KNOWLEDGE CREATION, INTEGRATION AND MANAGEMENT – A STUDY OF CIVIL ENGINEERING CONSULTING FIRMS

By

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A Thesis submitted to the University of Zambia in fulfilment of the requirements for the Degree of Doctor of Philosophy in Construction Management

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Signature **Date**

CERTIFICATE OF APPROVAL

This thesis of **Chabota Kaliba** has been approved as fulfilling the requirements for the award of the **Doctor of Philosophy** Degree in **Construction Management** by the University of Zambia

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ABSTRACT

Knowledge has been recognised as a resource that is critical to any organisation's survival and success in the globalised market. This is even more critical for civil engineering consulting firms because they are knowledge centric and their products are all knowledge-based. The desirability of Knowledge Creation, Integration and Management is however varied among different firms.

The research was aimed at developing a model which could be used to establish the organisation's performance with regards to Knowledge Creation, Knowledge Integration, and Knowledge Management based on the internal level of desirability. The study was set out to: establish the level of Knowledge Creation, Integration and Management awareness within the Zambian civil engineering consulting industry; identify key indicators of Knowledge Creation, Integration and Management in firms based on Zambian and international surveys; deduce the desirability of Knowledge Creation, Integration and Management within civil engineering consulting firms; develop and validate the Knowledge Creation, Integration and Management Evaluation Model ($CIMEM_k$); and prescribe possible uses and operations of the $CIMEM_k$.

The multi- paradigmatic position was adopted. Epistemologically, the research was objectivist. It was also positivist in paradigm. Ontologically, the research was parmenidean and realist. Using a detailed literature review, structured interviews and questionnaire surveys, the results of the study established that the level of awareness of Knowledge Creation, Integration and Management practices within the Zambian civil engineering consulting industry was fairly low. The key indicators of Knowledge Creation, Knowledge Integration and Knowledge Management were also established. The study established a total of 27 key indicators. The desirability was established as a function of the organisation's turnover and employee base. It was noted that Knowledge Creation and Knowledge Integration were highly desirable for small and medium sized enterprises while the desirability for Knowledge Management was high in medium to large sized firms within the civil engineering consulting industry.

Based on the key indicators and desirabilities for Knowledge Creation, Knowledge Integration and Knowledge Management, the $CIMEM_k$ was formulated. The $CIMEM_k$ utilised the firms' Knowledge Creation, Knowledge Integration and Knowledge Management scores combined with their respective desirability to produce the performance indices.

The $CIMEM_k$ was pretested and assessed for its functionality, validity as well as usefulness. Both Zambian and international civil engineering consulting firms upheld the functionality, validity and usefulness of the model. It was deduced that the $CIMEM_k$ would help enhance the competitiveness of civil engineering consulting firms by focusing on the areas that required improvement. The use of $CIMEM_k$ is however limited to internal performance measurement.

Keywords: Knowledge Creation, Knowledge Integration, Knowledge Management, civil engineering, consulting firms.

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List of Acronyms

$CIMEM_k$	Knowledge Creation, Integration and Management Evaluation Model
CuKPI	Current Knowledge Performance Index
KCI	Knowledge Creation Index
KCIM	Knowledge Creation, Integration and Management
KII	Knowledge Integration Index
KM	Knowledge Management
KMI	Knowledge Management Index
PoKPI	Potential Knowledge Performance Indicator
SECI	Socialisation, Externalisation, Combination, and Internalisation

CHAPTER 1: INTRODUCTION

1.1 Background

There are significant challenges facing today's civil engineering industry such as: increasing competition; globalisation of the construction market; demands from clients, customers and society; and the pace of change in Information and Communication Technologies. A further challenge lies in maintaining a highly skilled workforce at all levels from operative and technical, to managerial and professional office (Egbu and Robinson, 2008).

With the move of advanced economies from resource to knowledge-based production, many national governments have increasingly recognised knowledge and innovation as significant driving forces of economic growth, social development, and job creation (OECD, 1999). The world in general and the business community in particular are experiencing a paradigm shift towards knowledge-based organisations and a knowledge- based society (Drucker, 1993). It is widely claimed by a number of business and academic experts that in order for organisations to have a lasting competitive advantage, they would have to be knowledge driven (Drucker, 1993; Nonaka, 2007; Prahalad et al., 1990). Drucker (1993) asserted that the basic economic resource is neither long-term capital nor natural resources, but knowledge. In this context, the promotion of Knowledge Creation, Integration and Management has increasingly become a subject of public and economic policy. If knowledge is viewed as a resource that is critical to an organisation's survival and success in the global market, then like any other resource it demands good management. It is argued that those companies that develop best practices for managing knowledge capital would be the ones that would ride the competitive wave (Snyder et al., 2000). Organisational learning could create possibilities to gain competitive advantages, which involve the ability of a company to perform projects and activities at lower cost and time combined with higher quality of projects than other competitors. This is illustrated in Figure 1-1.

While Knowledge Creation, Integration and Management has value for every type of organisation, it plays a crucial role in professional service firms, where knowledge is a primary driver of competitive advantage and content is the main deliverable. Implemented effectively, Knowledge Creation, Integration and Management helps such organisations put their full institutional resources to work for their clients and ensures that the information gathered and lessons learned in each appointment are retained and made available for efficient future re-use (Carmel, 2009).

In most cases, a professional service appointment is a process rather than a specific event, involving different personnel, resources and skills each step of the way. Accordingly, Knowledge Creation, Integration and Management for professional services requires a holistic approach that applies a variety of disciplines and

technologies to support each stage of the appointment cycle that include the following (Carmel, 2009):

i.) pre-engagement - bringing the collective expertise of the firm to bear in winning new business;
ii.) engagement execution - enabling efficient execution, an especially important consideration as many engagements move to flat-rate pricing;
iii.) engagement close - identifying and extracting valuable knowledge and records from the rest of the content generated over the course of the engagement; and
iv.) post-engagement - ensuring that the knowledge generated in each engagement is retained and made available for re-use.

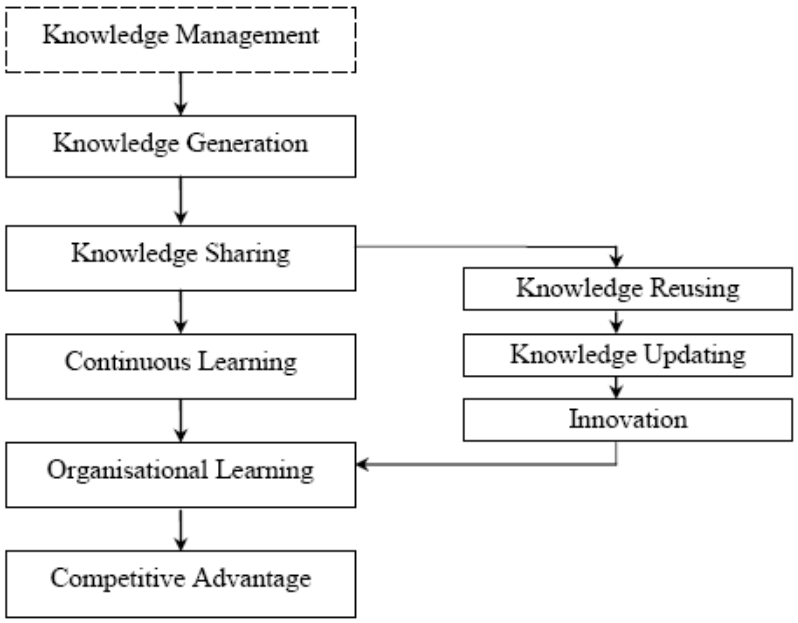

Figure 1-1: Knowledge Management as a means of enhancing competitive advantage

(*After* Ahmad and An, 2008; Li and Gao, 2003)

Although professional service organisations such as law firms, accounting firms, consulting groups and financial service institutions do different work, they share certain common characteristics. Unlike companies that produce or trade in material goods, the deliverables produced by such firms are driven entirely by content and knowledge - legal documents, court filings, accounting reports, consulting findings and so forth (Carmel, 2009). Knowledge is thus a primary source of competitive advantage; customers in specific fields make their selection based largely on a firm's track record, the expertise of its professionals and its ability to bring specialised knowledge and information resources to bear.

1.2 Rationale

One of the key factors of corporate success is the ability to quickly adapt to changing conditions in the environment, innovate continuously and achieve goals. Organisational knowledge provides this capability. More specifically, organisational knowledge provides the capability to understand the market, assess customers' needs and translate them into products and services by integrating various organisational resources. As nations move from the industrial age into the intelligence age, knowledge has become a central force behind the competitive success of firms. In an economy, where everything is uncertain, one sure source of sustaining competitive advantage is knowledge (Nonaka and Takeuchi, 2007). Knowledge has been identified to be a key resource for most firms, hence the need for effective management (Hedgebeth, 2007). Thus, Knowledge Creation, Integration and Management is a critical concern for creating and sustaining any organisation's core competencies.

The civil engineering industry is recognised as being poor in its approach to learning and performance improvement and is notoriously slow in adapting to change (Khosrowshahi and Arayici, 2012). On the other hand, knowledge is said to be the number one source of competitive advantage (Drucker, 1993; Hedgebeth, 2007). As such adoption of Knowledge Creation, Integration and Management practices is imperative for civil engineering consulting firms. There has been increased competition for consultancy services since these services could be sourced from virtually anywhere in the world. The Zambian civil engineering consulting firms, therefore, have to learn quickly and adapt to changes while managing and integrating their existing knowledge if they are to remain competitive within the industry.

Unfortunately, past studies have not exhaustively dealt with the issue of Knowledge Creation, Integration and Management within in professional services firms. The researchers have all had a general assumption that the level of desirability of Knowledge Creation, Knowledge Integration and Knowledge Management would be uniform for all organisation within the strata of large, medium and small enterprises. Measurement approaches for Knowledge Management have been developed by various scholars and could also be classified into deductive-summarising approaches and inductive-analytical approaches. Examples of deductive-summarising approaches are Tobin's Q or Calculated Intangible Value (Faisst and Resatsch, 2004; North et al., 1998), and examples of inductive-analytical approaches are Intellectual Capital (Myers, 2001), Intangible Assets Monitor (Sveiby, 1997), the Balanced Scorecard (Kaplan and Norton, 1996) and the Skandia Navigator (Skyrme and Amidon, 1998). All these approaches do not take into account the desirability of Knowledge Management within a given organisation. Tools to evaluate the organisation's performance with regards to Knowledge Creation, Integration and Management in relation to the level of its desirability are not readily available.

There was therefore need for a more coherent and structured approach for evaluating and monitoring the firms' performance in Knowledge Creation, Integration and

Management with respect to its internal desirability. Not only would such a measurement benefit consulting firms but client bodies who would in turn also have increased confidence on the services procured.

In a bid to close the existing knowledge gap, the study took an integrated approach to performance measurement of Knowledge Creation, Integration and Management within the civil engineering consulting firms. The findings of the research would contribute to the body of knowledge through the development of the Knowledge Creation Integrating and Management Evaluation Model ($CIMEM_k$) for civil engineering consulting firms.

1.3 Research questions

The study sought to answer the following questions:

i.) Are Zambian civil engineering consulting organisations aware of Knowledge Creation, Integration and Management?
ii.) What are the key indicators of Knowledge Creation, Integration and Management within a civil engineering consulting firm?
iii.) What is the desired level of Knowledge Creation, Integration and Management input required for improved performance given the firm's turnover and employee base?

1.4 Objectives of the research

1.4.1 Main objective

The overall objective was to develop a model which could be used to establish the organisation's performance with regards to Knowledge Creation, Integration and Management relative to the firm's own requirements. The model outputs would serve as a basis for encouraging civil engineering consulting firms to work towards enhancing Knowledge Creation, Integration and Management practices which in turn could contribute towards increasing their competitiveness.

1.4.2 Specific objectives

To achieve the main objective, the specific objectives included:

i.) establishing the level of Knowledge Creation, Integration and Management awareness within the Zambian civil engineering consulting industry;

ii.) identifying key indicators of Knowledge Creation, Integration and Management in firms based on Zambian and international consulting firms operating in Africa;
iii.) developing and validating the $CIMEM_k$; and
iv.) prescribing possible uses and operations of the $CIMEM_k$.

1.5 Summary of research methodology

The research took a multi-paradigmatic position. The research was objectivist and positivist in paradigm. The research was also realist because the objective of developing the $CIMEM_k$, with identifiable variables, provides evidence to support generalisations about the performance of civil engineering consulting firms. The methods adopted for this research were both quantitative and qualitative. The use of mixed-methods offered the advantage whereby weaknesses of one method were compensated for by the strengths of others. The theoretical attractiveness of multi-methodology lies in its abilities to enable the handling of problematic situations which require the effective linking of judgement and analysis (Rosenhead, 1997). The research adopted literature review, interviews, questionnaire surveys and case studies as data collection techniques.

1.6 Applications of the research

The study provides a tool that could be used by civil engineering consulting firms to enhance their competitive advantage through the adoption of appropriate Knowledge Creation, Integration and Management practices that match with their own requirements. Using the model, civil engineering firms would be able to see their Knowledge Creation, Integration and Management status compared to where they should actually have been. The findings provide practitioners with a practical method of monitoring and evaluating Knowledge Creation, Integration and Management in relation to the firm's turnover and number of employees. As firms adopt appropriate Knowledge Creation, Integration and Management practices as well as the $CIMEM_k$ model, clients would have more confidence in engaging Zambian civil engineering consulting firms, thereby increasing the sub-sectors' contribution to the country's gross domestic product. It is noteworthy also that the model, when developed further, could also be used by clients during proposal evaluation to prequalify consultants that are likely to have a reasonable knowledge base in a given field of specialisation.

1.7 Organisation of the thesis

The thesis consists of seven (7) chapters.

Chapter 1 outlines the background, rationale, aim and objectives of the study. It also suggests the application of the research.

Chapter 2 lays a foundation of the study through the review of literature relevant to Knowledge Creation, Integration and Management.

In *Chapter 3,* highlights of the various research methodologies and the justification for the methodology adopted for the study is presented.

Chapter 4 presents the results and analysis of the research findings.

Chapter 5 presents the model development steps. The chapter also presents the model and its use in enhancing Knowledge Creation, Integration and Management practices within the civil engineering consulting industry.

Chapter 6 presents a detailed discussion of the proposed theories and arguments.

The thesis ends with *Chapter 7* which presents the conclusions, limitations and recommendations of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The previous Chapter outlined an overview of Knowledge Creation, Integration and Management. The rationale and objectives of the study were also presented. This Chapter presents a review of available literature on the subject of Knowledge Creation, Integration and Management. The Chapter begins with examining a broader perspective of knowledge and narrows down to Knowledge Creation, Integration and Management within the civil engineering consulting firms. A critique of the validity of existing theories and literature is also presented in this Chapter.

2.2 Knowledge

Knowledge could be defined as the facts, skills and understanding that one has gained, especially through learning or experience, which enhance one's ability of evaluating context, making decisions and taking actions (Awad and Ghaziri, 2007). Because knowledge combines information and experience, by using Knowledge Management, organisations could provide their human capital with the ability to find and use methods and procedures that were created or used by others previously to solve similar problems, and to learn from past experiences, while maintaining and creating new experiences to be used in future (Baker et al., 1997; Davenport and Prusak, 1998; Tiwana, 1999). Many definitions have been developed in Knowledge Management literature to help in the understanding of knowledge and distinguish it from other forms of contents such as data and information.

Davenport and Prusak (1998) defined knowledge as a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information. In organisations, Knowledge Management often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices and norms. Nonaka and Takeuchi (2007) defined knowledge as information anchored in the beliefs and commitment of its holder while Bennet and Bennet (2008) defined it as the capacity, potential or actual, to take effective action in varied and uncertain situations.

2.2.1 Knowledge classification methods

Knowledge could be considered in a variety of ways. Classifying knowledge helps to identify the different types of knowledge with different nature that may need different procedures, tools and activities to process and manage (Lin et al., 2006; Tserng and Lin, 2004). Hence, classification helps organisations to manage important and available knowledge resources successfully.

a) Explicit and tacit knowledge

Explicit knowledge could be expressed in formal and systematic language and shared in form of scientific formulae, specifications, manuals and the like. Explicit knowledge is easy to be captured, retrieved, shared and used because it could be expressed in words and numbers that could be managed more easily. In project contexts, explicit knowledge may include project-related contents such as specifications, contracts, reports, drawings, change-orders and data (Lin et al., 2006). Explicit knowledge has also been described being readily available, recorded, codified and/or structured in a way that makes it easily transmissible and available to be retrieved and used, which could be found in a range of diverse sources such as human resource data, minutes of meetings and the Internet (Sitarski, 2012).

Tacit knowledge is the most valuable type of content since it combines information with experiences, skills and understanding of people, which could help people to find best solutions and reduce opportunities of repeating mistakes (Awad and Ghaziri, 2007; Baker et al., 1997; Davenport and Prusak, 1998; Tiwana, 1999; Tserng and Lin, 2004). In project contexts, tacit knowledge may include work processes, problems faced, problems solved, expert suggestions, know-how, innovations and experiences (Lin et al., 2006).

Tacit knowledge is highly personal and hard to be managed, shared or formalised since it includes experiences, know-how and perceptions, which normally reside in individuals' heads and memories (Lin et al., 2006; Nonaka, 2007). According to KLICON (Sitarski, 2012), tacit knowledge cannot be easily articulated with formal language since it is a personal knowledge that is embedded in people's experiences and involves intangible factors such as personal beliefs, perspectives and values. The best way for utilising tacit knowledge is by using methods and tools that encourage and facilitate collaboration and knowledge-sharing among the people in an organisation, such as applying e-messaging and e-meeting tools (Lin et al., 2006; Nonaka, 2007).

However, some tacit knowledge could be captured, mobilised and turned into explicit knowledge by using Knowledge Management tools such as knowledge capturing, publishing, categorising and editing tools. These help to transfer knowledge into more available and accessible forms that may help the organisation to progress rather than requiring its members to re-learn from the same stage all the time (Gore and Gore, 1999).

Although a complete tacit-explicit split cannot be achieved (Inkpen and Dinur, 1998; Nonaka and Takeuchi, 2007), it is a useful way to understand the different characteristics and nature of different types of knowledge that require different processing, procedures and tools to be managed and dealt with. Figure 2-1 represents a hierarchy that has been developed to provide a useful way to understand the differences and relationships among data, information explicit knowledge, tacit

knowledge and wisdom (Awad and Ghaziri, 2007; Bierly et al., 2000; Davenport et al., 1998). This representation helps to understand the different characteristics and values of the different types of contents and how these contents could be transformed from one type to another. It has been suggested that in order to gain competitive advantage, organisations need to enhance the information-knowledge balance through the implementation of IT-based improvements to augment information management and socially-based mechanisms to enhance Knowledge Management (Blumentritt and Johnston, 1999).

Tacit knowledge, according to Nonaka and Takeuchi (2007), could further be categorised into technical knowledge and cognitive knowledge. Technical knowledge depends on the experiences of individuals, which have been developed with time, so it could be captured in the form of 'know-how', while cognitive knowledge depends on mental models, perspectives and beliefs and therefore cannot easily be articulated (Nonaka, 2007). Technical knowledge contains many shapes of knowledge, such as descriptions of problems and solutions, experience notes and procedures. Cognitive knowledge includes ideas, viewpoints and innovations.

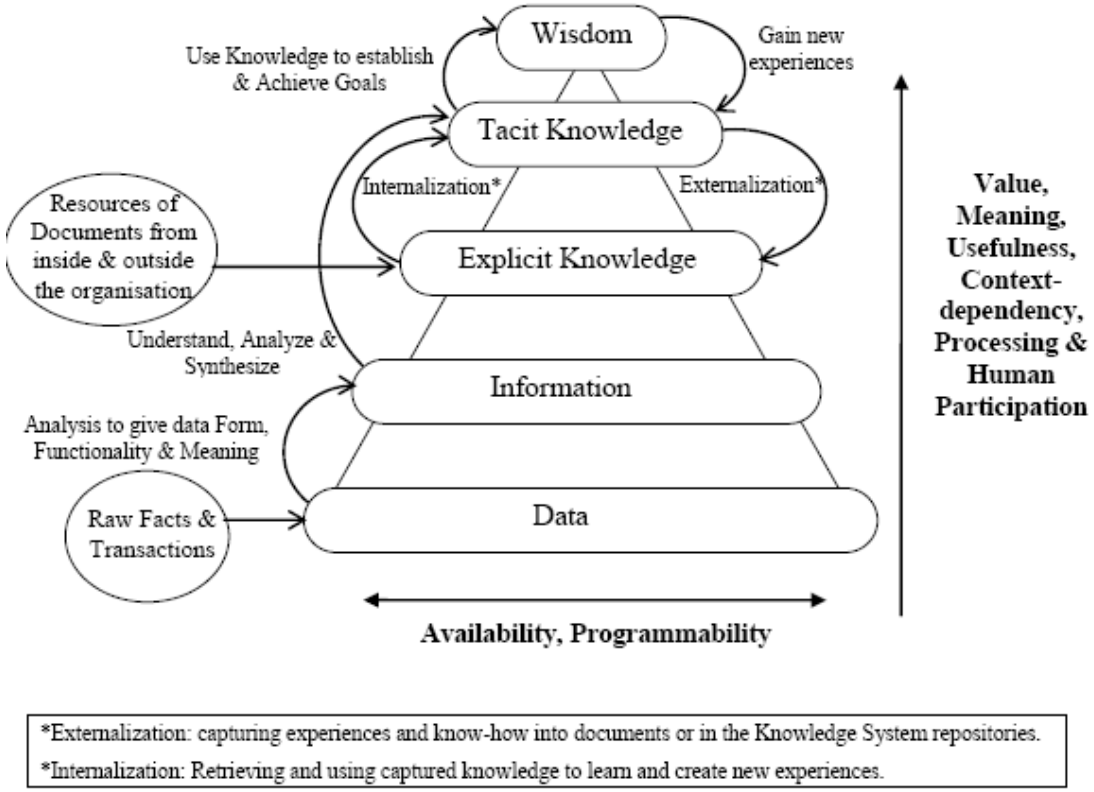

Figure 2-1: From data to wisdom hierarchy

(After Awad and Ghaziri, 2007)

Although tacit knowledge is difficult to capture simply by normal tables, it could be stored in forms similar to articles including those attached descriptions, pictures and

videos that provide more details and clarifications to the knowledge content. Another useful method is by encouraging sharing such knowledge through direct contacts, such as face-to-face meetings, e-chatting, video conferencing, and indirect contacts, such as e-messaging, e-discussions and e-commenting. Although these methods have been proven more convenient in the collection and sharing of tacit knowledge, it needs more effort to follow procedures that encourage people to capture and share their knowledge, and to provide classification and searching techniques that facilitate knowledge retrieving and reusing (Ahmad et al., 2007).

b) Explicit, implicit and tacit knowledge

Although many studies have used the terms tacit and implicit knowledge synonymously, others have differentiated three knowledge dimensions: explicit; implicit; and tacit, emphasising that tacit and implicit knowledge have significant differences and cannot be used interchangeably (Bennet and Bennet, 2008; Newman and Conrad, 2000; Nickols, 2003). Nickols (2003) introduced a representation that provides a useful way to distinguish among explicit, implicit and tacit knowledge as shown in Figure 2-2.

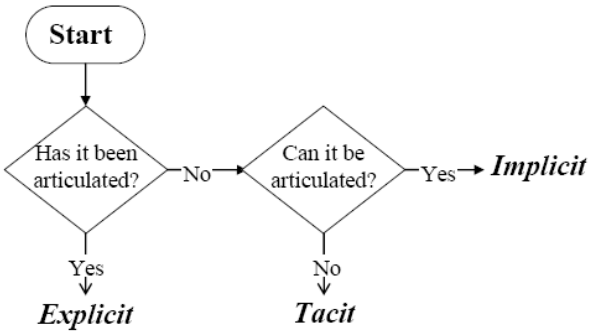

Figure 2-2: Distinguishing between explicit, tacit and implicit knowledge

(After Nickols, 2003)

Explicit knowledge consists of knowledge that has already been articulated or codified in the form of text, tables, diagrams, formulae, drawings, photos, audios and videos, so they could be directly and completely captured, used or shared, such as documented articles, books, reports, best practices, manuals, specifications and standards (Newman and Conrad, 2000; Nickols, 2003).

Implicit knowledge is the knowledge identified as that which could be expressed and turned into explicit in future but has not yet been articulated. This could be caused by various reasons such as: incomplete or non-commencement of codification or capturing process; lack of decision to capture this form of knowledge; or decided decision that there is no need to capture this form of knowledge at that particular time (Ahmad et al., 2007).

Tacit knowledge refers to intellectual property that individuals have which they cannot articulate, express using language or make explicit. Articulating or decomposing tacit knowledge fails to capture the essence of the individual's understanding (Nickols, 2003; Wilson, 2002). Examples include people skills and experiences that cannot be easily described such as how to deal with different individuals and read reactions on their faces or the ability and speed to work under pressure to meet tight time deadlines, solve problems, provide ideas and innovate.

The research by Bennet and Bennet (2008) discussed the differences and relationships among explicit, implicit and tacit knowledge and pointed out that explicit knowledge could be described accurately by words and/or visuals, while implicit knowledge is more complicated and not readily accessible. It is the knowledge that individuals do not know they have, but they discover it through questions, dialogues, reflective thoughts or as a result of an external event. Once this knowledge has emerged, the individual could have the ability to capture it in the form of explicit knowledge or may not have this ability and so the knowledge remains tacit. Finally, tacit knowledge is the knowledge that even if individuals know they have it, they still cannot put it into words or visuals that could be useful for others to use and to create new knowledge. Tacit knowledge has been studied in terms of four aspects: embodied; intuitive; affective; and spiritual, where each of these aspects represents different sources with different characteristics (Bennet and Bennet, 2008).

Embodied tacit knowledge relates to the movement of the body, such as knowing a craft or how to use a tool, and the five human senses such as knowing the quality of a material or a finished work from its appearance. This kind of knowledge could be learned through practising and behavioural skill training and through time it becomes embedded in memory and retrieved automatically when needed.

Intuitive tacit knowledge is that which may affect decisions and actions that come from an individual's sense and the actor cannot explain, consciously, the reason for taking this action. Intuitive knowledge has developed in people's minds as a result of continuous learning through meaningful experiences that could be built up by practice, making decisions and actions, collecting feedback on decisions and actions, and interpreting such feedback. These practices help people develop intuitive skills such as the ability to evaluate situations quickly and to predict the consequences of situations (Klein, 2002).

Affective tacit knowledge refers to human feelings that may have impact on behaviour, thoughts and responses. Thus, affective tacit knowledge is related to other types of knowledge because feelings as a form of knowledge could influence decisions and actions, such as feeling fear or being upset that could prevent the decision-maker from taking an action.

Finally, spiritual tacit knowledge could be described as the animating principles of human life such as its moral aspects, the emotional part of human nature and mental abilities, which may affect thoughts and actions.

c) Other methods

Many other methods for categorising knowledge have emerged and have been used within the Knowledge Management literature as a response to the growing interest in managing knowledge and the increasing awareness of its usefulness and importance. The other methods of knowledge classification have been proposed to enhance managing and processing knowledge in the organisations by adopting Knowledge Management techniques.

Collins (1993) provided a different way of classification by distinguishing between codified and non-codified knowledge, and proposed four categories of knowledge including symbolic-type knowledge that could be transferred without loss such as books and documents, embodied knowledge that cannot be easily transferred because it is held within the body of humans, embrained knowledge which is normally held within the brain, and encultured knowledge which relates to society and social groups.

For management purposes a number of classifications have been proposed to overcome the difficulty and inaccuracy of older methods. Lundvall (1996), for example, proposed four knowledge categories, i.e., know-what that is described as the knowledge that could be easily codified, know-why that includes principles and laws, know-how that refers to skills and capabilities to perform a given task successfully, and know-who which includes details about who knows how to do what.

Furthermore, Blumentritt and Johnston (1999) categorised knowledge into four types by distinguishing between codified knowledge and other forms real knowledge. The knowledge types proposed by that research are: codified knowledge, which refers to knowledge captured or written in an explicit transferable format; common knowledge, which includes routines and practices learned through working in a particular context without capturing them in formal explicit formats; social knowledge refers to cultural issues and interpersonal relationships such as cooperation and coordination; and lastly, embodied knowledge, which includes experiences, skills and backgrounds of individuals that affect the way a person deals with a given set of information to build and create appropriate knowledge to solve problems.

2.3 Knowledge Creation

Polanyi (1997) originally categorised knowledge as “tacit” and “explicit”, in which, tacit knowledge is in the human mind, behaviour, and perception, and thus, it is difficult to be formalised and communicated. It evolves from peoples’ interactions, and requires skills and practices. Comparatively, explicit knowledge could be easily

formalised and documented. It is what could be captured and shared through information technology (Nonaka, 1994). Zack (1999) believed that the degree of tacit and explicit of knowledge should be considered absolutely as an issue in developing knowledge strategies.

Nonaka and Konno introduced the Japanese concept of *"ba,"* which roughly translates into the English word "place." They grounded the concept of *ba* in an existentialist framework and assert that the key platform of Knowledge Creation is the "phenomenal" place. Such a place of knowledge could emerge in individuals, working groups, project teams, informal circles, temporary meetings, e-mail groups, and at the front-line contact with the customer (Nonaka and Konno, 1998).

They argued that if knowledge is separated from *ba,* it turns into information, which could then be communicated independently from *ba.* Information resides in media and networks as such it is tangible. In contrast, knowledge resides in *ba* and it is intangible. Within an organisation, knowledge-creating teams or projects play key roles in value creation. Value creation in knowledge-creating companies emerges from interactions within shared *ba* but is not restricted to the physical *ba.* The concept of *ba* unifies the physical space, the virtual space, and the mental spaces (Nonaka and Konno, 1998).

Leonard-Barton (Grigsby, 1996) took the point of view of organisational activity, and categorises four kinds of activities that might create knowledge. These included:

i.) solving problems together. As a problem occurs, it is better to let all the employees to give their wisdom to solve the problem;
ii.) implementing and combining new technology flow and instruments to enhance the operational effectiveness;
iii.) proceed experimentation and prototype trial-manufacturing style of organisational learning to create knowledge continually; and
iv.) inputting and absorbing outer technological knowledge to enhance the power for creating organisational knowledge.

Effective Knowledge Management is argued to require departures from the logic of hierarchical organisation. The alternative N-form is characterised and suggested as more appropriate. It entails combination of knowledge rather than its division. Other attributes are: temporary constellations of people; the importance of personnel at 'lower levels'; lateral communication; and a catalytic and architectural role for top management (Wiley and Hedlund, 1995).

Davenport and Prusak (1998) regarded experiences, facts, judgements, rule of thumbs, and intuition as knowledge components. They assumed five methods for obtaining knowledge:

i.) acquisition: knowledge could be obtained through procuring from outside the organisation or generating from inside the organisation:
ii.) division of labour: it would be helpful for an organisation to create knowledge by assigning specific responsibility unit.

iii.) combination: through grouping people with different points of view to take the responsibility of a project or solve a problem, new knowledge could be created.
iv.) adaptation: a sense of crisis arises when changes occur in environments, an organisation might generate new knowledge for adapting the changes to survive.
v.) network: an informal network in an organisation could be source of new knowledge; new knowledge might be generated through frequently interacting among people.

Nonaka and Takeuchi (2007) discussed success factors of some Japanese companies and propose two different viewpoints about generation of knowledge: essence and cognition. In the aspect of essence, they emphasised that only a personal could generate knowledge, an organisation cannot generate knowledge unless through individuals. They classify knowledge generation as four levels: individual; group; organisation; and inter-organisation, but all the knowledge of organisations eventually come from individuals. In the aspect of cognition, knowledge could be classified as tacit and explicit (Polanyi, 1997). Knowledge by all means is created from the interaction of tacit and explicit knowledge. The modes of their conversion are socialisation, externalisation, combination, and internalisation (SECI). Through continuous conversion, new knowledge is created. This knowledge conversion, also called knowledge spiral, is the process of knowledge generation, and is called as SECI process (Nonaka and Takeuchi, 2007). The SECI model is presented in Figure 2-3.

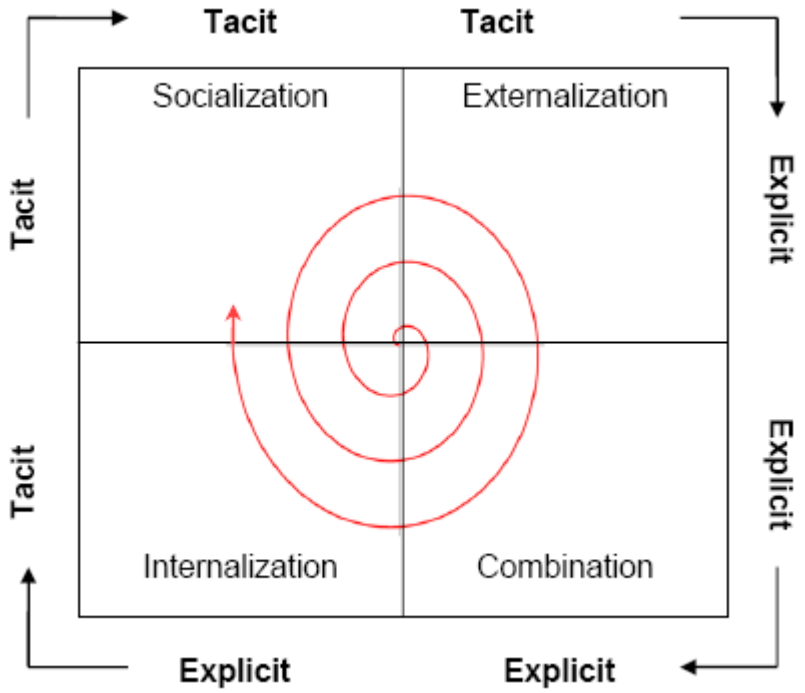

Figure 2-3: The SECI model

(After Nonaka and Takeuchi, 2007)

Nonaka and Takeuchi (2007) further argued that Knowledge Creation needs all these four stages, and cannot lack any one of it. On the part of knowledge-sharing, a person needs to have the ability to express his knowledge clearly otherwise, other people cannot make use of it. It is contended that personalised tacit knowledge must be shared with others, and further becomes a concept, a system and spreads around the organisation. Through this process, knowledge could be internalised by other personals. Therefore, Knowledge Creation is a process of self-surpass process, and organisation is a place for such a Knowledge Creation. The organisation needs to sufficiently support personals, because only personals are the source of tacit knowledge.

Li and Gao (2003) studied the fundamental points of tacit knowledge on the basis of Nonaka's SECI model regarding Knowledge Creation and its constraints. They underlined the importance of the spiral-type model in providing an analytical framework for knowledge activities in business management. The study relied on Polanyi (1997) to categorise the tacit knowledge into two parts: implicit and real tacit.

Implicit knowledge indicates the ability of people to express and articulate knowledge, but they may be unwilling to do that because of specific reasons under certain settings, such as behaviour, culture or organisational style. However, it was of great value for an organisation to arrange activities to help to transform implicit knowledge of employees into explicit through suitable incentive schemes to make this knowledge available for other employees across the organisation (Li and Gao, 2003). According to Polanyi (1997) it is hard for real tacit knowledge to be communicated among people with different levels of knowledge and it is useless and costly for an organisation to try to manage it for sharing.

McInerney (2002) argued that to effectively manage knowledge and successfully transfer tacit knowledge into explicit accessible formats in any organisation, there should be a clear understanding of the dynamic nature of knowledge. He defined explicit knowledge as the knowledge that has been explained, recorded or documented, while tacit knowledge is the rest of other forms of knowledge that, if it has not been represented and made explicit, there could be lost opportunities of competitive advantages.

Knowledge could also be a disadvantage for organisations if it is incorrect or misleading, if it is inhibiting or discouraging, or if it is not aligned with or does not satisfy an organisation's mission or strategy. Knowledge is considered to be dynamic because it is constantly changing in individuals through experiences and learning, and in organisations through the movement of knowledge to be transferred or shared. That requires keeping knowledge stored in the knowledge repositories current and updated, while keeping knowledge systems flexible enough to deal with continuous updates and changing requirements from all sectors of the organisation (McInerney, 2002).

McInerney (2002) suggested that instead of investing efforts in the initiatives of extracting knowledge from the employees, it might be more productive for organisations to invest efforts in creating a knowledge culture that encourages learning and sharing of knowledge using procedures such as establishing small group meeting rooms, conducting on-site seminars, rewarding those who continuously practice learning and who teach others what they know, offering informal "water cooler"-type meeting places throughout the workplace, encouraging trust, dialogue and collaboration among employees, etc. His study illustrated how tacit knowledge and explicit knowledge interact through internal and external processes within and among people in an organisation using a graphical representation of a Knowledge Management model as shown in Figure 2-4. Having a static collection of knowledge is not enough, but continuous Knowledge Creation is essential to manage knowledge more effectively and to keep organisations healthy and innovative (McInerney, 2002).

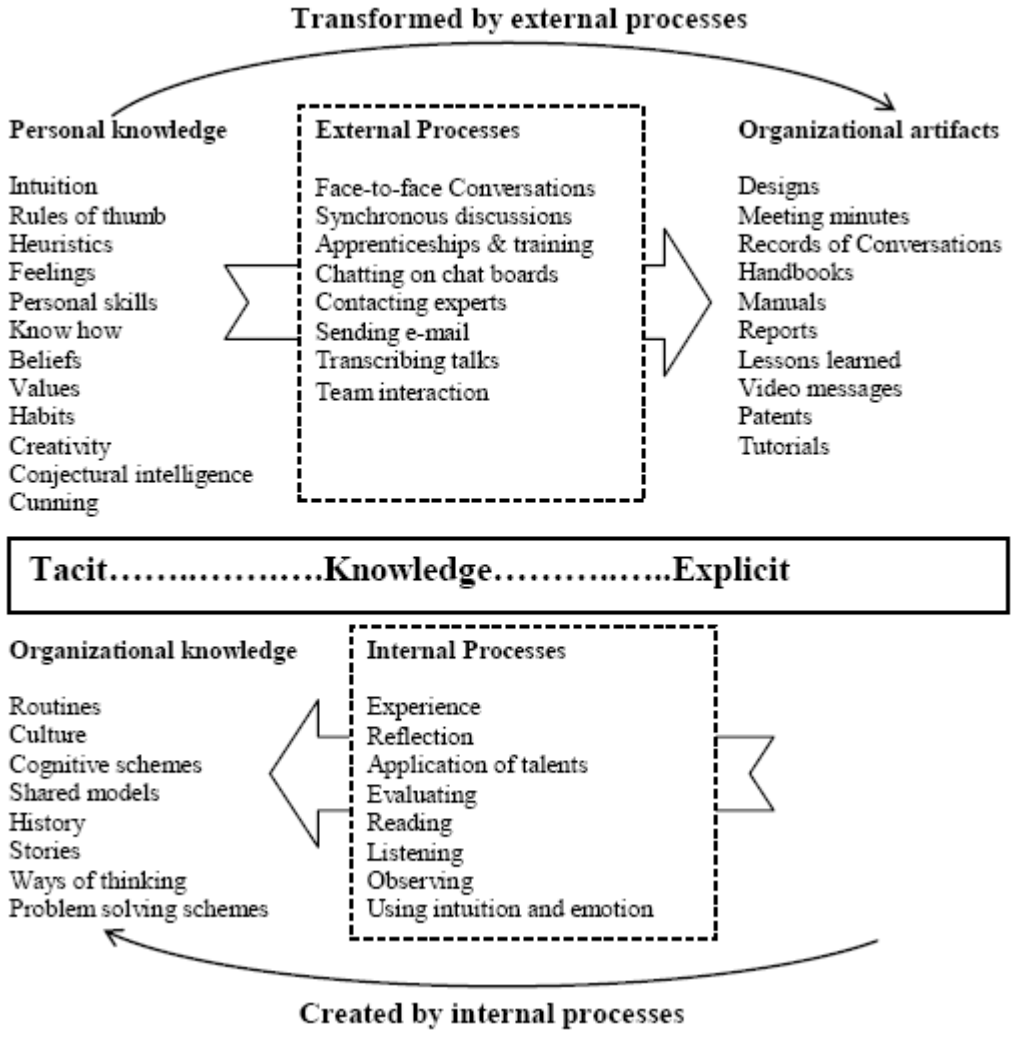

Figure 2-4: Tacit-explicit continuum

2.3.1 Knowledge Creation capability of an individual

Nonaka and Takeuchi (2007) pointed out that only a personal could create knowledge. An organisation could create knowledge only through personals. The four transformation processes of knowledge: SECI were also motivated and implemented by individuals. Therefore whether individuals have this knowledge conversion capability is the key factors to influence an organisational Knowledge Creation. And knowledge conversion capability is closely related with the four modes of capabilities: SECI owned by individuals. The four capabilities are explained as follows:

a) Capability of internalisation

Capability of internalisation is the ability to transform explicit knowledge to tacit knowledge. The explicit knowledge might be embodied in action and practice when internalising, one could acquire the knowledge by fulfilling other' s experience and internalise it to be part of his own tacit knowledge (Becerra-Fernandez and Sabherwal, 2001).

b) Capability of externalisation

Capability of externalisation is the ability to transform tacit knowledge to explicit knowledge that others could easily understand. Just like teachers deliver their knowledge to students through clear and comprehensible means. It may not be by language, but also by metaphor, analogy, figure, or body language (Nonaka and Takeuchi, 2007; Nonaka, 1994).

c) Capability of socialisation

Capability of socialisation is the ability to share one's tacit knowledge through common attending activities. For example, when an organisation implements a kind of socialising activities, like employee' s rotating among different departments, brainstorming activities, cooperate project cross departments, or delivering knowledge by apprentice, one' s ability to share and communicate tacit knowledge.

d) Capability of combination

Capability of combination is the ability to transform less complicated knowledge to more complicated knowledge. In other words, it is the ability such that an individual could organise, integrate, and spread knowledge. For example, when discussing a topic among people, an individual could induce the contents of discussion, and enhance the efficiency of discussion. It may also be the ability for combining old information with new ones to stimulate a new concept.

