centred around two main themes. These being project management and coordination and then project review and learning.

The findings show that knowledge management practices for the project depends on the individual project manager in place and the coordination that they personally view as important. If a project manager changes mid project the change in tactic is clearly seen by team members in the way that the project is run and where emphasis is put. In some instances, changes of project managers improved knowledge sharing and collaboration however, for others this was not the case. Organization wise it was felt that knowledge management is an area that can be improved with little effort but that this needed to be coordinated centrally and with the input of both project team and wider organization.

Question 4 has been answered by both soft systems methodology and the literature review.

The organization has still to commit significant resources to the work of knowledge management areas. Having not yet made any formal business cases to justify investments or plans to implement or review a knowledge management strategy has put the organization in a situation where the risk and reality of knowledge loss and inefficiency knowledge use is present.

This question asked what could the organization do to prevent reinventing the wheel and how knowledge management could be embedded into day-to-day work.

It was found that knowledge management strategy that built knowledge management around business processes would ensure that knowledge is not a product that is ignored. By building processes, that encaptured knowledge the organization could prevent reinventing of the wheel and the associated resource loss.

A first step for the organization would be to identify the processes in use. From data collection, it was seen that business processes for this particular organization would benefit from being made explicit and defined with an emphasis on clarity and awareness. Knowledge management processes could then be applied to the processes.

In summary, the chapters of this thesis have explained the rationale, aims and objectives of the study. Chapters two and three gave an overview of the literature in the area. The following chapters detailed the framework of the study and the methods and techniques used in the fieldwork. Analysis using soft systems methodology has been illustrated using rich pictures, root definition and CATWOE definitions.

These iterative elements are a part of the soft systems methodology that enables deeper understanding of the situation in question.
The approach is used to present perceptions of the situation in order to compare and make recommendations for procedural change and as a source of requirements for development.

This chapter has discussed in summary the analysis that has taken place and the findings from the previous chapters. It has shown that the organization is lacking in knowledge management practices. Structures that would support knowledge management are not in place and that there are many areas covering process, technology and culture where the organisation can take first steps towards a knowledge strategy.

9.2 Further Research

Although knowledge management is a highly researched area, industry reports identify issues of collaboration and communication, innovation and knowledge management as areas where organizational improvements can be made. This study has used SSM as a technique to explore the organizations current knowledge state. By using SSM as a technique, this can be applied to other construction organizations requiring a basis and framework for improvement programs.

A further study could collect information from respondents in strategic positions at headquarters level; this could make the study more robust from a triangulation point of view and include additional viewpoints based on senior management perception and local knowledge worker perceptions.

Data collection indicates that a lack of knowledge management systems in the organization has the effect of increased conflict and frustration. Since this is a view that a lack of knowledge infrastructure leads to increased conflict and frustration, measures of frustration and conflict could be reviewed in later research.

In summary, the research showed a lack of awareness of the benefits the knowledge management could bring to the project environment and within the organization. The majority of respondents were aware that project success required a holistic view but this was still absent from the organization. Managers should be trained in the knowledge aspects of project work and resources should be given to ensure that knowledge could be managed. Further research indicating awareness by small and medium sized construction companies could be undertaken in order to assess the extent of knowledge programmes.

Knowledge management has been defined in many ways, one of the underlying themes of knowledge management is that of utilising the intellectual capital of the organization in order to improve efficiency and maintain competitiveness. Although there has not been the time to carry out a longitudinal study, future research could pilot the use of knowledge management measures, document the impact on employee perceptions, and project success. This could be carried out with focus on the three criteria of efficiency, efficacy and effectiveness.
9.3 Conclusion

The study contributes to the field of knowledge management in the construction industry by showing that despite best practice availability an organization may not be using or taking advantage of this due to resource restrictions and lack of knowledge - a study such as this identifies to the organization areas for improvement and identifies the need for action. The actual methodology used is one that can be transferred to other organization structures.

The research supports the view from previous research that KM is of benefit to an organization and that a strategy should be in place to take advantage of the facets that KM offers.

The benefits are stated to be the identification of what is needed to support overall organizational goals, individual and project team activities leading to improvements in processes. This methodology can be of importance for other construction project environments operating under similar circumstances with the aim of improving processes and project collaboration.
Chapter Ten: Reflective Diary

"Nil Desperandum Perciverando Vicinimus"

Trevor Lee

Throughout the process of the practitioner doctorate programme doubt is in the background as to whether the goal of completing will be achieved and will the study help to overcome a workplace problem. Using motivation and enthusiasm for the area, this doubt is overcome. An important part of the programme is to believe in the research and the area that is to be improved. Clear thinking and self-belief helps to pursue paths that will eventually lead to increased understanding.

The DBA programme as stated in the DBA Handbook (p.12) aims to enable students to grow and achieve the ability “…to make informed judgements on complex issues sometimes in the absence of complete data and to be able to communicate ideas to both specialised and non-specialist audiences…” The programme has helped me make informed judgements in specialist fields not just academically but professionally and personally. Communication of ideas enables others to share in this positive aspect so that the benefit of self-development is transferred to others in the workplace via increased communication and collaboration in complex situations where critical thinking and reason is required. I feel that this has been achieved and feel confident in taking the lead and explaining situational problems and offering viewpoints either facilitating or offering guidance based on reason and evidence.

Continuing from this the programme aims to enable the student to contribute to new techniques and to develop ideas and approaches. The exposure to different quantitative and qualitative methods and philosophical approaches enlightens the student with appropriate viewpoints that can be carried forward in other problems.

Specifically from a professional and personal viewpoint, I feel that I am better able to critically read reports, make decisions based on information presented, and to reason and apply to management problems. In this respect the DBA programme has achieved a primary aim.

Personal responsibility is without question a must in the work environment. It is important not to underestimate the importance of planning, documenting and attention to detail of every aspect of the programme. Continuous reading and looking at different paths to see if any were worth pursuing or whether the research needed adjusting requires time and often these very paths can lead to feelings of lost time when dead ends are faced. However, the importance is the learning that comes out of these exercises without which confidence in choices would not be present.

The chance to research a problem that is experienced in the workplace has meant that I am able to make a real difference to the workplace and has I believe improved my professional status. At the same time I have been able to pursue both academic and professional growth.
By completing the programme I have been encouraged to think critically rather than accepting what is given. This critical thinking has included the asking of questions and probing for information, using language with precision, supporting reasons with evidence and making sound judgments' based on evaluated information.

The personal responsibility and initiative required to complete a programme that while contributing to a management problem is to be carried out alongside normal day to day responsibilities and special projects generates a sense of personal responsibility that if not already present before commencement of the program is certainly highlighted and enriched during the programme. The commitment and responsibility that is highlighted will filter through to other areas of professional life.

The opportunity to develop the ability to conceptualize and to analyze management problems, with increased skills to submit proposals for resolving management problems is an area that is of enormous benefit to both the student and the workplace. In this area I feel confident that my abilities to analyze and offer suggestions is well received as a result of the taught and research elements of the programme both in terms of gaining theoretically new knowledge and the experience of practical research. This experience can be transferred to other management problems that occur in the workplace requiring similar criteria and innovation to tackle.

The taught element was challenging and a new experience different from that of the work in the master’s programme that was followed. The taught element not only complemented the work of stage two in the programme but also in other areas of professional life. Contact with other research students during this taught element has helped both studies and fieldwork in terms of personal support.

The knowledge that the taught modules are completed successfully gave confidence during the second stage when the sheer amount of work and new knowledge to be gained gives you the realisation that in fact you are at the very beginning of a learning curve. Realising that you are at the beginning of a learning curve sometimes presented self-doubt during the programme as the rules of research were to be followed while actually learning the rules. Without the taught element of the programme the ability to read academic articles would not be possible, without this the completion of the literature review and fieldwork would have been impossible.