Simon (1991) argued that learning could take place in one's brain, but not in an organisation. The organisation requires its employees to absorb new knowledge, or introduce new knowledge via its new members. When their employees do not have

such knowledge conversion abilities, it could not generate new knowledge. More than that, it might even be a problem when introducing new knowledge or technology from outside and utilising them. It could be more essential for a Research and Design team, since it depends on knowledge generation to get performance (Simon, 1991).

From another point of view, learning and knowledge creativity have self-reinforcement mechanism (Cohen and Levinthal, 1990). The knowledge creativity of the organisational members is an important organisational capability, since it might be very likely to develop a core competence of the organisation, and enhance organisational competitive advantages (Hill and Jones, 2007).

2.3.2 Challenges in Knowledge Creation

Mobilising tacit knowledge is a key factor in Knowledge Creation process (Nonaka, 1994). The focus of socialisation lies at both quantity and quality of social interactions among individuals. Mutual trust is so crucial that it significantly determines whether individuals are willing to share their knowledge (Lee and Choi, 2003; Nonaka, 1994). However, the reality rarely matches the expectations. Practices such as building mutual trust and relying on group-based incentives are expected to improve knowledge-sharing. To advance knowledge for organisational uses, individuals also need to externalise their knowledge formally into certain systems. Self-transcendence is vital; individuals need to realise greater values of knowledge for others (Nonaka and Konno, 1998). Two eminent issues are the lack of commitment and the loss of potential knowledge during the conversion (Alavi and Leidner, 2014). As explicit knowledge becomes accessible, individuals should be trained to be aware of information security issues. Once individuals learn, adjust and absorb knowledge into their minds, internalisation occurs. The willingness and motivation to learn not only their own responsibilities but new skills through trainings are also key factors (Alavi and Leidner, 2014).

2.4 Knowledge Integration

The Knowledge Management models developed so far by other authors do not explicitly consider the need for activities to go outside the firm and detect knowledge from other organisations. Additionally, much is known in the Knowledge Management literature on internal Knowledge Management, but not so much is known about identifying, acquiring and using external knowledge.

The economic literature has extensively discussed two types of inter-organisational exchange mechanisms which have high implications for how Knowledge Management and Knowledge Integration happen: markets and networks (Liebeskind et al., 1996; Williamson, 1991).

For market exchanges to work properly, the goods to be exchanged must be very precisely defined, prices act as communication mechanisms, and coordination is realised via the price mechanism. The actors involved must be fully independent and, if the existing exchange mechanism does not work properly, brokers could be useful intermediaries. In the context of Knowledge Integration, this involves the exchange of explicit knowledge, such as knowledge documented in patents and software, or specified commercial services (Wijnhoven, 2006).

In the context of network exchanges, economic actors collaborate and, thus, are mutually beneficial to each other. The collaboration is mainly based on mutual trust and respect and, in such a situation, pricing is not needed. The network exchange context also enables the exchange of ambiguously and non-codified knowledge and, thus, enables the exchange of latent knowledge and the joint development of explicit and tacit knowledge in collaboration efforts (Wijnhoven, 2006).

2.5 Management of knowledge

The term 'Knowledge Management' which, according to Wiig (2008), was first coined in 1983, has its roots in the work of Peter Drucker in the 1960s, who highlighted that the most valuable asset to a company was its knowledge and a knowledgeable workforce. Swan (2011) also discussed the influence of Drucker in this regard, as well as the shift from an industrial to a post-industrial society, which brought more attention to the importance of 'knowledge work.'

It is argued by Tiwana (1999) that Knowledge Management, as a discipline, evolved from a variety of management philosophies which have developed since the 1950s, including Management by Objectives (1950s), Centralisation and Decentralisation (1960s), The Experience Curve (1970s), Corporate Culture (1980s), The Learning Organisation (1990s) towards Knowledge Management in the 2000s. This is a view which is shared by Wiig (2008), who also provides such examples of twentieth century efforts to improve organisational effectiveness.

The emergence of managing knowledge as a business and academic concept was crystallised in two seminal publications. Nonaka and Takeuchi (2007) explored the dynamics of innovation and Knowledge Creation in Japanese companies, while Davenport and Prusak (1998) popularised the concept of Knowledge Management (Tiwana, 1999). During this period, according to Quintas (2005) there was increased interest with a growth in academic articles, books and conferences on Knowledge Management; including the Periodicals Knowledge Management, Knowledge Management Review and the Journal of Knowledge Management.

On a broader level, the concept of a knowledge economy has come to the fore in recent literature. The implications of the increasing focus on knowledge are, according to

Egbu and Robinson (2008), an increased demand for knowledge, skills and learning, and growth of learning organisations. This interest in Knowledge Management stems from a number of issues: a dramatic improvement in data processing capabilities and communications technologies, an increased recognition that businesses must continuously improve, and an acknowledgement of learning as a core strategic competency (Sitarski, 2012), indicating strategic, technological and people aspects. Quintas (2005) confirms this by identifying six key drivers of the Knowledge Management agenda in recent years:

i.) Wealth being demonstrably and increasingly generated from knowledge and intangible assets
ii.) The rediscovery that people are the loci of much organisational knowledge
iii.) Accelerating change in markets, competition and technology, making continuous learning essential
iv.) The recognition that innovation is key to competitiveness, and depends on Knowledge Creation and application
v.) The growing importance of cross-boundary knowledge transactions
vi.) Technology limits and potentials: the limits of information technology and the potentials of communications and knowledge technologies

Jashapara (2011) defined Knowledge Management as the effective learning processes associated with exploration, exploitation and sharing of human knowledge, tacit and explicit, that use appropriate technology and cultural environments to enhance an organisation's intellectual capital and performance. Teece (2000) asserts that it could be used to describe the panoply of procedures and techniques used to get the most from a firm's knowledge assets. Knowledge Management requires the development of dynamic capabilities and the ability to sense and to seize opportunities quickly and proficiently. McInerney (2002) defined Knowledge Management as an effort to increase useful knowledge within the organisation. Ways to do this include encouraging communication, offering opportunities to learn, and promoting the sharing of appropriate knowledge artefacts. It is the process of continually managing knowledge of all kinds to meet existing and emerging needs, to identify and exploit and acquire knowledge assets and to develop new opportunities (Quintas et al., 1997).

Knowledge Management provides the tools and services for end-users to capture, share, re-use, update, and create new experiences, solutions to problems and best practices to aid employees in processes such as problem solving, decision making and innovation without having to spend extra time, effort and resources on re-inventing solutions that have already been developed elsewhere in organisations (Ahmad et al., 2007).

2.5.1 The importance and stimulus factors for Knowledge Management

Knowledge Management is now becoming more vital for successful management of civil engineering projects and a complement to the business activities of organisations. With the world economy increasingly becoming more knowledge-based, knowledge is becoming the most important asset for organisational success among other assets such as capital, materials, machinery and property (Fong, 2005; Kelleher and Levene, 2001). The study by Gupta et al. (2000), which discusses practices and challenges in a number of selected organisations, argued that Knowledge Management is the only competitive advantage for companies in the 21st century.

Civil engineering projects are in knowledge intensive environments where many interrelated components work together in a complex manner. The main benefit from adopting Knowledge Management systems is to enable firms to complete projects at reduced costs and within time while improving quality. By reusing and sharing previous experiences and knowledge, employees could find solutions to their problems without spending extra time, effort and resources on re-inventing solutions that have already been invented elsewhere in the organisation (Ahmad et al., 2007).

With successful capturing, sharing and creation of useful knowledge, companies could improve the process of organisational learning to enhance performance and create more possibilities to gain competitive advantages for the organisation (Ahmad and An, 2008; Sitarski, 2012)). Li and Gao (2003) argue that companies could enhance organisational learning through knowledge generation and sharing, which not only enriches the knowledge of employees and organisations, but also leads to increased strategic innovations. Improving organisational learning means enhancing the ability of the organisation to collect and use knowledge so that members exploit it to improve performance (Sitarski, 2012). Organisational learning could create possibilities to gain competitive advantage, which involve the ability of a company to perform projects and activities at lower cost and less time and of higher quality than competitors.

The current interest in Knowledge Management has been motivated by the need for continuous change and improvements to enhance the construction process that has benefited from the remarkable developments in computer technologies which provide professionals with the ability to digitally search, capture and transmit knowledge and electronically contact other people (Blumentritt and Johnston, 1999; Carrillo et al., 2000; Sitarski, 2012). Knowledge Management Systems provide the tools and services for end-users to capture, share, re-use, update, and create new experiences, find solutions to problems and best practices to aid employees in processes such as problem solving, decision making and innovation and to enhance the total performance of the organisation (Ahmad et al., 2007).

2.5.2 Challenges and factors affecting Knowledge Management

Many challenges to Knowledge Management implementation in the civil engineering industry such as the complexity of the industry, diversity of players, adversarial relationships and non-repetitive nature of work are all causes for much wastage and difficulties in accessing important knowledge (Sitarski, 2012). The complex nature of knowledge and project context increases the difficulty for organisations to plan and implement formal Knowledge Management initiatives.

While much of the literature has been concerned with discrete projects, project integration proved to be a major challenge for construction management. This is so because it goes beyond conventional systems integration that is largely concerned with technical integration of software, hardware and communication protocols. Project integration has to include coordination and management of the different activities necessary for the successful completion and delivery of the project as a whole (Alderman et al., 2001; Winch et al., 1998).

The challenges for Knowledge Management become more difficult when dealing with tacit knowledge because individuals normally regard this type of intellectual property as a source of strength and personal rather than organisational property (Carrillo et al., 2000). A vast amount of knowledge in the project-oriented organisations resides in the heads of numerous individuals who may belong to different companies with different professional backgrounds. On the other hand, many of these companies are unstable and could be completely changed during the period of the project life cycle. This causes difficulty for people to collect, share and manage their knowledge within limited time and budget of the construction projects (Carrillo et al., 2000).

Within organisations, employees are often reluctant to share their knowledge with others and changing this behavioural pattern is exigent (Egbu, 2004; Lin et al., 2006; Nonaka, 2007). Many individuals regard their knowledge as personal property and source of strength and most typical existing civil engineering organisations find it difficult to encourage the culture of knowledge-sharing (Carrillo et al., 2000). Case studies conducted by Carrillo and Chinowsky (2006) in six engineering design and construction organisations in the United States of America showed that employees' resistance to knowledge-sharing is one of the top barriers for Knowledge Management within such organisations. Reasons such as: lack of trust; time; Knowledge Management awareness; openness to new ideas among employees, intolerance of management for creative mistakes and refusal of solutions from people in lower positions could negatively affect knowledge-sharing processes (Davenport and Prusak, 1998).

The difficulty of Knowledge Management implementation for many construction organisations is caused not only by the complicated nature of Knowledge Management operations, but also by the fact that the implementation of Knowledge Management initiatives has often been unplanned and informal. A study conducted by Robinson et

al. (2005) based on leading construction organisations showed that such organisations lack a strategy of Knowledge Management implementation and coordination, and a high percentage of them have not appointed a knowledge manager or a team to implement their Knowledge Management strategy, with the effect that small and medium sized organisations are less successful than their larger counterparts in Knowledge Management implementation. Other studies have argued that UK construction companies with domestic operations are less successful in Knowledge Management implementation than their international counterparts because they lack the adoption of well formulated Knowledge Management strategies and implementation plans as well as Knowledge Management alignment with business strategy of the organisation (Robinson et al., 2005).

A survey carried out by Carrillo et al. (2004) in UK investigated the main barriers to implementing Knowledge Management strategies such as work processes, employee time, organisational culture, expenses, employees' resistance and poor IT infrastructure. The study indicated that the most significant barrier to Knowledge Management implementation is the lack of standard work processes such as having too many different procedures to perform similar activities and the lack of systematic procedures for collecting and reusing lessons learned and best practices.

The non-repetitive nature of construction projects is an important challenge to the management of knowledge in construction organisations. A solution to a problem or best practice in a project may confuse other users having similar challenges in different projects with different characteristics and contexts. In their study, Fong (2005) argued that despite the importance of Knowledge Management in reducing the risk of 're-inventing the wheel', it is sometimes difficult for individuals in a project to re-use and re-apply knowledge of other projects. The reason is that it is difficult for employees in a project to understand the context and the reasons for decisions that were made in other projects simply by using reports or drawings kept after the completion of those projects (Fong, 2005).

The ability of Knowledge Management initiatives to deliver desirable results for individuals and organisations could be affected by environmental factors such as organisational culture and management support (Burgess and Singh, 2006). Davenport et al. (1998) argued that in order to obtain successful Knowledge Management systems, organisations need not only to improve Knowledge Management processes and technological contents but they also need to enhance the knowledge environment through practices attempting to change behaviours of employees that relate to knowledge such as building Knowledge Management awareness and cultural acceptability.

Egbu and Botterill (2002) studied the use of Information Communication Technology-tools for Knowledge Management in construction organisations and concluded that Information Communication Technology is more useful for transmission of explicit knowledge while face-to-face interaction and verbal conversation are more efficient in

sharing and transferring tacit knowledge. Resultant Information Communication Technology inefficiency in sharing and capturing tacit knowledge could be due to the effect of environmental factors such as: lack of employee awareness of the potential benefits of Information Communication Technology-tools; lack of a formal strategy to apply Knowledge Management system; short term nature of projects that cause difficulties with building teams, and trust among employees; and human nature for preferring familiarity of using the old routine of doing jobs over having to learn new methods of applying and using new technologies (Egbu and Botterill, 2002).

Ahmad and An (2008) discussed environmental factors that could influence Knowledge Management design, implementation and use. The research categorised such factors into groups to simplify representing and understanding them as individual, organisational, technological, economical, customer and regulation factors. The study also highlighted the importance of management support and the role of Knowledge Management teams to maintain and improve the Knowledge Management system in the organisations. However, some factors may hinder the process of knowledge coordination and sharing among employees in different construction projects of the organisation that may cause every project to work as a separate unit, and so this may cause failure of using knowledge of other projects and learning from past mistakes and experiences (Carrillo et al., 2000).

The research by Davenport and Prusak (1998) indicated that some individual behaviour, or cultural friction, could negatively affect the Knowledge Management process. They suggested a set of solutions to reduce the influence of such factors and encouraged Knowledge Creation and sharing in organisations by applying certain procedures and approaches such as providing incentives, accepting and rewarding creative errors, providing time and places for learning, meeting and sharing knowledge, and encouraging relationships and trust among employees.

An and Ahmad (2010) discussed and presented the influence of environmental factors and the way they affect the ability of Knowledge Management methods, tools and activities in delivering desirable outcomes for individuals and organisations to simplify understanding their effects and enhance awareness of their importance in Knowledge Management implementation and application.

2.5.3 Knowledge Management in Construction

Construction is a project based industry, within which individual projects are usually custom-built to client specifications (Raidén and Dainty, 2006). Such projects are typically delivered by temporary project coalitions, comprising designers, consultants, contractors, specialist sub-contractors and suppliers. The industry is recognised as being poor in its approach to learning and performance improvement and is notoriously slow in adapting to change (Sitarski, 2012). The project based, fragmented and

unstable nature of the industry has led to chronic knowledge loss compared with other industries (Orange et al., 2003).

There are significant challenges facing today's construction industry, increasing competition, globalisation of the construction market, demands from clients, customers and society, and the pace of change in Information Communication Technology. A further challenge lies in maintaining a highly skilled workforce at all levels from operative and technical, to managerial and professional (Egbu and Robinson, 2008).

Knowledge Management is a managerial paradigm which considers knowledge as a resource at the basis of a company's competitiveness. It identifies the capabilities to generate value for a company's stakeholders with the explicit and systematic implementation of approaches, techniques and tools for the assessment and management of intellectual capital (Carlucci et al., 2004). According to Lee and Yang (2000), it is an emerging set of organisational design and operational principles, processes, organisational structures, applications and technologies that help knowledge workers dramatically leverage their creativity and ability to deliver business value.

As a fledgling academic discipline, Knowledge Management has been promoted as a means of harnessing and utilising intellectual resources to address these challenges, and to improve innovation, business performance and client satisfaction within the construction industry. There is, however, uncertainty about how to devise and implement a viable and cost effective Knowledge Management initiative (Quintas, 2005). Interest in Knowledge Management has stemmed from a number of issues: a dramatic improvement in data processing capabilities and communications technologies, an increased recognition that businesses must continuously improve, and an acknowledgement of learning as a core strategic competency (Sitarski, 2012).

In a study of Knowledge Management in North American construction organisations, Robnison et al., (2005) identified the main driver for Knowledge Management as the need to leverage knowledge to win work and provide a better service to their clients. However, the environment within which construction organisations operate exhibits a number of distinct characteristics which make the management of knowledge difficult:

i.) the temporary, project based nature of construction projects inhibits knowledge-sharing (Egbu and Botterill, 2002; Sitarski, 2012). Sommervile et al. (2004) asserted that the construction project environment is 'hostile' to the promotion of Knowledge Management and learning;

ii.) the geographical dispersion of sites from the organisations main and regional offices has a further detrimental effect, particularly in relation to forming social networks and contacts (Hari et al., 2005); and

iii.) the pressures to complete projects often leave little time for reflection and learning (Sitarski, 2012).

The most valuable form of knowledge for construction organisations is tacit, the accumulated experience of construction professionals, which manifests itself through social interaction (Kazi et al., 2005). Yet the project based nature of the industry inhibits participation in, and limits contact between different projects (Knauseder et al., 2005). With the increased pressure from clients to improve the quality of projects while reducing cost and time of work completion, the construction industry faces many challenges of how to implement and apply successful Knowledge Management systems that provide desirable results and benefits (Chinowsky and Meredith, 2000). Successful Knowledge Management implementation requires a major change in organisational culture and commitment at all organisational levels (Gupta et al., 2000).

The lack of employee and management awareness of the importance and future benefits of Knowledge Management to their organisations is a significant challenge to Knowledge Management application in the construction industry (Sitarski, 2012). Some empirical studies proved that construction companies, especially small and medium enterprises, suffer many problems in applying Knowledge Management and lack awareness of many important issues associated with knowledge capturing and its benefits for construction organisations (Hari et al., 2005).

2.6 Knowledge Creation, integration and management in Small to Medium enterprises

All over the world, small to medium enterprises have been found to play very crucial roles in the economic developments of most countries. They constitute the largest proportion of businesses and play key roles in generating employment, providing goods and services, enhancing a better standard of living and of course, contributing significantly to the gross domestic products of many countries (OECD, 2000; Okpara, 2000). Small to Medium Enterprises are unique in their own right and their contributions towards economic development has helped to dispel the previous erroneously held view of small to medium enterprises being “miniature versions” of larger companies (Gaskill, et al., 1993). Therefore, the concept of Knowledge Creation, Integration and Management is very much relevant to them, just as it is to large organisations.

There is no literature that combines the topic of Knowledge Creation, Integration and Management in small to medium enterprises. However, literature on Knowledge Management in Small to Medium Enterprises is available though scanty in quantum. Wong and Aspinwall (2004) characterised the need for Knowledge Management in small to medium enterprises under two factors, vis-à-vis the “Pull” and “Push” factors. While the “Pull” factors focus on the attraction to Knowledge Management from the perspective of knowledge being viewed as a key resource and strategic asset that could contribute significantly to improving organisational performance; the “Push” factors highlight the pressures of competition, inadequacy of resources and time that constrain

the operations of small to medium enterprises. In addition, Sparrow (2001) in his study of several small to medium enterprises found four distinct components of Knowledge Management: appreciation of individual and shared understanding; effective knowledge base and system; integrated and contextual action; and effective learning processes. On the other hand, Wong and Aspinwall (2004) proposed eleven critical success factors for implementing Knowledge Management in small to medium enterprises as follows: management and leadership support; culture; information technology; strategy and purpose; measurement; organisational infrastructure; processes and activities; motivational aids; resources; training and education; and Human Resource Management. These factors create a sense of importance about how small to medium enterprises view and manage their knowledge; because knowledge now appears to be the crucial "survival weapon" for them.

Knowledge Management has proved its importance by showing that growth of a firm and implementation of Knowledge Management are directly proportional to each other (Salojärvi et al., 2005). Similarly, growth of a firm in terms of financial performance and innovation are linked to Knowledge Management implementation. The higher the implementation of Knowledge Management, the higher would be the performance of company in financial terms and innovation (Wong, 2005). Knowledge Management is all about managing the expertise and skills of employees therefore, among different reasons for the success of small to medium enterprises, one is that they are managing their knowledge (Brush, 1992).

Knowledge Management is not only important for large organisations but also has the same significant importance for small to medium enterprises which makes it a key to success (Call, 2005). Knowledge Management helps an organisation to succeed by building better customer relationship and improving innovation (Call, 2005). Irrespective of the size and nature of an organisation, Knowledge Management is important for the success of any organisation. Small to Medium Enterprises could improve their performance by considering Knowledge Management carefully (Salojärvi et al., 2005).

The lack of employee and management awareness of the importance and future benefits of Knowledge Management to their organisations is a significant challenge to Knowledge Management application (Sitarski, 2012). As a result, organisations suffer many problems in applying Knowledge Management. They lack awareness of many important issues associated with knowledge capturing and its benefits for construction organisations (Hari et al., 2005).

2.7 Measurement of Knowledge and Knowledge Management performance

The contemporary approaches to the measurement of knowledge and Knowledge Management view knowledge and Knowledge Management as separate entities.

Knowledge is analysed as a resource or output product, while Knowledge Management incorporates all the actions, structures and processes of managing knowledge. These contemporary approaches further subdivide the combination of objects in terms of value and status. Value portrays monetary results and relations to business success, whereas status expresses the quality and development status. The next division involves splitting the instruments to be used under value and status analysis into practical instruments and theoretical approaches (Faisst and Resatsch, 2004).

The selection of which practical instrument to be used in the measurement of knowledge and Knowledge Management rests on the context of development status, controlling objects, management, costs of implementing an instrument and goals of the initiative.

Knowledge Management measurement approaches can also be classified into deductive-summarising approaches and inductive-analytical approaches. Examples of deductive-summarising approaches are Tobin's Q (North et al., 1998) or Calculated Intangible Value (Myers, 2001), and examples of inductive-analytical approaches are Intellectual Capital Navigator (Myers, 2001), Intangible Assets Monitor (Sveiby, 1997), the Balanced Scorecard (Kaplan and Norton, 1996) and the Skandia Navigator (Skyrme and Amidon, 1998).

Deductive-summarising approaches pay particular attention to the value of intangible assets, and as accumulated values, they assess the organisational knowledge base. The demerit of these approaches is that the cause and effect link between intervention and changes in the knowledge base cannot be identified.

Inductive-analytical approaches, on the other hand are more appropriate in the alignment of company objectives with specific interventions. There are two types of inductive-analytical approaches. The first one, involves the analytical description and evaluation of different components within the organisational knowledge base as well as additional intangible assets. The second type are approaches that assimilate financial and non-financial indicators that link measures to strategies.

Several measurement approaches are built on the fundamental assumptions of the industrial age business model; the tangible assets based explanations, though this model is gradually being substituted by the information age model. The information age model accepts a set of knowledge assets distributed among machines, people and processes in order to generate the desired outputs and operate processes.

Most of the described existing approaches are the first step in an evaluation of interventions and outcomes of the organisation's knowledge base (Faisst and Resatsch, 2004). Questionnaires are used to establish a subjective success although a targeted development of the knowledge base and the reference to business results appears difficult to determine. Most approaches focus on metrics that are influenced by a variety of single factors. Financials, customers, internal processes, and learning and

growth are the four viewpoints the balance scorecard measures. These viewpoints give a steady perception on financial and non-financial data of the present and future performance of the business.

According to an American Productivity and Quality Centre study (Lopez, 2001), it was identified that a Knowledge Management initiative undergoes several stages when implemented in a company. The study also discusses various performance measurement system in single stages. Formal measurement of Knowledge Management seldom takes place and is not essential in the early stages of Knowledge Management implementations. Measurement gradually increases as it grows to be more structured and widespread.

2.8 Critique of existing theories and research literature

Knowledge Management has received significant attention from the construction management academic community in recent years, most notably from research groups led by Chimay Anumba (2000) and Charles Egbu (2002). Evidence of this has also been seen in a number of recent publications and conferences (Walker, 2005). A distinction is made in the academic literature between two categories requiring Knowledge Management in the construction industry: within projects, that is, across temporary, multi-discipline project organisations, and within individual firms (Kamara et al., 2002). However, there exists no literature that attempts to discuss Knowledge Creation, Knowledge Integration and Knowledge Management as a whole.

There have been a number of studies into Knowledge Management in construction but little on Knowledge Creation and Knowledge Integration. Many of these studies have focused on both contracting and consultant organisations (Boyd et al., 2004; Egbu and Botterill, 2002; Hari et al., 2005; Kamara et al., 2002; Robinson et al., 2005). The characteristics of these types of firms are inherently different to each other, and approaches to managing knowledge should be adopted to reflect this. There exists no clear-cut research on Knowledge Creation, Integration and Management as it relates to the civil engineering consulting sector. Being a knowledge intensive sector, research on Knowledge Creation, Integration and Management within the civil engineering consulting fraternity is of great importance. It is worth mentioning that while a number of models have been developed in Knowledge Management, there is none that attempts to evaluate the level of Knowledge Creation, Knowledge Integration or Knowledge Management within an organisation or the industry in general.

The studies on Knowledge Creation, Knowledge Integration or Knowledge Management have also mainly focused on large firms and paying less attention to small to medium enterprises. There are still very few studies which examine Knowledge Creation, Knowledge Integration and Knowledge Management issues related to small to medium enterprises, despite the large numbers in every national

economy. Existing research reveals only a few studies about Knowledge Management application in small to medium enterprises, especially in the context of developing countries and Africa in general. If small to medium enterprises operate under pressure and suffer a lack of resources in developed countries, they have to face even greater difficulties in developing countries. The issues that small to medium enterprises would face would not be simply a scaled-down replica of large–company experience (Pillania, 2008; Sparrow, 2001; Wong, 2005).

Measurement approaches for Knowledge Management have been developed by various scholars (Kaplan and Norton, 1996; Myers, 2001; North et al., 1998; Skyrme and Amidon, 1998; Sveiby, 1997). All these approaches do not take into account the desirability of Knowledge Management within a given organisation. Tools to evaluate the organisation's performance with regards to Knowledge Creation, Integration and Management in relation to the level of its desirability are not readily available.

In all the reviewed literature, no attempt has been made to discuss Knowledge Creation, Integration and Management in civil engineering consulting firms. It is worth noting also that there is no focus on Zambia, be it for large or small organisations.

Table 2-1 summarizes literature reviewed and provides the critique on each one of them.

2.9 Contribution of the research to literature

The research is aimed at closing the knowledge gap identified in Sections 1.2 and 2.8. The research would contribute towards developing a framework for evaluating the organisation's performance with regards to Knowledge Creation, Integration and Management based on the level of desirability for that particular organisation. Factors that contribute to successful Knowledge Creation, Integration and Management would be identified and form a basis for development of working models for civil engineering consulting firms as wells other professional services organisations in general. The proposed $CIMEM_k$ would be used by practitioners to identify factors best suited for their situation to improve their Knowledge Creation, Integration and Management practices which would result in enhanced competitive advantage within the sub-sector of the economy.

Table 2-1: Content analysis of key literature reviewed

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
1.	Baker et al., 1997	To introduce some of the elements of Knowledge Management and outline the approaches to support the development of knowledge enablers within organisations.	Case Study.	The initial Knowledge Management focus of the organisation is aimed principally on explicit knowledge, and the establishment of tools which help to capture internal information. The long-term challenge is to capture the knowledge of the organisation in such a way that all of its employees could maximise the value they provide to the organisation's stakeholders.	Baker et al., (1997) provides foundational understanding of the importance of Knowledge Management in an organisation. The paper therefore is useful as a basis for further research.
2.	Blumettrit and Johnson, 1999	To develop a line of analysis, and consequent models for managing knowledge effectively in terms of having a much better understanding of the peculiar characteristics of this commodity, the ways in which it becomes embodied in economic goods, and the conditions governing its effective trade, transfer and ownership.	Literature review.	Five major conclusions were made: (1) Knowledge and information are different. (2) A boundary between knowledge and information could be clearly established. (3) Knowledge cannot be managed with the same tools as information. (4) The interaction of knowledge and information could be described in a model. (5) The management of information is already well developed; the management of knowledge is still in its infancy.	The paper lays a foundation for understanding Knowledge Management and Knowledge Integration. The information provided in this paper could be used as a basis for further research.
3.	Bierly et al., 2000	To improve the understanding of the impact of organisational learning and knowledge on competitive advantage, a framework that includes the constructs of data, information, knowledge, and wisdom was proposed.	Literature review.	Three important drivers for the development of organisational wisdom are experience, a passion to learn, and spirituality.	The paper lays a foundation for understanding Knowledge Management and Knowledge Integration. The information provided in this paper could be used as a basis for further research.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
4.	Gupta et al., 2000	To identify the Knowledge Management practices and challenges.	Literature review.	Knowledge Management is the only competitive advantage for companies in the 21st century. Successful Knowledge Management implementation requires a major change in organisational culture and commitment at all organisational levels.	The findings of this research provide insights for future research and development of the Knowledge Creation, Integration and Management Evaluation Model.
5.	Alderman et al., 2001	To establish Knowledge Management requirements of complex long-term engineering projects where a service innovation demands a major capital investment programme.	Case studies.	Contractors frequently learn what they need to know too late. The meta-project requires a front loading of the knowledge gathering and learning process. This means that appropriate staff development needs to be carried out to ensure that people with the right skills and experience could be brought into the project process at the appropriate stage. The absence of a meta-project integrator, contractors tends to decompose the meta-project into manageable discrete projects that individually they are more comfortable with, but with downstream implications for the integration of the meta-project.	In this paper, the need for Knowledge Management is highlighted. The paper however only deals with the contractor sub-sector of the construction industry. The paper also does not address issues related to Knowledge Integration and Knowledge Creation.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
6.	Becerra-Fernandez and Sabherwal, 2001	To develop a contingency framework, including two attributes of the organisational subunit's tasks: process or content orientation, and focused or broad domain, and links Knowledge Management processes to them: intemalisation for focused, process-oriented tasks; extemalisation for focused, content-oriented tasks; combination for broad, content-oriented tasks; and socialisation for broad, process-oriented tasks.	Interviews and surveys.	The results supported the contingency framework. All the Knowledge Management processes except extemalisation had a positive impact in the expected cell. At the overall level, combination and extemalisation, but not intemalisation and socialisation, affect knowledge satisfaction.	The framework provides foundational understanding of Knowledge Management within an organisation. It however does not provide a means for evaluating the effectiveness of the Knowledge Management programme within an organisation. It also deals with Knowledge Management in isolation of Knowledge Integration and Knowledge Creation.
7.	Egbu and Boterill, 2002	to identify the technologies that are used to manage knowledge in the construction industry; the effectiveness of these technologies and highlighting the strengths and weaknesses of particular IT for Knowledge Management.	Questionnaire survey and ethnographic interviews.	The research revealed that conventional technologies, such as the telephone, are used more frequently to manage knowledge, than more radical IT, such as Groupware or video conferencing. In construction organisations, the potential benefits of IT for Knowledge Management, are not fully exploited and many have expressed a need for greater implementation of IT, appropriated by sufficient training and education of staff.	Technologies that support Knowledge Management within the construction industry are discussed. These technologies are however not used to measure the effectiveness of Knowledge Management within a given organisation.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
8.	Kamara et al., 2002	To describe a framework for selecting a Knowledge Management strategy that is appropriate to the organisational and cultural context of an organisation.	Case study.	The approach represented in the framework underscores the fact that Knowledge Management is not an end in itself but a means towards the solution of business problems that militate against the efficiency and innovative capacity of a company.	The findings of this research provide insights for future research and development of a model for Knowledge Creation, Integration and Management monitoring and evaluation.
9.	McInerny, 2002	To show how the heart of Knowledge Management is related to the dynamic nature of knowledge.	Literature review.	Knowledge Management is another big idea that may not always retain its current golden cache, but it is bound to continue to influence the way we think about organisational processes and assets. The article critiques some current thinking in the Knowledge Management literature and concludes with a view towards Knowledge Management programmes built around knowledge as a dynamic process.	The paper lays a foundation for understanding Knowledge Creation, Knowledge Integration and Knowledge Management though in isolation. The information provided in this paper could be used as a basis for further research.
10.	Li and Gao, 2003	To better understand Nonaka's SECI model of Knowledge Creation and its constraints.	Literature review.	First, the "tacitness" of knowledge is broken down into two parts: implicitness and real tacitness. They argued that the tacit dimension of knowledge in the context of the model is different from that in Polanyi's original context; it actually includes considerable "implicitness" idiosyncratic in Japanese context. The separation of implicitness from real tacitness suggests carefully considering the potentialities of "unveiling" the secrets of tacit knowledge in different contexts. Second, considering most cases for the model mainly came from certain Japanese manufacturing companies that more or less relates to assemble lines, it is necessary to be cautious when the model is extended for a broader application.	The paper lays a foundation for understanding Knowledge Creation, Knowledge Integration and Knowledge Management though in isolation. The information provided in this paper could be used as a basis for further research.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
11.	Nickols, 2003	To clarify some terms commonly used in discussions about Knowledge Management.	Literature review.	Knowledge Management seeks to manage knowledge. Knowledge itself is a very slippery concept with many different variations and definitions. The nature of knowledge and what it means to know something are epistemological questions that have perplexed philosophers for centuries and no resolution looms on the horizon.	The paper lays a foundation for understanding Knowledge Creation, Knowledge Integration and Knowledge Management though in isolation. The information provided in this paper could be used as a basis for further research.
12.	Boyd et al., 2004	To test and improve a simple yet robust approach for collection, structuring and dissemination of knowledge.	Case study.	The preliminary findings from the research indicate that audio diary and debriefing as a tool for Knowledge Management are effective and efficient for practitioners to capture and distil their learning and tacit knowledge.	The paper lays a foundation for understanding Knowledge Management and Knowledge Integration. The information provided in this paper could be used as a basis for further research.
13.	Carlucci et al., 2004	To define an interpretative model that explains the links between the investments in Knowledge Management initiatives and business performance.	Literature review.	The knowledge value chain represents the conceptual basis for the development of a more prescriptive model for the definition and the implementation of Knowledge Management projects oriented to improve the value-generating capability of a company.	The paper shows that Knowledge Management could greatly improve business performance. The information contained in this paper could therefore be used to lay a foundation of the research.
14.	Carrillo et al., 2004	To examine UK's top construction companies Knowledge Management practices.	Literature review and questionnaire survey.	Identifies the Knowledge Management tools that the surveyed companies most often used when collecting and disseminating project-generated knowledge.	The paper identifies some tools that could be used a basis for further research within the context of consulting firms.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
15.	Egbu, 2004	To explores the importance of Knowledge Management and intellectual capital in organisations. To also establish the critical factors that lead to successful innovations and the role of Knowledge Management and Intellectual Capital in this regard.	Literature review and questionnaire surveys.	The paper argues that effective management of knowledge assets involves a holistic approach to a host of factors. It is also suggested that there are a host of factors that combine in different ways to produce successful organisational innovations. It recommends that more is needed on the education and training of construction personnel and that these education and training programmes should reflect the nature of innovation and Knowledge Management dimensions as very complex social processes.	The findings of this research provide insights for future research and development of the Knowledge Creation, Integration and Management Evaluation Model.
16.	Hari et al., 2004	To discuss the output of a research study focused on knowledge capture in small to medium enterprises in construction industry. The paper was also aimed at presenting and discussing a computer-based awareness tool on knowledge capture underpinned by Kolb's experiential learning theory.	Questionnaire survey. Also Grounded theory approach was adopted.	The results show that there is lack of awareness of complex issues associated with an effective knowledge capture process as well as ensuing benefits for small to medium enterprises in the construction industry. The effective implementation of knowledge capture in small to medium enterprises is partly dependent on the vision and flair of the owner/partners of the organisation. It is also determined by culture, structure, people, finance and technology, which warrants a coherent and structured approach.	The findings of this research provide insights for future research and development of the Knowledge Creation, Integration and Management Evaluation Model.
17.	Sommervile et al., 2004	Focus on the link between Knowledge Management and the impact of Knowledge Management approaches on the people within the enterprise i.e. engendering hardiness.	Literature review.	The findings indicate that within the construction industry they do not as yet fully embrace “soft issues” and therefore extract the full value from them in terms of reducing stress within the enterprise.	The paper indicates some challenges that are faced by the construction industry and brings out the need for further research on Knowledge Management. However, it does not address issues related to Knowledge Creation and Knowledge Integration.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
18.	Tserng and Lin, 2004	To study the application of Knowledge Management to construction projects in the construction phase and propose a Construction Activity-Based Knowledge Management concept and system for general contractors.	case study.	The results demonstrate the effectiveness of sharing knowledge in the construction phase. By utilising the latest web technology, knowledge exchange and storage concepts and modes of implementation, a Construction Activity-Based Knowledge Management system is an effective tool for all experts and engineers participating in the construction phase of a project.	The effectiveness of sharing knowledge was established. A platform for knowledge-sharing was also proposed. The findings therefore lay a foundation for further research especially as it relates to evaluation of Knowledge Creation, Integration and Management within an organisation.
19.	Wong and Aspinall, 2004	To redress some of the imbalances in literature by putting Knowledge Management in to the context of small businesses.	Literature review.	Fundamental Knowledge Management principles apply to all organisations but the huge resources required to implement Knowledge Management may not be available on small to medium enterprises. The notion of Knowledge Management should therefore be redefined to meet the circumstances under which it operates.	Provides insight on Knowledge Management in Small to Medium Enterprises and foundational concepts for development of the study,
20.	Fong, 2005	To establish whether a proposed Web-based prototype Knowledge Management system would be a feasible solution for capturing and reusing knowledge and experience in building maintenance.	Questionnaire survey.	It would be worth considering ways of capturing and reusing knowledge since it is very important for any organisation.	The need to capture and re-use knowledge is identified. No model however was proposed for capturing such data.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
21.	Robinson et al., 2005	To investigate how large UK construction organisations manage their knowledge assets. It then proposes STEPS, a mechanism for benchmarking organisation's Knowledge Management maturity.	Case study.	The investigation shows that the UK-based companies with international operations are ahead of their national counterparts in their Knowledge Management implementation efforts. The paper concludes that construction organisations are likely to be successful in implementing Knowledge Management if appropriate considerations are given to strategy formulation, implementation issues addressed and the link between Knowledge Management and business strategy is strengthened.	STEPS provides a mechanism for benchmarking Knowledge Management maturity for large organisations. The needs for small to medium enterprises are therefore not catered for within such a framework.
22.	Salojärvi, 2005	To make a contribution by examining the relationship between sustainable sales growth and Knowledge Management activities in 108 Finnish Small to Medium Enterprises.	Questionnaire survey and interviews.	Higher levels of Knowledge Management maturity were found to correlate positively with long-term sustainable growth. Although Finnish Small to Medium Enterprises display a surprisingly high awareness about Knowledge Management, only a minor proportion of the sample firms has been able to benefit in terms of growth from their Knowledge Management-related activities. The results have implications for policy formulation in the field of small to medium enterprises, since half the Finnish Small to Medium Enterprises in the sample do not grow. It was established that the fast-growing companies with high Knowledge Management maturity are applying Knowledge Management-related activities in a comprehensive and balanced way, thereby raising question marks around the effectiveness of eclectic "Knowledge Management implementations".	The study was focused on small to medium enterprises in general emanating from various sectors of the economy. The results are however useful.
23.	Wong, 2005	To bridge the gap in literature on critical success factors for implementing Knowledge Management in small to medium enterprises and large companies'.	Literature review and questionnaire surveys.	The effective implementation of Knowledge Management is governed and facilitated by certain factors. Organisations could certainly benefit from a more thorough understanding of the factors that are critical to the success of Knowledge Management.	The paper lays a foundation for understanding Knowledge Management in small to medium enterprises. The critical success factors were identified and will be used as a basis for further research.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
24.	Alonderiene et al., 2006	To define and clarify the concept of knowledge in both individual and organisational levels; to define tacit knowledge in the workplace and draw distinctions between tacit knowledge, explicit knowledge and implicit knowledge; to identify and describe informal learning in both individual and organisational levels, to clarify distinctions and find out liaisons between tacit knowledge and informal learning.	Literature review.	Analysis of liaisons between tacit knowledge and informal learning revealed that both concepts are sometimes used incorrectly. The concepts of informal knowledge and implicit learning appear and are used in ambiguous cases. Although tacit knowledge and informal learning are supposed to make great influence on individual and organisation they are not recognised in some cases. Several interconnection structures are used to define liaisons between the described concepts: types of knowledge/types of learning; level of knowledge analysis/level of learning analysis; and level of knowledge/learning recognitions.	The paper lays a foundation for understanding Knowledge Management and Knowledge Integration. The information provided in this paper could be used as a basis for further research.
25.	Call, 2006	To provide a broad understanding of Knowledge Management and how to successfully implement Knowledge Management.	Literature review.	A thorough overview of Knowledge Management and its building blocks, as well as examples that incorporate various degrees of technology are provided.	The paper deals with various aspects of Knowledge Management but does not deal with Knowledge Creation and Knowledge Integration. The paper also does not provide for means of measuring or evaluating Knowledge Management within an organisation.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
26.	Carrillo and Chinowski, 2006	To investigate how major United States engineering design and construction firms are implementing Knowledge Management initiatives in order to identify best practice.	Case study.	The study finds that there is a clear distinction between the Knowledge Management activities undertaken by large engineering design firms and those of construction firms. There is also a much greater emphasis on knowledge-sharing, which is just one component of Knowledge Management. Moreover, some companies have specific Knowledge Management initiatives while others have activities that are part of their normal business processes.	Knowledge Management activities in consulting firms are not the same as those of construction companies. The paper therefore helps shape the focus of the research.
27.	Lin et al., 2006	To present a novel and practical method to capture and represent construction project knowledge by using network knowledge maps.	Literature review and case studies.	The Map-Based Knowledge Management system indicates the effectiveness of sharing knowledge, particularly in the construction phase. Knowledge could be captured and managed to benefit future projects by effectively utilising information and web technologies during the construction phase of a project. The results of the study demonstrate that a Map-Based Knowledge Management like system could be applied effectively in Knowledge Management systems in the construction industry by using Map-Based Knowledge Management and web technology.	Introduces the concept of knowledge maps that could be explored further in developing an evaluation framework.
28.	Ahmad et al., 2007	To present a new Knowledge Management model that combines many of the recent research outputs from construction domain and other disciplines.	Case study.	The proposed model presents the essential Knowledge Management activities and features broken down into more manageable parts that are easy to understand and use, which simplifies the understanding of the sources of knowledge, the inputs and outputs, the flow of knowledge and the identification of other variables such as the cultural effects on the organisational knowledge.	The model identifies the essential variables and features of Knowledge Management but does not address Knowledge Creation and Knowledge Integration aspects.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
29.	Ahmad and An, 2008	To present a new Knowledge Management model that provides for effective and efficient means of managing knowledge in the construction industry.	Case study.	The results indicated that the proposed Knowledge Management model could facilitate the process of implementation, development and use of the Knowledge Management system.	The model however does not provide a means of effectively measuring Knowledge Management within an organisation. Knowledge Creation and Knowledge Integration are also not addressed within the context of the model.
30.	Bennet and Bennet, 2008	To identify and develop an understanding of the aspects of tacit knowledge that play a significant role in enabling organisational learning.	Literature review.	The recognition that tacit knowledge resides beyond ordinary consciousness leads to the search to develop greater sensitivity to information stored in the unconscious to facilitate the management and use of tacit knowledge. Surfacing, embedding and sharing tacit knowledge are approaches for mobilising tacit knowledge in support of individual and organisational objectives. In addition, it was forwarded that participating in or exposing ourselves to situations that induce resonance engages our personal passion in developing deeper knowledge and expanded awareness of that knowledge, which is, moving society towards extraordinary consciousness.	The paper lays a foundation for understanding Knowledge Management and Knowledge Integration. The information provided in this paper could be used as a basis for further research.
31.	Pillania, 2008	To study strategic issues in Knowledge Management in Small to Medium Enterprises in India, with particular reference to the automotive component sector.	Case studies and surveys.	Customer focused knowledge is the most common Knowledge Management strategy among Indian auto component manufacturers. Top management is more active and supportive in Knowledge Management initiatives in international auto component manufacturers. Indian small to medium enterprises need to focus more on the strategic issues in Knowledge Management for reaping the benefits of Knowledge Management for sustainable competitiveness.	Provides insight on Knowledge Management in Small to Medium Enterprises and foundational concepts for development of the study,

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
32.	An and Ahmad, 2010	To present a methodology for dealing with tacit knowledge efficiently and effectively in construction projects.	Case study.	Tacit and implicit knowledge require more efforts of the organisation to manage than explicit knowledge. But, however, tacit and implicit knowledge provide more value and benefits to the organisation. Therefore, the application of both technological services and non-technological activities and approaches through the Knowledge Management system to deal with such two types of knowledge is important. An effective way is to apply a set of non-technological activities and approaches to encourage employees to share, capture and create such knowledge and also requires the organisation to provide time and places for employees to learn the new procedures and methods of using the Knowledge Management system. Furthermore, the organisation may need to enhance the culture that encourage employees to spend time to perform high quality works rather than performing high quantity works with low quality that may cause additional costs and efforts of repeating works and fixing errors in the future.	The paper highlights the significance of tacit and implicit knowledge which are valuable to an organisation. The paper however does not explicitly show how these two types of knowledge could be captured and converted so as to enhance Knowledge Management, Knowledge Creation and Knowledge Integration within an organisation.
33.	Alavi and Leider, 2014	To present a review and interpretation of Knowledge Management literatures in different fields with focus towards identifying the important areas for research.	Literature review.	Organisational knowledge and Knowledge Management are popular topics in several extant literatures including strategic management and organisational theory as well as information systems. It is thus important that researchers be aware of, understand, and build upon the already significant work in the large extant literatures. This will provide the diversity of perspectives and approaches that the study of such multifaceted and complex phenomenon requires.	Significant work by other researchers is provided in this paper. It therefore forms a basis for further research.

2.10 Summary

This Chapter presented a review of literature on the subject of Knowledge Creation, Integration and Management. The reviewed literature showed that there has been high interest in the subject of Knowledge Management but little on Knowledge Creation and Integration. Knowledge Management studies have been more concerned with large organisation, paying little attention to small and medium enterprises. It was also noted that there exists no study that directly attempts to deal with Knowledge Creation, Integration and Management within the civil engineering consulting industry, and as such there exists no model to that effect. Also no model attempts to evaluate firms' performance with regards to Knowledge Creation, Knowledge Integration or Knowledge Management relative to their need. It was from that perspective that the motivation to undertake this study was drawn from.

The next Chapter discusses the research methodology adopted in the study. The merits and demerits of the various research methods are also discussed and presented.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The previous Chapter outlined reviewed literature on Knowledge Creation, Integration and Management. This Chapter outlines the methodology adopted to carry out the research presented in this thesis in order to address the defined study aim and objectives. Saunders et al. (2012) define research methodology as the theory of how research should be undertaken, and research methods as the techniques and procedures used to obtain and analyse data. The Chapter begins with a review of the methodological considerations that led to the adoption of a mixed method strategy of inquiry. Highlights of the various research methods that could be adopted for research purposes are presented. The Chapter further explains how the stated problem was investigated and describes the tools for investigation.

3.2 Research methodology

Generally, the search and gathering of data and information for the advancement of knowledge is regarded as research. A research methodology refers to the principles and procedures of logical thought processes which are applied to a scientific investigation (Fellows and Liu, 2003; Sutrisna, 2009). Easterby-Smith et al. (2008) defined research as a combination of techniques used to enquire into a specific situation. Research methodology therefore means the overall strategy designed to achieve the aim and objectives of the research. It includes the procedures and techniques of investigation for effective and reliable representation of the research.

The selection of research methodology and methods in management and social sciences represent the researcher's assumptions about the nature of the social world and the type of knowledge to be obtained (Creswell and Clark, 2007). These assumptions or paradigms are essential for the research because the researcher's chosen methods must reflect the context of the underlying assumptions.

3.2.1 The philosophical basis of research

To arrive at the appropriate philosophical position for the research, it is necessary to provide a descriptive analysis of the various philosophical assumptions about the nature of the social world. The analysis generally explores the reasons for studying philosophical issues in research and specifically with reference to research methodology.

There are strong reasons for a proper understanding of philosophical issues in research. Easterby-Smith et al. (2008) identified three reasons why the exploration of philosophy may be significant in research methodology:

i.) It could help the researcher to refine and specify the research methods. This includes the type of evidence gathered and its origin, the way it is interpreted and how it helps to answer the research questions.
ii.) The knowledge of research philosophy helps the researcher to evaluate different methodologies and methods in order to avoid inappropriate use and unnecessary work. The researcher therefore identifies the limitations of a particular approach at an early stage.
iii.) It may help the researcher to be creative and innovative in either selection or adaptation of methods that were previously outside the researcher's experience.

In addition, the nature of philosophical questioning often encourages in-depth thinking and this often generates further questions in relation to the topic under investigation (Crossan, 2003). Thus, understanding philosophical issues provides a sound basis for a methodological argument of the research.

3.2.2 Research philosophy

The most basic consideration and classification of research is the philosophical level or dimension. This level relates to research assumptions based on the most general features of the world. It encompasses such aspects as the mind, matter, reality, reason, truth, nature of knowledge and proofs of knowledge (Crossan, 2003). Simply put, research philosophy refers to the assumptions and undertakings which implicitly or explicitly guide an inquiry in a study. A literature scan of the various philosophical views reveals that the most prevalent positions are ontological or epistemological. Other views such as sociological and axiological assumptions could also be found in the research methodology literature (Easterby-Smith et al., 2008; Neuman, 2003).

a) Ontological view

Ontology explains the nature of knowledge and assumptions about reality (Pathirage et al., 2007). It explains the claims and assumptions that are made about the nature of reality. The ontological view therefore refers to the researcher's position or answer to the question about the nature of the reality under investigation. This assumption about the nature of the world complements the formulation of the research philosophy and so influences the selection of the appropriate research approach and methods. Shakantu (2004) identified two seemingly opposing but competing ontological views in which researchers and sociologists could base their methodology. He refers to what Babbie (2010), Neumann (2003) and Chia (2002) call "Parmenidean and Heraclitean" ontologies.

In the parmenidean context, according to Chia (2002), reality is composed of clear entities with identifiable or discrete properties and characteristics. In the Heraclitean world view on the other hand, reality is viewed or seen as 'inclusively processual'. In other words, all things are in constant flux regardless of how they appear to the senses. These polarised ontological views only provide a shared vocabulary which could be used to describe objects and/or concepts that exist, their properties and relationships between them. Ontological concerns therefore deal with the nature and conception of reality. Ontology, therefore, examines being or existence, its basic categories and relationships to determine what entities and what types of entities exist (Sutrisna, 2009).

There are two types of ontological views, based on whether the external world is having a predetermined nature and structure or not; the realist and idealist ontologies (Johnson and Duberly, 2000; Sexton, 2004). Realists start with a stance of a commonly experienced external reality with predetermined nature and structure, whereas idealists assume that different observers may have different viewpoints and that what counts for truth varies in space and time. This view is consistent with the proposition by Gill and Johnson (1997) that research methods could be positioned by taking nomothetic (realist) and ideographic ontologies into account. Gill and Johnson (1997) define nomothetic approach as that which utilises quantified methods for data analysis while ideographic approach deals with analysis of subjective accounts generated through inside situations that involve one in the everyday flow of life.

Nomothetic approaches emphasise the importance of basing research upon systematic techniques as well as methods employed in the natural sciences which focus on the process of testing hypothesis. It also emphasises the explanation of laws and deductions using quantified operational concepts. Ideographic approaches on the other hand, emphasise the analysis of subjective accounts that is generated by getting inside situations. The emphasis is upon theory rounded in empirical observations to gain explanation and understanding. In sum, while experiments and survey methods are associated with the nomothetic view; action research, case study and ethnography are associated with the ideographic view (Pathirage et al., 2007).

However, whichever illustrations or examples of ontological assumptions or views are described by authors, a connecting string in all the examples is provided by the objective and constructive continuum provided by Sutrisna (2009). Sutrisna (2009) explained that objectivism asserts that phenomena and their meanings have existence that is independent from the actors while constructivism asserts that phenomena and their meanings are continually being accomplished by their actors. Put differently, phenomena and their meanings are not only produced through interactions but also in a constant state of revision.

b) Epistemological view

Epistemology refers to the claims of what is assumed to exist and could be known. It examines the theory of knowledge with reference to its methods, validation and possible ways of gaining knowledge in the assumed reality. Simply put, epistemology describes what the researcher knows about the reality and assumptions about how knowledge should be acquired and accepted. Epistemology therefore is concerned with how and what the researcher knows and the questions about how and what is possible to know (Shakantu, 2004).

In epistemological undertakings, two most commonly used examples are positivism and interpretivism. Sometimes, these may be referred to as objectivism and subjectivism. Easterby-Smith et al. (2008) in their review of research philosophies refer to the two ends of epistemological undertakings as positivism and constructivism. The positivists believe that the social world exists externally and that its properties should be measured through objective measures where the observer must be independent of what is being observed. Social constructivism on the other hand stems from the view that reality is not objective and exterior; it is socially constructed and given meaning by people who are conscious, purposive actors with ideas about their world and attaching meanings to what is going on around them (Robson, 2011). These two fundamentally different and competing schools of thought demonstrate the complexity of the issues embodied in epistemological and ontological viewpoints.

However, Sutrisna (2009) provides a hyper simplification of these two philosophical viewpoints by stating that positivism mainly takes objectivism as the basis of understanding the reality and that there is only one objective reality experienced by all. Similarly, interpretivism mainly takes constructivism as the basis of understanding the reality which is constructed individually and interpreted differently. It must be noted that each of the two dimensions or viewpoints could be considered multi-dimensionally. This underlines the two-dimensional continuum explained by Sutrisna (2009). The intention of the continuum is to highlight the similarities of the assumptions or links between the philosophical viewpoints.

3.2.3 Research paradigms

The science of research has its roots in philosophy. The philosophy of research could therefore be viewed as a way of describing how research could be conducted and how the real world, empirical data, models and theories relate to each other. A research methodology is driven by certain ontological and epistemological assumptions about the reality of the social world. These assumptions invariably affect how the research is carried out.

A research paradigm is the fundamental model or scheme which organises the researcher's view and reasoning (Babbie, 2010). Social scientists make use of a variety of paradigms to organise how they understand and inquire into social life. Thus, paradigms provide a powerful range of possibilities for structuring a research. Babbie (2010) argued that each paradigm makes certain assumptions about the nature of reality. By their nature, paradigms are neither true nor false. They merely provide different ways of viewing and seeking explanations. Paradigms may be considered useful or not depending on the context of the study.

Saunders et al. (2012) asserted that although it is useful to attach research approaches to different philosophies/paradigms, such labelling has no real practical values. However, such representations or attachments provide an understanding of how theory is related to each research philosophy. The researcher must therefore find out ways in which a particular paradigm could be useful and how it could guide the research. It is also important to note that consistency between the aim and objectives of the research, the problem statements/research questions, the methods and personal philosophy of the researcher essentially underpins and drives the research process. At this point, the following sections provide an understanding of the two extremes of research paradigms; positivism and phenomenology.

a) The positivist paradigm

The term positivism generally represents the belief in a logically ordered objective reality that could come to be known (Babbie, 2010). Positivism which originates from the thinking of Comte; and for centuries was the dominant method of scientific enquiry derived from the study of natural sciences. Indeed, what could be described as the traditional scientific approach to research has its underpinnings in the philosophy of positivism. The positivist approach to the social sciences assumes that things could be studied as hard facts and that the relationship between these facts could be scientifically established as laws. According to the positivists, these laws have the status of truth and that social objects could be studied in much the same way as natural objects. Babbie (2010) suggested that there are three distinct generations of the positivist philosophy. These generations follow from the period which allowed the contemplation of social life to break away from religious interpretations and so established human beings as the main characters in the development and accumulation of scientific knowledge. The first generation of these philosophers include Locke, Hume, and Comte. This generation established in the 18th and 19th centuries were associated with the early traditions of positivism. They were followed by the second generation of logical positivism associated with the early 20th century philosophers. These include Carnap and Ayer collectively known as the Vienna circle (Crossan, 2003). The third generation emerged in the post war period associated with Hempel (Achinstein, 2010).

The fundamental reasoning of positivism assumes that an objective reality exists which is independent of human behaviour and therefore not a creation of the human mind. It suggests that the senses should be used to accumulate data that are objective, discernible and measurable. Any other thing should be rejected. This implies that positivism assumes that the real world could only be studied through the utilisation of methods that prevent human contamination of its apprehension or comprehension (Kheni et al., 2008). Logical positivists stress the importance of induction and verification and establishment of laws. This presents a major departure from the early tradition of positivism. The aim of the logical positivists is to cleanse scientific knowledge of subjective and speculative views. They do this by the use of mathematics and formal logic to analyse statements about the observed world using the process of induction as a means of establishing generalisations and laws. Put differently, the proponents of logical positivism argue that numerical methods and mathematics are considered above the human language of description and so assumed to be the only appropriate method for obtaining facts scientifically. The standard positivists, third generation, who emerged after the Second World War focused on the need for reasoning which moves from theoretical ideas to a logical conclusion through deductive thinking.

The general features of the positivist philosophy have several implications for researchers and social scientists. These implications include (Easterby-Smith et al., 2008; Pathirage et al., 2007):

i.) methodological; all research should be quantitative and that only quantitative research could form the basis for valid generalisations and laws;
ii.) value-freedom; the choice of how and what to study should be determined by objective criteria rather than by human beliefs and interests;
iii.) causality; the aim should be to identify causal explanations and fundamental laws that explain human behaviour;
iv.) independence; the researcher is independent of the subject under investigation; and
v.) reductionism; problems are understood better if they are reduced to the simplest possible elements.

A major shortcoming of the positivist philosophy is that it does not provide the means to measure human beings and their behaviour in an in-depth manner. Human beings are not objects and are therefore subject to many influences on behaviour, feelings, perceptions and attitudes. These attributes are rejected by positivists and regarded as irrelevant; belonging to the realm of metaphysics. Although the positivist approach yields useful data for analysis, these data are limited and therefore provides a superficial view of the phenomenon under investigation. However, the positivist philosophy embraces a conception of truth in which verifiable statements agree with identifiable and ascertainable facts of reality (Crossan, 2003). Positivism therefore promotes a more objective interpretation of reality using hard data from surveys and experiments.

b) Phenomenological paradigm

A phenomenon is an observable occurrence, experience, circumstance or fact that is perceptible to the senses. Phenomenology is therefore concerned with methods that examine people and their social behaviour. Phenomenology has its roots in the social sciences and so sees the social world as a world of meanings. Thus, the social world is not made up of entities which are external to the subjective experience of its members. The phenomenological or interpretivist perspective offers researchers and social scientists a radical alternative to the positivist methodology. From the phenomenological viewpoint, there is a fundamental difference between the subject matter of the natural sciences and that of the social sciences.

Natural science deals with matter which lacks consciousness; its behaviour could therefore be explained as a reaction to the external stimuli. But this cannot be said of human beings. Human beings see, interpret and experience the world in terms of meanings and actively construct their individual social reality. Meanings do not have independent existence; they are rather constructed and reconstructed by actors in the course of social interaction. This clearly explains why the positivist and phenomenological perspectives employ different research methods. They proceed from diametrically opposite assumptions about the nature of social reality (Easterby-Smith et al., 2008).

Phenomenology holds that assumed notions and perceptions are often out of contact with the entities they purport to see, know or interpret; it calls for a return to the foundations of meaning and experience. Shakantu (2004) noted that in phenomenological research, data are collected in the form of words and observations and analysis are based on the interpretation of these data rather than numbers and statistical manipulations. Authors (Crossan, 2003; Easterby-Smith et al., 2008; Saunders et al., 2012) have highlighted the main features or elements of the positivist and phenomenological paradigms of research. A summary of these features and research implications are provided in Table 3-1.

Table 3-1: Summary of implications and basic features of positivism and phenomenology

Key areas	Positivism	Phenomenology
Basic viewpoints and beliefs	The world is external and objective; the observer is independent; and science is value-free.	The world is socially constructed and subjective; the researcher is part of what is observed; and science is driven by human interests and motives.
Method of research	Focus on facts; look for causality and fundamental laws; reduces phenomenon to the simplest elements; and formulate hypotheses and test them.	Focus on meanings; try to understand what is happening; look at the totality of each situation; and develop ideas through induction from data.
Research design	Structural, formal and specific detailed plans.	Evolving and flexible.
Involvement of the researcher	The researcher remains distanced from the material being researched; short term contact.	The researcher gets involved with the phenomenon being researched; long-term contact; emphasis on trust and empathy.
Preferred strategy	Operationalisation of concepts so that they could be measured.	Use of multiple methods to establish different views of phenomena.
Sampling	Large samples and numbers selected randomly.	Small samples investigated in-depth or over time/small numbers of cases chosen for specific reasons.
Data collection methods	Experiments, surveys, structured interviews and observation.	Observations, documentation, open- ended and semi-structured interviews.
Research instruments	Questionnaires, scales, test scores and experimentation.	Researcher.
Strengths	Provides wide coverage of the range of situations.	Ability to look at change processes over time.

c) Combined research approach

The combined approach refers to a combination of the whole or parts of different research philosophies, either originating from the same or different paradigms in a particular research situation (Kheni et al., 2008; Pathirage et al., 2007). Many researchers discuss the various philosophical stances only from the perspective of their research. Nevertheless, philosophical stances actually portray a bigger picture because the researcher's perception of reality influences to a great extent the conduct of the research. Researchers could approach theory building and testing from different directions. While some researchers predominantly use experiments and surveys to test theories, others use action research and ethnography for theory building (Pathirage et al., 2007). This approach places research at polar opposites as it infers that the methods are mutually exclusive.

Evidently, a synthesis of the discussions on philosophical assumptions and paradigms shows that nomothetic; realist; parmenidean and objective viewpoints or assumptions are consistent with the positivist philosophy (positivism). On the other hand, ideographic; idealist; Heraclitean; interpretivist/subjective or constructivist viewpoints are consistent with phenomenology. Within the positivist ideology, research moves from theory to data and within the phenomenological ideology, research moves from data to theory (Pathirage et al., 2007). However, the richness of real world situations implies that a particular paradigm or assumption is unlikely to present a complete picture. Simply put, different philosophical assumptions or viewpoints provide different perspectives of the real world.

From the foregoing, the following arguments support the possibility of adopting more than one view point in a research. Providing insight into the nature of philosophical paradigms, Babbie (2010) argued that paradigms represent a variety of views; each of which offers insights the others lack while ignoring aspects of social life that the others reveal. In their view, Easterby-Smith et al. (2008) stated that the dichotomy between the positivist and phenomenological world views has led to sharp differences of opinion between researchers about the desirability of methods. Easterby-Smith et al. (2008) maintain that the practice of research involves a lot of compromises between pure positions. This understanding suggests that seeing positivism and phenomenology as related concepts is useful.

Again, the understanding that empirical and theoretical research is a dialectical relationship helps in seeing research approaches as a set of tools or directions which the researcher may draw on as and when appropriate. The growing disclosure on philosophical and methodological pluralism in modern research further challenges the polarised views on philosophies and approaches (Pathirage et al., 2007).

Construction management as a discipline combines highly complex, technical and social systems and is therefore at the centre of natural and social sciences (Shakantu, 2004). This implies that some aspects of positivism and phenomenology could both be relevant in construction management researches and could be therefore used in a complementary manner.

d) Research position and justification

The relationship between truth and theory is at the heart of science; determining when and if a theory should be accepted as reality (Pathirage et al., 2007). This philosophical realism and anti-realism debate explores the basis of a commonly accepted scientific truth. All the philosophical positions or views have their merits and demerits but adoption of a particular view point depends on the situation or context of the research. Given the problems highlighted in Sections 1.2 and 2.8, the research took a multi-paradigmatic approach. This multi-paradigmatic position follows from the research context of Knowledge Creation, Integration and Management and the complexity of information required in shedding light on civil engineering consulting firms. This particular field of research falls within construction management. Since construction management is at the centre of natural and social sciences, the combined approach is considered suitable for the research. Each view point brings special strengths and each compensates for the weaknesses of the other.

However, the justification for the adoption of the multi-method position is presented as follows:

i.) epistemologically, the research is objectivist. It is also positivists in paradigm. It is positivist because the problem being investigated is an objective social reality

requiring observation and survey of discrete and identifiable objects and phenomena; and

ii.) ontologically, the research is parmenidean and realist because the objective of developing a model for Knowledge Creation, Integration and Management evaluation, with identifiable variables, provides evidence to support generalisations about the performance of civil engineering consulting firms.

3.2.4 Research logic

The logic of research is strongly influenced by the philosophical stance of the researcher. Logic of the research refers to the interpretation of the research, the role of existing body of knowledge gathered in the literature study, the ways the researchers collect data and subsequent data analysis (Sutrisna, 2009). The research logic connects the researcher to the specific approaches and methods for collecting and analysing data. However, the research logic or approach could be empirical, non-empirical or a combination of the two. For the empirical research, whatever the purpose, empirical evidence is required and this means that the research must be based on data obtained from observation or experience. The study of real organisations or social setting may be based on the positivist or phenomenological paradigms (Easterby-Smith et al., 2008). There are three main dimensions of empirical research, namely: deductive and inductive research; quantitative and qualitative research; and subjective and objective research.

Although these dimensions do not necessarily represent a simple choice, they reflect the extent to which the elements of the research approach apply. Non-empirical research is based on pre-existing body of knowledge in a particular field. Some researchers depend entirely on this method and are generally known for searching and reviewing literature on a certain subject where the subject may be one of an historical nature. In this case, the research does not lend itself to any other form of investigation (Saunders et al., 2012). The combined approach took into account both empirical and non-empirical approaches to inform the structuring and execution of research activities. This research is contextually empirical and non-empirical and based on this understanding, the logic of the research is based on the combination of both approaches. At this point, it is necessary to discuss deductive and inductive; quantitative and qualitative; and subjective and objective approaches to empirical research.

a) Deductive research

A deductive research approach is simply a study in which theory is tested by empirical observation. It is sometimes described as moving from the general to the particular. Sutrisna (2009) contended that a deductive research traditionally begins by analysing the literature. That is, studying existing works in the field and providing the context of the

research. It continues by identifying and stating a single selected problem leading to the isolation of the major research sub-problems/questions in which the existing knowledge may be inadequate. For example, identified gaps between existing theories/evidence or contradictions to be explored/new contexts for applying previous findings. This is then followed by the formulation of hypotheses which may be in the form of a conceptual model, proposed to address the identified problem and sub-problems. It may further consist of steps to test the hypotheses. Sutrisna (2009) maintained that subsequent data collection using the proposed methods is followed by analysis resulting in findings closely linked to the existing body of knowledge earlier found.

Clearly, a deductive research tends to proceed from theory to data. As Gill and Johnson (1997) asserted, a deductive research entails the development of a theoretical and conceptual framework prior to its testing through empirical observation. In this approach, the researcher may have deduced a new theory by analysing and then synthesising ideas and concepts already present in the literature. The emphasis here is on the deduction of ideas or facts from the new theory in the hope that it provides a better or more coherent framework than the theories that preceded it. Highlighting a detailed description of the deductive process, Robson (2011) introduced five sequential stages of deductive research as:

i.) deducing a hypothesis from theory;
ii.) expressing the hypothesis in general terms;
iii.) testing the operational hypothesis;
iv.) examining the specific outcome of the enquiry; and
v.) if necessary, modifying the theory.

According to Collis and Hussey (2010), deduction is the dominant research approach in the natural sciences where laws present the basis of explanation, allow the anticipation of phenomena, predict their occurrence and permit them to be controlled. A deductive research could be considered in line with objectivism and positivism due to its reliance on current body of knowledge in composing hypothesis. Since there is only one objective truth, the researcher's investigation could be based on the existing body of knowledge which have been significantly proved and therefore must represent the objective truth (Sutrisna, 2009).

b) Inductive research

An inductive research is a study in which theory is developed from the observation of empirical reality. In this regard, general inferences are induced from a particular instance which is the reverse of the deductive research. It involves moving from individual observation to statements of general patterns or laws (Collis and Hussey, 2010). Inductive research tends to proceed from data to theory, that is, method, data, findings, theory.

Within the inductive approach, learning is done by reflecting upon particular past experiences through the formulation of abstract concepts and theories. Hence, the outcome of induction is theory (Gill and Johnson, 1997).

Providing insight into inductive research, Sutrisna (2009) stated that it intends to learn about the phenomena under investigation by applying a less structured methodology to obtain richer and deeper information. In an attempt to provide answers to the phenomena in question, inductive researchers try to keep their minds open for any possible results while proposing further steps for data collection. In certain methodologies for example, the grounded theory, a methodology that allows the researcher to develop a theoretical account of the general features of a topic while simultaneously grounding the account in empirical observations or evidence, a literature review is not recommended in the early stages to minimise the possibility of the researcher being influenced by presuppositions. Explanations and theories are then developed from observations of the empirical world.

Induction is the dominant research in the social sciences. Although the deductive/inductive research debate has a long history, Gill and Johnson (1997) claimed that the modern justification for taking an inductive approach in the social sciences tends to revolve around two related arguments:

i.) the explanation of social phenomena grounded in observation and experience; and
ii.) criticism of some of the philosophical assumptions embraced by positivism.

For most of the researchers working within the inductive tradition, explanations of social phenomena are relatively worthless unless they are grounded in observations and experience. The main difference between deductive and inductive research lies on the use of current body of knowledge and the role of data collection. Deductive researchers formulate hypotheses based on the current body of knowledge and then conduct a data collection and analysis to test the hypotheses. Inductive researchers on the other hand conduct data collection and analysis to come up with findings while using the current body of knowledge to inform their data analysis as deemed appropriate (Sutrisna, 2009). Inductive researchers argue that theory, inductively developed out of a systematic empirical research is more likely to fit the data and thus is useful, plausible, and accessible (Partington, 2000).

Another fundamental issue in the deductive/inductive debate is the subject matter of the social sciences and that of the natural sciences as mentioned earlier. Fundamentally, there is an ontological discontinuity between human beings and objects or things. The distinction here is that human beings experience the world, whereas things do not (Pathirage et al., 2007). This distinction underlines the philosophical stances of research. Inductive research therefore could be considered in line with phenomenology and subjectivism or interpretivism. The major differences between inductive and deductive research are provided in Table 3-2.

Table 3-2: Differences between deductive and inductive research

Deduction	**Induction**
Moves from theory to data.	Moves from data to theory
Common with natural sciences.	Common with social sciences
Approach is highly structured.	Approach is flexible and amenable to changes (less structured)
Explain causal relationships between variables.	Explanation is based on understanding of meanings attached to events by human beings (focus on meanings)
Select samples of sufficient size to generalise conclusions.	Pay less attention to the need to generalise
Reliability is high.	Reliability is low with high validity
Formulate hypotheses and test them.	Develop ideas through induction from data

Source: Adapted from Saunders et al. (2012).

Moreover, a further synthesis of discussions on research paradigms and research logic shows that deductive/objective research could be associated with positivism while inductive/subjective research could be associated with phenomenology or social constructivism. The research described in this proposal is both deductive and inductive. The arguments advanced for the multi-method position of this research in section 3.2.3c) underscores this approach. Specifically, the rationale behind the deductive and inductive logic of this research is explained as follows:

i.) deductively, the research moves from theory to data. This is evident in the review of pre-existing/current body of knowledge in Knowledge Creation, Integration and Management and therefore used as a source of reference for research in this field; and

ii.) from the perspective of induction, the exploratory approach is used to improve understanding of Knowledge Creation, Integration and Management perspectives and practices among the civil engineering consulting firms. This helps the researcher to obtain information on the stakeholders' opinion and perceptions about Knowledge Creation, Integration and Management in civil engineering consulting firms.

c) Subjective and objective research

This refers to the extent to which the researcher's prejudices/presuppositions influence the outcome of the research. This could be found in the research paradigm adopted by the researcher. If the researcher is involved in or has an influence on the research outcome; then, the researcher is subjective. If on the other hand, the researcher is distanced from or independent in the execution of the field work; then, the researcher is said to be objective.

Empirical research could be objective or subjective depending on the level of involvement of the researcher.

The traditional assumption that in science, the researcher must maintain complete independence if there is to be any validity in the results produced supports the positivist research paradigm which is mainly objective (Easterby-Smith et al., 2008). However, phenomenology by its very nature is subjective. Its use therefore requires participation in both real world circumstances and participation of the researcher. It must be accepted, however, that such a subjective approach used in a research requires the recognition of any influence or limitation the subjectivity may have on the conduct or findings of the research.

Supporting the combination of deductive and inductive logic in a research, Saunders et al. (2012) argued that not only is it perfectly possible to combine deduction and induction within the same piece of research, but it is often advantageous to do so.

3.3 Research methods

The discussion in this Section is anchored on the collection of data based on characteristics generally grouped as quantitative or qualitative. In other words, data is discussed here in terms of methods or approaches to data collection. As a convention, quantitative data requires a quantitative approach or method and qualitative data requires a qualitative approach or method in the collection and subsequent analysis of data (Sutrisna, 2009).

For many years, positivism and quantitative methods have been in the ascendancy in construction management research (Fellows and Liu, 2003). This has promoted an orthodoxy of the application of 'natural science' methods to study social phenomena and an attendant focus on explaining human behaviour. In contrast, proponents of interpretivism, as an alternative paradigm, espouse the importance of understanding human behaviour (Bryman and Bell, 2007). This has an emphasis on the empathetic comprehension of human action rather than the forces which shape it. This perspective arguably has the potential to provide complementary insights, enriching understanding of the perspectives of those who work in the sector.

In positioning the research methods or approaches, the philosophical assumptions and research paradigms must be taken into account. Therefore, the following sections provide an overview and discussions of these methods or approaches to research.

3.3.1 Quantitative method

Quantitative research is a study that utilises measureable methods for data collection and analysis. This research approach emphasises the importance of basing research upon systematic techniques and methods employed in the natural sciences. The approach focuses on the process of testing hypotheses (Pathirage et al., 2007). The quantitative research method seeks to gather factual data and study relationships between facts. The analysis of quantitative data yields quantitative results and conclusions are drawn from the evaluation of these results based on theory and literature.

Quantitative researchers seek causal determination, prediction and general isolation of findings. Thus, the methods employed are also known as scientific methods. Sutrisna (2009) argued that the quantitative approach positions the researcher as a neutral observer of the phenomena in question in order to maintain distance or objectivity from the research subject.

This implies that the quantitative approach is based on the positivist ideal which advocates that mathematics is the perfect tool to understand the worldly creation. Supporting this view, Nahiduzzaman (2006) maintained that researchers who use logical positivism employ experimental methods and quantitative measures to test hypothetical generalisation. Nahiduzzaman (2006) further claimed that quantitative researchers emphasise the measurement and analysis of causal relationships between variables. Quantitative methods are assumed to be repeatable and capable of isolation from reality without compromising the cause and effects being studied. Illustrating the meaning of quantitative research in the explanation of social problems, Nahiduzzaman (2006) noted that charts and graphs illustrate the results of quantitative research and commentators employ words such as 'variables, populations and result' as part of their daily vocabulary.

Quantitative research allows the researcher to be familiarised with the problem or concept to be studied. Since the emphasis is on facts and causes of behaviour, the information derived is in form of numbers that could be quantified and summarised. Furthermore, as the mathematical process is the norm for analysing the numerical data, the final result is expressed in statistical terminologies. The quantitative research as supported by the positivist or scientific paradigm leads us to regard the world as made up of observable and measurable facts.

A quantitative researcher attempts to fragment and delimit phenomena into measurable or common categories that could be applied to all subjects or even a wider range of similar situations. In this regard, the researcher's method involves the use of standardised measures in order to accommodate the varying perspectives and experiences of people, in a limited number of predetermined response categories to which numbers are assigned (Patton, 2002). To illustrate this approach, a quantitative researcher may prepare a list of behaviours to be checked or rated by an observer using a predetermined schedule or number scale as an instrument. This quantitative researcher needs to construct an instrument to be administered in a standardised manner according to the predetermined

procedures. In doing this, the researcher must ensure that the instrument measures what it is supposed to measure. The significance of this test is to ensure reliability or repeatability of the results.

3.3.2 Qualitative method

The qualitative method of research is that which uses a naturalist approach to understand phenomena in their context-specific settings. Qualitative methods have been considered capable of studying complex situations, particularly research involving human beings and therefore yield rich findings (Sutrisna, 2009). Qualitative research focuses on the qualities of the phenomena under investigation rather than numeric measurement. In this method, the researchers believe that the real world phenomena need to be assessed from within the context of that reality. The qualitative approach affords the means of providing distinct data and evaluation of theoretical problems and approaches (McKie, 2002). In broad terms, any kind of research that produces findings which are not obtained from statistical procedures or other quantitative means could be regarded as a qualitative research. This implies that the findings of a qualitative research are obtained from real world settings where the phenomena of interest unfold naturally.

The qualitative approach is based on the assumption that there is no singular objective reality. Thus, the observed reality is related to the researcher's interaction with the phenomenon (Creswell, 2013; Sutrisna, 2009). Accordingly, the qualitative research naturally emerges from the phenomenological and interpretivist/ constructivist paradigm. Supporting this view, Nahiduzzaman (2006) argued that qualitative and quantitative analysis result in different types of knowledge. While the qualitative approach relies on the underlying phenomenological philosophy; enjoying detailed interview and observation, the quantitative approach relies on the positivist paradigm; enjoying the rewards of both numbers and words. This suggests that such methods as interviews and observations are dominant in the naturalist (interpretivist) paradigm and supplementary in the positivist paradigm. Graziano and Raulin (2010) argued that qualitative research could be used as a method or as a precursor to the quantitative method in less explored areas. It could also be used to provide descriptive information for the generation of theory.

Two major objectives of a qualitative research are to describe and analyse the processes through which social realities are constructed; and the social relationships through which people are connected to one another. The approaches to qualitative research include:

i.) grounded theory which uses the principles of inductive approach to develop theory from data collected using qualitative data gathering techniques such as unstructured interviews and participant observation;

ii.) case study which allows an in-depth investigation of social phenomena using a combination of data gathering techniques. The case study approach allows for an in-depth investigation of a particular issue within the context of its relationship with the real world;

iii.) phenomenology which focuses on generating meanings and gaining insights into phenomena by concentrating studies on human experience and the essence of human experience;
iv.) ethnographical research method which is common to the field of sociology and anthropology. It employs a multi-method of data collection including participant observation, interviews, conversations, photographs, life histories, documentary analysis and films;
v.) hermeneutics relating to the meaning given to texts, cultures and past civilisations. Its underlying assumption is the interpretivist ideology; and
vi.) historical research method which is concerned with the process of learning the past through the collection and analysis of relevant information such as records, letters, reminiscences, buildings and artefacts, autobiography and diaries.

Practically, these qualitative approaches may adopt either a field research or a non-reactive research. Brewer and Hunter (2006) define a field work as observing and studying people and events first hand in natural social settings, whereas a non-reactive research employs un-obstructive observational techniques, artefacts, archival records, official statistics or by-products of past social life. A summary of the major differences between qualitative and quantitative research approaches is provided in Table 3-3.

Table 3-3: Major differences between quantitative and qualitative research methods

Quantitative method	**Qualitative method**
Developed in the natural sciences to study natural phenomena.	Developed in the social sciences to study social and cultural phenomena.
Positions the researcher as neutral observer of phenomena.	No singular objective reality; observed reality is related to researcher's interaction with phenomenon.
Method is based on positivist ideal.	Method is based on phenomenological viewpoint; focuses on meanings and perceptions.
Quantitative researches are deductive by nature.	Qualitative researches are inductive by nature.
Quantitative methods include surveys, laboratory experiments and mathematical models.	Methods include action research, case studies and ethnography.
Findings are focused on numeric measurements/quantitative data.	Findings are focused on illuminating the qualities of phenomena.
Approaches are repeatable, capable of isolation and therefore generalisable.	Yield rich but complex data and so not easily isolated or generalised.
Credibility depends on construction of data collection instrument: content related and criteria related.	The researcher is the instrument and so validity depends on the rigour, thoroughness and appropriateness of method.