I found the philosophical underpinnings of research module to be very interesting and the content of an introduction to management research and the meaning of knowledge and truth. Especially since the thesis is based around knowledge management this module helped me to understand the approaches to knowledge and the different viewpoints of what knowledge is. Additionally contemplation over my own values and beliefs allowed me to question and personally evaluate my own views and why I have or don’t have particular views. I later revisited this area during the thesis stage when considering viewpoints and meanings of knowledge and assumptions made both personally and professionally.

The taught element of the DBA provided the groundwork to build the thesis upon.

I felt that supervisor progress meetings helped to calm and focus the study giving confidence and the reality that a scrambled brain of thought is natural when starting
out on the programme and during the programme. Supervisor meetings helped to motivate and install clear thinking when reflection was required in order to progress.

Theoretical and practical knowledge of research methods carry forward personal lessons ranging from not to make assumptions as to others thinking, nor to under estimate the amount of time needed for work carried out on your own and for work carried out with others. In other words consideration for others and others viewpoints helps to understand and be more appreciative of problems. An awareness of the advantages and disadvantages of different methods give the ability to use the most appropriate method for a given situation.

The importance to document every small thought throughout the process, to learn when to step back and look at the whole, when to stop reading, start thinking and start doing and then to start writing has been a learning experience. Similarly, although detailed diary notes at the start of the research may seem like an extra chore it proves invaluable when writing up and remembering what you thought a year back or even two years back.

From a more personal point of view, life outside of the DBA goes on and it is important to balance out the work that is required for the DBA with social and family responsibilities. As a mother of two very young children this has been a constant struggle. Combine this with a full time challenging day job and sanity questions are raised! Academic and philosophic challenges have given an insight to – sharing of experiences, challenges, motivation to achieve, motivation to change situations both in personal and professional life.

Time management skills are tested to the limit as juggling a family with two sons under four for the majority of the programme and working full time in a challenging, rewarding job means that time for the DBA is at a premium. Being passionate and grounded is important and realising that being super human is more than likely going to affect one’s health allows you to plan the day with precision and to keep to plans. When you plan your days (and evenings and nights) with precision for the years that the program takes – it is your motivation and commitment to the programme that takes over to complete. This self-responsibility is one that is transferred both to the programme and to the workplace. Immersing one self in the subject and crucial time management is of importance in reducing the feeling of guilt when the balance is not correct either towards the family or towards the DBA. This skill of juggling time has been enhanced by following the programme and in many ways has helped to achieve more than may have been possible before. Learning to delegate time to different aspects of life is a skill that is not only required but also necessary for sanity and good health. The discipline aspect here is crucial in achieving this, there is no doubt that by following the programme this has been an important element of personal growth.

However when crisis is encountered the best laid plans are not able to be kept and an assessment of the situation is then called for. Learning to cope with uncertainties is an important element of life that is not always easy to understand or accept. A positive outlook and mental strength is called upon in order to overcome personal and family challenges.
Setbacks during the fieldwork give a chance to learn and accept that paths are not always your choice and that taking stock of where you are and trying again can provide motivation and reinforces a can do attitude. Again learning to accept change and learn from mistakes is a useful lesson for other areas of social and professional life.

Overall, the programme has been an extremely beneficial aspect of my life for the last four years. I believe that I have both professionally and personally grown, that my workplace has benefited from a learning perspective and that I better understand others, myself and my abilities.

However, learning is continuous and the very act of carrying out the programme, contemplation and self-reflection has identified the ways that I would approach situations differently in future.

In summary as part of this learning and self-reflection process, I have understood that the wider issue in both personal and professional situations is one’s own beliefs that are bought into question and my own tacit information and perceptions that I rely on. Using both project management and neuro linguistic programming techniques, this has helped me to understand my own knowledge and how I personally view myself, my learning and goals. This has been of enormous help in taking action and to continue modifying my own behaviours in order to achieve and modify my behaviour for the better. The programme has granted me the avenue and the resources and knowledge to carry out this reflection of my self-knowledge.

It follows that as I have grown personally then from a professional viewpoint; the completion of the programme has enabled me to become better informed. This has made me a more confident member of the workplace able to make decisions based on critical evaluation, understanding and logical argument taking into account the appropriateness of the complex situations both professionally and personally.
References


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Appendix A: Executive Summary – Practitioner Report

Improving Knowledge Retention and Use in Construction Project Team Environments

KNOWLEDGE MANAGEMENT EXECUTIVE SUMMARY
EXECUTIVE SUMMARY

This report is intended to improve the organizations management of knowledge. The overall aim and purpose is to promote the value of knowledge sharing within the organization. By promoting knowledge and learning, this ensures that personnel have access to the knowledge they require, wherever this knowledge may have originated, and that this knowledge is applied for best results.

Over the past two years between 2005 and 2007, I have been analyzing data documents, surveying personnel via questionnaire and following up with interviews as part of a research study on knowledge management and its use within the organization and its project environments.

The aim of the research was to establish a report on the extent of knowledge reuse and its use to the project environment with the ultimate aim of benefiting the organization with an improved awareness of knowledge and suggestions to improve the way we as an organization use our knowledge to improve the business.

Knowledge management has been defined in many ways, one of the underlying themes of knowledge management is that of utilising the intellectual capital of the organization in order to improve efficiency and maintain competitiveness.

The British Standards Institute defines Knowledge Management (KM) as; "the creation and subsequent management of an environment which encourages knowledge to be created, shared, learnt, enhanced, organized and utilized for the benefit of the organization and its customers"

There are many other definitions, which follow a similar stance. It is common sense that knowledge not shared will not be fully used and will eventually be lost. Mistakes and rework will be the course, as the organization does not learn as a whole. Not sharing knowledge will mean constantly 'starting from scratch' and 'reinventing the wheel'.

The more projects completed the more experience the organization has from encountering and solving problems. What is needed is a way of remembering the solutions for use in future projects. KM helps to achieve this.

This report summarises the key points, findings and recommendations of the research. The full thesis is available on request.

THE FRAMEWORK OF THE STUDY

The objective of the research is to understand particular problems that the company is experiencing involving individuals, teams and use of its knowledge.

Thus, it is hoped that by exploring how knowledge management is used within the project team, the answers to four specific questions will be clearer:
• Why the area of knowledge transfer processes seems to be neglected — Identifies why the organization is not doing more to retain knowledge.

• To explore how the company can derive knowledge from team members thus making tacit knowledge explicit within the company and the project team — discussing the role of knowledge management and the impact on the project.

• To explore how project team members and non-project team members perceive their work in aiding the knowledge creation and learning of the organization, and the success of the project — revealing assumptions made about knowledge management.

• To explore knowledge strategy that allows project teams to avoid reinventing the wheel — Looks at how knowledge management can be integrated in daily activities and recommendations.

The benefits are the identification of what is needed to support overall organisational goals, individual and project team activities leading to improvements in processes.

It has been proposed by Nelson that the where or what of knowledge in the company lays primarily in organizational routines (Nelson 1982). According to the conceptualization of the project environment, this is accepted as a fast changing and demanding environment where organizational routines are flexible. Consequently the nature of knowledge is a learning process that is adapted to an unstable position.

The choice of Soft Systems Methodology (SSM) for this research is matched to the interpretative qualitative approach which views social reality as a world built of meaningful interpretations, which are changeable depending on circumstance, time and view.