Source: Adapted from Nahiduzzaman (2006)

3.3.3 Methods adopted in the research

The approach adopted for this research is a combination of both quantitative and qualitative. This is also referred to as a mixed method approach. The assumptions

underlying the quantitative and qualitative approaches to research represent the two extremes of the data continuum. While the quantitative approach is linked with the deductive-objective-generalising domain, the qualitative approach is associated with inductive-subjective-contextual domain (Morgan, 2007; Sutrisna, 2009). Nevertheless, research problems do not usually tie neatly with the assumptions of these methods/approaches. Rather, research problems are better understood by employing both methods and using them in a complementary manner (Pathirage et al., 2007). It is common to adopt both the quantitative and qualitative methods in research because such approach benefits from the advantages associated with each of the methods while at the same time avoiding the weaknesses of each. The use of mixed-methods offers the advantage that the weaknesses of one method are compensated for by the strengths of others. Supporting the adoption of mixed-methods/multi-methodology in a research, Brewer and Hunter (2006) argue that the fundamental objective of a combined or mixed method is to attack a research problem with an arsenal of methods that have no overlapping weaknesses in addition to their complementary strengths. This is illustrated in Table 3-4.

Table 3-4: Strengths and weaknesses of quantitative and qualitative methods of research

Quantitative method (**Strengths**)	**Qualitative method** (**Strengths**)
Representativeness	Holistic and detailed
Possibility of impartial disproof	Reactivity
Control (rigour)	Naturalism
Weaknesses	**Weaknesses**
Limited scope	Non-representative
Artificiality	Lack of control of bias

Research employing this approach benefits from a world view of social reality which encompasses the assumptions underlying both methods. The mixed method provides the researcher with the freedom to use all methods that are suitable to a research problem; both quantitative and qualitative techniques may be used in combination with inductive and deductive logic. The method therefore allows the researcher to be flexible and practical in the use of procedures for data collection and analysis. The multi-method approach is often labelled triangulation which refers to the combination of two or more theories, data sources, methods or investigators in a study of a particular phenomenon to converge at a single construct (Shakantu, 2004).

The theoretical attractiveness of multi-methodology lies in its abilities to enable the handling of problematic situations which require the effective linking of judgement and analysis (Rosenhead, 1997). In other words, it provides a framework for utilising the plurality of methodologies in order to understand or intervene in a complex situation. Given the inherent complexity of the construction industry as an arena within which to conduct research, and the problem-focused orientation of construction management

research (Harty and Leiringer, 2007), the theoretical benefits of multi-methodology seem obvious. Thus, in some respects the future development of construction management research would depend upon the willingness of its research community to see qualitative and quantitative research as complementary rather than competitive and mutually exclusive (Loosemore et al., 1996).

Solutions to research problems based on the multi-method approach are likely to have a firmer empirical base and greater theoretical scope as such methods may be grounded in different paradigms (Brewer and Hunter, 2006). Again, the position of this research essentially underscores the adoption of the multi-method approaches to the study. The assumptions underlying the multi-method are based on a blend of both quantitative and qualitative assumptions to provide a view of the nature of the social world and the nature of knowledge. This multiple world view presents the researcher with a better understanding of the issues raised in relation to Knowledge Creation, Integration and Management within the study context. For these reasons, data collection techniques such as literature review, interviews and questionnaire surveys were adopted for this study

3.4 Data gathering techniques

Different research types also have different data gathering methods. Data collection techniques could be broadly classified as:

i.) secondary; and
ii.) primary.

3.4.1 Secondary technique

This technique involves the use of available information that was collected by somebody else. The researcher in this case is the secondary user of the information. An example of such a technique is literature review. This technique has some advantages and disadvantages as well (Bryman, 2004).

Advantages include:

i.) it is inexpensive in that the data is already in existence and one just has to pick it; and
ii.) it permits the analysis of trends such as traffic or population growth trends.

Disadvantages include:

i.) ethical issues of confidentiality for instance in the case of on-going government projects might make the information not to be availed to the researcher; and
ii.) information may be incomplete and imprecise – this relates to issues of the methods employed.

3.4.2 Primary technique

This is the technique used to collect one's own data or information. The collector of such data is the first to ever embark on collecting it. This technique includes methods such as observations, interviews and administration of questionnaires (Nkhata, 1997). Focus Group Discussion is also one of the primary techniques of data collection.

a) Observation

This is a method of data collection that requires a researcher to attain membership of some alien or exotic group or organisation being studied. Once the researcher joins the organisation, the aim would be to learn all their behaviour and habits. This involves total immersion in the group being studied (Achola and Bless, 1988). Within the construction industry, the observer would join an organisation with the aim of studying the construction processes.

There are various types of observation approaches that a researcher could opt to use. These include (Nkhata, 1997):

i.) complete observation, where the researcher hides his or her identity, objectives and hypothesis. The group being studied does not know that they are being observed since the researcher behaves in the same way as they do. This allows the researcher to obtain the exact picture of the group's behaviour. Special devices like tape recorders could be used. However, there could be adverse effects if the researchers' behaviour arouses suspicion; and

ii.) participant observer, where the researcher's role is known. This mode minimises the risk of role pretending. The group is aware of the objectives of the study. This might induce an aspect of pretence among the observed, thereby reducing the validity of the study.

b) Case study

Case studies are detailed and thorough investigations of a few real life situations. They provide a way of organising data and looking at the objects to be studied as a whole. All aspects are considered, which means that the development over time of the event constitutes an important dimension. Thus a case study offers advantages of acquiring detailed information about the subject through an in-depth study. On the other hand, the data obtained would be more or less reliable depending on the objectivity of the researcher (Achola and Bless, 1988).

c) Survey research

This is a method that involves the administration of questionnaires to a sample selected from a population. Interviews and questionnaires are the methods used. It is appropriate for both descriptive and explanatory research (Bryman, 2004).

(i) Interviewing

This is a data collection method involving oral questions to either individuals or groups but more often individuals. It involves an interpersonal relationship between the interviewer and the interviewee. This method has, however, its own advantages and disadvantages (Bryman, 2004).

Its advantages being that it:
i.) incorporates illiterate respondents;
ii.) permits clarification of issues; and
iii.) gives a higher response rate than written questionnaires.

Disadvantages of the method include:
i.) the presence of the interviewer may influence responses;
ii.) reports of events may not be as complete as in the case of observation;
iii.) personal interviews are costly in terms of time and money; and
iv.) a danger of serious disparities is likely if more than one interviewer is used and this reduces comparability of responses.

(ii) Questionnaires

This method involves the use of written questions that are presented to the respondent. These are to be answered by the respondent in a written form. Two types of questionnaire surveys are available. These are (Achola and Bless, 1988; Bryman, 2004):
i.) self-administered questionnaires are posted to respondents and returned completed; and
ii.) administered questionnaires are delivered by the interviewer.

This method has its merits and demerits when used in a survey (Bryman and Bell, 2007; Nkhata, 1997). Its advantages include:
i.) less expense than interviews, i.e., when one takes self-administered questionnaires, they are less expensive;
ii.) it allow for anonymity that could result in more honesty responses;
iii.) it does not require research assistants; and
iv.) questionnaires eliminate bias due to phrasing because questions are phrased and framed the same way for all respondents.

Disadvantages of the method include:

i.) self-administered questionnaires cannot be used with illiterates;
ii.) low response rates may result as some respondents may decide to put the questionnaires in the rubbish bins as opposed to completing them; and
iii.) questions may be misunderstood in the absence of the interviewer.

There are two types of questions: (Achola and Bless, 1988):

i.) open-ended; and
ii.) closed-ended or structured questions.

Open-ended questions are those that permit free responses which should be reported in the respondent's own way, i.e., the respondent is not given possible answers to choose from. This is important when the researcher wants to get information on opinions, attitudes and reactions to sensitive questions (Achola and Bless, 1988).

Advantages of open-ended questions include:

i.) issues that may not have been asked may be explored, thereby allowing the researcher to gain more information;
ii.) information is given spontaneously and it is more likely to be true than answers which are limited to choice; and
iii.) the information in the respondent's own way may be very useful as examples or illustrations that add interest to the final report.

Disadvantages include: analysis of information based on open-ended questions could be time consuming, requiring responses which are not numeric and may mean going through all the questions and summarising the relevant information.

Closed-ended or structured questions offer a list of options from which respondents must make a choice of what is most suitable. The options must be exhaustive and stiff (Achola and Bless, 1988).

Advantages of closed-ended questions include:

i.) answers could be recorded quickly; and
ii.) analysis of answers is very easy

Disadvantages include:

i.) they are not suitable for face-to-face interviews;
ii.) respondents may choose options that they might otherwise not have thought of especially if the options are not exhaustive;
iii.) information may be missed out through lapses; and
iv.) the respondents may lose interest and suffer from boredom and fatigue.

3.5 Research design

Research design describes the ways in which the data was collected, analysed in order to answer the research questions and so provide a framework for undertaking the study (Bryman and Bell, 2007). Making decisions about research design is fundamental to both the philosophy underpinning the study and the contributions that it is likely to make. It was considered essential to obtain a full understanding of the study by setting out the various elements in a logical sequence so as to avoid misunderstanding at any point in the research. The problem statement, aims and objectives of the research were therefore stated at the outset. In order to present clear perspectives about Knowledge Creation, Integration and Management in civil engineering consulting firms in Zambia, the research comprised four principle activities. These were literature review, data collection, data analyses, and drawing of conclusions and recommendations. A flexible but objective approach to the tasks was used to ensure that the study was successfully completed.

3.5.1 Ethical Considerations

According to Bryman and Bell (2007) the following ten principles of ethical considerations have been compiled as a result of analysing the ethical guidelines of nine professional social sciences research associations:

i.) Research participants should not be subjected to harm in any ways whatsoever.
ii.) Respect for the dignity of research participants should be prioritised.
iii.) Full consent should be obtained from the participants prior to the study.
iv.) The protection of the privacy of research participants has to be ensured.
v.) Adequate level of confidentiality of the research data should be ensured.
vi.) Anonymity of individuals and organisations participating in the research has to be ensured.
vii.) Any deception or exaggeration about the aims and objectives of the research must be avoided.
viii.) Affiliations in any forms, sources of funding, as well as any possible conflicts of interests have to be declared.
ix.) Any type of communication in relation to the research should be done with honesty and transparency.
x.) Any type of misleading information, as well as representation of primary data findings in a biased way must be avoided.

In order to address ethical considerations, the following measures were put in place during the study.

a) Voluntary participation of respondents

Participation in the research was on a voluntary basis. The interviewees and questionnaire respondents were not forced to participate. Those who opted not to participate freely indicated their position.

b) Use of appropriate language

Through the study, use of offensive, discriminatory, or other unacceptable language was avoided. The questions in both the interview and questionnaire survey were constructed in an appropriate language.

c) Privacy and anonymity

The participants in all surveys were assured of their privacy and anonymity. Throughout the study, the names of respondents were not disclosed pursuant to the assurance given at data collection stage.

d) Acknowledgement of works of other authors

All works of other authors were acknowledged and referenced appropriately.

e) Maintenance of the highest level of objectivity

The study maintained a high level of objectivity in discussions and analyses throughout the research.

3.5.2 Literature review

Literature was reviewed in terms of its content and methodology employed by other researchers in similar studies. This approach was fundamental in laying the foundation of the study, building up on what has been done in other parts of the world (Nkhata, 1997). The advantage of this approach was that it is cost-effective as articles from almost all over the world could readily be accessed without having to travel to see how other countries have dealt with the research problem. Literature from journal articles was of interest during the review period because it offers a relatively concise, up to date format for research and all reputable journals are refereed. Where adequate information was missing, other articles were sought. These were in form of: conference proceedings; government/corporate reports; thesis and dissertations; and e-journals.

3.5.3 Data collection

Data was collected using interviews and questionnaire surveys. Triangulation in data collection was used to enhance the confidence that could be placed on the research findings (Sutrisna, 2009).

a) Interviews

Interviews were conducted prior to questionnaire surveys. They were aimed at obtaining preliminary data that would enhance the questionnaire survey as such the sample did not exceed 20 participants. The participants were well selected to ensure that the various views of the main stakeholders involved in civil engineering consultancy are incorporated in the main survey. The participants were drawn from registered consulting firms in Zambia. The selection method was based on convenience.

b) Questionnaire survey

The questionnaire survey was used as the main instrument for data collection and generalisation of research findings. The choice was based on the advantages that a large coverage of population could be realised with little time or costs. The survey targeted civil engineering, quantity surveying and architectural consulting firms. The results obtained would be used for coming up with a general statement about the problem in Zambia as the research would cover most of the stakeholders. To effectively use this tool, respondents were assured of anonymity which in turn helped them to be honest in their answers. Bias due to personal characteristics of the interviewer was avoided, as no interviewer was present. This method allowed the respondents to have adequate time to consult where they were not sure thereby allowing adequate responses to questions. The research tool was also carefully designed to ensure that there was no ambiguity.

3.5.4 Analysis and discussion

The data obtained was analysed and discussed. The quantitative data was analysed using the Statistica and Microsoft Excel computer programs.

3.5.5 Development and validation of $CIMEM_k$

Based on the research findings and data analysis, a model for evaluating Knowledge Creation, Integration and Management performance of civil engineering consulting firms was developed. The model was generic so that it could be adapted for use internationally.

The model was validated using professionals from Zambian and International the civil engineering consulting firms. The model was then subjected to assessment of its functionality, usefulness and validity.

3.5.6 Recommendations and conclusions

Recommendations were made accordingly, based on the findings of the research. The results for all the research tools utilised were carefully analysed to ensure that results were concisely documented in the final report. Based on the findings, the $CIMEM_k$ was developed.

3.6 Summary

This Chapter described the methodology used to carry out the research and address its aims and objectives. Highlights about the various methodologies that could be adopted for research purposes were also included in this Chapter. The Chapter further gave an explanation of how the problem was investigated and described the tools used to undertake the investigation. It also described the characteristics of the research sample and the method of analysis that was employed.

The next Chapter discusses the data collected and analysed in the study.

CHAPTER 4: DATA COLLECTION AND ANALYSIS

4.1 Introduction

The previous Chapter outlined the methodology for carrying out the research and the methods used to analyse the data collected. This Chapter presents data collection and analysis.

4.2 Interview data collection, analysis and discussion

Structured interviews were conducted between July and November 2013. The interviews were preliminary in nature and targeted ten professionals working for civil engineering consulting firms in Zambia. The interviewees were sampled based on the prominence of their organisation as well as their experience in the construction industry. One executive from each consulting firm was targeted. The interviewee's organisations were members of the Association of Consulting Engineers Zambia. The purpose was to obtain an in-depth understanding of how the various stakeholders in Zambia view Knowledge Creation, Integration and Management.

4.2.1 Profiles of interviewees and their firms

Nine out of the targeted ten professionals participated in the interviews. Out of the nine interviewees, seven had over fifteen years of experience in civil engineering consultancy, while the other two interviewees had between ten and fifteen years of experience, see Figure 4-1. It is noteworthy that all interviewees held management positions within their firms. This provided an assurance of reasonable professional experience in civil engineering consultancy. Most of the interviewees' firms had a long history of involvement in consultancy. The firms' experience in construction ranged from seven to 55 years.

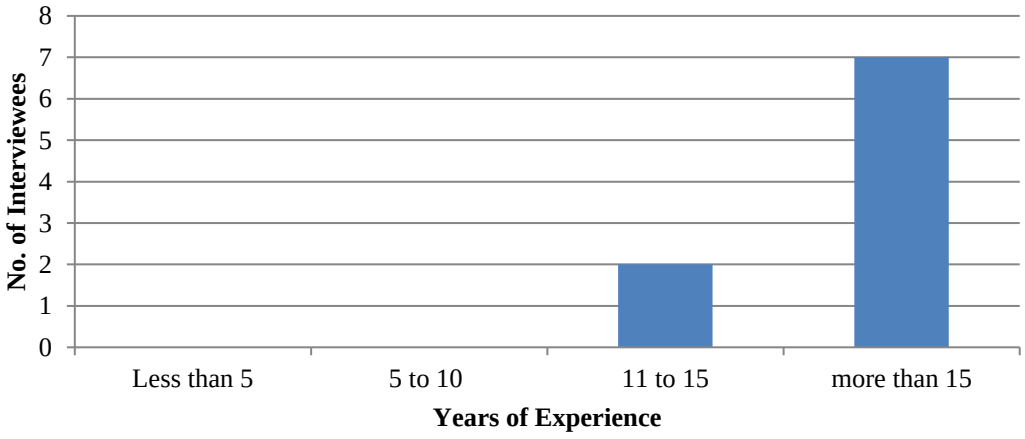

Figure 4-1: Interviewee's experience in civil engineering consultancy

4.2.2 Knowledge Management and Organisational Learning

Interviewees were asked if they were familiar with organisational learning. Only three out of nine interviewees were familiar with organisational learning. On the other hand, all the nine respondents were familiar with Knowledge Management. This could be seen in Figure 4-2.

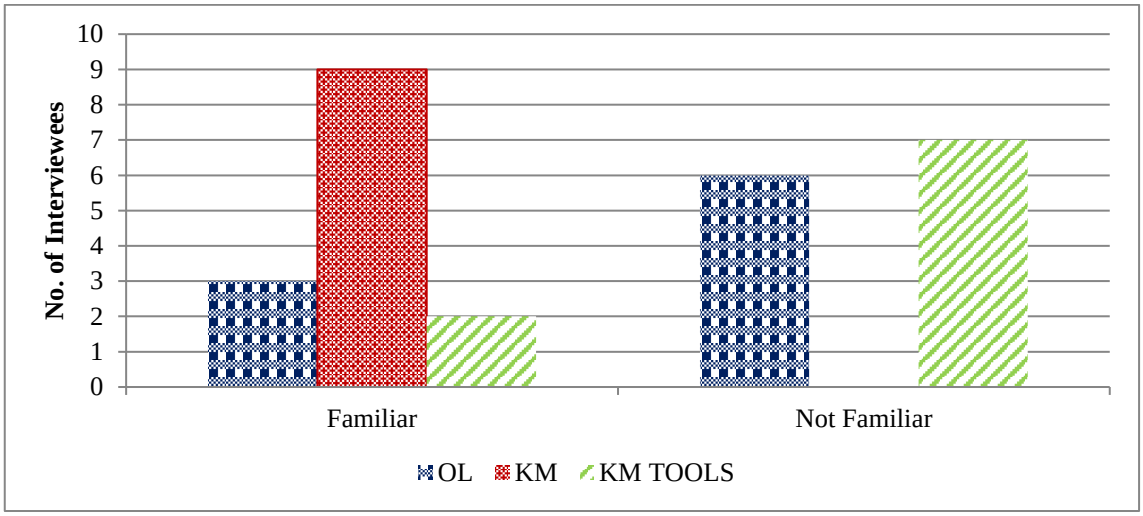

Figure 4-2: Interviewee's familiarity with Organisational Learning, Knowledge Management and Knowledge Management Tools

Despite their familiarity with Knowledge Management, Figure 4-2 also shows that most of the interviewees were not aware of any Knowledge Management tools. Only two interviewees were able to state the Knowledge Management tools they were familiar with. The tools included:

i.) communities of practice;
ii.) knowledge audits;
iii.) peer assists;
iv.) exit interviews;
v.) after action reviews; and
vi.) social networking analysis.

It is noteworthy that there are other common tools that the interviewees did not mention. These include:

i.) developing Knowledge Management strategies;
ii.) identifying and sharing best practices;
iii.) knowledge centres;
iv.) knowledge harvesting;
v.) storytelling; and
vi.) white pages.

It was also noted that most of the firms represented by the interviewees did not employ the tools and techniques listed above. However, some of the tools were in use as part of individuals' initiatives. Two of the interviewees indicated that their firms used tools such as 'peer assists' and 'after action reviews' though they did not have a formal Knowledge Management programme or system.

4.2.3 Advantages of Knowledge Management and Organisational Learning

Interviewees were asked whether Knowledge Management or Organisational Learning could contribute to the wellbeing of their firms. All the interviewees confirmed that Knowledge Management or Organisational Learning would positively contribute to the wellbeing of their firms. They stated that Knowledge Management or Organisational Learning would help their firms in the following ways:

i.) the organisation would have a pool of knowledge;
ii.) information would be up to date and readily available to authorised personnel;
iii.) tacit knowledge could be tapped from leading experts on various technical aspects;
iv.) Knowledge Management would increase the organisation's long-term competitive advantage;
v.) Knowledge Management would increase productivity by avoiding unnecessary repetitions;
vi.) firms would easily identify their strengths and weaknesses; and
vii.) the firms could streamline their operations and enhance staff retention.

4.2.4 Knowledge Creation

Interviewees were asked to state whether their firms viewed Knowledge Creation as an important ingredient for success and sustainability in the consulting industry. All the interviewees confirmed that Knowledge Creation was an important ingredient for success and sustainability. However, it was noted that the interviewees' firms did not have any tools for monitoring and evaluating Knowledge Creation. The interviewees were also not aware of any tools that could be used to monitor or evaluate Knowledge Creation within their firms.

4.2.5 Knowledge Integration

As was the case with Knowledge Creation, the interviewees confirmed that Knowledge Integration is an important ingredient for sustainability and success within the civil engineering consulting industry. However, they were not aware of any tools that could be used to monitor or evaluate Knowledge Integration within their firms.

4.2.6 Monitoring and evaluation framework

Some of interviewees stated that a framework that would help them monitor and evaluate Knowledge Creation, Knowledge Integration and Knowledge Management would be of importance to the wellbeing of their firms. They stated that the framework would promote Knowledge Management practices, capacity building and continuous learning.
They also stated that such a framework would benefit the civil engineering consulting industry in general through:

i.) enhancement of individual continuous professional development;
ii.) promotion of new ideas and concepts;
iii.) benchmarking of firms and a basis of comparing the organisations; and
iv.) monitoring capacity building within the sub-sector of the economy.

Some of the interviewees, however, argued that the Zambian civil engineering consulting industry was not yet ready for Knowledge Creation, Knowledge Integration and Knowledge Management because of the existing gap between the country's developmental standing and that of the world at large. They argued that Zambian clients did not demand for highly sophisticated products, i.e. most clients required common services such as design review and construction supervision, as such there was no need for innovation in the Zambian firms. The distribution of responses is presented in Figure 4-3.

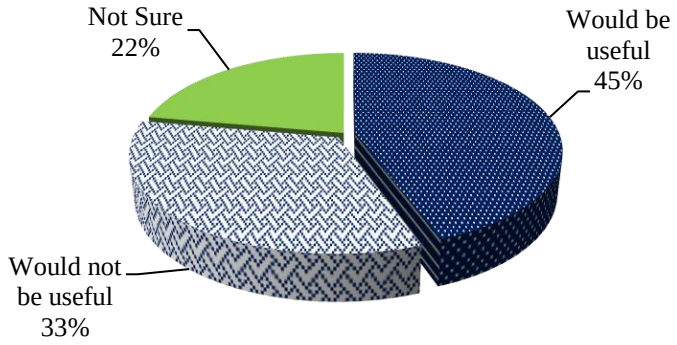

Figure 4-3: Perceived usefulness of a monitoring and evaluation model for Knowledge Creation, Integration and Management

4.2.7 Interpretations of the findings

The data reported in the sections above shows that some practitioners within the civil engineering consulting industry in Zambia were familiar with the basics of Knowledge Management. However, not much was known about Knowledge Creation and integration. It was noteworthy that most of the practitioners unknowingly used some of the tools of Knowledge Creation, Integration and Management. It would therefore be beneficial to the industry if sensitisation workshops were held to make practitioners aware of the concepts, tools and techniques.

Civil engineering consulting firms in Zambia also do not have formal tool, techniques or framework for monitoring and evaluating Knowledge Creation, Knowledge Integration and Knowledge Management. Though it has been argued by some of the interviewees that a framework for monitoring and evaluating Knowledge Creation, Integration and Management would not be very useful in Zambia considering the fact that the clients are currently demanding for basic engineering services, lack of formal framework disadvantages the Zambian firms especially in the face of the growing international competition. Such a framework would help improve the Zambian firms' competitiveness within the country and across the borders.

4.3 Questionnaire survey results

Following the interviews, a questionnaire was designed, pretested and administered. The questionnaire survey was carried out over a period of three (3) months from March 2014 to May 2014.

4.3.1 Survey sample

The survey sample was drawn from civil engineering consulting firms that had business presence in Africa. The Zambian respondents were drawn from the Association of Consulting Engineers Zambia database of registered engineering consulting firms. As of March 2014, 31 engineering consulting firms were registered with the Association of Consulting Engineers Zambia with 25 practising civil engineering. The inclusion criteria for Zambian firms were that they should have a majority Zambian shareholding and should have been in existence for at least 5 years.

The international firms were identified from similar bodies as Association of Consulting Engineers Zambia such as Consulting Engineers South Africa, Association of Consulting Engineers in Nigeria, Association of Consulting Engineers of Kenya, Association of Consulting Engineers Tanzania and Association of Consulting Engineers Botswana. The inclusion criteria for international firms were that they should have had an operational footprint in at least 5 countries in Africa and should have been in existence for at least 10 years.

The total number of respondents targeted was 40 out of which 20 were Zambian and the other 20 were international firms. The sample was representative of both Zambian and international firms.

4.3.2 Questionnaire design

The questionnaire was designed to have two parts. The first part was aimed at collecting the responsive firms' attributes as well as the respondents' profile. Multiple choice

questions were presented with the respondent restricted to only making one choice for each question.

The second part was aimed at establishing common indicators of Knowledge Creation, Knowledge Integration and Knowledge Management. The measurement used to collect data was ordinal. The characterisation of key indicators of Knowledge Creation, Knowledge Integration and Knowledge Management were based on mean score rating as such numerical values were assigned to the ordinal scale with 5 being very important, 3 being moderately important and 1 being unimportant.

The formula for calculating the mean score was based on weighted averages and is shown as Equation 4-1.

$$Mean\ Score = {\sum_{j=1}^{5} I_j R_j}\Big/{\sum R_j} \quad \text{..... Equation 4-1}$$

Where: Ij is the Importance weight (1, 2, 3, 4 or 5) assigned to option j; $\mathbf{R_j}$ is the number of respondents who provided responses to option j. The mean score values were further interpreted to reflect the responding rating to aid conversion of continuous data into discrete categories (Kululanga et al., 2002). The discrete categories were classified as follows:

4.5 < mean score ≤ **5.0**	very important as an indicator
3.5 < mean score ≤ **4.5**	important as an indicator
2.5 < mean score ≤ **3.5**	moderately important as an indicator
1.5 < mean score ≤ **2.5**	of little importance as an indicator
0.0 < mean score ≤ **1.5**	unimportant as an indicator

4.3.3 Questionnaire survey administration and response rate

The data was collected using both online methods as well as paper based surveys. The online data collection was undertaken via the MonkeySurvey website. The questionnaire was accompanied by a covering letter: identifying the type of research, sponsoring organisation and the researcher's name; explaining the purpose and the benefits of the study; and informing the participants that their name, department, or company name will not appear in the study documentation. Follow ups were made to non-responding firms at intervals of 4 weeks to remind the executives of the questionnaire and request their response.

Out of the 40 questionnaires that were administered, 29 responded, giving a response rate of 72.5 percent. This was deemed to be highly acceptable based on the sectorial and

industrial norms where response rates are normally between 20 to 35 percent (Kululanga et al., 1999). The graph indicating the proportion of respondents by grouping is shown in Figure 4-4.

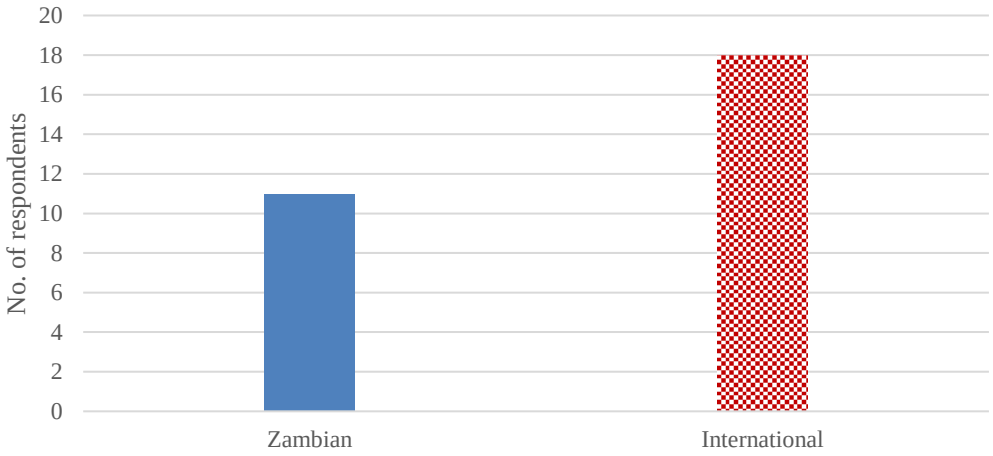

Figure 4-4: Categorisation of respondents by regional grouping

4.3.4 Individual respondents' profiles

An analysis of the respondents' profiles was undertaken. All the respondents worked for civil engineering consulting firms. The respondents also had at least some basic understanding of Knowledge Management and Organisational Learning.

The respondents generally had high level of responsibility within their firms. Most of the respondents, 55 percent, held senior level management positions while 21 percent were shareholders or owners of civil engineering consulting firms. Those in middle management accounted for 17 percent while those in junior management accounted for 7 percent of the responses. This is illustrated in Figure 4-5.

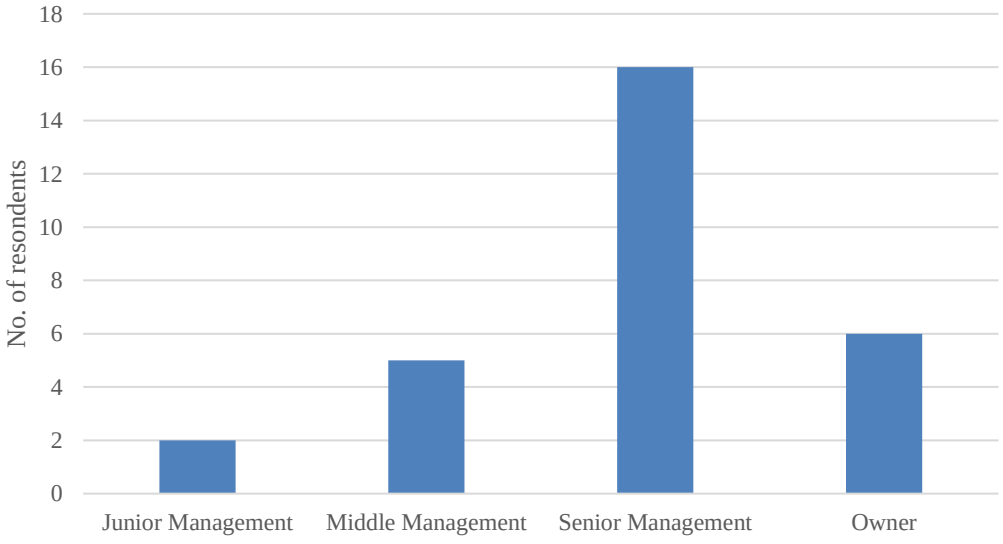

Figure 4-5: Position of respondents in their firm

Respondents with more than 20 years of experience in civil engineering consultancy accounted for 48 percent of the responses while those with 15 to 20 years accounted for 7 percent. Those with 10 to 15 years accounted for 35 percent and those with 5 to 10 years accounted for 10 percent. None of the respondents had less than five (5) years of experience in civil engineering consultancy. This is illustrated in Figure 4-6.

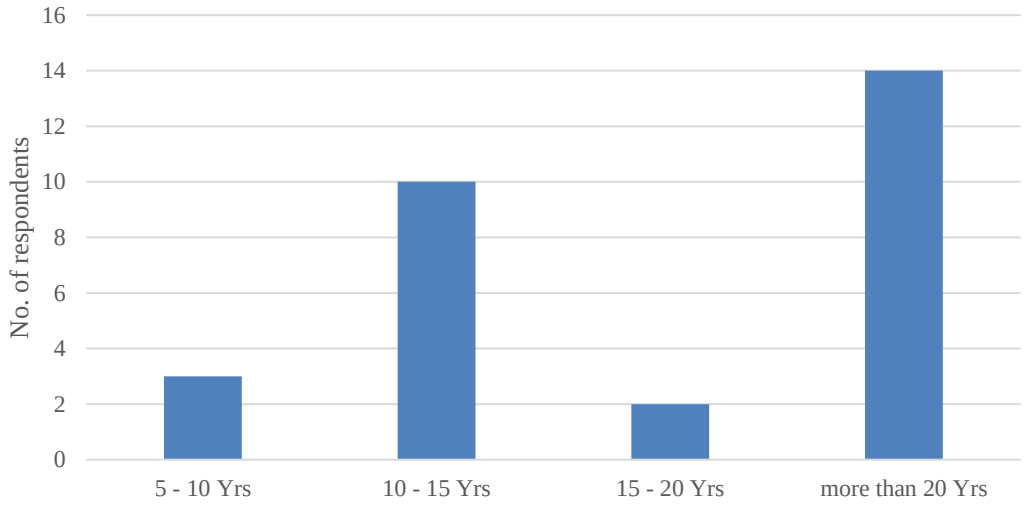

Figure 4-6: Respondents' years of experience in civil engineering consultancy

4.3.5 Profile of respondents' firms

An assessment of the respondents' firms was undertaken. Of interest was the categorisation of responses by firm size and experience.

a) Experience of respondents' firms

The respondents were predominantly working for firms that have been in existence for either 10 to 20 years or more than 60 years. To have an insight into the composition of responsive firms, categorisation in terms of Zambian and international firms was undertaken. The results showed that the Zambian firms generally had been in existence for less than 40 years while the majority of the responsive international firms had been in existence for more than 40 years. Figure 4-7 shows the experience in civil engineering consultancy of all the responsive firms while Figure 4-8 categorises the experience by the locality.

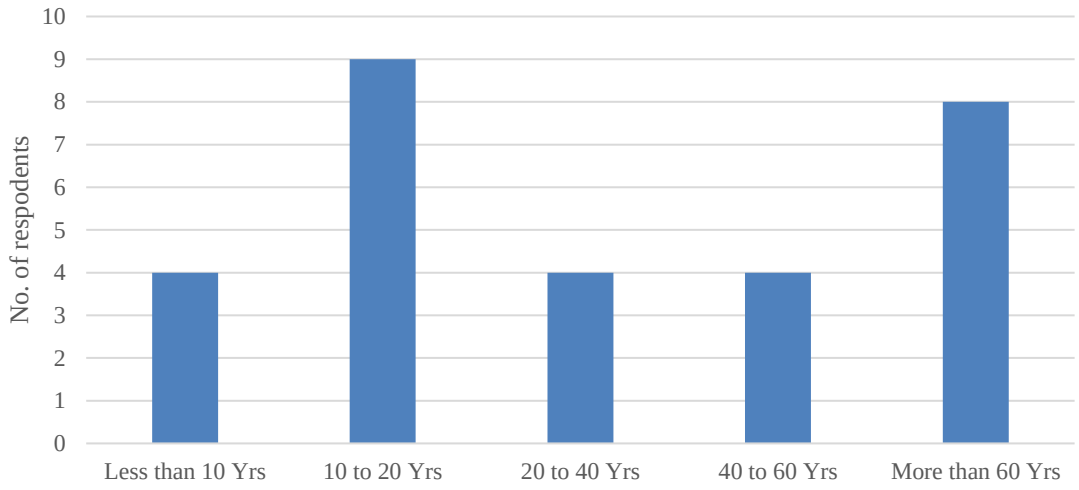

Figure 4-7: Experience of respondents' firms

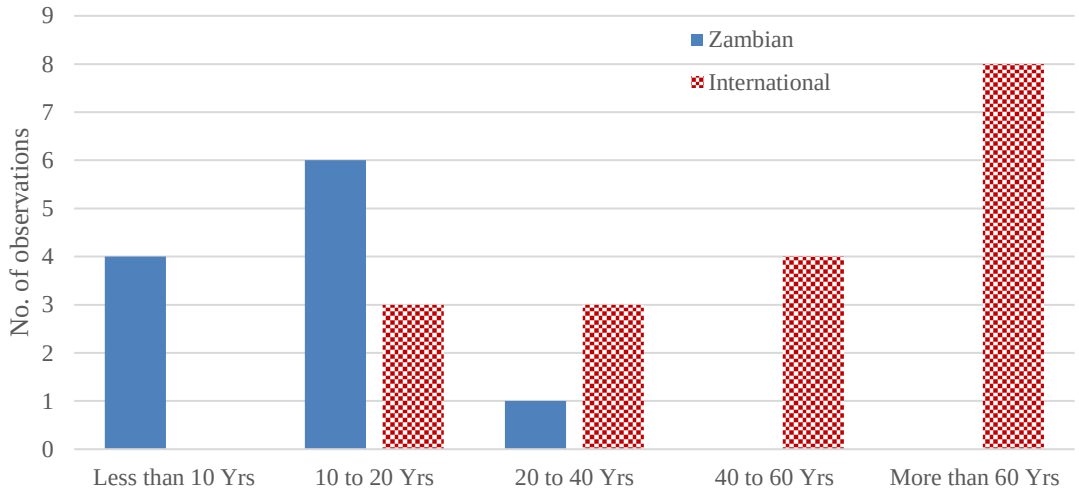

Figure 4-8: Categorisation of responsive firms' experience by regional grouping

b) Employee base

With regards to the size of the respondent firms in terms of number of employees, international firms were larger than Zambian firms. The responses indicate that Zambian firms in Zambia had an employee base of less than 250. The distribution of responsive firms' employee base is presented in Figure 4-9.

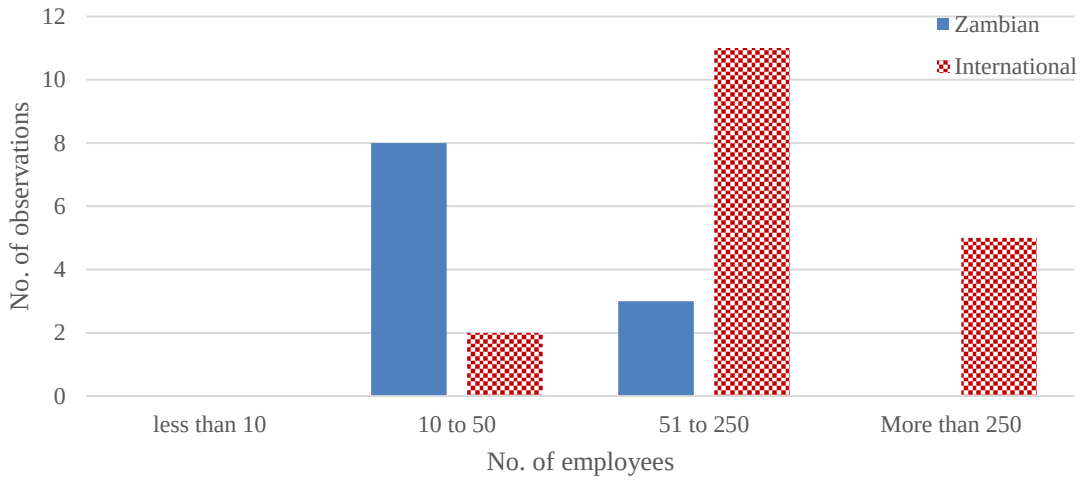

Figure 4-9: Distribution of the employee base of surveyed firms

c) Turnover

The majority of the responsive firms had average annual turnover of between US$3 million and US$15 million. The Zambian firms generally had average annual turnovers on the lower end with less than US$3 million while some international firms had average annual turnover in the range of US$15 million to US$75 million. The distribution of the responsive firms' annual turnover is presented in Figure 4-10.

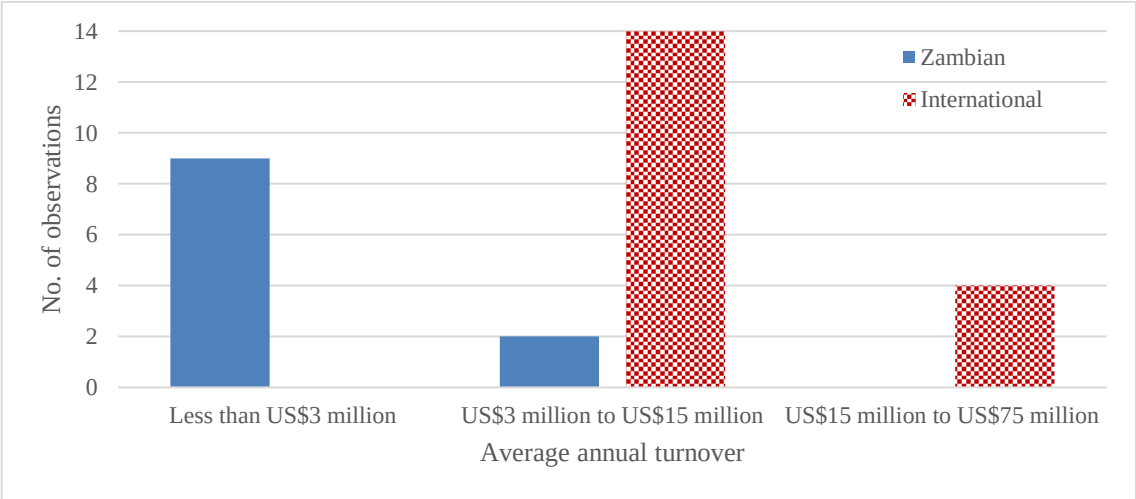

Figure 4-10: Distribution of annual turnover of surveyed firms

d) Classification of responsive firms

By international standards, all Zambian firms surveyed could be categorised as small to medium enterprises based on the definition provided by the European Commission (2005). Based on the same definition, the responsive international firms could also be classified as small to medium enterprises despite some employing more than 250 persons since none of them had turnover in excess of US$75 million.