By participating in the process of research, personnel deepen their sensitivity to the perspectives and needs of the project and organisation, thereby developing professionally. The learning that occurs is two fold and has been called “systemic praxis” Bawden and Packham (1998) referenced in (Patton 2002):

1. The inquiry can yield specific insights and findings that can change practice

2. Those who participate in the inquiry learn to think more systematically about what they are doing and their own relationship to those with whom they work

It is important to state here that SSM is a methodology used to understand the situation and not a manner in which to frame the situation as a system. Systems’ thinking enables complexity to be discussed and understood rather than trying to map the processes to a system. The soft systems methodology (SSM) is used as a method to comprehend the underlying processes and to highlight the related issues.
THE STUDY PARTICIPANTS AND PROJECTS

Documents were analysed from three UK based projects that have taken place over the last five years. The projects were not specific to any one technology, the criteria for the project being a UK based project with both parent and subsidiary input.

The questionnaire was administered during July, August and September 2006 and sent to recipient e-mail inboxes. The questionnaire consisted of 28 questions, consisting of multiple choice, yes or no and likert scale questioning. Overall, 188 names were extracted from documentation, only 4 specifically refused to participate, 140 continued with the questionnaire, 53 fully completed. The survey therefore generated an overall completion rate of 38%.

The questions covered the following areas:

1. Basic background of respondents (Questions 1-8)
2. Reflection time in projects (Questions 9-14)
3. Knowledge management practices used (Question 15)
4. Respondents views and knowledge of and on knowledge management policies /effect on project success (Questions 16 – 24)
5. Collaboration within the organization project team (Question 25)
6. Collaboration between the project team and others external to the organization (Question 26)
7. Respondents views on project structure (Question 27)

The questionnaire ended with an open-ended question (Q28) allowing respondents to raise any comment that they felt relevant.

Respondents were identified and chosen for receipt of the questionnaire from project organigrams and telephone lists provided by the project documentation used in the document analysis stage and from lists available to the researcher. Many of these respondents had since moved on to new projects thus the sample of projects now grew to a total of seven projects from the initial three.

The questionnaires completed were divided between the following segments of job type where respondents stated their job title:


Respondents revealed that they had a vast number of years of experience between them. The average number of years worked for the organization was over 10 years.

To follow on from the questionnaire interviews took place with a number of respondents. Validation of the questionnaire results took place within the interviews.
and the interviews were used to expand on knowledge management aspects within the project environment.

Follow up and validation of the overall results were carried out using rich pictures presented to a small number of interviews.

**FINDINGS**

The findings from the study identify the growing importance of the organizations knowledge and its contribution to project and organization success. The findings illustrate that knowledge management must span functions in order to leverage knowledge and embed knowledge in organizational processes.

The ultimate aim is to improve on the organizations current state of knowledge management. The points below are summarised findings from the data collection stages. Since the data collection stages some of these points have been or are in the process of correction via improvement programs. The list should be read as areas where improvements can be made rather than the apportionment of blame.

- There is no documented knowledge management strategy in place.
- The company has many gaps in the documentation of business and project processes. Personnel often are unaware of their duties and rely on mentoring to "settle into a job"
- Some documented business processes exist but many of these are out of date or simply not followed in the day to day operations.
- The organization is relatively small despite large value contracts and relies on verbal and mail communication heavily.
- Project review is not given formal time. This hinders project learning. The consistency of project review varied between respondents and the call for project review methods and time was evident from all data collection sources. The results indicated that more than half of the respondents (63%) spent time reflecting individually on project work at a regular basis throughout the project. The least chosen option was at the end of the project.
- When reflecting on time spent sharing thoughts with other team members again the most popular answer was on a regular basis throughout the project, although this was mainly informal time and mostly conversations while travelling or catching up on matters informally rather than through structured discussion and review activities.
- Knowledge management practices were most commonly used during project review and before project review although only a third of respondents stated that they did this. Common practices included consulting outside literature or consultants or the Internet.
A majority of 78% felt that the Group should amend project review procedures to ensure discussion and capture of knowledge while 20% said that procedures already existed.

Knowledge management best practice is not followed – the organization viewing itself as "too small" to benefit from this or many where unaware of best practice.

No formal or informal structures are in place for knowledge capture and reuse. The organization suffers from knowledge loss and wasted time spent in "recreating the wheel". This is acknowledged by the organization members who express a desire to learn and re-use knowledge if given a structure to achieve this. Repetitive mistakes were identified from project to project.

Document management is not controlled organization wide – each office follows its own documentation standards. This results in confusion, delay and lost documents. Version control and access is hindered by this situation. Personnel do not know where to access particular documents as there is no one common area for documents.

Similarly, project documentation has not always been kept in a consistent manner, searches for documents take too long and relevant project information was not accessible to all participating members when needed.

It was viewed by respondents who had worked across many projects that project management standards vary from project to project depending on the skill of the project and site management teams. A uniform project methodology did not appear to be in place in the organization. Awareness of project standards are limited, with many members unsure of project conventions or methodology that may be in place at organization level.

20% of respondents felt that the company was not effective in identifying good practice, escalation of issues, communicating, understanding roles and responsibilities, meeting expectations, and cooperating with other firms in the project setting. Just under half of respondents felt that project issues in their most recent project were effective, as was resolving these issues if they had been escalated.

Awareness of the procedures and access to documented procedures is limited. Documentation of procedures differs amongst areas in the group or are confused by personnel working on the same project but for different organizations and thus under different procedures where they do exist.

Project collaboration and cooperation was also identified as an area where the organization could improve both internally and externally.

Better definition of processes, procedures, best practice and a greater awareness of knowledge management would be of benefit to the organization.

Knowledge management techniques and the implementation of processes would ensure consistent improvement and application of best practice proven in the industry. Respondents indicated a strong agreement that
knowledge management needs a holistic approach and that project success depends on good cooperation, communication, clear responsibilities, project reflection and review.

- However, responsibility for knowledge management was not clear. Over half felt that the project team and or the individual are responsible while 13% stated that they did not know who was responsible.

- Generally, there are gaps in knowledge management practices within the organization: Knowledge management best practise is available and generally well known to the construction industry and other industries. However, this best practice is not utilized within the organization, particularly in terms of the project and wider organization environment, in terms of adding value; this is an area that the organization would benefit to improve on.

- This problem is not unique to the organization or its project environments. The literature shows that this is a common problem in many project-based organizations.

- Knowledge management is not an area that our personnel both staff and contractors are aware of in any depth, nor are they aware of any organization strategy to preserve knowledge. Where contractors have used knowledge systems in prior workplaces this is not transferred to the organization.

- Lack of project review and time to reflect with colleagues was identified as an area where improvements should be taken. Project review is often overlooked due to resource restrictions.

- Strategies for the prevention of knowledge loss and reinventing the wheel were areas that were identified for review by personnel. Historically teams are broken up and people move onto other projects or leave the company, financial resource restrictions force this issue. Better learning processes and sharing of knowledge via work processes is essential in order to capture personnel knowledge and learning for reuse.

- Strategies to improve knowledge reuse: The literature shows that construction and project environments benefit from the application of knowledge management strategies.

- Tacit Knowledge: The knowledge that our personnel have within the organization is very important. It has been experienced that when these personnel leave the organization the knowledge leaves with them.

- Setting up strategies to encourage knowledge transfer such as mentoring, exit interviews, on going project reviews, collaboration and experience sharing strategies will facilitate knowledge transfer between personnel.
- Awareness and evidence of organizational routines lacked. Where routines existed these were not documented and varied from project to project. This variance in routines included project management procedures as well as organizational procedures.

- KM activities are of most benefit and seamless when embedded in organizational routines.

The sample represents the views of a wide mix of personnel with experience of the project environment both at site, head office and senior management level. Follow up discussions have taken place to clarify respondent comments and to ensure that the ideas presented were validated.

The conclusions from this research show that the assumption of complexity in the project environment is one that is shared by all project members. Project members see knowledge management, collaboration and co-operation as very important to project success and efficiency. However, there is no consistent approach to these areas and overall knowledge management is not fostered in the organization.