4.3.6 Indicators of Knowledge Creation, integration and management

The respondents were asked to rate possible indicators of Knowledge Creation, Integration and Management on a Likert scale of 1 to 5. The respondents also had an option of indicating whether the indicator listed was not applicable within the context provided. A list of 32 indicators obtained from literature review and preliminary interviews was adopted for this study. The list was as presented in Table 4-1.

Table 4-1: List of possible indicators for Knowledge Creation, Knowledge Integration and Knowledge Management within an organisation

ID No.	Indicator/Factor
1	Ability of the organisation to protect knowledge from inappropriate use
2	Amount of non-assigned working time within an organisation
3	Amount of time assigned to project meetings
4	Availability of monitoring and evaluation systems
5	Availability of policies for protection of knowledge at corporate level
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.
7	Firm's flexibility to accommodate experimentation within a work place
8	Frequency of use of the knowledge base
9	Number of communities of practice within an organisation
10	Number of management/leadership who are aware of Knowledge Management
11	Number of new ideas implemented
12	Number of new ideas submitted by staff
13	Number of staff pursuing further studies
14	Number of staff who are able to give example of incremental innovations
15	Number of staff with direct linkages to experts in a given field of work
16	Number of workshops/seminars attended by staff
17	Number of workshops/seminars organised by the organisation
18	Proportion of current project documents that make reference to previous documents
19	Proportion of organisational policies which make reference to Knowledge Management
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover
21	Proportion of staff that are current and knowledgeable within their field of work
22	Proportion of staff that have a sense of ownership in what they do
23	proportion of staff that know a lot about their fellow staff's field of work
24	Proportion of staff who are aware of the organisation's Knowledge Management policies
25	Proportion of the organisation's budget available/spent on research and new designs
26	Quantity of project data stored in electronic format
27	Quantity of project records kept by the organisation
28	Reduction of staff time spent looking for information
29	Regulated of use of the knowledge base
30	Regulated socialisation within an organisation
31	Retention of staff for longer period of time within an organisation
32	Years of experience of staff within the industry

a) Descriptive statistics of Knowledge Creation indicators

Based on the responses submitted, the possible indicators were analysed with respect to Knowledge Creation within an organisation. Descriptive statistics were used in the preliminary stages of analysis. There were differences in perception of key indicators of

Knowledge Creation by Zambian and International consulting firms. The descriptive statistics for the different groups are presented in Tables 4-2, 4-3 and 4-4.

Table 4-2: Descriptive statistics of Knowledge Creation indicators based on all responses

No.	INDICATOR	MEAN SCORE	VARIANCE
1	Ability of the organisation to protect knowledge from inappropriate use	3.793	1.027
2	Amount of non-assigned working time within an organisation	4.207	0.170
3	Amount of time assigned to project meetings	4.207	0.599
4	Availability of monitoring and evaluation systems	4.586	0.680
5	Availability of policies for protection of knowledge at corporate level	4.379	0.672
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	3.621	0.244
7	Firm's flexibility to accommodate experimentation within a work place	4.000	1.286
8	Frequency of use of the knowledge base	4.207	0.170
9	Number of communities of practice within an organisation	3.207	0.599
10	Number of management/leadership who are aware of Knowledge Management	3.379	0.672
11	Number of new ideas implemented	4.000	0.857
12	Number of new ideas submitted by staff	4.207	0.599
13	Number of staff pursuing further studies	3.379	3.244
14	Number of staff who are able to give example of incremental innovations	3.586	0.680
15	Number of staff with direct linkages to experts in a given field of work	3.414	1.108
16	Number of workshops/seminars attended by staff	2.552	2.328
17	Number of workshops/seminars organised by the organisation	2.345	1.877
18	Proportion of current project documents that make reference to previous documents	3.586	1.108
19	Proportion of organisational policies which make reference to Knowledge Management	3.207	0.170
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	2.966	0.820
21	Proportion of staff that are current and knowledgeable within their field of work	4.379	0.244
22	Proportion of staff that have a sense of ownership in what they do	3.966	0.820
23	proportion of staff that know a lot about their fellow staff's field of work	3.621	0.672
24	Proportion of staff who are aware of the organisation's Knowledge Management policies	2.828	1.005
25	Proportion of the organisation's budget available/spent on research and new designs	3.172	3.148
26	Quantity of project data stored in electronic format	3.966	0.820
27	Quantity of project records kept by the organisation	4.000	0.429
28	Reduction of staff time spent looking for information	3.793	1.027
29	Regulated of use of the knowledge base	3.621	0.672
30	Regulated socialisation within an organisation	3.207	1.456
31	Retention of staff for longer period of time within an organisation	2.931	3.709
32	Years of experience of staff within the industry	4.000	1.286

Table 4-3: Descriptive statistics of Knowledge Creation indicators based on responses from Zambian firms

No.	INDICATOR	MEAN SCORE	VARIANCE
1	Ability of the organisation to protect knowledge from inappropriate use	4.000	0
2	Amount of non-assigned working time within an organisation	4.000	0
3	Amount of time assigned to project meetings	3.455	0.273
4	Availability of monitoring and evaluation systems	3.909	1.091
5	Availability of policies for protection of knowledge at corporate level	4.455	0.273
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	3.545	0.273
7	Firm's flexibility to accommodate experimentation within a work place	4.000	0
8	Frequency of use of the knowledge base	4.545	0.273
9	Number of communities of practice within an organisation	3.545	0.273
10	Number of management/leadership who are aware of Knowledge Management	3.455	0.273
11	Number of new ideas implemented	3.455	0.273
12	Number of new ideas submitted by staff	3.455	0.273
13	Number of staff pursuing further studies	1.818	4.364
14	Number of staff who are able to give example of incremental innovations	3.455	0.273
15	Number of staff with direct linkages to experts in a given field of work	3.545	0.273
16	Number of workshops/seminars attended by staff	1.818	4.364
17	Number of workshops/seminars organised by the organisation	1.818	4.364
18	Proportion of current project documents that make reference to previous documents	3.455	0.273
19	Proportion of organisational policies which make reference to Knowledge Management	3.000	0
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	3.455	0.273
21	Proportion of staff that are current and knowledgeable within their field of work	4.455	0.273
22	Proportion of staff that have a sense of ownership in what they do	4.455	0.273
23	proportion of staff that know a lot about their fellow staff's field of work	3.000	0
24	Proportion of staff who are aware of the organisation's Knowledge Management policies	3.091	1.091
25	Proportion of the organisation's budget available/spent on research and new designs	1.818	4.364
26	Quantity of project data stored in electronic format	4.455	0.273
27	Quantity of project records kept by the organisation	4.000	0
28	Reduction of staff time spent looking for information	4.000	0
29	Regulated of use of the knowledge base	3.545	0.273
30	Regulated socialisation within an organisation	3.545	0.273
31	Retention of staff for longer period of time within an organisation	2.273	6.818
32	Years of experience of staff within the industry	4.000	0

Table 4-4: Descriptive statistics of Knowledge Creation indicators based on responses from International firms

No.	INDICATOR	MEAN SCORE	VARIANCE
1	Ability of the organisation to protect knowledge from inappropriate use	3.667	1.647
2	Amount of non-assigned working time within an organisation	4.333	0.235
3	Amount of time assigned to project meetings	4.667	0.235
4	Availability of monitoring and evaluation systems	5.000	0
5	Availability of policies for protection of knowledge at corporate level	4.333	0.941
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	3.667	0.235
7	Firm's flexibility to accommodate experimentation within a work place	4.000	2.118
8	Frequency of use of the knowledge base	4.000	0
9	Number of communities of practice within an organisation	3.000	0.706
10	Number of management/leadership who are aware of Knowledge Management	3.333	0.941
11	Number of new ideas implemented	4.333	0.941
12	Number of new ideas submitted by staff	4.667	0.235
13	Number of staff pursuing further studies	4.333	0.235
14	Number of staff who are able to give example of incremental innovations	3.667	0.941
15	Number of staff with direct linkages to experts in a given field of work	3.333	1.647
16	Number of workshops/seminars attended by staff	3.000	0.706
17	Number of workshops/seminars organised by the organisation	2.667	0.235
18	Proportion of current project documents that make reference to previous documents	3.667	1.647
19	Proportion of organisational policies which make reference to Knowledge Management	3.333	0.235
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	2.667	0.941
21	Proportion of staff that are current and knowledgeable within their field of work	4.333	0.235
22	Proportion of staff that have a sense of ownership in what they do	3.667	0.941
23	proportion of staff that know a lot about their fellow staff's field of work	4.000	0.706
24	Proportion of staff who are aware of the organisation's Knowledge Management policies	2.667	0.941
25	Proportion of the organisation's budget available/spent on research and new designs	4.000	0.706
26	Quantity of project data stored in electronic format	3.667	0.941
27	Quantity of project records kept by the organisation	4.000	0.706
28	Reduction of staff time spent looking for information	3.667	1.647
29	Regulated of use of the knowledge base	3.667	0.941
30	Regulated socialisation within an organisation	3.000	2.118
31	Retention of staff for longer period of time within an organisation	3.333	1.647
32	Years of experience of staff within the industry	4.000	2.118

Further analysis of the indicators presented in the Table 4-2 to 4-4 was undertaken so as to identify those which were either important or very important. The cut off point for the mean score was set at 3.5 as indicated in Section 4.3.2. Out of the 32 indicators, 14 were found to have a mean score greater than 3.5. Figure 4-11 illustrates the indicators with overall mean score greater than 3.5. The indicators are represented by their identification numbers given in Table 4-1.

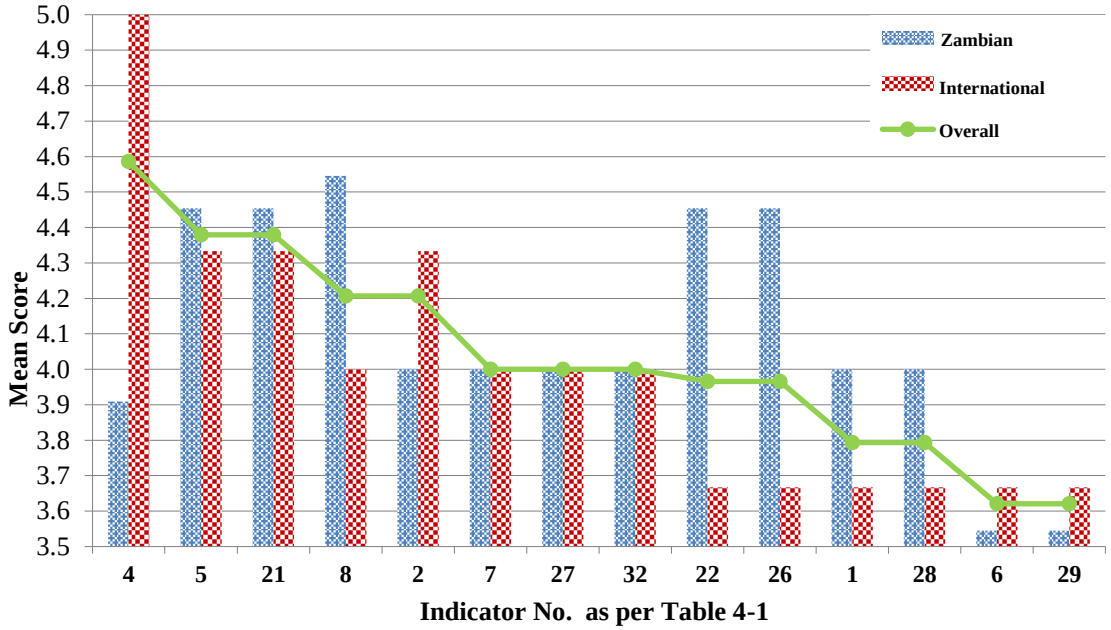

Figure 4-11: Indicators of Knowledge Creation having an overall mean score greater than 3.5

The indicators whose mean scores were greater than 3.5 were further tested for significance using the standard t-test. It was established that 10 out of 14 indicators were statistically significant at $p<0.05$. The statistical test results are presented in Table 4-5.

Table 4-5: Standard t-test results for key indicators of Knowledge Creation

Indicator	Mean	Std.Dv.	N	Std.Err.	Reference	t-value	*df*	*p*
Ability of the organisation to protect knowledge from inappropriate use	3.79	1.013	29	0.188	3.5	1.557	28	0.131
Amount of non-assigned working time within an organisation	4.21*	0.412	29	0.077	3.5	9.234	28	0.000
Availability of monitoring and evaluation systems	4.59*	0.825	29	0.153	3.5	7.094	28	0.000
Availability of policies for protection of knowledge at corporate level	4.38*	0.820	29	0.152	3.5	5.775	28	0.000
Codification of knowledge such as know-how, technical skill, problem solving, etc	3.62	0.494	29	0.092	3.5	1.316	28	0.199
Firm's flexibility to accommodate experimentation within a work place	4.00*	1.134	29	0.211	3.5	2.375	28	0.025
Frequency of use of the knowledge base	4.21*	0.412	29	0.077	3.5	9.234	28	0.000
Proportion of staff that are current and knowledgeable within their field of work	4.38*	0.494	29	0.092	3.5	9.589	28	0.000
Proportion of staff that have a sense of ownership in what they do	3.97*	0.906	29	0.168	3.5	2.768	28	0.010
Quantity of project data stored in electronic format	3.97*	0.906	29	0.168	3.5	2.768	28	0.010
Quantity of project records kept by the organisation	4.00*	0.655	29	0.122	3.5	4.113	28	0.000
Reduction of staff time spent looking for information	3.79	1.013	29	0.188	3.5	1.557	28	0.131
Regulated of use of the knowledge base	3.62	0.820	29	0.152	3.5	0.793	28	0.435
Years of experience of staff within the industry	4.00*	1.134	29	0.211	3.5	2.375	28	0.025

**Significant at $p<0.05$*

b) Descriptive statistics of Knowledge Integration indicators

Based on the responses submitted, identified indicators were analysed with respect to Knowledge Integration within an organisation. As was the case with Knowledge Creation, descriptive statistics were used in the preliminary stages of the analysis. Differences in perception of key indicators of Knowledge Integration by Zambian and International consulting firms were also noted. The descriptive statistics for the different groups are presented in Tables 4-6, 4-7 and 4-8.

Table 4-6: Descriptive statistics of Knowledge Integration indicators based on all responses

S/N	INDICATOR	MEAN SCORE	VARIANCE
1	Ability of the organisation to protect knowledge from inappropriate use	3.759	1.404
2	Amount of non-assigned working time within an organisation	4.207	0.170
3	Amount of time assigned to project meetings	4.000	0.429
4	Availability of monitoring and evaluation systems	3.552	1.042
5	Availability of policies for protection of knowledge at corporate level	3.379	1.958
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	3.621	1.101
7	Firm's flexibility to accommodate experimentation within a work place	4.034	0.392
8	Frequency of use of the knowledge base	4.000	0.429
9	Number of communities of practice within an organisation	3.621	0.672
10	Number of management/leadership who are aware of Knowledge Management	3.379	0.672
11	Number of new ideas implemented	4.414	0.251
12	Number of new ideas submitted by staff	4.000	0.429
13	Number of staff pursuing further studies	2.586	2.394
14	Number of staff who are able to give example of incremental innovations	3.586	3.680
15	Number of staff with direct linkages to experts in a given field of work	4.621	0.244
16	Number of workshops/seminars attended by staff	3.138	3.052
17	Number of workshops/seminars organised by the organisation	3.000	3.857
18	Proportion of current project documents that make reference to previous documents	3.207	0.599
19	Proportion of organisational policies which make reference to Knowledge Management	3.414	0.251
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	3.000	3.857
21	Proportion of staff that are current and knowledgeable within their field of work	4.414	0.680
22	Proportion of staff that have a sense of ownership in what they do	4.172	1.433
23	proportion of staff that know a lot about their fellow staff's field of work	4.379	0.244
24	Proportion of staff who are aware of the organisation's Knowledge Management policies	3.586	1.966
25	Proportion of the organisation's budget available/spent on research and new designs	3.172	2.291
26	Quantity of project data stored in electronic format	3.759	1.404
27	Quantity of project records kept by the organisation	3.759	1.404
28	Reduction of staff time spent looking for information	4.172	1.433
29	Regulated of use of the knowledge base	3.379	0.672
30	Regulated socialisation within an organisation	3.586	0.680
31	Retention of staff for longer period of time within an organisation	3.793	0.170
32	Years of experience of staff within the industry	3.793	2.313

Table 4-7: Descriptive statistics of Knowledge Integration indicators based on responses from Zambian firms

S/N	INDICATOR	MEAN SCORE	VARIANCE
1	Ability of the organisation to protect knowledge from inappropriate use	5.000	0
2	Amount of non-assigned working time within an organisation	4.000	0
3	Amount of time assigned to project meetings	4.000	0
4	Availability of monitoring and evaluation systems	4.455	0.273
5	Availability of policies for protection of knowledge at corporate level	4.000	-
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	4.091	1.091
7	Firm's flexibility to accommodate experimentation within a work place	3.545	0.273
8	Frequency of use of the knowledge base	4.000	0
9	Number of communities of practice within an organisation	3.000	0
10	Number of management/leadership who are aware of Knowledge Management	4.000	0
11	Number of new ideas implemented	4.000	0
12	Number of new ideas submitted by staff	4.000	0
13	Number of staff pursuing further studies	1.364	2.455
14	Number of staff who are able to give example of incremental innovations	1.818	4.364
15	Number of staff with direct linkages to experts in a given field of work	4.545	0.273
16	Number of workshops/seminars attended by staff	2.273	6.818
17	Number of workshops/seminars organised by the organisation	1.364	2.455
18	Proportion of current project documents that make reference to previous documents	3.545	0.273
19	Proportion of organisational policies which make reference to Knowledge Management	3.545	0.273
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	1.364	2.455
21	Proportion of staff that are current and knowledgeable within their field of work	4.545	0.273
22	Proportion of staff that have a sense of ownership in what they do	4.455	0.273
23	proportion of staff that know a lot about their fellow staff's field of work	4.455	0.273
24	Proportion of staff who are aware of the organisation's Knowledge Management policies	4.000	0
25	Proportion of the organisation's budget available/spent on research and new designs	2.364	2.455
26	Quantity of project data stored in electronic format	4.455	0.273
27	Quantity of project records kept by the organisation	4.455	0.273
28	Reduction of staff time spent looking for information	5.000	0
29	Regulated of use of the knowledge base	4.000	0
30	Regulated socialisation within an organisation	4.000	0
31	Retention of staff for longer period of time within an organisation	4.000	0
32	Years of experience of staff within the industry	4.000	0

Table 4-8: Descriptive statistics of Knowledge Integration indicators based on responses from International firms

S/N	INDICATOR	MEAN SCORE	VARIANCE
1	Ability of the organisation to protect knowledge from inappropriate use	3.000	0.706
2	Amount of non-assigned working time within an organisation	4.333	0.235
3	Amount of time assigned to project meetings	4.000	0.706
4	Availability of monitoring and evaluation systems	3.000	0.706
5	Availability of policies for protection of knowledge at corporate level	3.000	2.824
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	3.333	0.941
7	Firm's flexibility to accommodate experimentation within a work place	4.333	0.235
8	Frequency of use of the knowledge base	4.000	0.706
9	Number of communities of practice within an organisation	4.000	0.706
10	Number of management/leadership who are aware of Knowledge Management	3.000	0.706
11	Number of new ideas implemented	4.667	0.235
12	Number of new ideas submitted by staff	4.000	0.706
13	Number of staff pursuing further studies	3.333	0.941
14	Number of staff who are able to give example of incremental innovations	4.667	0.235
15	Number of staff with direct linkages to experts in a given field of work	4.667	0.235
16	Number of workshops/seminars attended by staff	3.667	0.235
17	Number of workshops/seminars organised by the organisation	4.000	2.118
18	Proportion of current project documents that make reference to previous documents	3.000	0.706
19	Proportion of organisational policies which make reference to Knowledge Management	3.333	0.235
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	4.000	2.118
21	Proportion of staff that are current and knowledgeable within their field of work	4.333	0.941
22	Proportion of staff that have a sense of ownership in what they do	4.000	2.118
23	proportion of staff that know a lot about their fellow staff's field of work	4.333	0.235
24	Proportion of staff who are aware of the organisation's Knowledge Management policies	3.333	3.059
25	Proportion of the organisation's budget available/spent on research and new designs	3.667	1.647
26	Quantity of project data stored in electronic format	3.333	1.647
27	Quantity of project records kept by the organisation	3.333	1.647
28	Reduction of staff time spent looking for information	3.667	1.647
29	Regulated of use of the knowledge base	3.000	0.706
30	Regulated socialisation within an organisation	3.333	0.941
31	Retention of staff for longer period of time within an organisation	3.667	0.235
32	Years of experience of staff within the industry	3.667	3.765

Further analysis of the indicators presented in Tables 4-6 to 4-8 was undertaken in order to identify those which were either important or very important. The cut off point for the mean score was set at 3.5 as indicated in Section 4.3.2. Out of the 32 indicators, 13 were found to have a mean score greater than 3.5. Figure 4-12 illustrates the indicators with overall mean score greater than 3.5.

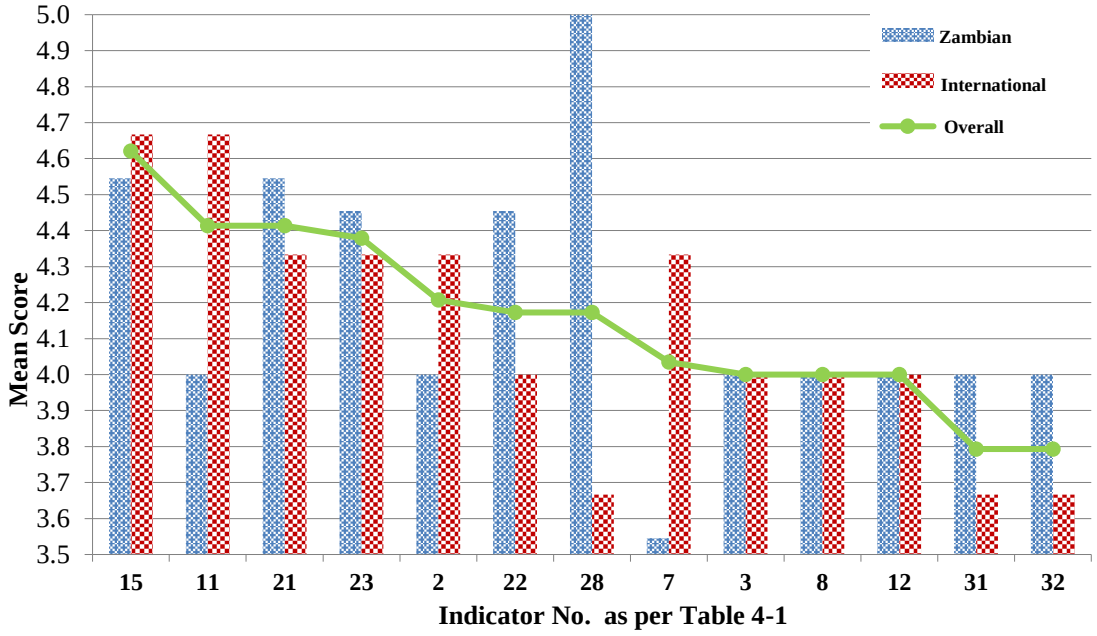

Figure 4-12: Indicators of Knowledge Integration having an overall mean score greater than 3.5

The indicators whose mean scores were greater than 3.5 were further tested for significance using the standard t-test. It was established that 12 out of the 13 indicators were statistically significant at $p<0.05$. The statistical test results are presented in Table 4-9.

Table 4-9: Standard t-test results for key indicators of Knowledge Integration

Indicator	Mean	Std.Dv.	N	Std.Err.	Reference	t-value	*df*	*p*
Amount of non-assigned working time within an organisation	4.21*	0.412	29	0.077	3.5	9.234	28	0.000
Amount of time assigned to project meetings	4.00*	0.655	29	0.122	3.5	4.113	28	0.000
Firm's flexibility to accommodate experimentation within a work place	4.03*	0.626	29	0.116	3.5	4.599	28	0.000
Frequency of use of the knowledge base	4.00*	0.655	29	0.122	3.5	4.113	28	0.000
Number of new ideas implemented	4.41*	0.501	29	0.093	3.5	9.818	28	0.000
Number of new ideas submitted by staff	4.00*	0.655	29	0.122	3.5	4.113	28	0.000
Number of staff with direct linkages to experts in a given field of work	4.62*	0.494	29	0.092	3.5	12.222	28	0.000
Proportion of staff that are current and knowledgeable within their field of work	4.41*	0.825	29	0.153	3.5	5.968	28	0.000
Proportion of staff that have a sense of ownership in what they do	4.17*	1.197	29	0.222	3.5	3.024	28	0.005
proportion of staff that know a lot about their fellow staff's field of work	4.38*	0.494	29	0.092	3.5	9.589	28	0.000
Reduction of staff time spent looking for information	4.17*	1.197	29	0.222	3.5	3.024	28	0.005
Retention of staff for longer period of time within an organisation	3.79*	0.412	29	0.077	3.5	3.829	28	0.001
Years of experience of staff within the industry	3.79	1.521	29	0.282	3.5	1.038	28	0.308

**Significant at p<0.05*

c) Descriptive statistics of Knowledge Management Indicators

The indicators were also analysed with respect to Knowledge Management within an organisation. Similar analyses as those of Knowledge Creation and Knowledge Integration were adopted. The descriptive statistics for the different groups are presented in Table 4-10, Table 4-11 and Table 4-12.

Table 4-10: Descriptive statistics of Knowledge Management indicators based on all responses

S/N	INDICATOR	MEAN SCORE	VARIANCE
1	Ability of the organisation to protect knowledge from inappropriate use	4.793	0.170
2	Amount of non-assigned working time within an organisation	2.552	3.185
3	Amount of time assigned to project meetings	3.793	0.170
4	Availability of monitoring and evaluation systems	4.586	0.251
5	Availability of policies for protection of knowledge at corporate level	4.621	0.244
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	4.414	0.251
7	Firm's flexibility to accommodate experimentation within a work place	3.586	0.251
8	Frequency of use of the knowledge base	3.621	0.244
9	Number of communities of practice within an organisation	3.793	0.170
10	Number of management/leadership who are aware of Knowledge Management	4.414	0.251
11	Number of new ideas implemented	4.000	0.429
12	Number of new ideas submitted by staff	4.172	0.576
13	Number of staff pursuing further studies	2.759	3.118
14	Number of staff who are able to give example of incremental innovations	4.207	0.170
15	Number of staff with direct linkages to experts in a given field of work	4.414	0.251
16	Number of workshops/seminars attended by staff	3.172	3.148
17	Number of workshops/seminars organised by the organisation	2.759	3.118
18	Proportion of current project documents that make reference to previous documents	4.793	0.170
19	Proportion of organisational policies which make reference to Knowledge Management	4.414	0.251
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	4.414	0.680
21	Proportion of staff that are current and knowledgeable within their field of work	4.414	0.251
22	Proportion of staff that have a sense of ownership in what they do	4.379	0.244
23	proportion of staff that know a lot about their fellow staff's field of work	4.793	0.170
24	Proportion of staff who are aware of the organisation's Knowledge Management policies	4.000	0
25	Proportion of the organisation's budget available/spent on research and new designs	2.931	2.852
26	Quantity of project data stored in electronic format	4.207	0.170
27	Quantity of project records kept by the organisation	4.586	0.251
28	Reduction of staff time spent looking for information	4.621	0.244
29	Regulated of use of the knowledge base	3.793	0.170
30	Regulated socialisation within an organisation	3.793	0.170
31	Retention of staff for longer period of time within an organisation	4.793	0.170
32	Years of experience of staff within the industry	3.793	2.313

Table 4-11: Descriptive statistics of Knowledge Management indicators based on responses from Zambian firms

S/N	INDICATOR	MEAN SCORE	VARIANCE
1	Ability of the organisation to protect knowledge from inappropriate use	4.455	0.273
2	Amount of non-assigned working time within an organisation	2.909	1.091
3	Amount of time assigned to project meetings	4.000	0
4	Availability of monitoring and evaluation systems	4.455	0.273
5	Availability of policies for protection of knowledge at corporate level	4.000	0
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	4.000	0
7	Firm's flexibility to accommodate experimentation within a work place	4.000	0
8	Frequency of use of the knowledge base	3.545	0.273
9	Number of communities of practice within an organisation	4.000	0
10	Number of management/leadership who are aware of Knowledge Management	4.000	0
11	Number of new ideas implemented	3.455	0.273
12	Number of new ideas submitted by staff	3.909	1.091
13	Number of staff pursuing further studies	1.818	4.364
14	Number of staff who are able to give example of incremental innovations	4.000	0
15	Number of staff with direct linkages to experts in a given field of work	4.000	0
16	Number of workshops/seminars attended by staff	1.818	4.364
17	Number of workshops/seminars organised by the organisation	1.818	4.364
18	Proportion of current project documents that make reference to previous documents	4.455	0.273
19	Proportion of organisational policies which make reference to Knowledge Management	4.000	0
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	3.455	0.273
21	Proportion of staff that are current and knowledgeable within their field of work	4.000	0
22	Proportion of staff that have a sense of ownership in what they do	4.455	0.273
23	proportion of staff that know a lot about their fellow staff's field of work	4.455	0.273
24	Proportion of staff who are aware of the organisation's Knowledge Management policies	4.000	0
25	Proportion of the organisation's budget available/spent on research and new designs	2.273	6.818
26	Quantity of project data stored in electronic format	4.000	0
27	Quantity of project records kept by the organisation	4.455	0.273
28	Reduction of staff time spent looking for information	4.000	0
29	Regulated of use of the knowledge base	4.000	0
30	Regulated socialisation within an organisation	4.000	0
31	Retention of staff for longer period of time within an organisation	4.455	0.273
32	Years of experience of staff within the industry	4.000	2.313

Table 4-12: Descriptive statistics of Knowledge Management indicators based on responses from International firms

S/N	INDICATOR	MEAN SCORE	VARIANCE
1	Ability of the organisation to protect knowledge from inappropriate use	5.000	0
2	Amount of non-assigned working time within an organisation	2.333	4.471
3	Amount of time assigned to project meetings	3.667	0.235
4	Availability of monitoring and evaluation systems	4.667	0.235
5	Availability of policies for protection of knowledge at corporate level	5.000	0
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	4.667	0.235
7	Firm's flexibility to accommodate experimentation within a work place	3.333	0.235
8	Frequency of use of the knowledge base	3.667	0.235
9	Number of communities of practice within an organisation	3.667	0.235
10	Number of management/leadership who are aware of Knowledge Management	4.667	0.235
11	Number of new ideas implemented	4.333	0.235
12	Number of new ideas submitted by staff	4.333	0.235
13	Number of staff pursuing further studies	3.333	1.647
14	Number of staff who are able to give example of incremental innovations	4.333	0.235
15	Number of staff with direct linkages to experts in a given field of work	4.667	0.235
16	Number of workshops/seminars attended by staff	4.000	0.706
17	Number of workshops/seminars organised by the organisation	3.333	1.647
18	Proportion of current project documents that make reference to previous documents	5.000	0
19	Proportion of organisational policies which make reference to Knowledge Management	4.667	0.235
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	5.000	0
21	Proportion of staff that are current and knowledgeable within their field of work	4.667	0.235
22	Proportion of staff that have a sense of ownership in what they do	4.333	0.235
23	proportion of staff that know a lot about their fellow staff's field of work	5.000	0
24	Proportion of staff who are aware of the organisation's Knowledge Management policies	4.000	0
25	Proportion of the organisation's budget available/spent on research and new designs	3.333	0.235
26	Quantity of project data stored in electronic format	4.333	0.235
27	Quantity of project records kept by the organisation	4.667	0.235
28	Reduction of staff time spent looking for information	5.000	0
29	Regulated of use of the knowledge base	3.667	0.235
30	Regulated socialisation within an organisation	3.667	0.235
31	Retention of staff for longer period of time within an organisation	5.000	0
32	Years of experience of staff within the industry	3.667	3.765

Further analysis of the indicators presented in Table 4-10 to 4-12 was undertaken so as to identify those which were either important or very important. The cut off point for the mean score was set at 3.5 as indicated in Section 4.3.2. Out of the 32 indicators, 24 were found to have a mean score greater than 3.5. Figure 4-13 illustrates the indicators with overall mean scores greater than 3.5.

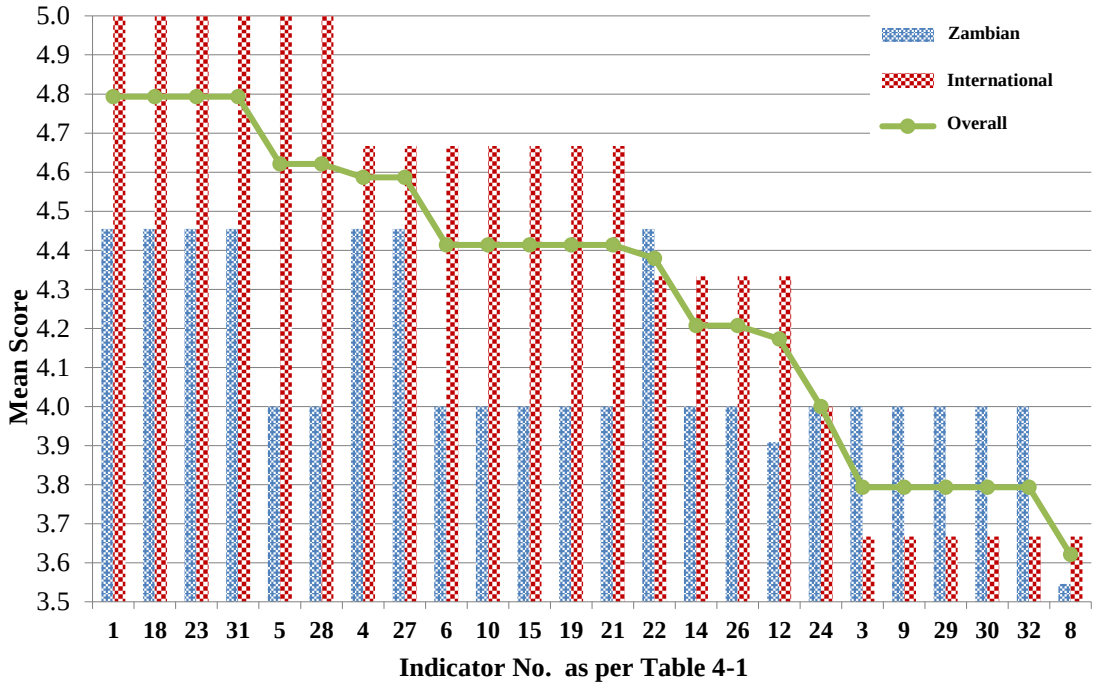

Figure 4-13: Indicators of Knowledge Management having an overall mean score greater than 3.5

The indicators whose mean score was greater than 3.5 were further tested for significance using the standard t-test. It was established that 22 out of the 24 indicators were statistically significant at $p<0.05$. The statistical test results are presented in Table 4-13.

Table 4-13: Standard t-test results for key indicators of Knowledge Management

Indicator	Mean	Std.Dv.	N	Std.Err.	Reference	t-value	*df*	*p*
Ability of the organisation to protect knowledge from inappropriate use	4.79*	0.412	29	0.077	3.5	16.892	28	0.000
Amount of time assigned to project meetings	3.79*	0.412	29	0.077	3.5	3.829	28	0.001
Availability of monitoring and evaluation systems	4.59*	0.501	29	0.093	3.5	11.670	28	0.000
Availability of policies for protection of knowledge at corporate level	4.62*	0.494	29	0.092	3.5	12.222	28	0.000
Codification of knowledge such as know-how, technical skill, problem solving, etc	4.41*	0.501	29	0.093	3.5	9.818	28	0.000
Frequency of use of the knowledge base	3.62	0.494	29	0.092	3.5	1.316	28	0.199
Number of communities of practice within an organisation	3.79*	0.412	29	0.077	3.5	3.829	28	0.001
Number of management/leadership who are aware of Knowledge Management	4.41*	0.501	29	0.093	3.5	9.818	28	0.000
Number of new ideas submitted by staff	4.17*	0.759	29	0.141	3.5	4.770	28	0.000
Number of staff who are able to give example of incremental innovations	4.21*	0.412	29	0.077	3.5	9.234	28	0.000
Number of staff with direct linkages to experts in a given field of work	4.41*	0.501	29	0.093	3.5	9.818	28	0.000
Proportion of current project documents that make reference to previous documents	4.79*	0.412	29	0.077	3.5	16.892	28	0.000
Proportion of organisational policies which make reference to Knowledge Management	4.41*	0.501	29	0.093	3.5	9.818	28	0.000
Proportion of staff that are current and knowledgeable within their field of work	4.41*	0.501	29	0.093	3.5	9.818	28	0.000
Proportion of staff that have a sense of ownership in what they do	4.38*	0.494	29	0.092	3.5	9.589	28	0.000
proportion of staff that know a lot about their fellow staff's field of work	4.79*	0.412	29	0.077	3.5	16.892	28	0.000
Proportion of staff who are aware of the organisation's Knowledge Management policies	4.03*	0.186	29	0.034	3.5	15.500	28	0.000
Quantity of project data stored in electronic format	4.21*	0.412	29	0.077	3.5	9.234	28	0.000
Quantity of project records kept by the organisation	4.59*	0.501	29	0.093	3.5	11.670	28	0.000
Reduction of staff time spent looking for information	4.62*	0.494	29	0.092	3.5	12.222	28	0.000
Regulated of use of the knowledge base	3.79*	0.412	29	0.077	3.5	3.829	28	0.001
Regulated socialisation within an organisation	3.79*	0.412	29	0.077	3.5	3.829	28	0.001
Retention of staff for longer period of time within an organisation	4.79*	0.412	29	0.077	3.5	16.892	28	0.000
Years of experience of staff within the industry	3.79	1.521	29	0.282	3.5	1.038	28	0.308

**Significant at p<0.05*

4.4 Summary

In this Chapter, the data from interviews as well as the questionnaire survey was analysed. Through the questionnaire survey, the key indicators of Knowledge Creation, Knowledge Integration and Knowledge Management were established. A total of 27 key indicators were established out of which:

i.) one (1) was unique to Knowledge Creation;

ii.) one (1) was unique to Knowledge Integration;

iii.) ten (10) were unique to Knowledge Management;
iv.) three (3) were common to Knowledge Creation and Knowledge Integration only;
v.) six (6) were common to Knowledge Integration and Knowledge Management only;
vi.) four (4) were common to Knowledge Creation and Knowledge Management only; and
vii.) two (2) were common to Knowledge Creation, Knowledge Integration and Knowledge Management.

The key indicator that was unique to Knowledge Creation was 'years of experience of staff within the industry' while that which was unique to Knowledge Integration was 'number of new ideas implemented'. On the other hand, those unique to Knowledge Management were:

i.) ability of the organisation to protect knowledge from inappropriate use;
ii.) codification of knowledge such as know-how, technical skill, problem solving;
iii.) number of communities of practice within an organisation;
iv.) number of management staff who are aware of Knowledge Management;
v.) number of staff who are able to give example of incremental innovations;
vi.) proportion of current project documents that make reference to previous documents;
vii.) proportion of organisational policies which make reference to Knowledge Management;
viii.) proportion of staff who are aware of the organisation's Knowledge Management policies;
ix.) regulated of use of the knowledge base; and
x.) regulated socialisation within an organisation.

Key indicators that were common to Knowledge Creation and Knowledge Integration included:
i.) amount of non-assigned working time within an organisation;
ii.) firm's flexibility to accommodate experimentation within a work place; and
iii.) frequency of use of the knowledge base.
iv.) Those common to Knowledge Creation and Knowledge Management were:
v.) availability of monitoring and evaluation systems;
vi.) availability of policies for protection of knowledge at corporate level;
vii.) quantity of project records kept by the organisation; and
viii.) quantity of project data stored in electronic format.

On the other hand, those common to Knowledge Integration and Knowledge Management included:
i.) amount of time assigned to project meetings;
ii.) number of new ideas submitted by staff;
iii.) proportion of staff that are current and knowledgeable within their field of work;
iv.) proportion of staff that know a lot about their fellow staff's field of work;
v.) reduction of staff time spent looking for information; and

vi.) retention of staff for longer period of time within an organisation.

The indicators which were common to Knowledge Creation, Integration and Management were:

i.) number of staff with direct linkages to experts in a given field of work; and
ii.) proportion of staff that have a sense of ownership in what they do.

These were used as inputs into model development which is presented in Chapter 5.