The following rich pictures illustrate the main areas of concern:

Figure A.1 Rich picture derived from questionnaire
Comments from interviews appear as excerpts in the full thesis in order to illustrate perceptions; these comments exist in this summary via the above rich pictures. All interview comments have been made anonymous.

Despite the bleak pictures, the majority of the respondents said that they used knowledge and managed knowledge but with differing degrees of use and understanding of knowledge management practices being displayed. This use of knowledge thus appeared to be individualistic. The following illustrates the overall problematic situation described above:

Figure A.3. Rich picture of problematic situation

It is the recommendation of this report that these areas are reviewed by the organization.
The organization should start by asking what is required to support the main business strategy and to operate efficient processes.

An efficient model is illustrated below, this model is the ideal situation to be achieved.

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Figure A4. Knowledge efficiency

In order to achieve this, the organization should focus on strategy, culture and capture.

Strategy should focus on how to organise the knowledge, how to establish means of obtaining knowledge and how to communicate and measure knowledge success. The strategy should be to promote the value of knowledge sharing within the organization and actively encourage knowledge-based processes.

Culture should focus on allowing allotted time for knowledge management practices, and changing attitudes to sharing and collaborating. By providing the opportunity and structure for knowledge management the opportunity and motivation for knowledge sharing will increase. The promotion of an achieving, learning and sharing culture, decreases the possible existence of an underachieving environment with a blame culture.

Capture of knowledge embedded in business processes enables the organization to capture knowledge in a manner that leverages existing knowledge. Knowledge assets are created in day-to-day work activities. Processes such as project reviews, project after action reviews, progress meetings, accounting information, post project reviews,
project team kick offs, lessons learnt logs are all areas where knowledge capture can be embedded as part of the business process.

Although technology is not seen as knowledge management per se, enabling technologies are one part of the people, process and technology scenario, it is therefore useful to look at the technology in use and make comments on usage within the organization currently.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Use</th>
<th>In Use Currently</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>Rapid distribution of documents and drawings allows greater and increased consultation</td>
<td>Yes – fully in use by all, archiving not seamless.</td>
</tr>
<tr>
<td>Web access</td>
<td>Access to supplier information, standards, regulations, general guidance</td>
<td>Yes – in use by most</td>
</tr>
<tr>
<td>Document Management</td>
<td>Better visibility of documentation, improved information security, reduced costs of distribution, better accountability, improved searching and version control giving greater confidence.</td>
<td>Yes but deficient in terms of meeting stakeholder expectations. A review of the systems in place is needed with one system for all and a system that meets objectives of stakeholders.</td>
</tr>
<tr>
<td>Digital photography</td>
<td>Aids consultation between project participants</td>
<td>Yes – fully in use</td>
</tr>
<tr>
<td>Conferencing and web cameras</td>
<td>Aids consultation between project participants</td>
<td>Video conferencing is an important tool for communication between sites and offices. Not in use fully. Web cameras in use in some places but not an organization wide initiative.</td>
</tr>
<tr>
<td>Project Databases</td>
<td>Access to previous / current project information in a searchable form</td>
<td>Yes – but not available company wide to all, does not contain all project information, seen as a hindrance rather than enabler by most. Does not meet stakeholder expectations.</td>
</tr>
<tr>
<td>Intranet and Extranet</td>
<td>Effective communication, consultation, sharing of information throughout company. Access to relevant information project information, regardless of locations, for both internal and external members of the project</td>
<td>Not in use although is in place. No priority or understanding of its usage and importance. Requires awareness and increased implementation.</td>
</tr>
<tr>
<td>Company Website</td>
<td>Provision of information on company and current projects, for staff, potential customers and any interested parties</td>
<td>Yes but not updated, nor importance given to as a method of communication to external stakeholders.</td>
</tr>
</tbody>
</table>

Figure A5 Technology

Many variations of knowledge management practices were found, the following are the key recommendations of this report, which would be appropriate to address the organizations current knowledge inefficiencies.
1. Each project adds to the long-term strategy of improvement. A manner in which to identify improvement enables the organization to learn from experience. As part of the project management controls project review must be undertaken. This project review can take the form of learning during and after actions and project closure.

After action reviews can be undertaken after any significant task or phase during the project. These reviews are focussed meetings whereby discussion takes place regarding what was supposed to happen, what actually happened based on fact, why a difference occurred (if it did) and the lessons learnt.

After action reviews can be used to record small tasks or large. The importance is that learning takes place, which can then be transferred within the project or to the next project.

After action reviews originated from the US Army and are a proven method of capturing lessons and actions. The illustration below gives a sample form for capturing the knowledge. This form can be an A4 sheet of paper stored in the knowledge database.

<table>
<thead>
<tr>
<th>What was supposed to happen</th>
<th>What actually happened</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Why was there a difference</th>
<th>What have we learned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure A6 AAR Form

At the end of each project a method for learning after the project should be integrated into the project management process. One way of doing this is for one person either the project co-ordinator or the project manager to report back on what was achieved. Alternatively and the recommendation is for a holistic approach would involve the team discussing lessons learnt. This follows on from the post project review and will ask how we can avoid the problems in the future, how can future projects benefit from good and bad lessons learnt from this project. Retrospect’s may be held at the end of each major phase of the project in order to learn during the project, and to apply to other projects at different stages. Retrospect’s can aid in reviewing business processes and should be considered within improvement plans. Where there is a history of team disbandment and personnel leaving before the end of the project then interviews can take place with individuals and then put together to
gain common themes. The inclusion of as many stakeholders as possible should be the aim in order to generate a full review.

2. Idea management is the collection and development of ideas that can deliver value to the organization. Ideas can be based on individual experience and knowledge and thus should be captured. Knowledge management aids idea management by sharing ideas and providing ways of collecting and evaluating ideas and suggestions. Ideas should be collected and reviewed to ascertain whether they can generate results or changes in processes.

3. The implementation of a lessons learnt log that is made available to all personnel. This log should be updated regularly throughout the project phases. A lessons learnt log is illustrated below. This log could be kept project specific and then at the end of the project amalgamated into the organization knowledge database.

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Lesson Learnt</th>
<th>Action</th>
<th>Responsibility or Owner</th>
<th>Process Update</th>
</tr>
</thead>
</table>

Figure A7 Lessons Learnt Log

Lessons can be applied when considering for example new contracts as part of contract review and for application in risk management. Lessons learnt need to be actionable lessons rather than statements of what went wrong or what was a success. Project activity creates lessons learned which are then reviewed and applied. As they are applied, they are refined and can be adopted as business processes and procedures.

The illustration below demonstrates the cycle of learning:

Figure A8 Knowledge Reuse Cycle

The lessons learnt logs should be kept in an area where they are accessible by as many as possible for example; the organization intranet would enable ease of access.
4. Organization and project roles should be clearly defined. Job descriptions should be defined for all project and organization roles. This information should be communicated to all. This increases visibility of personnel and structure of responsibility. Organization and project charts can help to communicate the structure of the project and organization.

5. Communication of news to be implemented via newsletter. The advantage of a newsletter either paper or electronic is to offer a method to communicate regularly with personnel and create an atmosphere of cohesion despite geographical location. The newsletter can broadcast that organizational procedures are in place and provide the necessary awareness of the benefits of knowledge sharing. Some personnel are likely to gain motivation and satisfaction by inclusion in the newsletter and recognition of activities. Team working can also be rewarded in this way.

6. Project management integration should be increased. Project methodology should be followed on each project and the methodology should be communicated so that an understanding of phases and protocols is in place. If there is no standard methodology used then this area should be reviewed with the aim of adopting a standard organization project methodology that would ensure consistency across projects with set authorisation levels and responsibilities. All project managers would be trained to this methodology. By following a project methodology this would clarify authority levels and establish roles and responsibilities that are clear throughout the organization.