CHAPTER 5: MODEL DEVELOPMENT

5.1 Introduction

In the previous Chapter, the data collected through interviews and questionnaires was analysed. From the results presented in Chapter 4, it was essential to develop a model that could be used to evaluate Knowledge Creation, Integration and Management within civil engineering consulting firms. This Chapter therefore focuses on model development and the theories behind it. The model is then presented and validated.

5.2 Theoretical perspective

Measurement approaches which have been developed by various scholars do not take into account the firms' desirability of Knowledge Creation, Integration and Management. Much as Knowledge Management has been embraced by many firms and implemented, most of them have not achieved the desired results. It was therefore important to integrate the Knowledge Management requirements with the organisations' desires for such practices. The framework of the model is as shown in Figure 5-1.

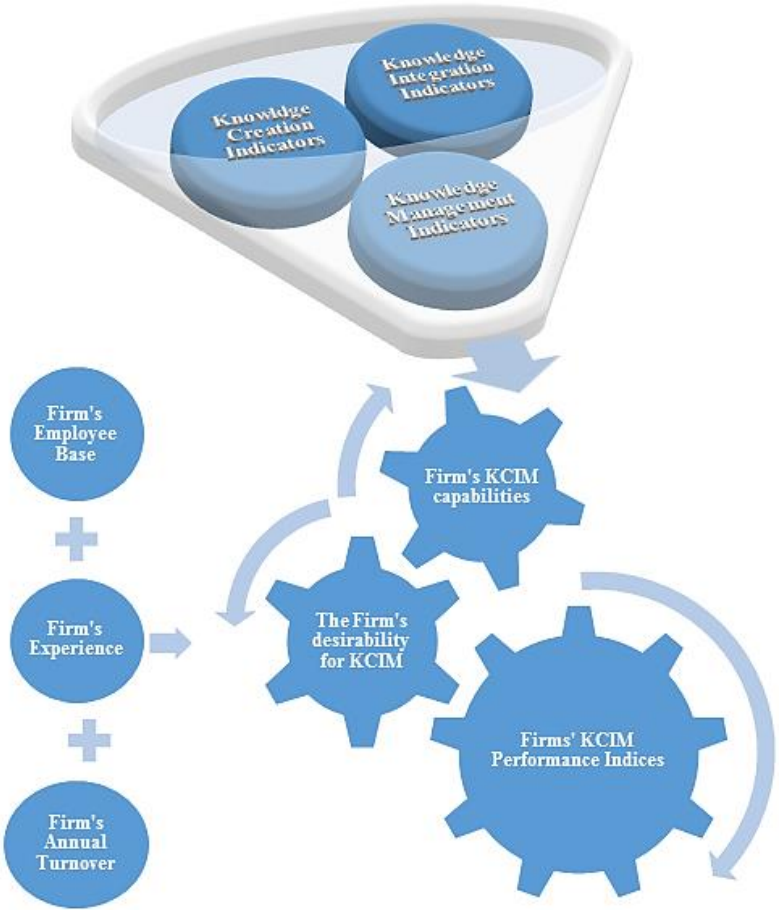

Figure 5-1: Framework for the Knowledge Creation, Integration and Management Evaluation Model

The firm's Knowledge Creation, Integration and Management performance index was designed to take into account the employee base, experience, turnover and the key indicators. The desirability equations took care of the firm's turnover and employee base. On the other hand, the indicator coefficients took care of the firm's capabilities in terms of Knowledge Creation, Integration and Management. The performance index was therefore a product of the firm's desirability and knowledge capabilities.

5.2.1 Desirability of Knowledge Creation, Integration and Management

A usual problem in the real world environment involves selecting a set of input conditions which would result in a product with a desirable set of outputs. Desirability function help to solve such optimisation problems. Desirability functions and desirability indices are powerful tools for multi-criteria optimisation and multi-criteria quality control purposes (Trautmann and Weihs, 2006). They are based on the idea that the quality of a product or process that has multiple quality characteristics, with one of them outside of some desired limits, is completely unacceptable. The method finds operating conditions that provide the most desirable response values (Box and Wilson, 1951; Myers et al., 2009; NIST/SEMATECH, 2012).

The desirability function was adopted as a means of computing the firm's performance scores with regards to Knowledge Creation, Integration and Management. It is noteworthy that the desirability for each firm would be different depending on the combination of its resources and its annual turnover. As is the case within quality control environments the goal may be to find the levels of the quality characteristics of the process so that the quality of the product or responses has the desired characteristics (Montgomery, 2012).

The results of the descriptive statistics were used to further understand how the choices of indicators were influenced by the organisation's annual turnover as well as the employee base. The purpose of the analysis was to establish the desirability functions with respect to the firm's turnover and its employee base. This is very important for civil engineering consulting firms because their sales are dependent on the employee base as well as the expertise within the firm. Using Statistica software package, the results were synthesised and are presented in the subsections below.

a) Firm's desirability of Knowledge Creation

The indicators of Knowledge Creation whose importance score was greater than 3.5 were tested for desirability. The Analysis of Variance method was used to derive the desirability function. The desirability function for these indicators was established to be as presented in Equation 5-1.

$D_{kc} = 0.099 + 0.271n + 0.326t - 0.172n^2 + 0.185nt - 0.197t^2$..... Eqn. 5-1

Where: ***D*kc** is the desirability of Knowledge Creation, ***n*** parametric equivalent of the average number of employees **N** (*where* $N = 2e^{1.6094n}$), ***t*** is parametric equivalent of the annual turnover **T** (where $T = 6 \times 10^5 e^{1.6094t}$).

When plotted, the equation produces an elliptic paraboloid whose contours shows that the same desirability can be achieved for a number of combinations of the employee base and turnover. The desirability plot for the fitted equation is presented in Figure 5-2. The green colour represent lower desirability while the deep red colour represents the highest level of desirability. In practice, firms have different combinations of the employee base and turnover yet through these equations, it is possible to determine their desirability for Knowledge Creation. Solving the above equation to determine the maxima shows that:

$$\max\{0.099 + 0.271n + 0.326t - 0.172n^2 + 0.185nt - 0.197t^2\} = \frac{(334168 - 101311\,n)n + 184288}{788000} \; for\; t = \frac{1}{394}(185\,n + 326).$$

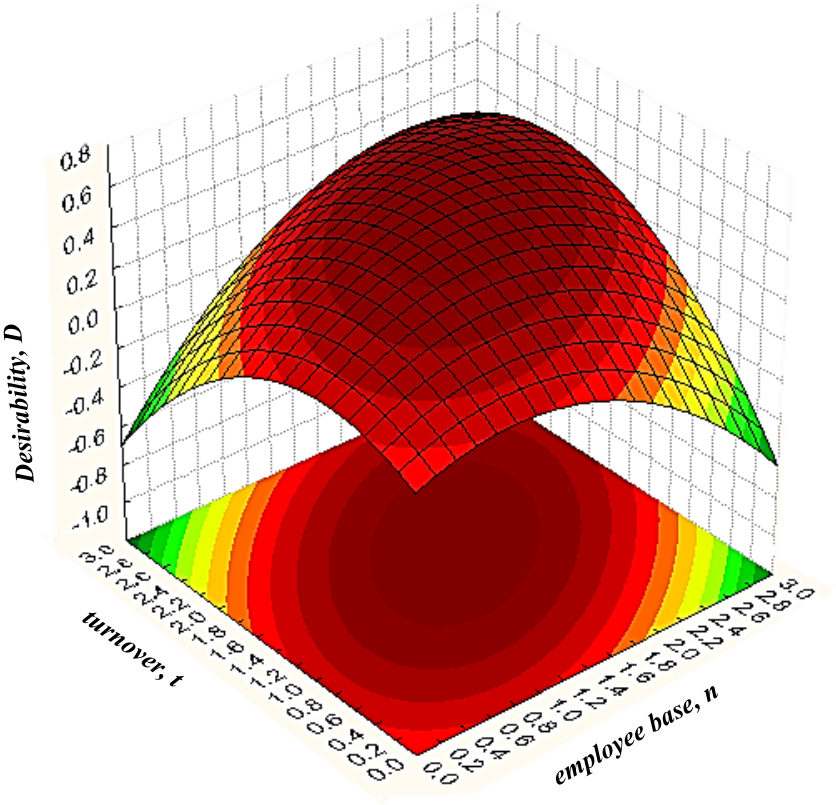

Figure 5-2: Desirability plot of Knowledge Creation

b) Firm's desirability of Knowledge Integration

The indicators of Knowledge Integration whose importance score was greater than 3.5 were tested for desirability. The Analysis of Variance method was used to derive the

desirability function. The desirability function for these indicators was established to be as presented in Equation 5-2.

$D_{ki} = -0.014 + 0.148n + 0.535t - 0.134n^2 + 0.171nt - 0.239t^2$…….... Eqn. 5-2

Where: $\boldsymbol{D_{ki}}$ is the desirability of Knowledge Integration, $\boldsymbol{n}$ parametric equivalent of the average number of employees **N** ($where\ N = 2e^{1.6094n}$), $\boldsymbol{t}$ is parametric equivalent of the annual turnover **T** (where $T = 6 \times 10^5 e^{1.6094t}$).

The desirability plot for the fitted equation whose geometric figure is that of an elliptic paraboloid is presented in Figure 5-3. Solving the above equation to determine the maxima shows that:

$$\max\{-0.014 + 0.148\,n + 0.535\,t - 0.134\,n^2 + 0.171\,n\,t - 0.239\,t^2\} = \frac{(324458 - 98863\,n)n + 272841}{956000}\ for\ t\ = \frac{1}{478}(171\,n + 535)$$

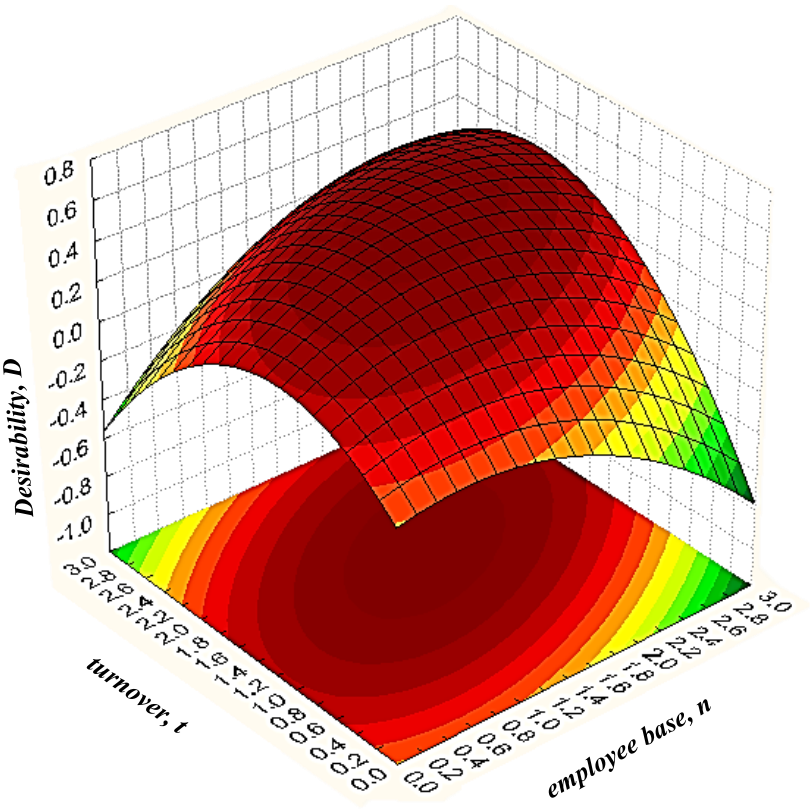

Figure 5-3: Desirability plot of Knowledge Integration

c) Firm's desirability of Knowledge Management

The indicators of Knowledge Management whose importance score was greater than 3.5 were tested for desirability. The Analysis of Variance method was used to derive the

desirability function. The desirability function for these indicators was established to be as presented in Equation 5-3.

$$D_{km} = -0.172 + 0.249n + 0.534t - 0.160n^2 + 0.198nt - 0.233t^2 \ldots\ldots\ldots \text{ Eqn. 5-3}$$

Where: $\boldsymbol{D_{km}}$ is the desirability of Knowledge Management, $\boldsymbol{n}$ parametric equivalent of the average number of employees **N** (*where* $N = 2e^{1.6094n}$), $\boldsymbol{t}$ is parametric equivalent of the annual turnover **T** (where $T = 6 \times 10^5 e^{1.6094t}$).

The desirability plot for the fitted equation whose geometric figure is that of an elliptic paraboloid is presented in Figure 5-4. Solving the above equation to determine the maxima shows that:

$$\max\{-0.172 + 0.249\,n + 0.534\,t - 0.16\,n^2 + 0.198\,n\,t - 0.233\,t^2\}$$
$$= \frac{(110883 - 27479\,n)n + 31213}{233000}\ for\ t\ = \frac{1}{233}(99\,n + 267)$$

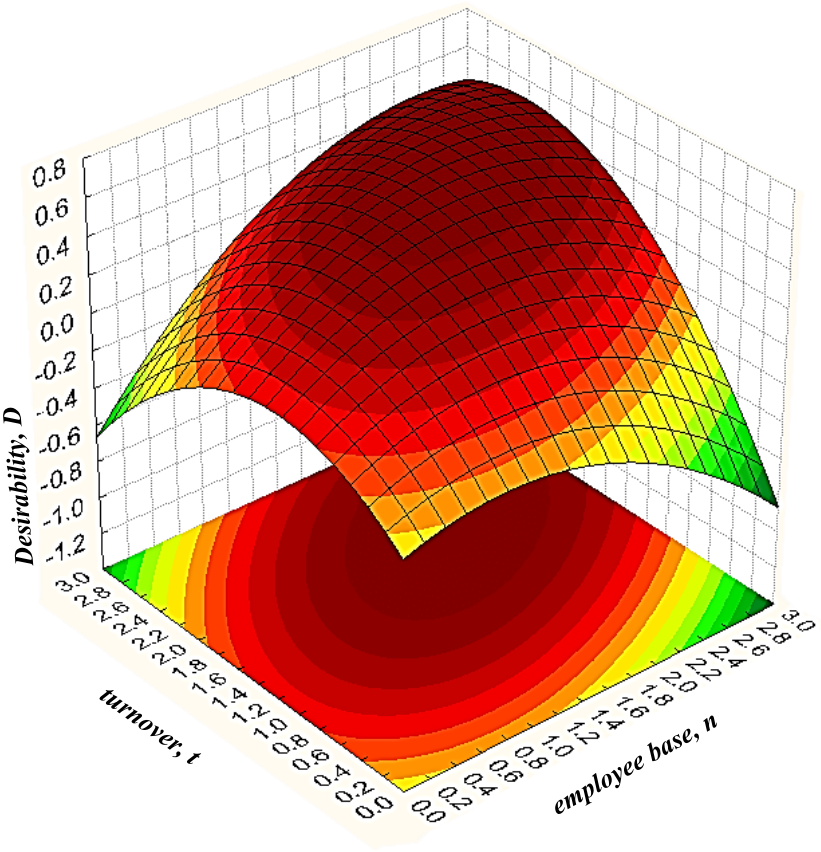

Figure 5-4: Desirability plot of Knowledge Management

d) Firm's desirability of Knowledge Creation, Integration and Management

The indicators of Knowledge Creation, Knowledge Integration and Knowledge Management whose importance score was greater than 3.5 were tested for desirability as a whole. The Analysis of Variance method was used to derive the desirability function.

The desirability function for these indicators was established to be as presented in Equation 5-4.

$$D_{kcim} = -0.077 + 0.231n + 0.498t - 0.155n^2 + 0.183nt - 0.229t^2 \ldots\ldots \text{ Eqn. 5-4}$$

Where:

D**kcim* is the desirability of Knowledge Creation, Integration and Management, ***n parametric equivalent of the average number of employees **N** (*where* $N = 2e^{1.6094n}$), ***t*** is parametric equivalent of the annual turnover **T** (where $T = 6 \times 10^5 e^{1.6094t}$).

The desirability plot for the fitted equation whose geometric figure is that of an elliptic paraboloid is presented in Figure 5-5. Solving the above equation to determine the maxima shows that:

$$\max\{-0.077 + 0.231\,n + 0.498\,t - 0.155\,n^2 + 0.183\,n\,t - 0.229\,t^2\}$$
$$= \frac{(393864 - 108491\,n)n + 177472}{916000} \; for\; t\; = \frac{1}{458}(183\,n + 498)$$

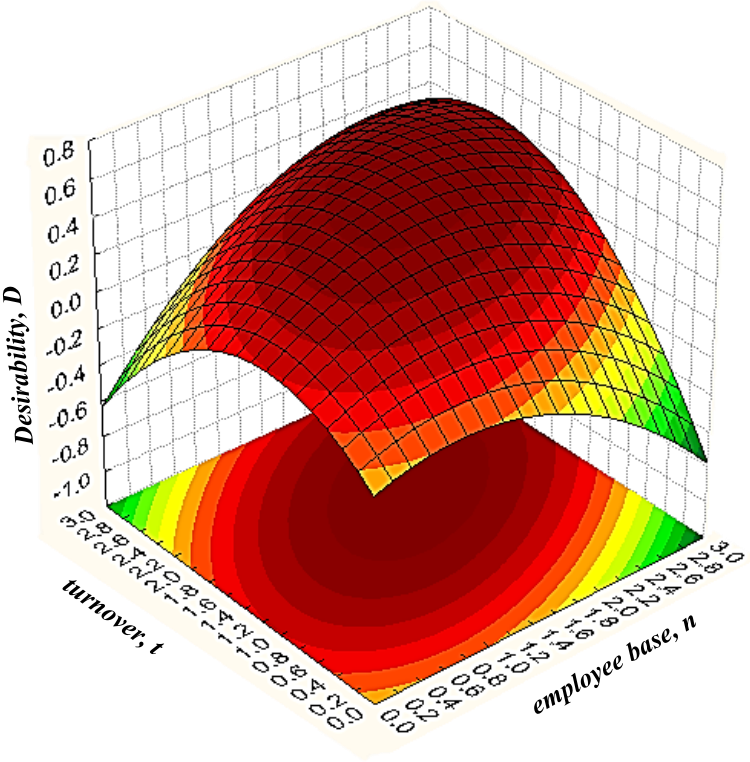

Figure 5-5: Desirability plot of Knowledge Creation, integration and management

5.2.2 Coefficients of Knowledge Creation, Integration and Management

The key indicators for Knowledge Creation, Knowledge Integration and Knowledge Management identified in Section 4 were processed further so as to derive the desired coefficients for each indicator.

The coefficients for each indicator were derived using the formula:

$$Indicator\ coefficient = \left(\left(\frac{5-S_i}{5-3.5}\right)/\sum_{i=1}^{n}\left(\frac{5-S_i}{5-3.5}\right)\right)$$ ..... Eqn. 5-5

Where: S_i is the mean score for Indicator *i*, [*1*, *n*].

The coefficients were computed and stored as presented in Table 5-1

.

Table 5-1: Coefficients of Knowledge Creation, Knowledge Integration and Knowledge Management

S/N	Indicator	Knowledge Creation Mean Score	Knowledge Integration Mean Score	Knowledge Management Mean Score	Knowledge Creation Coefficient	Knowledge Integration Coefficient	Knowledge Management Coefficient
1	Ability of the organisation to protect knowledge from inappropriate use	N/A	N/A	4.79	0.000	0.000	0.015
2	Amount of non-assigned working time within an organisation	4.21	4.21	N/A	0.095	0.081	0.000
3	Amount of time assigned to project meetings	N/A	4.00	3.79	0.000	0.102	0.085
4	Availability of monitoring and evaluation systems	4.59	N/A	4.59	0.050	0.000	0.029
5	Availability of policies for protection of knowledge at corporate level	4.38	N/A	4.62	0.075	0.000	0.027
6	Codification of knowledge such as know-how, technical skill, problem solving	N/A	N/A	4.41	0.000	0.000	0.041
7	Firm's flexibility to accommodate experimentation within a work place	4.00	4.03	N/A	0.120	0.099	0.000
8	Frequency of use of the knowledge base	4.21	4.00	N/A	0.095	0.102	0.000
9	Number of communities of practice within an organisation	N/A	N/A	3.79	0.000	0.000	0.085
10	Number of management/leadership who are aware of Knowledge Management	N/A	N/A	4.41	0.000	0.000	0.041
11	Number of new ideas submitted by staff	N/A	4.00	4.17	0.000	0.102	0.058
12	Number of new ideas implemented	N/A	4.41	N/A	0.000	0.060	0.000
13	Number of staff who are able to give example of incremental innovations	N/A	N/A	4.21	0.000	0.000	0.056
14	Proportion of staff that are current and knowledgeable within their field of work	N/A	4.62	4.41	0.000	0.039	0.041
15	Proportion of current project documents that make reference to previous documents	N/A	N/A	4.79	0.000	0.000	0.015
16	Proportion of organisational policies which make reference to Knowledge Management	N/A	N/A	4.41	0.000	0.000	0.041
17	Number of staff with direct linkages to experts in a given field of work	4.38	4.41	4.41	0.075	0.060	0.041
18	Proportion of staff that have a sense of ownership in what they do	3.97	4.17	4.38	0.124	0.085	0.044
19	proportion of staff that know a lot about their fellow staff's field of work	N/A	4.38	4.79	0.000	0.063	0.015
20	Proportion of staff who are aware of the organisation's Knowledge Management policies	N/A	N/A	4.00	0.000	0.000	0.070
21	Quantity of project records kept by the organisation	4.00	N/A	4.59	0.120	0.000	0.029
22	Quantity of project data stored in electronic format	3.97	N/A	4.21	0.124	0.000	0.056
23	Reduction of staff time spent looking for information	N/A	4.17	4.62	0.000	0.085	0.027
24	Regulated of use of the knowledge base	N/A	N/A	3.79	0.000	0.000	0.085
25	Regulated socialisation within an organisation	N/A	N/A	3.79	0.000	0.000	0.085
26	Retention of staff for longer period of time within an organisation	N/A	3.79	4.79	0.000	0.123	0.015
27	Years of experience of staff within the industry	4.00	N/A	N/A	0.120	0.000	0.000
Total					1.000	1.000	1.000

*N/A means not applicable as a key indicator

5.2.3 Knowledge Creation, Integration and Management performance indices

To obtain an overall picture of the organisation's performance with respect to Knowledge Creation, Integration and Management, a performance index was required. The performance index is a management tool that allows multiple sets of information to be compiled into an overall measure. It is noteworthy that performance measurement endorses a process perspective where the focus is on the internal process of quantifying the effectiveness and the efficiency of action with a set of metrics (Neely et al., 2005). The measures and indicators act as surrogates or proxies for organisational phenomena (Micheli and Mari, 2013). Performance measurement represents management and control systems that produce information to be shared with internal and external users. Furthermore, as it encompasses all aspects of the business management cycle, it constitutes a process for developing and deploying performance direction (Nanni et al., 1992).

Two key performance indices were developed i.e. the Current Knowledge Performance Index (CuKPI) and the Potential Knowledge Performance Indicator (PoKPI). The CuKPI represented the evaluated score achieved and was calculated as a product of indicator score and the desirability using the formula:

$$CuKPI = D_{kcim} \sum_{i=1}^{n} C_i R_i \quad \text{Eqn. 5-6}$$

Where: D_{kcim} is the organisation's desirability for Knowledge Creation, integration and management; C_i is the coefficient of indicator i; and R_i is the rating of indicator i. The minimum and maximum rating for each indicator are presented in Table 5-2.

On the other hand, the PoKPI represented the maximum possible score for a given firm and was computed using the same Equation 5-6 with $\sum_{i=1}^{n} C_i R_i$ being equal to 5.

Based on these indices, an organisation could be aware of how it was performing in terms of Knowledge Creation, Integration and Management relative to its potential.

Subsidiary indices for Knowledge Creation, Knowledge Integration and Knowledge Management were also developed. The indices answered to the firms desire to know areas where much effort was required. The subsidiary indices were computed using the formula:

$$I_k = (D_k \sum_{i=1}^{n} C_i R_i)/5D_k \quad \text{Eqn. 5-8}$$

The three subsidiary indices included:

i.) Knowledge Creation Index (KCI);
ii.) knowledge Integration Index (KII); and
iii.) Knowledge Management Index (KMI).

Table 5-2: Minimum and maximum ratings of indicators

S/N	Indicator	Min Rating	Max Rating	Scale Type
1	Ability of the organisation to protect knowledge from inappropriate use	0.00	5.00	Nominal
2	Amount of non-assigned working time within an organisation	0.00	5.00	Ratio
3	Amount of time assigned to project meetings	0.00	5.00	Ordinal
4	Availability of monitoring and evaluation systems	0.00	5.00	Nominal
5	Availability of policies for protection of knowledge at corporate level	0.00	5.00	Nominal
6	Codification of knowledge such as know-how, technical skill, problem solving, etc.	0.00	5.00	Nominal
7	Firm's flexibility to accommodate experimentation within a work place	0.00	5.00	Ordinal
8	Frequency of use of the knowledge base	0.00	5.00	Ordinal
9	Number of communities of practice within an organisation	0.00	5.00	Ratio
10	Number of management/leadership who are aware of Knowledge Management	0.00	5.00	Ordinal
11	Number of new ideas submitted by staff	0.00	5.00	Ratio
12	Number of new ideas implemented	0.00	5.00	Ratio
13	Number of staff who are able to give example of incremental innovations	0.00	5.00	Ratio
14	Proportion of staff that are current and knowledgeable within their field of work	0.00	5.00	Ratio
15	Proportion of current project documents that make reference to previous documents	0.00	5.00	Ordinal
16	Proportion of organisational policies which make reference to Knowledge Management	0.00	5.00	Ordinal
17	Number of staff with direct linkages to experts in a given field of work	0.00	5.00	Ratio
18	Proportion of staff that have a sense of ownership in what they do	0.00	5.00	Ratio
19	proportion of staff that know a lot about their fellow staff's field of work	0.00	5.00	Ordinal
20	Proportion of staff who are aware of the organisation's Knowledge Management policies	0.00	5.00	Ordinal
21	Quantity of project records kept by the organisation	0.00	5.00	Nominal
22	Quantity of project data stored in electronic format	0.00	5.00	Ordinal
23	Reduction of staff time spent looking for information	0.00	5.00	Nominal
24	Regulated of use of the knowledge base	0.00	5.00	Nominal
25	Regulated socialisation within an organisation	0.00	5.00	Nominal
26	Retention of staff for longer period of time within an organisation	0.00	5.00	Ordinal
27	Years of experience of staff within the industry	0.00	5.00	Ratio

5.3 The CIMEM$_k$

A computer-based model known as the CIMEM$_k$ was developed based on the framework presented in Figure 5-1 as well as the theoretical perspective presented in the sections above. The schematic architecture of the CIMEM$_k$ is presented in Figure 5-6.

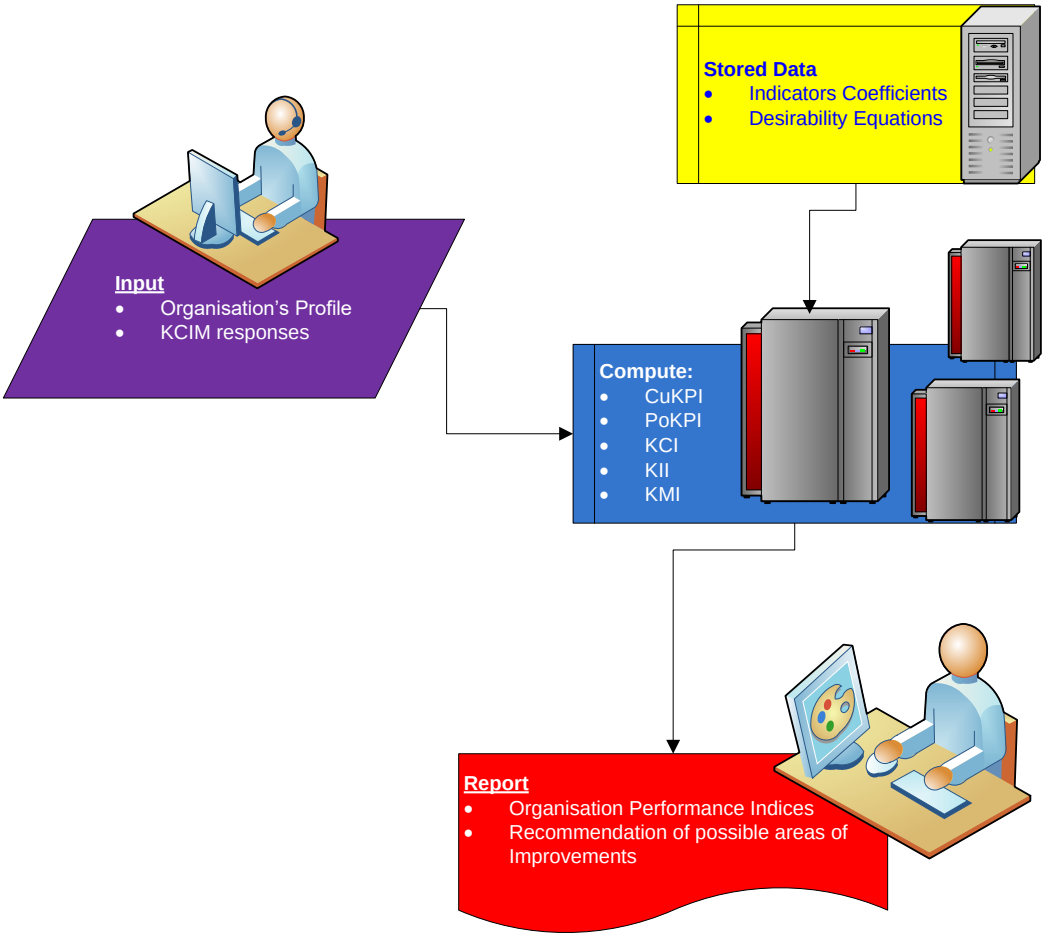

Figure 5-6: Schematic and Architecture of the CIMEM$_k$

The model has hidden and visible layers. The visible layers comprise of pages which would provide displays to the user while the invisible layers contain stored data and computational formulae.

5.3.1 The hidden layers

The model has three main hidden layers which are used for computation of outputs. These include:

i.) the internal storage;
ii.) desirability functions; and
iii.) computation layer.

5.3.2 Visible layers

There are five main displays. These include the following:

i.) Getting Started;
ii.) Firm's Profile;
iii.) User Knowledge Creation, Integration and Management Input;
iv.) CIMEM$_k$ Results; and
v.) Recommendations.

Each of these pages or displays is discussed in the subsections below.

a) Getting started page

This is the first page of the model. It welcomes the user to the model and provide quick links to subsequent pages. A screenshot of this page is shown in Figure 5-7.

Figure 5-7: Snapshot of the "Getting Started" page

b) Firm's profile page

The user is required to enter the organisation's profile data on this screen. The information required includes the firm's:

i.) name and address (optional);
ii.) year of first registration (mandatory);
iii.) current number of employees (mandatory); and
iv.) average annual turnover (mandatory).

The mandatory information is required for subsequent computations of the various indices and scores. Note that the scores are firm specific as each organisation has its own, not necessarily unique, desirability of Knowledge Creation, Integration and Management. A screenshot of this page is shown in Figure 5-8.

Figure 5-8: Snapshot of the "Firm's Profile" page

c) User Knowledge Creation, Integration and Management input page

The user is required to answer 27 questions that relate to Knowledge Creation, Integration and Management. These questions are based on the final list of indicators for Knowledge Management, Knowledge Integration and Knowledge Management presented in Section 5.2.2. Each response contributes to the firm's score for Knowledge Creation, Knowledge Integration, Knowledge Management and Knowledge Creation, Integration and Management. A snapshot of this page is shown in Figure 5-9.

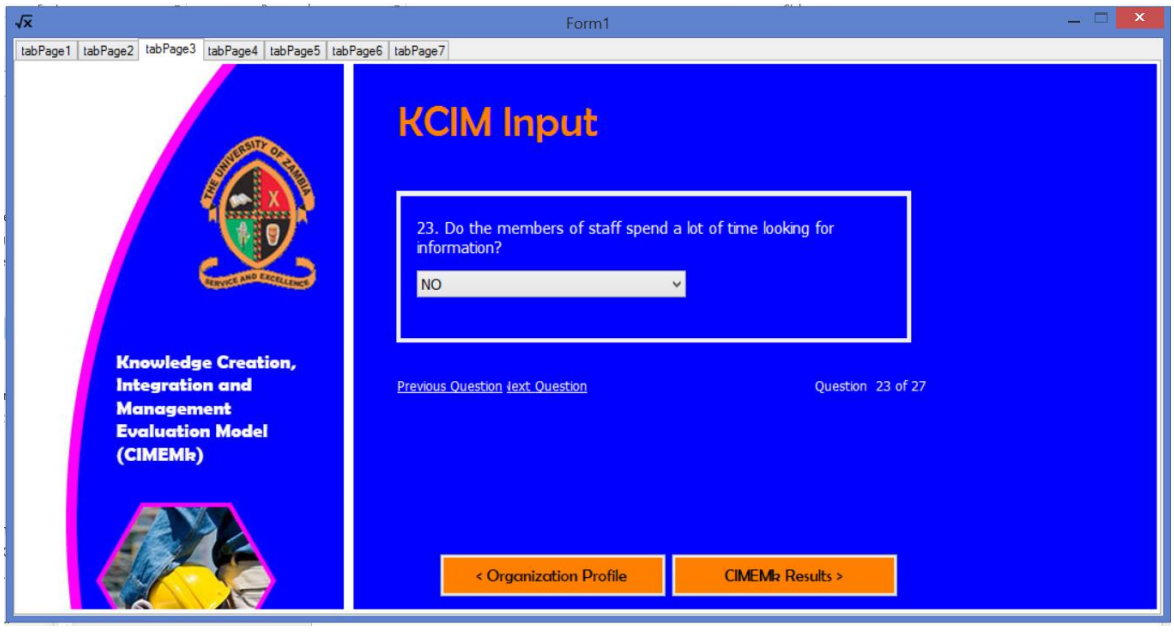

Figure 5-9: Snapshot of the "User Knowledge Creation, integration and management Input" page

To enhance the validity of the results, it was important to set data rules for all the questions. The questions and the corresponding data rules are presented in Table 5-3.

Table 5-3: User Knowledge Creation, Integration and Management questions and data rules

S/N	Question	Data Rules
1	Does your organisation have the ability to protect knowledge from inappropriate use?	Dropdown Menu (Yes, No)
2	In a 40 hour week, how many hours are designated as non-assigned working time within your organisation?	Whole Number between 0 and 40
3	What proportion of the total working time within your organisation is assigned to project meetings?	Dropdown Menu (0 percent,5 percent,10 percent,15 percent,20 percent, more than 20 percent)
4	Does your organisation have monitoring and evaluation systems?	Dropdown Menu (Yes, No)
5	Does your organisation have policies for protection of knowledge at corporate level?	Dropdown Menu (Yes, No)
6	Is there a deliberate measure/ action to codify knowledge such as know-how, technical skill, problem solving, etc. within your organisation?	Dropdown Menu (Yes, No)
7	How much flexibility does your organisation have with regards to accommodation of experimentation within a work place?	Dropdown Menu (0 percent,20 percent,40 percent,60 percent,80 percent, 100 percent)
8	How frequent do the staff within your organisation use the company/firm's knowledge base?	Dropdown Menu (0 percent,20 percent,40 percent,60 percent,80 percent, 100 percent)
9	How many communities of practice do you have within your organisation?	Whole Number between 0 and 5000
10	What is proportion of Management staff is conversant with the tenets of Knowledge Management?	Dropdown Menu (0 percent,20 percent,40 percent,60 percent,80 percent, 100 percent)
11	On average, how many new ideas are submitted by the members of staff within your organisation?	Whole Number between 0 and 5000
12	Out of the number of new ideas submitted, how many are implemented?	Whole Number between 0 and Value for Q11
13	How many members of staff within your organisation are able to showcase incremental innovations?	Whole Number between 0 and "Current Number of Employees"
14	How many members of staff could your comfortably say are current and knowledgeable within their field of work?	Whole Number between 0 and "Current Number of Employees"
15	What is the proportion of current project documents that make reference to previous documents or past projects?	Dropdown Menu (0 percent,20 percent,40 percent,60 percent,80 percent, 100 percent)
16	What is the proportion of your organisational policies that make reference to Knowledge Management?	Dropdown Menu (0 percent,20 percent,40 percent,60 percent,80 percent, 100 percent)
17	How many members of staff within your organisation have direct linkages to experts in their given field of work?	Whole Number between 0 and ["Current Number of Employees" minus value for Q14]
18	How many members of staff could you comfortably say have a sense of ownership in what they do?	Whole Number between 0 and "Current Number of Employees"
19	What is the proportion of members of staff know a lot about their fellow staff's field of work	Dropdown Menu (0 percent,5 percent,10 percent,15 percent,20 percent, more than 20 percent)
20	What proportion of staff could you comfortably say are aware of the organisation's Knowledge Management policies?	Dropdown Menu (0 percent,20 percent,40 percent,60 percent,80 percent, 100 percent)
21	Does your organisation keep documentation and records for both current and past projects?	Dropdown Menu (Yes, No)
22	What percentage of these records is stored in electronic format?	Dropdown Menu (0 percent,20 percent,40 percent,60 percent,80 percent, 100 percent)
23	Do the members of staff spend a lot of time looking for information?	Dropdown Menu (Yes, No)
24	Does your organisation regulate the use of the company/firm's knowledge base?	Dropdown Menu (Yes, No)
25	Does your organisation plan and organise social functions for members of staff?	Dropdown Menu (Yes, No)
26	What is the employee turnover rate within your organisation?	Dropdown Menu (0 percent,20 percent,40 percent,60 percent,80 percent, 100 percent)
27	On average, how many years of experience do your members of staff have within the civil engineering industry?	Whole Number between 0 and 50

d) *CIMEM$_k$ results page*

Once all the required data has been keyed, the user could navigate to the results page. A snapshot of this page is shown in Figure 5-10.

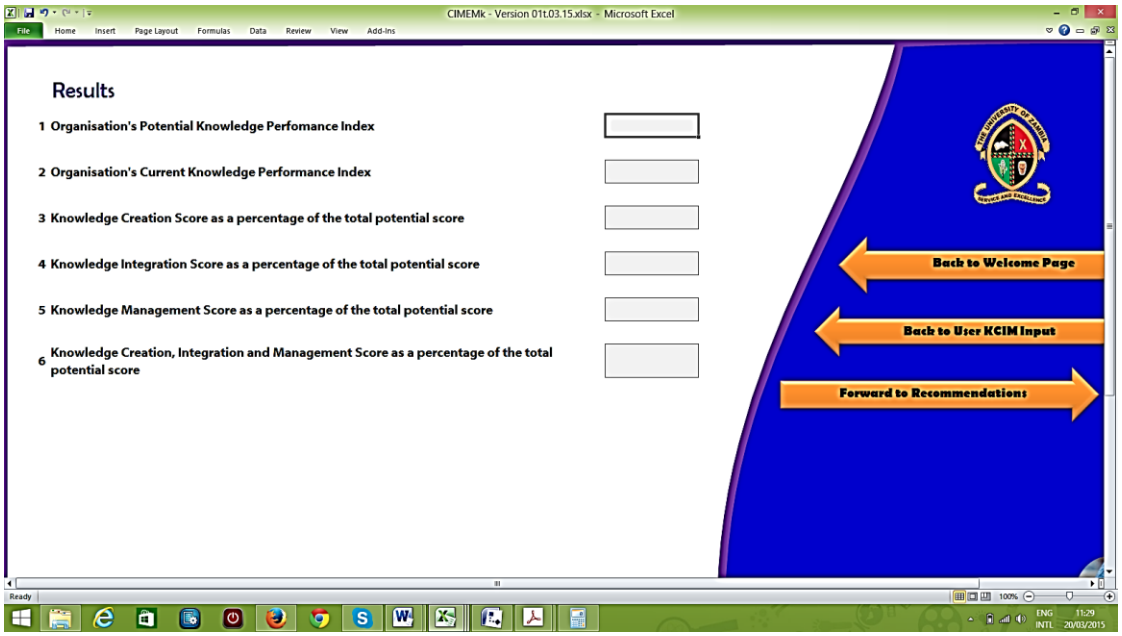

Figure 5-10: Snapshot of the "CIMEM$_k$ Results" page

Five key results are produced by the model. These include the firm's:

i.) PoKPI;
ii.) CuKPI;
iii.) KCI;
iv.) KII; and
v.) KMI.

e) *Recommendation page*

On the basis of the results obtained, the user could proceed to the recommendations page. On this page, areas which require attention are highlighted. The organisation could then focus their attention on the highlighted areas during the subsequent review period. A snapshot of this page is shown in Figure 5-11.