7. Business processes should be developed and adopted regardless of location. Agreement should be reached as to local business processes and these should be adopted by the project. Clear definitions will help to relieve ambiguity. Current Integrated Management System (IMS) improvements should be agreed upon at Director level across the group and mandated for project work.

8. Knowledge management processes should be seamless and integrated into business processes so that they are part of day-to-day activities. Knowledge management then becomes “the way we work” rather than extra workload.

9. Employ regional engineering or knowledge managers or similar in a position where knowledge transfer and project coordination can be improved by improving support between sites and head offices. Knowledge managers (or another title to suit) are responsible for knowledge, lessons learnt and facilitating review meetings. As part of this role, they would ensure consistency and coordination between individuals, departments, teams and projects.

10. Increase the awareness of knowledge management via communication of the benefits of knowledge sharing and learning for both individual, project and organization.
11. Tacit knowledge of personnel whether contract or staff is at risk of leaving the organization. By performing knowledge interviews with key members of staff, the expertise of these staff can be mapped out and knowledge transfer plans created. The process of knowledge interviews and knowledge profiles will result in learning and knowledge transfer to the organization and to other individuals involved in the process. In this manner the risk of knowledge can be ascertained and plans can be made for knowledge transfer and learning.

12. Checklists from the knowledge interviews can be created from areas that personnel currently perform tacitly. This can then be made explicit and formalised, reviewed and adopted as procedure. In this manner new entrants do not have to recreate working methods where previously the tacit knowledge of the individual was used.

13. Following on from knowledge interviews are exit interviews in order to ascertain personnel views and knowledge that may not have been gained from the initial knowledge interview. This would enable knowledge to be captured before it leaves the organization.

Many of the above recommendations are ones that can be implemented in a short manner of time. Where possible the creation of a small centralized knowledge management team focussed on tool maintenance, community and cultural development and communication of knowledge management would be of benefit for coordinating knowledge activities. The programme of knowledge capture and transfer starts at the tendering stage and continues to handover. For the organization knowledge capture and transfer is a continuous cycle.

Of special interest to the project environment are the project review reports. This type of report generates knowledge assets and enables learning to take place, which can be used on future projects. Considering that the organization is a project based environment this type of report should be mandatory as part of the project management process.

The end project report for instance gives detail as to whether the project has performed against planned cost and schedule. The report describes the impact of approved changes, and the quality of work carried out. The report should contain a summary of achievements, any changes that were approved and their effect on the project plan, an analysis of change issues and the overall effect of changes to the plan and costs.

Post Project reviews including lessons learned workshops and post decision reviews can be implemented in order to understand in detail why specific projects were more successful than others. Increasing knowledge visibility enables knowledge to become embedded in reflection practices and transfer to future projects.

Risk management is an area that is dependent on knowledge management. Knowledge management processes can help risk assessments and contingency planning. Knowledge management can enhance processes by ensuring widespread knowledge
and integration of business processes, this ensures that risks are considered and processes are incorporated that manage risk.

This executive summary has acknowledged that knowledge management is crucial to the improvement of the organization. It has highlighted that there are areas that the organization would do well to improve on and that knowledge management can help to develop the principles that are required. Activities have been suggested whereby the organization can take its first steps to achieving knowledge efficiency.

A detailed report is available which takes the form of the thesis.
Appendix B: The Organization – historical and cultural context

A. Introduction

The organization is a group of companies operating worldwide in the fields of process engineering and plant construction. The organization primary function is the build and supply of turnkey plants, the UK organization is one such subsidiary. The business is generally characterised by large individual order volumes, an international orientation, long-term planning, long project terms and complex contractual and financing arrangements. The risks involved in large-scale projects lie principally in:

- The fact that the prevailing market conditions and circumstances may change during the course of the project.
- The application of the process technology needs to meet stringent performance obligations set out in the contract.
- The project has to be completed in a timely manner or penalties will apply.
- The work of all participating companies has to be dovetailed together so that each party meets its own contractual obligations.

The UK subsidiary was incorporated in 1964. The decision was prompted by the recognition of the growing importance of the UK as a centre for the engineering contracting industry, as well as for international contract financing, coupled with the expanding role of the organization as a major international process engineering contractor.

The UK subsidiary has one main office, the organization moved to their present offices after originally being incorporated in the City of London.

Historically from 1995, documents show the organization to have been very busy with the award of major contracts for sewage sludge incineration and Offgas Incineration plants, which reinforced the organizations position in the market. The Task force concept was adopted at this point and with the award of two sewage sludge incineration contracts in London this meant the enlarging of the engineering office with the addition of floor space and personnel in the main office.

The beginning of 1998 was marked by a medium term development of the structure of the parent organization enhanced by the consolidation of the parent company in with Strategic Business Units (SBUs) and in particular, the focused approach and support for the UK market of the Thermal Treatment and Municipal Waste Treatment SBUs.

The highlights of 1998 included the completion of the London Sludge Incineration contracts and the opening of the plants by the Duke of Edinburgh.

By the end of 1999 the parent company had reorganised again and the parent company had acquired its sister organization in order to pursue opportunities in other markets. This year also introduced a change of Managing Director after 13 years and the introduction of a new management structure in the UK.
The securing of another sludge incinerator contract supplemented the award of the complete refurbishment of a municipal waste incinerator with a waste to energy plant.

Markets remained competitive in 2000 and the Life Sciences markets were pursued in both the UK and Ireland. The year 2000 also saw restructuring of the parent businesses and the shift of the UK to a new part of the group focussed on the Energy and Environment market segments.

The following year saw the completion of a number of contracts. The parent company continued to centralise its corporate activities along with the new business units.

The whole of 2002 presented a continued economic downturn in business across the business. This was demonstrated by an initial decision by the Group not to award general increases in remuneration. This was heavily felt in the UK where it was argued that staff morale and general costs of living should be considered.

The downtrend in business continued and both the UK and German organizations went through a process of business reorganization resulting in many staff leaving or being offered redundancy. Floor space at in the UK decreased to reflect the number of staff now employed. It was viewed that at this point a lot of knowledge left the company both in the UK and in Germany.

The start of 2006 presented significant developments, first with the start of the two major Flue Gas Desulphurization (FGD) contracts and then a name change for the company. The name change reflected the global branding strategy of the ultimate parent company for its plant engineering sector with a view to sell this part of the business in the near future. This announcement came in tandem with the UK signing a third contract for another FGD with the continued guarantee of the ultimate parent company.

The sale of the plant-engineering sector has both been seen as a vehicle for change and an opportunity for the company to embrace collaborated working with many discussions taking place as to how best to consolidate knowledge and share with the new owners.

A decision on the sale is due to be made in December 2007 by the anti-trust authorities.

How the company is organized

The UK business is organised as a project-centred organization. Each department head is responsible for one or more functional areas supporting project managers and site teams. Both contractors and permanent staff are employed in positions of responsibility with most contractors having been in the employment of the company for 5 or 10 plus years.

Salaries (for permanent staff) and hourly/daily rates (for contractors) are fixed and depends on skill, ability and scope of responsibilities. There are end of year bonuses and special bonuses based on performance during the year.
There is no limit to mobility between job roles, and one's job does not necessarily correspond to any kind of reporting structure. All managers tend to coordinate particular functional areas and serve as mini project leaders, reporting directly to the Managing Director. Depending on the nature of their work, some may spend 100% on functional tasks (i.e., secretarial support, IT, accounts), others 100% on project work.