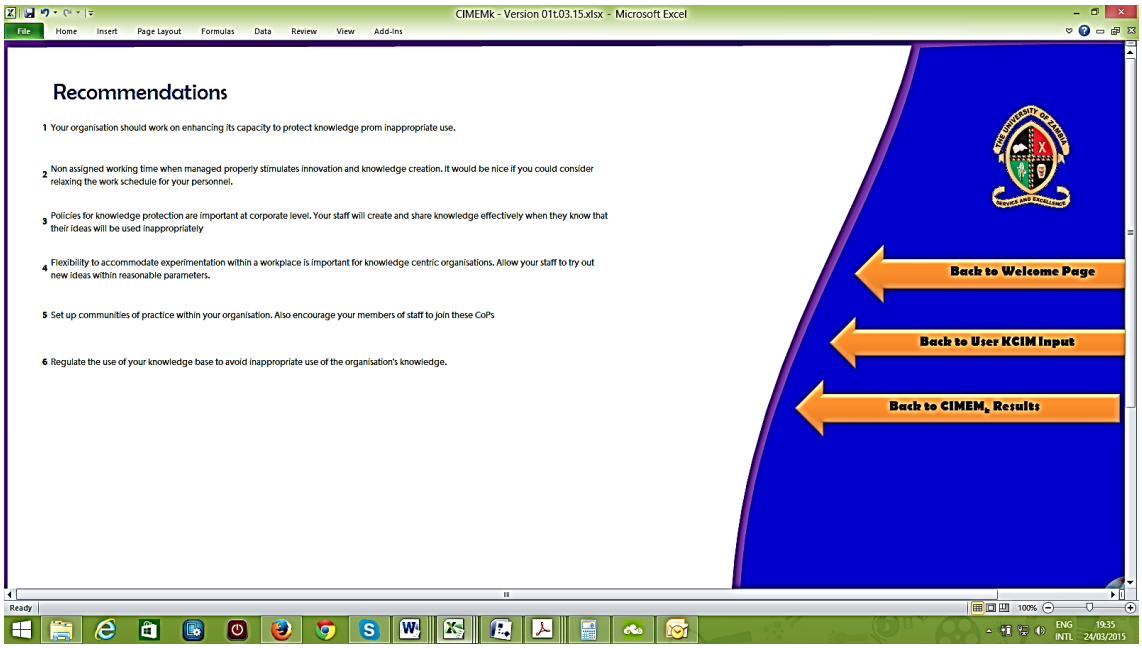

Figure 5-11: Snapshot of the "Recommendations" page

5.4 Validation of the model

The $CIMEM_k$ was validated using practitioners within Zambian civil engineering consulting sector. The validation process focused on the model's validity, legitimacy and functionality. A total of 20 directors were targeted in the validation exercise. Responses were received from only 11 out of which 5 represented Zambian firms and 6 international companies. The respondents were availed with the model to conduct their assessment. Prior to commencement of the assessment, a brief overview of the model was presented to them. The validation results are presented in the subsections below.

5.4.1 Profile of respondents

An assessment of the respondents' firms was undertaken. Of interest was the categorisation of responses by firm size and experience.

a) Respondent firms' age

The respondent firms were predominantly less than 20 years old. There were however two firms that had been in existence for more than 40 years. The distribution of the firms' age in civil engineering consultancy is presented in Figure 5-12.

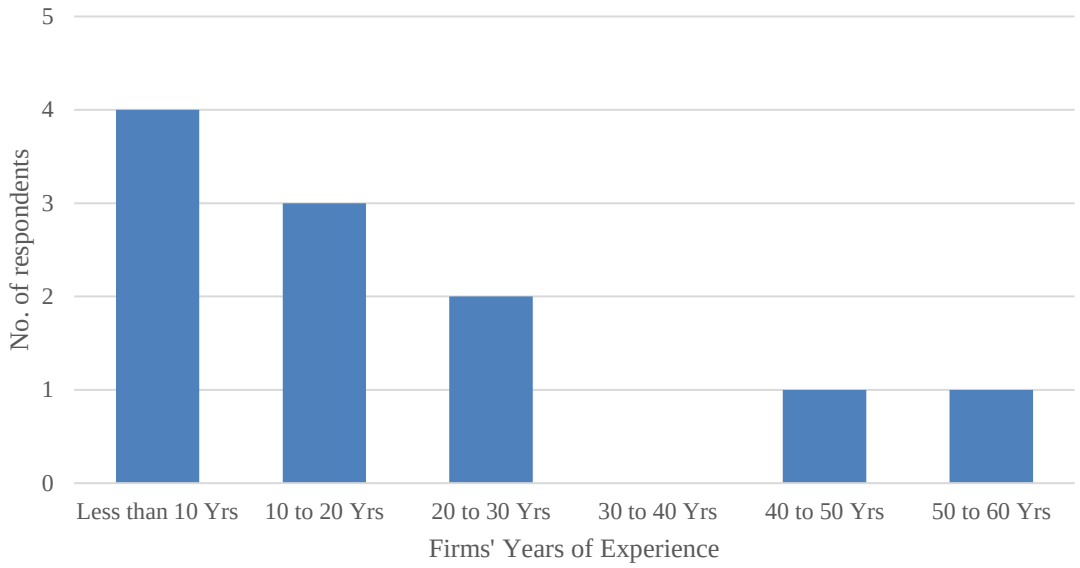

Figure 5-12: Distribution of respondent firms' by age

b) Respondent firms' number of employees

With regards to the number of employees, it was noted that five (5) firms had less than 100 employees while three had more than 200 employees. The rest of the firms had an employee base between 100 and 200. The distribution of respondent firms' employee base is presented in Figure 5-13.

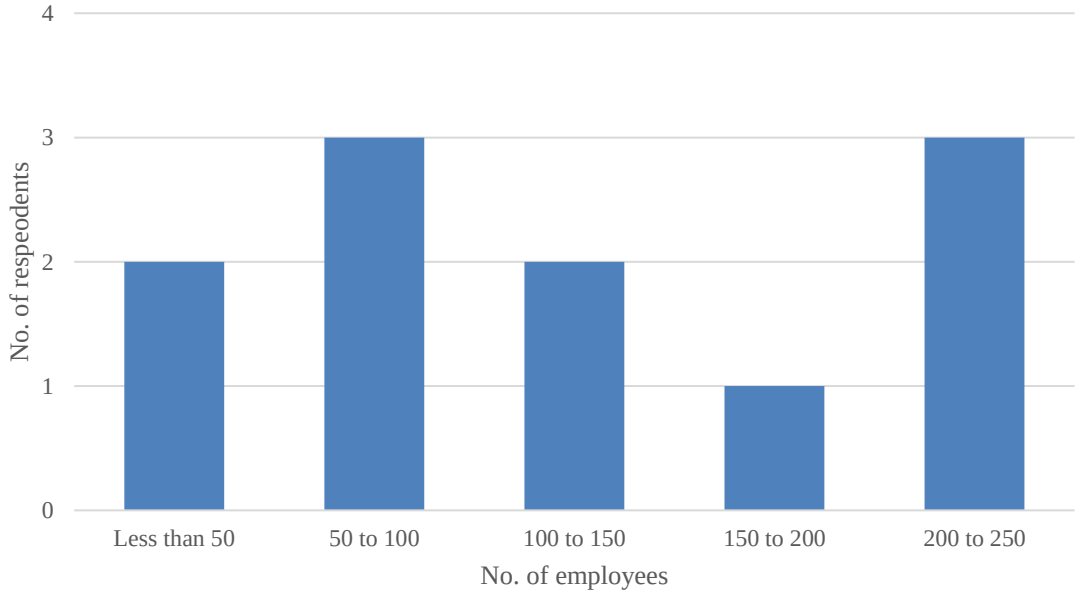

Figure 5-13: Distribution of respondent firms' by number of employees

c) Respondent firms' turnover

With regards to annual turnover, the majority of the responsive firms had average annual turnover of less than US$2million. The distribution of the respondent firms' annual turnover is presented in Figure 5-14.

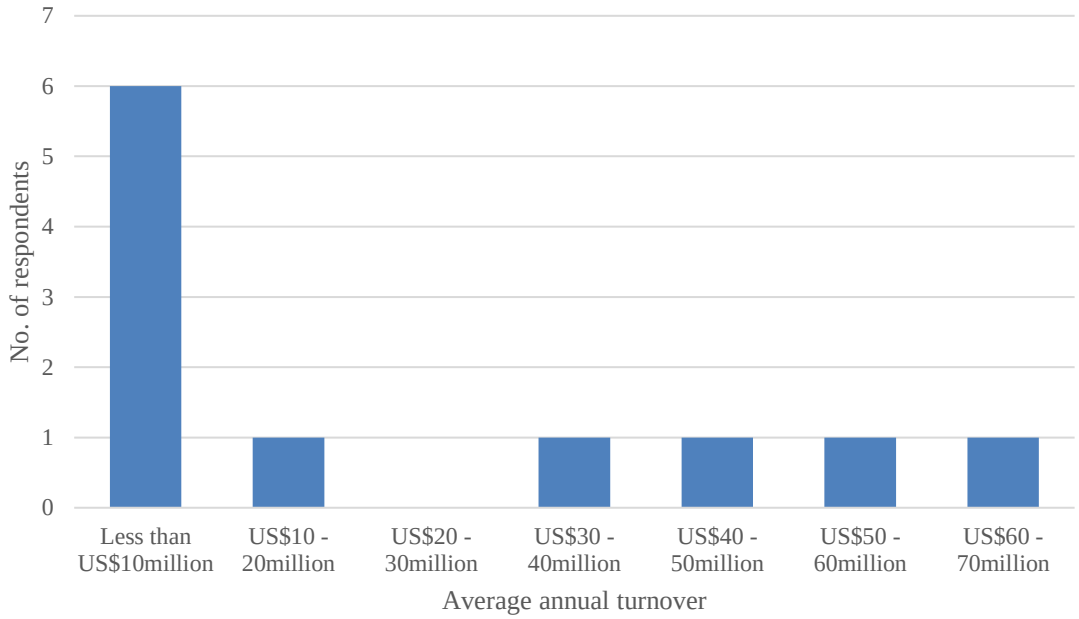

Figure 5-14: Distribution of Respondent Firms' Annual Turnover

5.4.2 Sufficiency of the functional part of the model

The respondents were asked to provide feedback on the functionality of the model. The functional attributes measured as well as the statistical results are presented in Table 5-4. The functional score of the $CIMEM_k$ taken as an arithmetic mean of the attribute score was 4.38. The standard deviation of responses was 0.73. The results were tested for significance using the standard t-test. It was established that all the responses were significant at $p<0.05$. The calculated results reflect a high standard of functionality.

Table 5-4: Functionality assessment results of the $CIMEM_k$

Functional attributes	Mean	Std.Dv.	N	Std.Err.	t-value	df	p
The titles of the model links reflect the content of their respective pages	4.181818	0.750757	11	0.226362	3.012072	10	0.013071
It is easy to navigate through the model	4.272727	0.904534	11	0.272727	2.833333	10	0.017750
It was easy to enter the required inputs	4.545455	0.687552	11	0.207305	5.043084	10	0.000504
The results of the model were clear	4.454545	0.522233	11	0.157459	6.062178	10	0.000122
The recommendations were visible	4.454545	0.820200	11	0.247299	3.859877	10	0.003161

5.4.3 Validity of the model outputs

The $CIMEM_k$ was assessed for validity. The validity attributes measured as well as the statistical results are presented in Table 5-5. It was established that the validity score of the $CIMEM_k$ was 4.55. The standard deviation of responses was 0.59.

Table 5-5: Validity assessment results of the $CIMEM_k$

Validity attributes	Mean	Std.Dv.	N	Std.Err.	t-value	df	p
The model results were a true reflection of our organisation's status	4.636364	0.504525	11	0.152120	7.470179	10	0.000021
The recommendations were in line with our expectations	4.454545	0.687552	11	0.207305	4.604555	10	0.000973

The results were tested for significance using the standard t-test. It was established that all the responses were significant at $p<0.05$. The calculated results reflect a high standard of validity.

5.4.4 Usefulness of the model

The $CIMEM_k$ was assessed for its usefulness. The usefulness attributes measured as well as the statistical results are presented in Table 5-6. It was established that the usefulness score of the $CIMEM_k$ was 4.78. The standard deviation of responses was 0.73. The results were tested for significance using the standard t-test. It was established that all the responses were significant at $p<0.05$. The calculated results reflect a high standard of the model's acceptability and usefulness.

Table 5-6: Usefulness assessment results of the $CIMEM_k$

Usefulness attributes	Mean	Std.Dv.	N	Std.Err.	t-value	df	p
The model is useful	4.272727	0.786245	11	0.237062	3.259601	10	0.00858
Proper use of the model could help us to improve our processes with the organisation	4.727273	0.64667	11	0.194978	6.294407	10	0.00009
Improvements resulting from proper use of this model could enhance our competitiveness	4.363636	0.80904	11	0.243935	3.540441	10	0.005353
I could recommend the use of this model to other consulting firms	4.545455	0.687552	11	0.207305	5.043084	10	0.000504

5.5 Summary

This Chapter presented the development and validation of the $CIMEM_k$. The model was validated by the practitioners within the Zambian civil engineering consulting sector. The model was established to be functional, valid and legitimate. The next Chapter presents a discussion of the research findings.

CHAPTER 6: DISCUSSION OF RESULTS

6.1 Introduction

The previous Chapter presented the model development and validation. This Chapter discusses the findings of the research in relation to what other scholars have established. This Chapter sets out by identifying key theoretical perspectives which have been highlighted within the study. In all studies, it has not been disputed that Knowledge Management enables organisations to gain competitive advantage and to enhance many others advantages such as to produce higher-value services for the firm (Turban et al., 2011).

6.2 Awareness of Knowledge Management

The findings of the interviews in Section 4.2.7 showed that the level of awareness of Knowledge Creation, Integration and Management among civil engineering consulting firms was low. The interviewees' firms were predominantly small to medium enterprises which according to Bozbura (2007) they should have had a high perception of Knowledge Management. The study of the Finnish firms showed that there was a high level of awareness of Knowledge Management among small to medium enterprises (Salojärvi *et al.*, 2005).

The findings of this study however tends to agree more with Jafari, *et.al.* (2007) on the assertion that the size of the company had no effect on the awareness of Knowledge Management. It also agrees with the assertions of Nunes *et al.* (2006) in which Managers of SMEs were not aware of the long-term potentials of Knowledge Management. Most Knowledge Management activities were carried out informally and usually not supported with purposely designed tool. It can be deduced that the firms in developed countries are more likely to be aware of Knowledge Management practices than their counterparts in developing economies. Related to the awareness, it was important to note that every firm had its own priority and measurement. The results therefore depend on the respondents' knowledge, experiences, academic background, roles, resources availability, their business activities and location.

6.3 Key indicators of Knowledge Creation, Integration and Management

Traditional literature has often viewed Knowledge Creation and integration as subsets of Knowledge Management (Drucker, 1993; Prahalad *et al.*, 1990; Snyder *et al.*, 2000). Recent studies, though not stated directly, tend to go with a view that Knowledge Creation and Knowledge Integration form part of the attributes of Knowledge Management and not necessarily subsets (Carbó and Osca, 2011; Liao, 2008; Liu and Liu, 2011; Steward, 2008). This view point seems to agree with the findings of this study in which 27 key indicators were identified out of which:

i.) ten (10) were unique to Knowledge Management;
ii.) six (6) were common to Knowledge Integration and Knowledge Management;
iii.) four (4) were common to Knowledge Creation and Knowledge Management;
iv.) three (3) were common to Knowledge Creation and Knowledge Integration;
v.) two (2) were common to Knowledge Creation, Knowledge Integration and Knowledge Management;
vi.) one (1) was unique to Knowledge Creation; and
vii.) one (1) was unique to Knowledge Integration.

This supports the notion pointed out by Bajaria (2000), where he asserted that Knowledge Creation and Knowledge Management were inseparable twin yet brought together by integration so as to enhance the business competitiveness of the firm.

Studies by previous scholars have not categorised the key indicators according to Knowledge Creation, Knowledge Integration and Knowledge Management. Throughout the study, no literature was found which ranks the indicators of Knowledge Management. This study however identified and categorised the key indicators.

6.4 Monitoring and evaluation of Knowledge Creation, Integration and Management in firms

The ability to monitor and evaluate an initiative's performance is crucial for its long-term success. Performance indicators are therefore required so as to assess progress, devise improvements, and compare one's own situation to that of a different organisation (Wu et al., 2010). The Zambian consulting firms were initially divided on the need to have a model for monitoring and evaluating Knowledge Management performance. Studies by other scholars have however shown that measurement is important so that the organisations can be able to show the value of Knowledge Management application. It is also important to make sure the activities are aligned with the objectives and to track the progress as such the evaluation, comparison, control and improvement upon the performance of knowledge activities (Wong, 2005).

Through the study, it was noted that almost all measurement models developed tend to concentrate on either the effects (Ahn and Chang, 2004; Chaudhry, 2003) or enablers (Lee and Choi, 2003; Pee and Kankanhalli, 2009) of Knowledge Management within the business environment. This study however took a view point of monitoring and evaluating the existence of the key indicators within the firm there after integrating the desirability of such indicators to obtain the knowledge performance. The proposed approach allows for continuous process improvement while working within the firms' own desirability realms.

Scholars have argued that Knowledge Management must be linked to economics, meaning that its value must be made apparent (Botha et al., 2008). The intangible nature of knowledge (Moballeghi and Moghaddam, 2011) and the fact that value creation is

often indirect and long-term (Carlucci *et al.*, 2004) makes such an assessment very difficult. Yet performance indicators are crucial for management to continue investing in knowledge efforts (Heaidari et al., 2011; Wu et al., 2010). The model proposed in this study provides a linkage between the intellectual capital and the firm's financial values in terms of annual turnover. This was based on the understanding that it is the leveraging of intellectual capital that allow an organisation to create and sustain a competitive advantage (Tomé and Gonzalez-loureiro, 2014). The intellectual capital is established through the measurement of knowledge indicator while the financial value is incorporated through desirability functions which take into account the firms' annual turnover and resource base.

6.5 Summary

This Chapter presented a discussion of the key findings of the research. The findings were discussed in relation to what other scholars have established on the subject of Knowledge Creation, Integration and Management. Chapter 7 presents the conclusion and recommendations of the study.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

Knowledge has been recognised as a resource that is critical to any organisation's survival and success in the global market. This is even more critical for civil engineering consulting firms because they are knowledge centric and their products are all knowledge-based (Carmel, 2009). This research aimed at developing a model which could be used to establish the organisation's performance with regards to Knowledge Creation, Knowledge Integration, Knowledge Management and Knowledge Creation, Integration and Management. The research was set out to:

i.) establish the level of Knowledge Creation, Integration and Management awareness within the Zambian civil engineering consulting industry;
ii.) identify key indicators of Knowledge Creation, Integration and Management in firms based on Zambian and international consulting firms operating in Africa;
iii.) develop and validate the $CIMEM_k$; and
iv.) prescribe possible uses and operations of the $CIMEM_k$.

7.2 Conclusions

The objectives of the study were all met successfully. Through this study, the level of awareness of Knowledge Creation, Integration and Management practices within the Zambian civil engineering consulting industry was established. It was established that the practitioners within the civil engineering consulting industry in Zambia are familiar with the basics of Knowledge Management. However, not much was known about Knowledge Creation and integration. It was also noted that most of the practitioners unknowingly use some of the tools of Knowledge Creation, Integration and Management. It was therefore established that the level of awareness of Knowledge Management and its practices was low in civil engineering consulting firms operating in Zambia. It was also established that civil engineering consulting firms in operating in Zambia do not have formal tools, techniques or systems for monitoring and evaluating Knowledge Creation, Integration and Management.

The key indicators of Knowledge Creation, Integration and Management were established. The key indicators of Knowledge Creation were identified include among other:

i.) amount of non-assigned working time within an organisation;
ii.) availability of monitoring and evaluation systems;
iii.) availability of policies for protection of knowledge at corporate level;
iv.) firms' flexibility to accommodate experimentation within a work place;
v.) proportion of staff that are current and knowledgeable within their field of work;
vi.) proportion of staff that have a sense of ownership in what they do; and

vii.) years of experience of staff within the industry.

The key indicators for Knowledge Integration were identified to include:
i.) amount of non-assigned working time within an organisation;
ii.) amount of time assigned to project meetings;
iii.) firm's flexibility to accommodate experimentation within a work place;
iv.) frequency of use of the knowledge base;
v.) number of new ideas submitted by staff; number of new ideas implemented;
vi.) number of staff with direct linkages to experts in a given field of work; and
vii.) retention of staff for longer period of time within an organisation.

On the other hand, the key indicators of Knowledge Management that were identified include:
i.) ability of the organisation to protect knowledge from inappropriate use;
ii.) availability of monitoring and evaluation systems;
iii.) codification of knowledge such as know-how, technical skills, problem solving;
iv.) number of communities of practice within an organisation;
v.) proportion of staff who are aware of the organisation's Knowledge Management policies;
vi.) regulated of use of knowledge base; and
vii.) regulated socialisation within an organisation.

The $CIMEM_k$ was developed based on the survey results. The purpose and operations of the model were also prescribed. The model was validated by 5 Zambian and 6 international consulting firms operating in Africa. Both Zambian and international civil engineering consulting firms upheld the functionality, validity and usefulness of the model. It was deduced from validation that the $CIMEM_k$ would help improve the competitiveness of civil engineering consulting firms within and outside their countries.

7.3 Contributions of the research

Through this study, the desirability for Knowledge Creation, Integration and Management was established. The desirability was established as a function of the organisation's turnover and employee base. The study established that the level of desirability for Knowledge Creation, Integration and Management was different, but not necessarily unique for each organisation. The developed desirability functions can be used to determine the required level of effort for any given organisation within the civil engineering consulting sector.

A model that evaluates Knowledge Creation, Integration and Management performance within an organisation was developed through this study. In particular, five performance indices were developed. Two main performance indices:
i.) Firm's PoKPI; and

ii.) Firm's CuKPI.

While the subsidiary indices that help firms focus on specific knowledge performance areas included:

i.) KCI;
ii.) KII; and
iii.) KMI.

The study established that it is possible to optimise Knowledge Creation, Integration and Management efforts relative the organisations' requirements. This new found knowledge opens the frontiers of enhanced performance management of knowledge within organisations.

7.4 Limitations of the study

The research was limited to the study of Knowledge Creation, Integration and Management within civil engineering consulting firms. The findings of the study could only be applied to other industries or sectors after calibration as their operations may not be exactly the same as those of civil engineering consulting firms. The civil engineering consulting firms surveyed were all categorised as small to medium enterprises by international definition. This implies that the findings within the civil engineering consulting firms cannot be generalised to large firms. However, the model outputs could serve as a basis for encouraging civil engineering consulting firms to work towards enhancing their Knowledge Creation, Integration and Management practices which in turn could contribute towards increasing their competitiveness. The low level of awareness of Knowledge Creation, Integration and Management among civil engineering consulting firms in Zambia could not allow for case studies involving alpha testing of the $CIMEM_k$.

7.5 Recommendations

A number of aspects have been identified from the study that could yield useful results for both academic research and practical applications to enhance the adoption and implementation of Knowledge Creation, Integration and Management practices within civil engineering consulting firms. The recommendations include:

i.) calibration of the $CIMEM_k$ for use in other industries;
ii.) calibration of the $CIMEM_k$ for use in large firms;
iii.) further development of the $CIMEM_k$ for use as a benchmarking tool;
iv.) further studies on the use of model and development of enhanced desirability functions; and
v.) increased sensitisation on the importance of Knowledge Creation, Knowledge Integration and Knowledge Management among the small to medium enterprises and industry practitioners in general.

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Appendix 1 – Interview Guide

INTERVIEW GUIDE

1. Name of Interviewee: ……
2. Organization/ Firm: …….....
3. How many years of experience do you have (general): ……..
4. Years of experience in consultancy: ……..
5. How long has this consultancy firm been in existence? …….....
6. How long have you been working for the firm? .....
7. Are you familiar with Organization Learning (OL)? ……
8. If so, what are some of the OL tools that you are familiar with? …… …… …… …… …… ……
9. Are you familiar with Knowledge Management (KM)? ……
10. If so, what are some of the KM tools that you are familiar with? …… …… …… …… …… …… ……
11. Does your organization employ any of these tools? ……..
12. Which tools in particular does your organization use? …… …… …… …… ……
13. Do you think KM or OL is important to the well being of your organization? ……
14. What are some of the advantages of OL or KM to an organization like this one? …… …… …… …… …… …… …… …… ……

INTERVIEW GUIDE

15. Does your firm view Knowledge Creation (KC) as an important ingredient for success and sustainability within the consulting industry? …….....
16. If so, do you have tools to monitor and evaluate KC within your firm? …….
17. What are some of the tools that you use to monitor and evaluate the level of KC within your organization?
    ……
    ……
    ……
    ……
    ……
    ……
    ……
    ……
    ……..
18. Does your firm view Knowledge Integration (KI) as an important ingredient for success and sustainability within the consulting industry? …….....
19. If so, do have tools to monitor and evaluate KI within your firm? …….
20. What are some of the tools that you use to monitor and evaluate the level of KC within your organization?
    ……
    ……
    ……
    ……
    ……
    ……
    ……
21. Would a framework that helps you monitor and evaluate KC, KI and KM be of importance to the well being of your organization? (Please state the reason for your answer)
    ……
    ……
    ……
    ……
22. Would such a framework be of any benefits to the civil engineering industry in general? (provide a reason for your response)
    ……
    ……
    ……
    ……..

Thank you very much for your contribution.

Appendix 2 – Questionnaire

The University of Zambia,
School of Engineering,
Dept. of Civil & Environmental Engineering,
P.O. Box 32379,
Lusaka.
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3rd March 2014

……
……
……
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Dear Sir/Madam,

QUESTIONNAIRE SURVEY: KEY INDICATORS OF KNOWLEDGE CREATION, INTEGRATION AND MANAGEMENT WITHIN A CIVIL ENGINEERING CONSULTING FIRM/ORGANIZATION

I am a PhD Candidate in Construction Management at the University of Zambia. I am undertaking a research on the topic "**Knowledge creation, integration and management: A study of the civil engineering consulting firms**".

The study seeks to establish the key indicators of knowledge creation, knowledge integration and knowledge management within professional services firms/organizations. The results obtained from this study will contribute towards the development of indices that can be used for the following purposes:

- *By firms/organizations – to monitor and evaluate how they are performing within the knowledge sphere.*
- *By client bodies and regulators – to assess firms that exhibit growth characteristics with the knowledge dimensions (since knowledge is the principle asset the consulting firms must possess.)*

Attached to this letter is a questionnaire and based on your experience in the field of civil engineering and/or knowledge management, you are requested to spare some of your valuable time to complete it. Please answer all questions. All the information gathered will be used only for purpose of the research with strict confidentiality.

Should there be any queries, please do not hesitate to get in touch with the undersigned using the address and contact details provided. Your assistance and cooperation is highly appreciated.

With Kind Regards

Chabota Kaliba
PhD Candidate

The purpose of this study is to identify the key indicators that can be used for monitoring and evaluation of knowledge creation, integration and management within civil engineering consulting firms.
Please respond to the following questions either by ticking appropriately or by writing your answer in the space provided.

Please note:

- *The answers should be based on your experience in the professional services industry and knowledge management.*
- *All information provided will be treated in the strictest of confidence.*

PART A: FILTER QUESTIONS

A.1. Do you work for a Civil Engineering Consulting Firm?

A. Yes
B. No
C. Other please specify _____

A.2. Do you have the basic understanding of knowledge management and/or Organisational Learning?

A. Yes
B. No

A.3. What position do you hold within your organisation?

A. Owner
B. Senior level management
C. Middle level management
D. Junior level management
E. Employee

A.4. How many years of experience do you have within the civil engineering consulting industry?

A. <5 years
B. 5-10 years
C. 10-15 years
D. 15-20 years
E. >20 years

PART B: ORGANISATIONAL PROFILE

B.1. How long has this organisation been in existence?

A. Less than 10 years
B. 10-20 years
C. 20-40 years
D. 40-60 years
E. More than 60 years

B.2. Number of Employees?

A. Less than 10
B. 10-50
C. 50-250
D. More than 250

B.3. Annual Turnover?

A. Less than US$3 million
B. US$3 million to US$15 million
C. US$15 million to US$75 million
D. Above US$75 million

PART C: INDICATORS OF KNOWLEDGE CREATION, INTEGRATION AND MANAGEMENT

C.1. Indicators of Knowledge Creation

Below is a list of 32 indicators of Knowledge Creation. Kindly rate their importance with respect to monitoring and evaluations of Knowledge Creation within an organisation on a scale of 1 to 5, with 1 being 'not important' and 5 being 'very important' by marking in the appropriate space provided. N.A means not applicable as an indicator

S/N	Indicator/Factor	Importance					
		1	2	3	4	5	N.A
1	Ability of the organisation to protect knowledge from inappropriate use						
2	Amount of non-assigned working time within an organisation						
3	Amount of time assigned to project meetings						
4	Availability of monitoring and evaluation systems						
5	Availability of policies for protection of knowledge at corporate level						
6	Codification of knowledge such as know-how, technical skill, problem solving						
7	Firm's flexibility to accommodate experimentation within a work place						
8	Frequency of use of the knowledge base						
9	Number of communities of practice within an organisation						
10	Number of management/leadership who are aware of knowledge management						
11	Number of new ideas implemented						
12	Number of new ideas submitted by staff						
13	Number of staff pursuing further studies						
14	Number of staff who are able to give example of incremental innovations						
15	Number of Staff with direct linkages to experts in a given field of work						
16	Number of workshops/seminars attended by Staff						
17	Number of workshops/seminars organised by the organisation						
18	Proportion of current project documents that make reference to previous documents						
19	Proportion of organisational policies which make reference to KM						
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover						
21	Proportion of staff that are current and knowledgeable within their field of work						
22	Proportion of staff that have a sense of ownership in what they do						
23	proportion of staff that know a lot about their fellow staff's field of work						
24	Proportion of staff who are aware of the organisation's KM policies						
25	Proportion of the organisation's budget available/spent on research and new designs						
26	Quantity of project data stored in electronic format						
27	Quantity of project records kept by the organisation						
28	Reduction of staff time spent looking for information						
29	Regulated of use of the knowledge base						
30	Regulated socialisation within an organisation						
31	Retention of staff for longer period of time within an organisation						
32	Years of experience of staff within the industry						

C.2. Indicators of Knowledge Integration

Below is a list of 32 indicators of Knowledge Integration. Kindly rate their importance with respect to monitoring and evaluations of Knowledge Integration within an organisation on a scale of 1 to 5, with 1 being 'not important' and 5 being 'very important' by marking in the appropriate space provided. N.A means not applicable as an indicator

S/N	Indicator/Factor	Importance					
		1	2	3	4	5	N.A
1	Ability of the organisation to protect knowledge from inappropriate use						
2	Amount of non-assigned working time within an organisation						
3	Amount of time assigned to project meetings						
4	Availability of monitoring and evaluation systems						
5	Availability of policies for protection of knowledge at corporate level						
6	Codification of knowledge such as know-how, technical skill, problem solving						
7	Firm's flexibility to accommodate experimentation within a work place						
8	Frequency of use of the knowledge base						
9	Number of communities of practice within an organisation						
10	Number of management/leadership who are aware of knowledge management						
11	Number of new ideas implemented						
12	Number of new ideas submitted by staff						
13	Number of staff pursuing further studies						
14	Number of staff who are able to give example of incremental innovations						
15	Number of Staff with direct linkages to experts in a given field of work						
16	Number of workshops/seminars attended by Staff						
17	Number of workshops/seminars organised by the organisation						
18	Proportion of current project documents that make reference to previous documents						
19	Proportion of organisational policies which make reference to KM						
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover						
21	Proportion of staff that are current and knowledgeable within their field of work						
22	Proportion of staff that have a sense of ownership in what they do						
23	proportion of staff that know a lot about their fellow staff's field of work						
24	Proportion of staff who are aware of the organisation's KM policies						
25	Proportion of the organisation's budget available/spent on research and new designs						
26	Quantity of project data stored in electronic format						
27	Quantity of project records kept by the organisation						
28	Reduction of staff time spent looking for information						
29	Regulated of use of the knowledge base						
30	Regulated socialisation within an organisation						
31	Retention of staff for longer period of time within an organisation						
32	Years of experience of staff within the industry						

C.3. Indicators of Knowledge Management

Below is a list of 32 indicators of Knowledge Management. Kindly rate their importance with respect to monitoring and evaluations of Knowledge Management within an organisation on a scale of 1 to 5, with 1 being 'not important' and 5 being 'very important' by marking in the appropriate space provided. N.A means not applicable as an indicator

S/N	Indicator/Factor	Importance					
		1	2	3	4	5	N.A
1	Ability of the organisation to protect knowledge from inappropriate use						
2	Amount of non-assigned working time within an organisation						
3	Amount of time assigned to project meetings						
4	Availability of monitoring and evaluation systems						
5	Availability of policies for protection of knowledge at corporate level						
6	Codification of knowledge such as know-how, technical skill, problem solving						
7	Firm's flexibility to accommodate experimentation within a work place						
8	Frequency of use of the knowledge base						
9	Number of communities of practice within an organisation						
10	Number of management/leadership who are aware of knowledge management						
11	Number of new ideas implemented						
12	Number of new ideas submitted by staff						
13	Number of staff pursuing further studies						
14	Number of staff who are able to give example of incremental innovations						
15	Number of Staff with direct linkages to experts in a given field of work						
16	Number of workshops/seminars attended by Staff						
17	Number of workshops/seminars organised by the organisation						
18	Proportion of current project documents that make reference to previous documents						
19	Proportion of organisational policies which make reference to KM						
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover						
21	Proportion of staff that are current and knowledgeable within their field of work						
22	Proportion of staff that have a sense of ownership in what they do						
23	proportion of staff that know a lot about their fellow staff's field of work						
24	Proportion of staff who are aware of the organisation's KM policies						
25	Proportion of the organisation's budget available/spent on research and new designs						
26	Quantity of project data stored in electronic format						
27	Quantity of project records kept by the organisation						
28	Reduction of staff time spent looking for information						
29	Regulated of use of the knowledge base						
30	Regulated socialisation within an organisation						
31	Retention of staff for longer period of time within an organisation						
32	Years of experience of staff within the industry						

The End!

Thank you for your positive contribution

Appendix 3 –Journal Papers (Published and under Review) and Conference Papers

A. Published Papers in Peer Reviewed Journals

1. **Kaliba, C.**, Muya, M. and Mwiya, B. (2015), "Key Indicators of Knowledge Creation Within Civil Engineering Consulting Firms in Africa", *International Journal of Engineering Researches and Management Studies*, Vol. 2 No. 2, pp. 19–27.

B. Papers under consideration in Peer Reviewed Journals

1. **Kaliba, C.**, and Muya, M. (TBA), "Desirability of Knowledge Management in Civil Engineering Consulting Firms", *Electronic Journal of Knowledge Management*.

C. Conference Papers

1. **Kaliba C.,** Muya M., and Mwiya B., (2014) "Knowledge creation, integration and management in civil engineering consulting industry – a preliminary state of the nation", *The Engineering Institution of Zambia National Symposium*, Livingstone, EIZ.

2. **Kaliba C.,** Muya M., and Sichombo B., (2012) "Knowledge Creation, Integration and Management in Civil Engineering Consulting Industry – Opportunities and Challenges", *The Engineering Institution of Zambia National Symposium*, Livingstone, EIZ.

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KEY INDICATORS OF KNOWLEDGE CREATION WITHIN CIVIL ENGINEERING CONSULTING FIRMS IN AFRICA

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ABSTRACT

Knowledge creation has been recognised to be one of the key drivers for competitiveness within the professional services industry. The civil engineering industry has however been recognised as being poor in its approach to learning and performance improvement. The study reported in this paper was aimed at establishing the key indicators of knowledge creation especially with SMEs operating within the civil engineering industry in Africa. Through the questionnaire survey, 14 key indicators of KC were established. Further analysis showed that these indicators were related to productivity, utilisation and protection through the firm's resources, systems and policies. A combination of these factors was established to be key ingredients of knowledge creation within civil engineering consulting firms in Africa. The findings of this study add a new dimension on the subject of knowledge creation.

KEYWORDS: knowledge creation, civil engineering, consulting industry.

INTRODUCTION

With the move of advanced economies from resource to knowledge-based production, many national governments have increasingly recognised knowledge and innovation as significant driving forces of economic growth, social development, and job creation (OECD, 1999). It is widely claimed by a number of business and academic experts that in order for organisations to have a lasting competitive advantage, they will have to be knowledge driven (Drucker, 1993; Nonaka, 1991; Prahalad and Hamel, 1990). Drucker (1993) asserts that the basic economic resource is neither longer-term capital nor natural resources, but knowledge. In this context, the promotion of knowledge creation, integration and management has increasingly become a subject of public and economic policy.

The civil engineering consulting firms are knowledge centric. In professional service firms knowledge is a primary driver of competitive advantage and content is the main deliverable (Carmel, 2005). If knowledge is viewed as a resource that is critical to an organisation's survival and success in the global market, then like any other resource it demands good management.

Nonaka and Takeuchi (1995), in discussing success factors of some Japanese companies, proposed two different viewpoints about generation of knowledge: essence and cognition. In the aspect of essence, they emphasized that only a person can generate knowledge, an organization cannot generate knowledge unless through individuals. They classify knowledge generation as four levels: individual; group; organization; and inter-organization, but all the knowledge of organizations eventually come from individuals. Knowledge by all means is created from the interaction of tacit and explicit knowledge. The modes of their conversion are socialization, externalization, combination, and internalization. Through continuous conversion, new knowledge is created. This knowledge conversion, also called knowledge spiral, is the process of knowledge generation, and is called as SECI process (Nonaka and Takeuchi, 1995). Li and Gao (2003) studied the fundamental points of tacit knowledge on the basis of Nonaka's SECI model regarding knowledge creation and its constraints. They underlined the importance of the spiral-type model in providing an analytical framework for knowledge activities in business management. The study relied on Polanyi (1997) to categorise the tacit knowledge into two parts: implicit and real tacit.

According to McInerney (2002), knowledge can also be a disadvantage for organisations if it is incorrect or misleading, if it is inhibiting or discouraging, or if it is not aligned with or does not satisfy an organisation's mission or strategy. Knowledge is considered to be dynamic because it is constantly changing in individuals through experiences and learning, and in organisations through the movement of knowledge to be transferred or shared. That requires keeping knowledge stored in the knowledge repositories current and updated, while keeping knowledge

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systems flexible enough to deal with continuous updates and changing requirements from all sectors of the organisation.

From the foregoing, it can be realised that Knowledge Creation (KC) has been identified as an essential component within knowledge centric organisations. It is noteworthy that much as there have been studies on KC and its processes, very little has been documented on the indicators within an organisation. This paper is aimed at identifying the key indicators of KC within the civil engineering consulting firms.

METHODOLOGY

A mixed design approach was adopted for the research. The study reported in this paper is however only based on the quantitative data analysis. Questionnaire surveys were adopted as a means of data collection. The survey was conducted between March and May 2014.

Survey Sample

The survey sample was drawn from civil engineering consulting firms that have business presence in Africa. The respondents were drawn from the FIDIC affiliates within Africa such as the Association of Consulting Engineers Zambia (ACEZ), Consulting Engineers South Africa (CESA), and Association of Consulting Engineers in Nigeria (ACEN), Association of Consulting Engineers of Kenya (ACEK), Association of Consulting Engineers Tanzania (ACET) and Association of Consulting Engineers Botswana (ACEB). The inclusion criteria for were that the firm should have had an operational footprint in at least five (5) countries in Africa and should have been in existence for at least 10 years. The total number of respondents targeted was 40.

Questionnaire design

The questionnaire was designed to have two parts. The first part was aimed at collecting the responsive organisation's attributes as well as the respondent's profile. Multiple choice questions were presented with the respondent restricted to only making once choice for each question.

The second part was aimed at establishing common indicators of KC. The measurement used to collect data was an ordinal level measurement: very important, important, neutral, unimportant and very unimportant. The characterisation of key indicators of KC were based on mean score rating as such numerical values were assigned to the ordinal scale with 5 being very important, 3 being neutral and 1 being very unimportant.
The formula for calculating the mean score was based on weighted averages and is shown as Equation 4-1.

$$Mean\ Score = \sum_{j=1}^{5} I_j R_j \Big/ \sum R_j \quad \text{..... Equation 1}$$

Where: $\boldsymbol{I}_j$ is the Importance weight (1, 2, 3, 4 or 5) assigned to option *j;* $\boldsymbol{R}_j$ is the number of respondents who provided responses to option *j*. The mean score values were further interpreted to reflect the responding rating to aid conversion of continuous data into discrete categories (Kululanga, 1999). The discrete categories were classified as follows:

4.500 < mean score ≤ **5.000**	very important as an indicator
3.500 < mean score ≤ **4.500**	important as an indicator
2.500 < mean score ≤ **3.500**	could be or could not be important as an indicator
1.500 < mean score ≤ **2.500**	unimportant as an indicator
0.000 < mean score ≤ **1.500**	very unimportant as an indicator

SURVEY RESULTS

Questionnaire survey administration and Response Rate

The data was collected using both online methods as well as paper based surveys. The online data collection was undertaken via the MonkeySurvey website. The questionnaire was accompanied by a covering letter: identifying the type of research, sponsoring organisation and the researcher's name; explaining the purpose and the benefits of the study; and informing the participants that their name, department, or company name will not appear in the study

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documentation. Follow ups were made to non-responding firms at intervals of 4 weeks to remind the executives of the questionnaire and request their response.
Out of the 40 questionnaires that were administered, the response rate of the questionnaire survey was 73%. This was deemed to be highly acceptable based on the sectorial and industrial norms where response rates are normally between 20 to 35% (Kululanga, 1999).