Most work combines the two; the distribution is not necessarily tied to a particular role. The company is ideologically committed to a flat, open organization, these elements of structure represent the need for clear responsibilities for functional and project work. The structure is still far more fluid than traditional hierarchies are, as people may be shifted around based on project needs, and report to multiple individuals.

The UK business subcontracts work to subcontractor companies for project work to provide technical and site labour. The UK business is the main contractor for projects in the UK and subcontracts back to the parent company. The UK business remains contractually liable to the client and the contract is signed between the UK and the client.

The technical and process expertise is generally centralised in the German offices, while the UK provides the local marketing skills and services to secure the contracts following on with project management systems, detailed engineering, procurement skills, health and safety, and site supervision to execute the project in accordance with local regulations and conditions. However, in recent years, this has slowly reduced to construction site management, health and safety, accounting and IT support services, the design, engineering and procurement being handled now by the German office.

The UK, together with the relevant German department, progress the contract from the initial process definition stage through to turnkey completion, gaining the maximum benefits from their respective expertise and skills. Before the restructuring, the basic engineering had been carried out in the German head office, followed by detailed engineering in either the UK office or at a Task Force office near the client.

The diagram in Figure 16. shows a typical contract process experienced by the organization. The diagram illustrates the process from first initial client enquiry to the ultimate handover:

This complex process clearly needs a great deal of collaboration between all parties concerned and reuse of information. It can be said that 80% of the knowledge in an organization is tacit (Leonard-Barton, 1998). A personalisation strategy focuses on linking the source of tacit knowledge. One study (Hansen, Nohria and Tierney, 1999) found that most organizations had a mix of systems to accommodate both explicit and tacit knowledge. Companies that provide highly customised solutions, as is the case within this industry normally adopt personalisation strategies.

At every point of the process, there is scope for knowledge creation, learning and transfer to the next stage.
Collaboration tools

Information technologies have been implemented to facilitate various modes of work. These include technologies such as standard word processing and spreadsheet applications, presentation tools, and graphics packages. They also include groupware technologies such as Lotus Notes and Docma, which were unfamiliar to most users, and which require not only new technical skills but the development of new ways of working. Technologies such as shared Notes databases and a calendaring/scheduling tool support asynchronous group work; but up to very recently (May 2006) have not been used within either the UK or the parent company. Use is still limited to the project team and not support functions of the team, project team members are confused as to how to use the software, as training has not been made available to users. Issues of system response and functionality have been raised by users, with some users stating that they only read entries and often do not have the time to deposit information into the Docma system. Desktop conferencing also has limited usage, although efforts are being made to widen the usage of this facility with the installation of conferencing equipment and webcams to allow video linkages across multiple sites. However, the culture of the organization favours telephone meetings or face-to-face physical meetings. In spite of initial reservations and the problems associated with the actual software most users accept

The use of 3D plant design software had been implemented and driven by the UK and the benefits for knowledge sharing and design advantages had been reviewed and accepted by both UK and German counter parts in the engineering departments of the parent company however in spite this recognition the use of 3d plant design and review was not championed and the decision to use 2D was mandated. Design review software is now based on an ad hoc project manager basis, thus there exists no conformity over the use of the tool.

The use of Lotus Notes mail for interpersonal communication, to share memos and spreadsheets, to keep people "in the loop," and to document activities or decisions is regular. All employees and contractors have access to Notes and users regularly submit reports electronically. People tend to use Notes as an audit trail often using the return receipt as confirmation that a point has been made and taken. A lot of information that should be stored in the project Docma storage area is stored in individual mailboxes until the user has the time to populate Docma. Quite often, this does not take place as the user will leave the company or move onto another project.

The ability to access mail anywhere, any time, via the network remote client supports a distributed, travel-oriented organization, with dispersed project teams.

The various Docma databases should encompass routine and non-routine work, and should form a kind of glue that holds different groups together. Docma is designed to keep people up-to-date on project activities and give them an on-going overview of the work of the organization, facilitating horizontal and lateral communication.

In terms of representing work, however, it is not equally effective from everyone's perspective. Contributions through routine work (such as financial reporting or information systems or administrative functions) and support work (such as answering technical questions or making sure a meeting goes smoothly) are not easily reflected
in Docma. Support functions do not necessarily have authorisation to access Docma. The use of the system is further hindered by restricted use amongst the project team members itself with not all project team members having access to the system.

Finally, some people find it hard to understand the use of Docma and find it slow and irritating to upload e-mails that they receive out of the Docma system, this is amplified by the field and message presentation of Docma in the German language in spite the language of the contract agreed as English. The following two quotes illustrate the tensions with the system:

“I need a cost code just to upload my e-mails to Docma – and if I don’t then there is no record and people will not act upon information” (engineer).

“it is very restrictive, e-mails are sent to me in Docma but I am not allowed access by the project managers, how can this be ? – how am I supposed to act on information or even be aware, if I have to rely on other personnel informally saying to me “hey, you have a document in docma, do you want me to print it out?” - really makes no sense does it?”

While many face-to-face meetings still occur, and people's work lives are characterized by heavy travel, this technology is being implemented to enable meetings in situations where it would not be cost- or time-effective to bring all the participants together in one location. Germany makes use of the conferencing system and the UK has now implemented a system, which is aimed to be used between sites and the main offices in the UK and Germany.

A major benefit of this technology is that it will extend participation in important business events. Enabling the UK and its staff, contractors, suppliers and members of the Parent company to attend meetings whose content relates to their own work, but in which they may not have been included if travel had been required. The ability to attend these reviews is especially valued by people who due to travel restrictions placed upon them may not necessarily have the option to attend these kinds of discussions. This is assuming that the use of the conferencing system is recognised when these informational meetings take place.

Both German and UK personnel are highly motivated, and hard working. They continue to build their formal educational backgrounds through conferences and user group meetings, on-going professional programs, and journals. They seek out career opportunities that will offer them new challenges. Personnel can be said to be knowledge workers in that they take responsibilities for their actions and adapt to situations.

However, time for reflection, self-improvement and benchmark learning is not company time and learning is an individual activity managed by the individual rather than the company. There is no known training or development program for personnel nor review of performance in the company. Additionally few people outside of the IT functions across the UK and the Parent company come with a lot of experience in using computers or collaboration tools. While many were familiar with basic PC applications and a few had years of experience this was not in up to date practices on computers. Despite training and extensive user guides, many feel that they do not
fully understand all of the technologies available to them either in the UK or in the German office, nor have the time to learn the software. They feel overwhelmed by the number of new applications, the changing technical environment, and the need to balance technical learning with learning other aspects of the job. This has a knock on effect on the use of collaborative software – users neither understand the use of the software or the methods behind the use.

All users have access to email, spreadsheets, word processing package, and a set of databases. Some of these applications are extremely malleable and lend themselves to tailoring for specific needs. Some are tailored to the groups own needs resulting in differing tools throughout the company. This stands true for the procedures followed on individual projects, which are tailored to suit the project team in place. This results in inconsistencies in information availability and understanding.

A. Why Knowledge Management in project teams?

The fast moving, complex environment of the construction project team is an ideal one in which to explore the use of knowledge management within project relationships and project success.

Construction project teams and support/ administrative teams can be viewed as functional “communities of practice” (Wenger, 1998). Members of the project team and the site team are drawn from employee bases in Germany and the UK, subcontractors, and contractors.

They provide services in various collective configurations to project clients, staff, colleagues and to the parent company in identifiable terms within specific project or overhead capacity.

The subsidiary is at the heart of each project. This private limited business may be viewed as a knowledge-intensive firm and as a professional service firm (Alvesson 2004) given the professional partnership structure and their status as independent contractors. The other members of the team include a range of ‘attached’ subcontractors and support workers. Their employing organizations incorporate different organizational models, incorporating diverse structures, cultures and accountability frameworks. In this environment projects progress through a succession of stages from concept to completion.

The projects have the following characteristics:

- Are the construction of sludge incineration awarded by UK water companies together with major municipal waste incineration contracts using conventional grate and fluid bed technologies OR are flue gas desulphurisation systems on coal fired boilers.
- Are on a turnkey basis
- Consist of team members from the parent organization in Germany and the subsidiary company in the UK
- Members of the project can be based in Germany, UK site or UK head office locations
- Most members of the project team have worked before on similar projects
Initially feasibility studies consider technical and logistic questions. If these initial studies indicate that it would be effective to proceed with the project, and assuming that finance has been arranged, work proceeds to the planning stage. The planning stage contains the details such as the scope of the project, the project plan, the site, the characteristics of the production process, the plant layout and studies of the possible traffic problems and environmental impacts.

Plant design involves the analysis of the process flows and the production of specifications from which the detailed specification of the plant and equipment are derived. These entail preparation of a large number of engineering drawings of the plant itself, and the site infrastructure. The procurement stage covers the preparation and issue of bid documents (accompanied by the drawings and specifications), the evaluation and analysis of bids received, the placing of orders, expediting and co-ordinating delivery and supervising quality control.

The preparation of the site, health and safety plans, erection of the buildings and installation of plant requires skills in the organization and management of a large labour force and in co-ordinating a number of sub-contractors. Once the plant is installed, each unit must be tested separately to see that it conforms to the performance characteristics specified in the contract document. Commissioning involves the operation of the plant as a whole, or large sections of it, and includes the preparation of operating and maintenance routines and instructions, and often the training of operators.
Appendix C: Consent letter from organization for document analysis

20th January 2006

Mrs. Georgette Banham,

Dear Mrs. Banham,

This letter constitutes the Company’s approval for you to carry out research using the Company’s general project documents as part of your Doctorate in Business Administration. As part of the research, it is understood that questionnaires and/or interviews will be carried out after the analysis of documents. Approval for these questionnaires/interviews will be given once personnel are named and the questionnaire/interview guides have been agreed.

The draft and final thesis submission should be made available to the Company before final submission to the examiners.

The Company acknowledges that, with regard to ethical issues, the University guidelines will be adhered to by both the University and yourself.

Yours faithfully,

for (removed: company name)

(removed: name)
(removed: job title)
Appendix D: Information memo sent prior to questionnaire distribution

Memo sent in form of e-mail 14/07/2006 13:42

From: Managing Director UK
To: Engineering Director, Engineering Manager GmbH
CC: Personnel Manager GmbH, Georgette Banham

Subject: Knowledge Management Questionnaire

Gentlemen,

Georgette Banham, our IT Manager, has for the past couple of years been carrying out a Doctorate in Business Administration at Surrey University on a part-time basis. The culmination of this Doctorate is a thesis she has to prepare on knowledge management using the company as a case study. Part of the exercise she needs to carry out is to survey personnel within the organization as to the extent of knowledge management encountered within their day-to-day work activities. Responses to the survey are essential for Georgette to produce a meaningful thesis and I am convinced that her thesis will provide some useful feedback to the organization in relation to knowledge management issues.

Completion of the questionnaire should take no more than 15 minutes and I would ask you to support this exercise by ensuring that the personnel within your departments complete the questionnaire. Attached is a list of the personnel to whom the questionnaire is being issued. These are principally the people that, in recent years, have worked on U.K. projects but if you have any further people that are not on the list who you think should complete the questionnaire, then please ask them to do so.

The questionnaire is web-based and instructions to each individual will be issued during the course of next week.

Regards

Managing Director
Appendix E: Main Questionnaire (administered online)

Your participation in this study is completely voluntary. Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential. If you have questions at any time about the survey or the procedures, you may contact Georgette Banham at georgette_banham@lentjes.de. Thank you very much for your time and support. Please start with the survey now by clicking on the Continue button below.

First Name

Second Name

Please choose which organisation you are associated with

- Lentjes GmbH
- Lentjes UK Limited

Your gender?

- Male
- Female

What is your job title?

How many years have you worked with this company?

Please contact georgette_banham@lentjes.de if you have any questions regarding this survey.
How many engineering construction projects have you worked on with this company?

Have you worked in a construction site environment during any of your project time with this company?
- Yes
- No

Do you have planned time for reflection on the work you do on projects?
- Yes
- No

If you answered yes to the last question roughly how much time do you have for reflection on projects in hours per month?

Please choose whether the hours you stated in the above question relate to:
- A regular basis throughout the project
- At the end of the project
- Both of the above options
- Not applicable

Please contact georgette_banham@lentjes.de if you have any questions regarding this survey.
Do you have planned time to share thoughts with other team members?
- Yes
- No

If you answered yes to the last question roughly how much time in hours per month is spent on this?

Please choose whether the hours you stated in the above question relate to:
- A regular basis throughout the project
- At the end of the project
- Both of the above options
- Not applicable

Which knowledge management practices do you use?
- Before project review
- During project review
- After action project review
- Networking
- Yellow pages
- Intranet
- Communities of Practice
- Sharing of best practices
- Document Management Systems
- Collaboration Tools
- Peer Assist
- Knowledge Centres
- Other ______

Please contact georgette_banham@lentjes.de if you have any questions regarding this survey.
Do you think that there should be formal time allocated for reflection (project knowledge review) activities?

☐ Yes
☐ No

Do you think that the Lentjes Group should amend project review procedures to ensure discussion and capture of knowledge?

☐ Yes
☐ No
☐ Procedures already ensure this

Do you think that best practices should be made available to ALL staff via some form of communication (e.g. over the IT network or via forums)?

☐ Yes
☐ No

Which of the following groups is responsible for the knowledge management practices in use in the organisation?

☐ Human Resources
☐ Information Technology
☐ Knowledge Management Unit
☐ Project Team
☐ Individuals
☐ Research Department
☐ Don't know

Effective knowledge management requires a holistic approach which considers the different aspects of knowledge management. Please indicate your feelings to the following statements.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

Please contact georgette_banharn@lentjes.de if you have any questions regarding this survey.
| There should be access to appropriate resources for all those that need it |
| There should be processes for capture and management of tacit knowledge |
| There must be appropriate communication mechanisms that enable knowledge sharing |
| Organisational culture and individual attitudes should enable and not hinder knowledge sharing |
| There should be records management systems that enable knowledge sharing |

Generally, to what extent do you personally agree or disagree that the following factors are important to project success:

| Good cooperation between members of the Lentjes Group | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| Good cooperation between project members | | | | | |
| Good cooperation between project members and others (e.g. subcontractors) | | | | | |
| Clear roles and responsibilities | | | | | |
| Strict change control/request procedures | | | | | |
| Clear and concise contractual terms for all | | | | | |
| Appropriate project procurement | | | | | |

Please contact georgette_banham@lentjes.de if you have any questions regarding this survey.
<table>
<thead>
<tr>
<th>systems</th>
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</thead>
<tbody>
<tr>
<td>Appropriate project review systems</td>
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<tr>
<td>Ongoing project reflection systems</td>
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<tr>
<td>Good project organisation</td>
</tr>
<tr>
<td>Clear project communication</td>
</tr>
<tr>
<td>Timely, valuable information from different parties</td>
</tr>
<tr>
<td>Accurate initial cost estimates</td>
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<tr>
<td>Emphasis on past experience</td>
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**In terms of meeting stipulated project budgets to what extent do you agree or disagree that:**

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>One or more success factors in 21 is 100% vital</td>
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**In terms of meeting stipulated project quality, to what extent do you agree or disagree that:**

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<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>One or more success factors listed above in 21 is 100% vital</td>
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</table>

**In terms of meeting stipulated project timings, to what extent do you agree or disagree that:**

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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</thead>
<tbody>
<tr>
<td>One or more success factors in 21 is 100% vital</td>
<td></td>
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</tbody>
</table>

Please contact georgette_banham@lentjes.de if you have any questions regarding this survey.
Thinking generally about the level of cooperation among colleagues in your own organisation when working on projects, to what extent do you agree or disagree that they:

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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</thead>
<tbody>
<tr>
<td>Are keen to help each other achieve project goals</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mutually collaborate with each other</td>
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<tr>
<td>Willfully contribute useful opinions to each other</td>
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<tr>
<td>Actively assist each other in solving difficult problems</td>
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<tr>
<td>Are cooperative with each other</td>
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</table>

This time, thinking about the level of cooperation between your own organisation and other firms working on projects, to what extent do you agree or disagree that our own organisations colleagues:

<table>
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<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are keen to help other firms achieve project goals</td>
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<tr>
<td>Mutually collaborate with other firms</td>
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<td>Willfully contribute useful opinions to other firms</td>
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<tr>
<td>Actively assist other firms in solving difficult problems</td>
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<tr>
<td>Are cooperative with other firms</td>
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</table>

How effectively do you rate the following aspects within the project environment?

Please contact georgette_banham@lentjes.de if you have any questions regarding this survey.
<table>
<thead>
<tr>
<th>Not Effective</th>
<th>Fairly Effective</th>
<th>Effective</th>
<th>Very Effective</th>
<th>Extremely Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication of project issues in your most recent project</td>
<td></td>
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<tr>
<td>Issue management on this project</td>
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<tr>
<td>Resolving of issues before escalation to the next management level was necessary</td>
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<tr>
<td>Resolving of issues if escalation was required</td>
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<tr>
<td>Issues able to be resolved without affecting the project schedule or budget</td>
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<tr>
<td>The organisation structure that was established</td>
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<tr>
<td>The understanding by the project team of their specific roles and responsibilities</td>
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<tr>
<td>How well your expectations were met regarding the extent of your role involvement in the project</td>
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<tr>
<td>Practices that provide high quality results identified in order that they are adopted as best practice</td>
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</tbody>
</table>

Do you have any comments that you would like to add?

Please contact georgette_banham@lentjes.de if you have any questions regarding this survey.

Thank you very much for your time.
Appendix F: Consent Form

September 2006

Project title:
The challenge of knowledge management: improving knowledge retention and use in the constant change of construction project team environments

Interview Consent Form

I have read the information sheet on the research project above which is to be conducted by Georgette Banham and all queries have been answered to my satisfaction.

I agree to voluntarily participate in this research and give my consent freely. I understand that the project will be conducted in accordance with the Information Sheet.

I understand I can withdraw from the project at any time, without penalty, and do not have to give any reason for withdrawing.

I consent to:

- Participate in an interview that will take approximately 30 minutes by either telephone or face to face contact (whichever is the easier).
- The note taking and/or recording of my contribution to the interview.

I understand that all information collected will remain confidential to the researcher. My identity will not be revealed without consent to anyone other than the investigator conducting the project.

Print Name: ____________________________________________

Signature: _____________________________________________

Date: ____________________________
Appendix G: Interview Guideline

Section 1: Establishing Rapport

Thank you for completing the questionnaire that was sent to you. Would you mind a short interview of say 20 to 30 minutes to follow up some issues in order to improve our knowledge management within the company? This will not be recorded and is anonymous; however, I will be note taking.

I would like to improve the interviews so I would appreciate any feedback or suggestions on how to improve the format for future interviews.

Thanks again for making yourself and the time available.

Section 2: Open Ended Questions

Descriptive/ Linear Questions
1. Could you tell me if you have any written policies or guidelines that you follow for your work?

Narrative:
2. Can you tell me how these are stored?

Structural
3. Do you know who else uses this information/ what are the stages involved using this information?

Contrast:
4. Can you tell me if any lessons learned/ good practice from other projects were applied to this project

Prompt/ Probes:
5. Can you tell me a bit more about that?

Evaluative:
6. How do you feel about the response to the questionnaire whereby 90% said that formal time should be allocated for reflection activities

7. How do you feel about the procedures in place to ensure discussion and capture of knowledge

8. How do you feel about finding information and prompt / probe.

9. What have been/ are the challenges you and the project struggled with the most (critical incident from a negative point of view) – can you tell me a bit more

10. What were successful incidents – can you tell me a bit more
11. If you were to think about a successful project what techniques would be good to use again

12. Based on your experience at what point during a project do you think it is most useful for project reflection

13. What do you think about our successes and failures – do we talk about them enough to consider what we do right or wrong?

Section 3: End

Thank you for your time, you have been great and I really appreciate the information you have given. Are there any questions you think I should add, or changes you think will improve the interview? Would you mind if I contacted you again to clarify any answers and to enable validation of mind maps that are produced.
## Appendix H: Document Analysis Summary Sheet Example

<table>
<thead>
<tr>
<th>Number</th>
<th>Internal/External</th>
<th>Salient Points</th>
<th>Significance</th>
<th>Themes/Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Internal</td>
<td>Underestimation of secretary hours - transfer of funds to cover</td>
<td>Contract control job transfers and changes to forecasts</td>
<td>Coordination between UK and GmbH</td>
</tr>
<tr>
<td>15</td>
<td>External</td>
<td>Contribution to liquidated damages sought Contractor A</td>
<td>Delays caused to project</td>
<td>Lack of cooperation other subcontractors</td>
</tr>
<tr>
<td>16</td>
<td>External</td>
<td>Application of extension of time to Contractor B</td>
<td>Claimed additional cost of site establishment and cost as a result of contract delays</td>
<td>Coordination between UK and GmbH</td>
</tr>
<tr>
<td>17</td>
<td>External</td>
<td>Claim for costs by Contractor C</td>
<td>Rejection and explanation of claimed costs</td>
<td>Cooperation with subcontractors</td>
</tr>
<tr>
<td>18</td>
<td>Internal</td>
<td>No follow up of requests</td>
<td>Request for reply as to evidence of costing</td>
<td>Poor cooperation with colleagues</td>
</tr>
<tr>
<td>19</td>
<td>Internal</td>
<td>No knowledge of operating procedure</td>
<td>Documentation Storage</td>
<td>Difficulties with finding documents</td>
</tr>
<tr>
<td>20</td>
<td>Internal</td>
<td>No knowledge of operating procedure</td>
<td>Training required</td>
<td>No training given</td>
</tr>
<tr>
<td>21</td>
<td>Internal</td>
<td>Request for information</td>
<td>Information Management</td>
<td>Lack of information</td>
</tr>
<tr>
<td>22</td>
<td>External</td>
<td>Changes to instruction</td>
<td>Information Management</td>
<td>Out of date information</td>
</tr>
<tr>
<td>23</td>
<td>External</td>
<td>Disagreement over decisions made</td>
<td>Technical and Project Review</td>
<td>Collaboration / Communication</td>
</tr>
<tr>
<td>24</td>
<td>Internal</td>
<td>Request for detail as to why a decision made</td>
<td>Technical and Project Review</td>
<td>Collaboration / Communication</td>
</tr>
<tr>
<td>25</td>
<td>External</td>
<td>Reply to letter, query over source of internal information</td>
<td>Technical and Project Decisions</td>
<td>Miscommunication</td>
</tr>
<tr>
<td>26</td>
<td>External</td>
<td>Author felt as if letter was patronising</td>
<td>Technical and Project Decisions</td>
<td>Conflict</td>
</tr>
<tr>
<td>27</td>
<td>External</td>
<td>Assumptions made incorrect</td>
<td>Technical and Project Decisions</td>
<td>Collaboration / Communication</td>
</tr>
</tbody>
</table>