Individual Respondent's Profiles
An analysis of the respondent's profiles was undertaken. All the respondents worked for a civil engineering consulting firm/organisation. The respondents also had at least some basic understanding of KM and/or OL.
The respondents generally had high level of responsibility within their organisations/firms. Most of the respondents (55%) held senior level management positions while 21% were shareholders/owners of civil engineering consulting firms/organisations. Those in middle level management accounted for 17% while those in junior level management accounted for 7% of the responses.

The respondents also had a lot of experience in civil engineering consultancy. Respondents with more than 20 years of experience in civil engineering consultancy accounted for 48% of the responses while those with 15 to 20 years accounted for 7%. Those with 10 to 15 years accounted for 35% and those with 5 to 10 years accounted for 10%. It is noteworthy that none of the respondents had less than five (5) years of experience in civil engineering consultancy. This is illustrated in Figure 1.

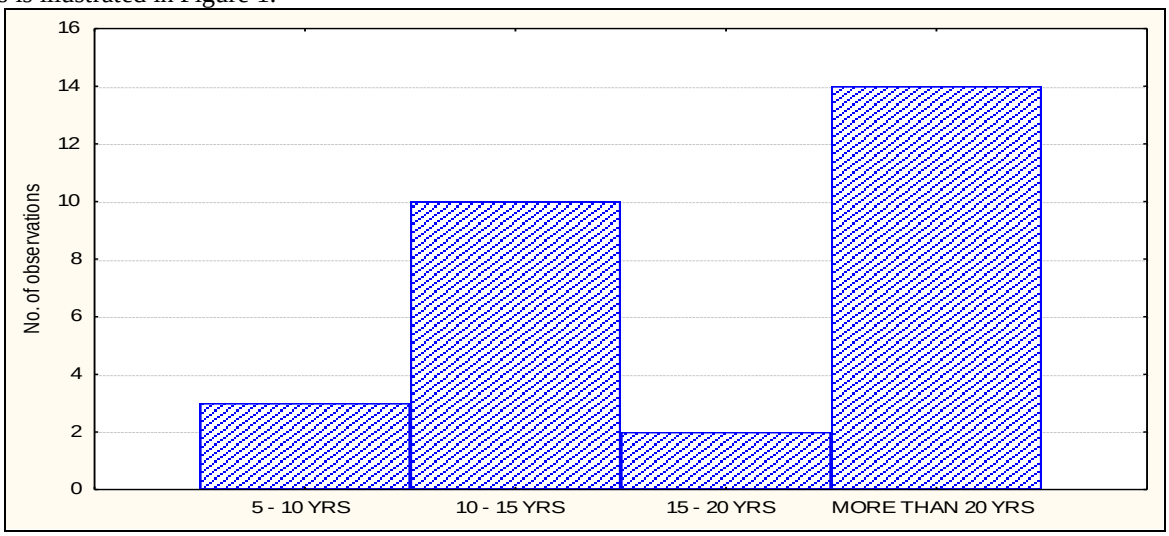

Figure 1: Respondents' years of experience in civil engineering consultancy

Profile of Respondent's Organisations
An assessment of the respondent's organisations was undertaken. Of interest was the categorization of responses by firm size and experience.

Experience of Respondent's Firm/Organisation
The respondents were predominantly working for organisations/firms that have been in existence for either 10 - 20 years or more than 60 years. Figure 2 shows the experience in civil engineering consultancy of all the responsive firms.

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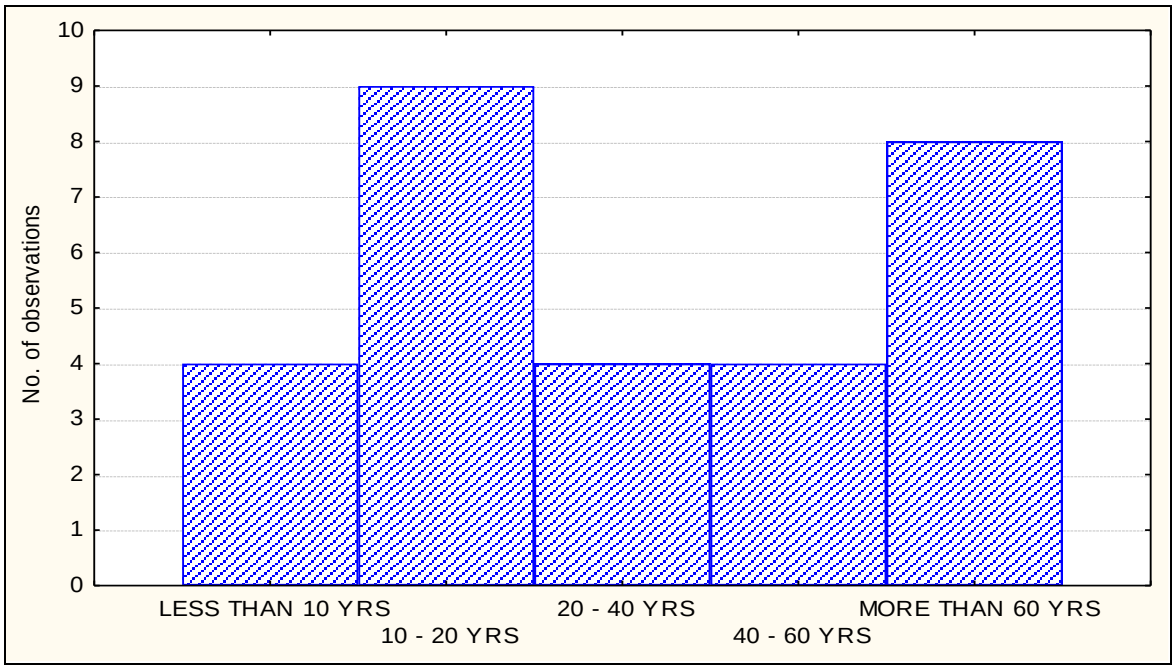

Figure 2: Responsive organisation's experience

Employee base

With regards to the size of the respondent organisations in terms of number of employees, it was noted that most of the firms surveyed have an employee base of less than 250. The distribution of responsive firm's employee base is presented in Figure 3.

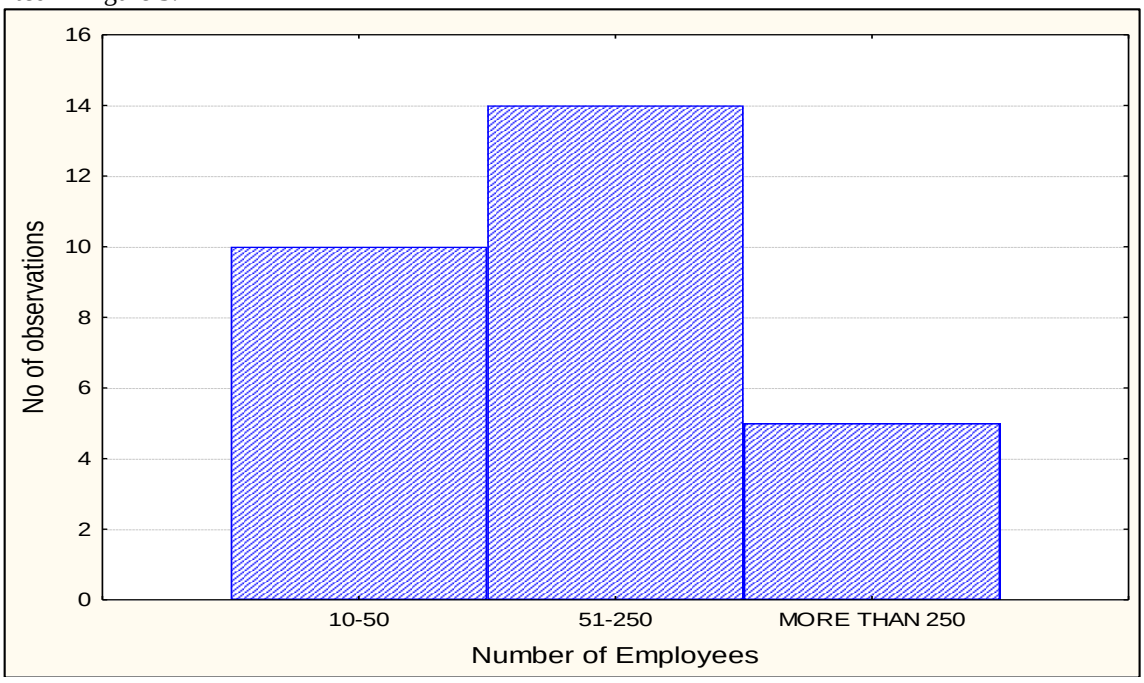

Figure 3: Distribution of the employee base of surveyed firms

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Turnover

With regards to annual turnover, the majority of the responsive firms had average annual turnover of between 3 and 15 Million US Dollars. The distribution of the responsive firms' annual turnover is presented in Figure 5.

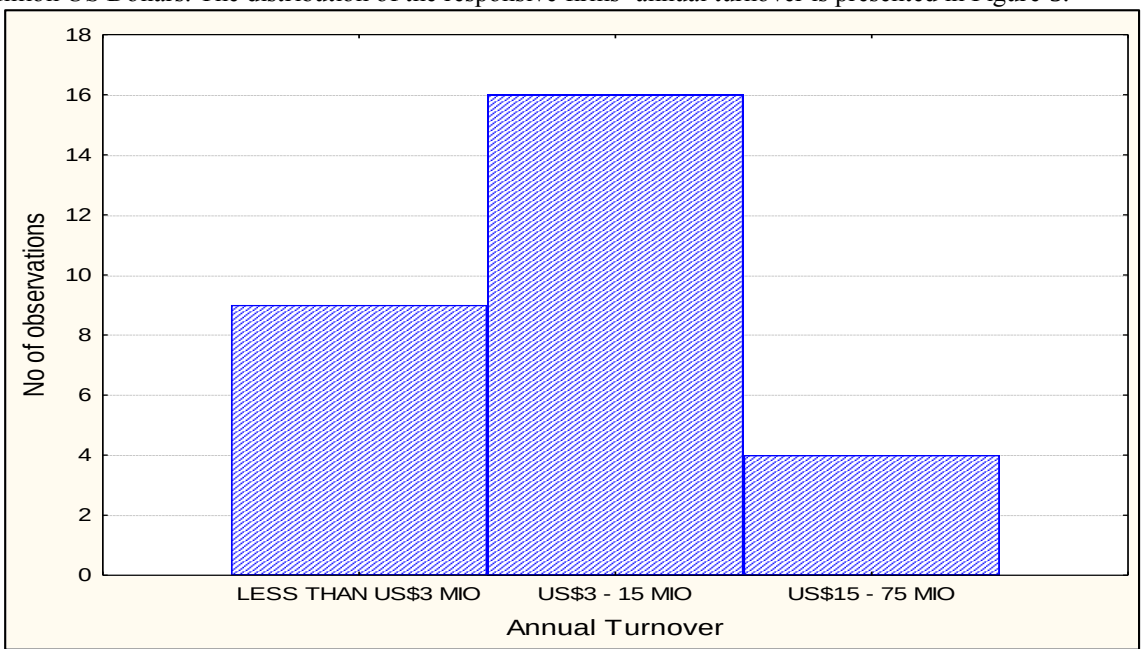

Figure 4: Distribution of annual turnover of surveyed firms

Indicators of Knowledge Creation

The respondents were asked to rate each of the 32 possible indicators of knowledge creation on a Likert scale of 1 to 5. The respondents also had an option of indicating whether the indicator listed was not applicable within the context provided.

Descriptive Statistics of Knowledge Creation Indicators

Descriptive statistics was used in the preliminary stages of analysis. The mean scores are presented in Table 1.

Table 1: Respondent's mean scores for the KC Indicators

No.	INDICATOR	SCORE
1	Ability of the organisation to protect knowledge from inappropriate use	3.793
2	Amount of non-assigned working time within an organisation	4.207
3	Amount of time assigned to project meetings	4.207
4	Availability of monitoring and evaluation systems	4.586
5	Availability of policies for protection of knowledge at corporate level	4.379
6	Codification of knowledge such as know-how, technical skill, problem solving , etc.	3.621
7	Firm's flexibility to accommodate experimentation within a work place	4.000
8	Frequency of use of the knowledge base	4.207
9	Number of communities of practice within an organisation	3.207

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10	Number of management/leadership who are aware of knowledge management	3.379
11	Number of new ideas implemented	4.000
12	Number of new ideas submitted by staff	4.207
13	Number of staff pursuing further studies	3.379
14	Number of staff who are able to give example of incremental innovations	3.586
15	Number of Staff with direct linkages to experts in a given field of work	3.414
16	Number of workshops/seminars attended by Staff	2.552
17	Number of workshops/seminars organised by the organisation	2.345
18	Proportion of current project documents that make reference to previous documents	3.586
19	Proportion of organisational policies which make reference to KM	3.207
20	Proportion of outgoing staff who complete an exit interview which includes knowledge handover	2.966
21	Proportion of staff that are current and knowledgeable within their field of work	4.379
22	Proportion of staff that have a sense of ownership in what they do	3.966
23	proportion of staff that know a lot about their fellow staff's field of work	3.621
24	Proportion of staff who are aware of the organisation's KM policies	2.828
25	Proportion of the organisation's budget available/spent on research and new designs	3.172
26	Quantity of project data stored in electronic format	3.966
27	Quantity of project records kept by the organisation	4.000
28	Reduction of staff time spent looking for information	3.793
29	Regulated of use of the knowledge base	3.621
30	Regulated socialisation within an organisation	3.207
31	Retention of staff for longer period of time within an organisation	2.931
32	Years of experience of staff within the industry	4.000

Further analysis of the indicators presented in Table 1 was undertaken so as to identify those which were either important or very important. The cut off point for the mean score was set at 3.5 for each respondent group. Out of the 32 indicators, 14 were found to have a mean score greater than 3.5. Figure 5 illustrates the indicators with overall mean score greater than 3.5.

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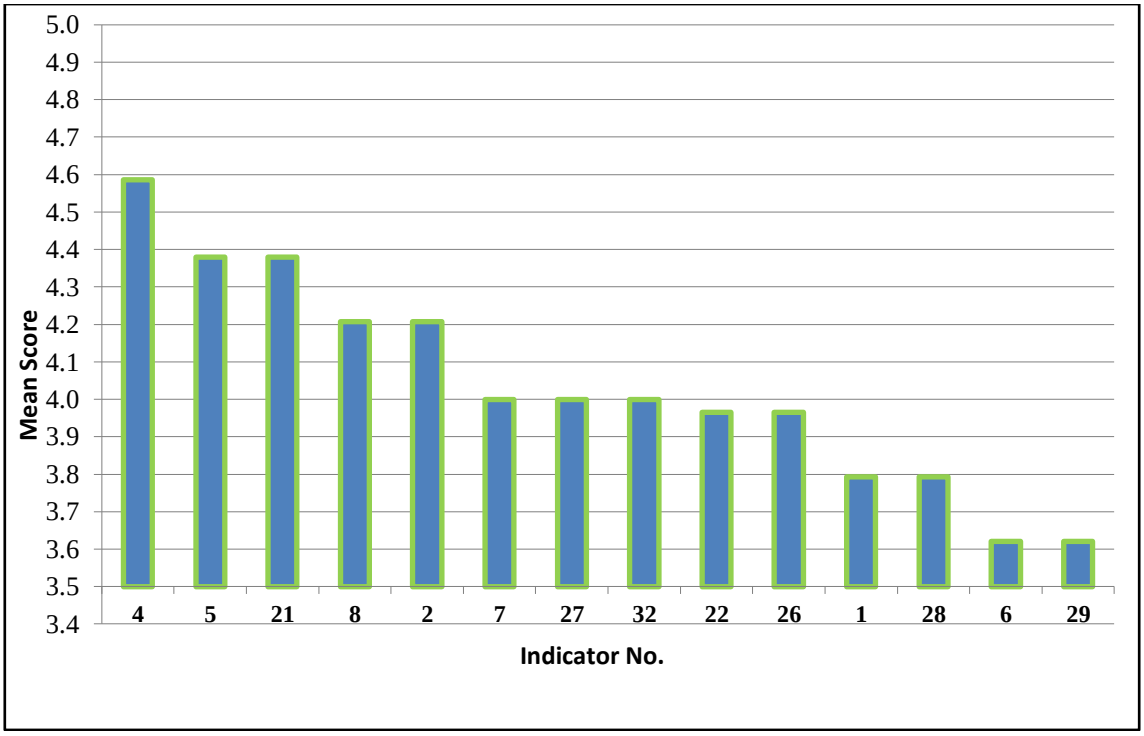

Figure 5: Indicators of KC having an overall mean score greater than 3.5

Inferential Statistics of Knowledge Creation Indicators

The 14 key indicators were further analysed using Factor Analysis using the principal factor extraction method. The analysis yielded a three-factor solution. The Cronbach alpha coefficient using SAS was then determined for the three factors. The purpose was to measure internal consistency and the degree to which instruments items are homogeneous and reflect the same underlying construct(s). The quartimax rotated normalised loadings as well as the individual alpha values (reliability) of the three factors are presented in Table 2.

Table 2: Quartimax Factor and Reliability Analysis Results

Indicators	Factor 1	Factor 2	Factor 3	Reliability
Proportion of staff that have a sense of ownership in what they do	0.9281			0.8963
Quantity of project data stored in electronic format	0.9281			0.8963
Proportion of staff that are current and knowledgeable within their field of work	0.9053			0.9140
Codification of knowledge such as know-how, technical skill, problem solving , etc.	0.9053			0.9140
Amount of non-assigned working time within an organisation	0.7525			0.5930
Quantity of project records kept by the organisation	0.7121			0.8688
Ability of the organisation to protect knowledge from inappropriate use		0.9641		0.9467
Years of experience of staff within the industry		0.8988		0.9223

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Availability of policies for protection of knowledge at corporate level		0.8448		0.9386
Regulated of use of the knowledge base		0.8448		0.9386
Firm's flexibility to accommodate experimentation within a work place		0.7703		0.9174
Reduction of staff time spent looking for information		0.7233		0.9350
Availability of monitoring and evaluation systems			0.9581	0.9347
Frequency of use of the knowledge base			0.9581	0.9347

From the analysis, it was established that the indicator "amount of non-assigned working time within an organisation" had a low reliability value. This entails that it cannot be relied upon to have significant contribution to Factor 1. The other indicators yielded reliabilities higher than 85%.

It can be deduced that there are three principal factor indicators of KC within civil engineering consulting firms. These three factors can be depicted as shown in Figure 6.

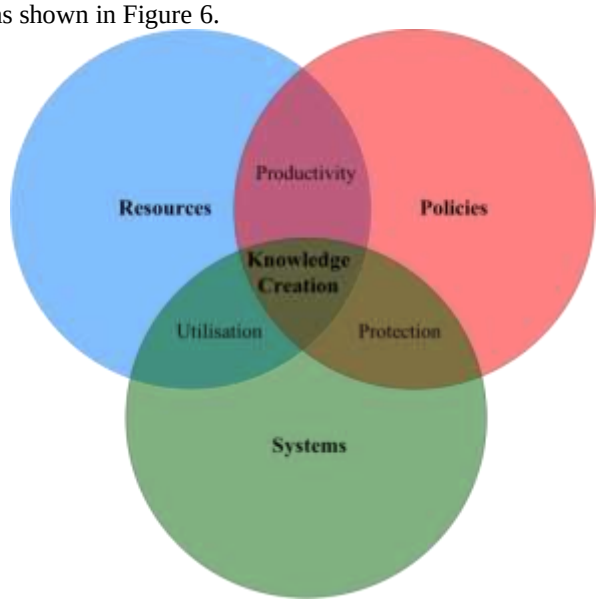

Figure 6: Key KC Factor Indicators within a Civil Engineering Consulting Firm

DISCUSSION

The results tie in with the propositions of Nonaka and Takeuchi (1995). KC is a process of self-surpass. The firm serves as a place for such a KC. The organization needs to sufficiently support personals, because only personals are the source of tacit knowledge. It can be noted from the results that Factor 1 comprises indicators that relate to the resources within civil engineering consulting firms. The key resources within civil engineering consulting firms are the technical personnel. For a firm to produce or create knowledge, the workforce requires an environment which promotes higher productivity as well as efficient resource utilisation.

Factor 2 comprises of indicators that are related to the firm's policies. The firm's policies must promote higher productivity while at the same time protect the knowledge from inappropriate use. The firms' personnel will create new knowledge when they are assured that their contribution is valued.

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Factor 3 comprises of indicators that relate to systems within a firm. The firm must have in place systems that can be used to monitor and evaluate knowledge creation as well as the utilisation of the new knowledge. These systems must help protect the organisation from loss of vital knowledge. On the other hand, utilisation of the firm's knowledge can be evaluated with the aim of enhancing the productivity of the resources.

Mobilizing tacit knowledge is a key factor in knowledge creation process (Nonaka, 1994). For a firm, the utilisation of its resources and systems, having polices and systems that project its knowledge enhance productivity. The combination of these factors brings about knowledge creation within the form. The focus of socialization which lies at both quantity and quality of social interactions among individuals can be achieved through the interactions of these three factors.

CONCLUSION

Through this study, 14 key indicators of KC were established. The key indicators of KC were established to be: availability of monitoring and evaluation systems; availability of policies for protection of knowledge at corporate level; proportion of staff that are current and knowledgeable within their field of work; frequency of use of the knowledge base; amount of non-assigned working time within an organisation; firm's flexibility to accommodate experimentation within a work place; quantity of project records kept by the organisation; years of experience of staff within the industry; proportion of staff that have a sense of ownership in what they do; quantity of project data stored in electronic format; ability of the organisation to protect knowledge from inappropriate use; reduction of staff time spent looking for information; codification of knowledge such as know-how, technical skill, problem solving, etc.; and regulated of use of the knowledge base.

These indicators however can be grouped into three major factors i.e. Productivity, Utilisation and Protection (PUP) which evolve around the firm's resources, systems and policies (RSP). The firm can be assured of creating knowledge when the PUP is integrated with its RSP. This has been established to be the case with civil engineering consulting firms in Africa.

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KNOWLEDGE CREATION, INTEGRATION AND MANAGEMENT IN CIVIL ENGINEERING CONSULTING INDUSTRY – A PRELIMINARY STATE OF AWARENESS

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Abstract

Knowledge creation, integration and management (KCIM) has been recognised to be one of the key drivers for success within the professional services industry. The civil engineering industry has however been recognised as being poor in its approach to learning and performance improvement and is notoriously slow in adapting to change. Organisational knowledge provides the capability to understand the market, assess the customer's needs and translate them into products and services by integrating various organisational resources. The study reported in this paper was aimed at assessing the state of awareness of the local industry to the concepts of knowledge creation, integration and management. Through interviews with selected civil engineering consulting firms, it was established that the state of awareness of KCIM concepts among the practitioners was relatively fair. Consented efforts however, in highlighting the importance of KCIM within the local industry are necessary especially if our local firms are to compete favourably within the global market.

Keywords: *knowledge creation, knowledge integration, knowledge management, civil engineering, consulting industry.*

INTRODUCTION

With the move of advanced economies from resource to knowledge-based production, many national governments have increasingly recognised knowledge and innovation as significant driving forces of economic growth, social development, and job creation (OECD, 1999). It is widely claimed by a number of business and academic experts that in order for organisations to have a lasting competitive advantage, they will have to be knowledge driven (Drucker, 1993; Nonaka, 1991; Prahalad and Hamel, 1990). Drucker (1993) asserts that the basic economic resource is neither longer-term capital nor natural resources, but knowledge. In this context, the promotion of knowledge creation, integration and management has increasingly become a subject of public and economic policy.

It has been argued that one of the key factors of corporate success is the ability to quickly adapt to changing conditions in the environment; innovate continuously and achieve goals. Organisational knowledge provides this capability. More specifically, organisational knowledge provides the capability to understand the market, assess the customer's needs and translate them into products and services by integrating various organisational resources. While knowledge creation, integration and management (KCIM) has value for every type of organization, it plays a crucial role in professional

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service firms, where knowledge is a primary driver of competitive advantage and content is the main deliverable. Implemented effectively, KCIM helps such organizations put their full institutional resources to work for their clients and ensures that the information gathered and lessons learned in each appointment are retained and made available for efficient future re-use (Carmel, 2005).

If knowledge is viewed as a resource that is critical to an organisation's survival and success in the global market, then like any other resource it demands good management. In most cases, a professional service appointment is a process rather than a specific event, involving different personnel, resources and skills each step of the way. Accordingly, KCIM for professional services requires a holistic approach that applies a variety of disciplines and technologies to support each stage of the appointment cycle (Carmel, 2005).

In a global marketing environment where civil engineering consulting services can be sourced from anywhere, the local consulting industry is threatened with obliteration if no efforts are made to strengthen their competitive edge. This paper is aimed at highlighting the current state of awareness of KCIM concepts within the local civil engineering consulting industry. The paper also presents some of the shortcomings with regards to implementation of KCIM within the local industry. It is noteworthy that the study reported in this paper is only a part of the broader research being undertaken on this subject.

LITERATURE REVIEW

The civil engineering industry is recognised as being poor in its approach to learning and performance improvement and is notoriously slow in adapting to change (Chen and Johnson, 2002, KLICON, 1999). The project-based, fragmented and unstable nature of the industry has led to chronic knowledge loss compared with other industries (Orange *et al.*, 2003, Bresnen, 1999).

The most valuable form of knowledge for civil engineering organisations is tacit, the accumulated experience of professionals, which manifests itself through social interaction (Kazi *et al.*, 2005). Yet the project-based nature of the industry inhibits participation in, and limits contact between different projects (Knauseder *et al.*, 2005).

Civil engineering projects are in knowledge-intensive environments where many interrelated components work together in a complex manner. The main benefit from adopting Knowledge Management (KM) is to enable firms to complete projects at reduced costs and within time while improving quality. By re-using and sharing previous experiences and knowledge, employees can find solutions to their problems without spending extra time, effort and resources on re-inventing solutions that have already been invented elsewhere in the organization or industry (Ahmad *et al.*, 2007).

With successful capturing, sharing and creation of useful knowledge, companies can improve the process of organisational learning to enhance performance and create more possibilities to gain competitive advantages for the organisation (Ahmad and An, 2008; KLICON, 1999;). Li and Gao (2003) argue that companies can enhance organisational learning through knowledge generation and sharing, which not only enriches the knowledge of employees and organisations, but also leads to increased strategic innovations. Improving organisational learning means enhancing the ability of the

organisation to collect and use knowledge so that members exploit it to improve performance (KLICON, 1999). Organisational learning can create possibilities to gain competitive advantage, which involve the ability of a company to perform projects and activities at lower cost and less time and of higher quality than competitors.

KM Systems provide the tools and services for end-users to capture, share, re-use, update, and create new experiences, find solutions to problems and best practices to aid employees in processes such as problem solving, decision making and innovation and to enhance the total performance of the organisation (Ahmad *et al.*, 2007).

METHODOLOGY

The research methodology in the reported study evolved around the need to establish the state of awareness of KCIM among the civil engineering consulting firms. Interviews were adopted as a means of data collection. Structured interviews were conducted between July and November 2013. The interviews were preliminary in nature and targeted ten professionals working for civil engineering consulting firms in Zambia. The interviewees were sampled based on the prominence of their organization as well as their experience in the construction industry. One executive from each consulting firm was targeted. According to the Association of Consulting Engineers Zambia database, there are 31 registered consulting firms. The sample size was therefore sufficient to derive a preliminary basis of the state of awareness amongst the practitioners. The purpose was to obtain an understanding of how the various stakeholders in Zambia view knowledge creation, integration and management.

SURVEY RESULTS

Profiles of interviewees and their firms

Nine out of the targeted ten professionals participated in the interviews. Out of the nine interviewees, seven had over fifteen years of experience in the civil engineering consultancy and while the other two interviewees had between ten and fifteen years of experience. It is noteworthy that all interviewees held management positions within their organisations. This provided an assurance of reasonable professional experience in civil engineering consultancy. Most of the interviewees' firms had a long history of involvement in consultancy. The firms' experience in construction ranged from seven to fifty-five years.

Knowledge Management and Organizational Learning

Interviewees were asked if they were familiar with organisational learning (OL). Only three out of nine interviewees were familiar with OL. On the other hand, all the nine respondents were familiar with the term "knowledge management" (KM). Despite their familiarity with the term, most of the interviewees were not aware of any KM or OL tools. Only two interviewees were able to state the KM tools they were familiar with. The tools included:

- *Communities of practice;*
- *Knowledge audits;*
- *Peer assists;*
- *Exit interviews;*

- *After action reviews; and*
- *Social networking analysis.*

It is noteworthy that there are other common tools that the interviewees did not mention. These include:

- *Developing knowledge management strategies;*
- *Identifying and sharing best practices;*
- *Knowledge centres;*
- *Knowledge harvesting;*
- *Storytelling; and*
- *White pages.*

It was also noted that most of the firms represented by the interviewees did not employ the tools and techniques listed above. However, some of the tools were in use as part of the individuals' initiatives. Two of the interviewees indicated that their organisations used tools such as 'peer assists' and 'after action reviews' though they did not have a formal KM programme or system.

Advantages of KM and/or OL

Interviewees were asked whether KM or OL would contribute to the wellbeing of their organisation. All the interviewees confirmed that KM or OL would positively contribute to the wellbeing of their organisations. They stated that KM or OL would help their organisations in the following ways:

- *The organisation would have a pool of knowledge;*
- *Information would be up to date and readily available to authorised personnel;*
- *Tacit knowledge can be tapped from leading experts on various technical aspects;*
- *KM would increase the organisation's long term competitive advantage;*
- *KM would increase productivity by avoiding unnecessary repetitions;*
- *Organisations would easily identify their strengths and weaknesses; and*
- *The organisations can streamline their operations and enhance staff retention.*

Knowledge Creation

Interviewees were asked to state whether their organisations viewed Knowledge Creation (KC) as an important ingredient for success and sustainability in the consulting industry. All the interviewees confirmed that KC was an important ingredient for success and sustainability. However, it was noted that the interviewees' organisations did not have any tools for monitoring and evaluations of KC. The interviewees were also not aware of any tools that can be used to monitor or evaluate KC within their organisations.

Knowledge Integration

As was the case with KC, the interviewees confirmed that Knowledge Integration (KI) is an important ingredient for sustainability and success within the civil engineering consulting industry. However, they were not aware of any tools that could be used to monitor or evaluate KI within their organisations.

Monitoring and Evaluation Framework

Some of interviewees stated that a framework that would help them monitor and evaluate KC, KI and KM would be of importance to the wellbeing of their organisation. They stated that the framework would promote KM practices, capacity building and continuous learning.

They also stated that such a framework would benefit the civil engineering consulting industry in general through:

- *Enhancement of individual continuous professional development;*
- *Promotion of new ideas and concepts;*
- *Benchmarking of firms and a basis of comparing the organisations; and*
- *Monitoring of capacity building within the subsector of the economy.*

Some of the interviewees however argued that the Zambian civil engineering consulting industry was not yet ready for KC, KI and KM because of the existing gap between the country's developmental standing and that of the world at large. They argued that the local clients do not demand for highly sophisticated products (most clients require common services such as design review and construction supervision) as such there was no need for innovation in the local firms.

INTERPRETATIONS OF THE FINDINGS AND CONCLUSION

The data reported in this paper above shows that the practitioners within the civil engineering consulting industry in Zambia are familiar with the basic of knowledge management. However, not much is known about knowledge creation and integration. It is noteworthy that most of the practitioners unknowingly use some of the tools of knowledge creation, integration and management. It would therefore be beneficial to the industry if sensitization workshops are held to make practitioners aware of the concepts, tools and techniques.

The civil engineering consulting firms in Zambia also do not have formal tool, techniques or framework for monitoring and evaluating KC, KI and KM. Though it has been argued by some of the interviewees that a framework for monitoring and evaluating KCIM would not be very useful in Zambia considering the fact that the clients are currently demanding for basic engineering services, lack of formal framework disadvantages the local firms especially in the face of the growing international competition. Such a framework would help improve the local firms' competitiveness within the country and across the borders.

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KNOWLEDGE CREATION, INTEGRATION AND MANAGEMENT IN CIVIL ENGINEERING CONSULTING INDUSTRY – OPPORTUNITES AND CHALLENGES

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Abstract

The civil engineering industry is recognised as being poor in its approach to learning and performance improvement and is notoriously slow in adapting to change. The project-based, fragmented and unstable nature of the industry has led to chronic knowledge loss compared with other industries. One of the key factors of corporate success is the ability to quickly adapt to changing conditions in the environment, innovate continuously and achieve goals. Organisational knowledge provides this capability. More specifically, organisational knowledge provides the capability to understand the market, assess the customer's needs and translate them into products and services by integrating various organisational resources. The study reported in this paper was aimed at highlighting the opportunities and challenges of knowledge creation, integration and management (KCIM) as it relates to the civil engineering consulting industry. Through a literature review, it was established that the creation of awareness of KCIM practices would help strengthen the competitive advantage of the local civil engineering consulting industry.

Keywords: *knowledge creation, knowledge integration, knowledge management, civil engineering, consulting industry.*

Introduction

The construction industry is a conglomeration of diverse fields and participants that are loosely lumped together as a sector of the economy (Hendrickson and Au, 2003). The construction industry plays a central role in the creation of any nation's wealth. For developing economies, it forms the backbone of most industries. Construction is a project-based industry, within which individual projects are usually custom-built to client specifications (Raiden and Dainty, 2006). Such projects are typically delivered by temporary project coalitions, comprising design and supervision consultants, contractors, specialist sub-contractors and suppliers, and are often characterised by adversarial and litigious relationships. Civil engineering consulting firms provide the professional services required for efficient and effective delivery of projects.

There are significant challenges facing today's civil engineering industry such as: increasing competition; globalisation of the construction market; demands from clients, customers and society; and the pace of change in Information and Communication Technologies (IT). A further challenge lies in maintaining a highly skilled workforce at all levels from operative and technical, to managerial and professional (Egbu and Robinson, 2005). In addition to the impact of technology and new market opportunities,

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Chen and Mohamed (2005) highlight the impact of economic swings, and protection against competitors, as being major external elements which strategically affect civil engineering organisations.

With the move of advanced economies from resource to knowledge-based production, many national governments have increasingly recognised knowledge and innovation as significant driving forces of economic growth, social development, and job creation (OECD, 1999). It is widely claimed by a number of business and academic experts that in order for organisations to have a lasting competitive advantage, they will have to be knowledge driven (Drucker, 1993; Nonaka, 1991; Prahalad and Hamel, 1990). Drucker (1993) asserts that the basic economic resource is neither longer-term capital nor natural resources, but knowledge. In this context, the promotion of knowledge creation, integration and management has increasingly become a subject of public and economic policy.

The civil engineering industry is however recognised as being poor in its approach to learning and performance improvement and is notoriously slow in adapting to change (Chen and Johnson, 2002, KLICON, 1999). The project-based, fragmented and unstable nature of the industry has led to chronic knowledge loss compared with other industries (Orange *et al.*, 2003, Bresnen, 1999). One of the key factors of corporate success is the ability to quickly adapt to changing conditions in the environment, innovate continuously and achieve goals. Organisational knowledge provides this capability. More specifically, organisational knowledge provides the capability to understand the market, assess the customer's needs and translate them into products and services by integrating various organisational resources.

While knowledge creation, integration and management (KCIM) has value for every type of organization, it plays a crucial role in professional service firms, where knowledge is a primary driver of competitive advantage and content is the main deliverable. Implemented effectively, KCIM helps such organizations put their full institutional resources to work for their clients and ensures that the information gathered and lessons learned in each appointment are retained and made available for efficient future re-use (Carmel, 2005).

If knowledge is viewed as a resource that is critical to an organisation's survival and success in the global market, then like any other resource it demands good management. In most cases, a professional service appointment is a process rather than a specific event, involving different personnel, resources and skills each step of the way. Accordingly, KCIM for professional services requires a holistic approach that applies a variety of disciplines and technologies to support each stage of the appointment cycle (Carmel, 2005).

In a global environment where civil engineering consulting services can be sourced from anywhere, the local consulting industry is threatened with obliteration if no efforts are made to strengthen their competitive edge. This paper highlights some of the benefits and challenges of KCIM within civil engineering consulting firms in Zambia. The paper also identifies the shortcomings in existing literature on the subject of KCIM in civil engineering consulting firms. Adoption of KCIM practices as well as enhancing the already existing measures would go a long way towards assuring continuous existence of local consulting firms.

Methodology

The research methodology in the reported study evolved around the need to identify the benefits and challenges of KCIM to civil engineering consulting firms and as such a literature review was conducted. The main objective throughout the literature review stage was to identify knowledge creation, integration and management benefits or challenges likely to be relevant to civil engineering consulting firms.

Knowledge and its classification

To present a clear understanding of knowledge, its creation, integration and management, a theoretical framework is presented. Knowledge can be defined as the facts, skills and understanding that one has gained, especially through learning or experience, which enhance one's ability of evaluating context, making decisions and taking actions (Awad and Ghaziri, 2004; Tserng and Lin, 2004). It can be classified in a variety of ways. Classifying knowledge helps to identify the different types of knowledge with different nature that may need different procedures, tools and activities to process and manage (Lin *et al.,* 2006; Tserng and Lin, 2004). Some classifications are discussed below.

a) Explicit and Tacit Knowledge

Explicit knowledge can be expressed in formal and systematic language and shared in form of scientific formulae, specifications, manuals and the like. Explicit knowledge is easy to be captured, retrieved, shared and used because it can be expressed in words and numbers that can be managed more easily. Tacit knowledge is the most valuable type of content since it combines information with experiences, skills and understanding of people, which can help people to find best solutions and reduce opportunities of repeating mistakes (Awad and Ghaziri, 2004; Tserng and Lin, 2004; Gupta *et al.*, 2000; Tiwana, 1999; Davenport and Prusak, 1998; Baker *et al.*, 1997). Although a complete tacit-explicit split cannot be achieved (Inkpen and Dinur, 1998; Nonaka and Takeuchi, 1995), it is a useful way to understand the different characteristics and nature of different types of knowledge that require different processing, procedures and tools to be managed and dealt with.

b) Explicit, implicit and tacit knowledge

Although many studies have used the terms tacit and implicit knowledge synonymously, others have differentiated three knowledge dimensions: explicit; implicit; and tacit, emphasizing that tacit and implicit knowledge have significant differences and cannot be used interchangeably (Nickols, 2010; Bennet and Bennet, 2008; Alonderiene *et al.,* 2006; Newman and Conrad, 1999). Nickols (2010) introduced a representation that provides a useful way to distinguish explicit, implicit and tacit knowledge as shown in Figure 1.

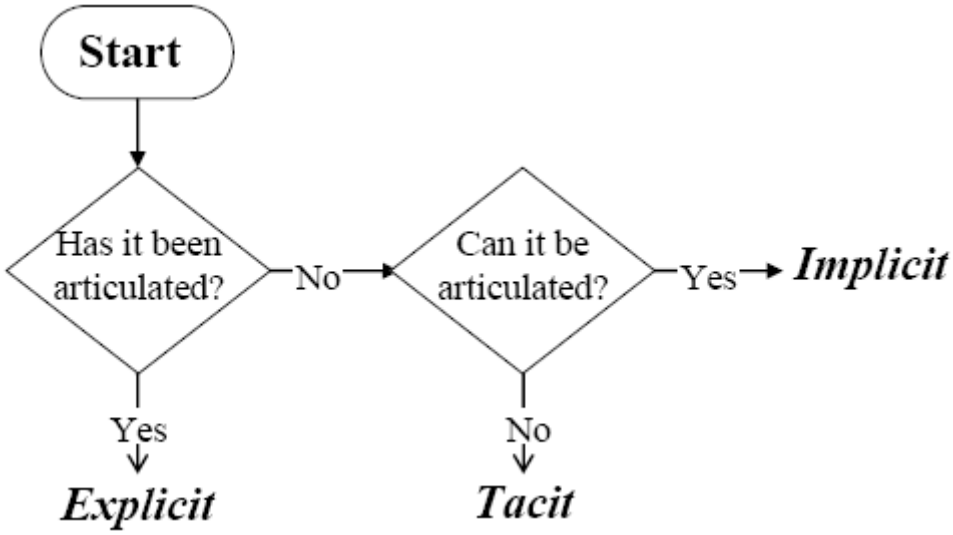

Figure 1: Distinguishing between Explicit, Tacit and Implicit Knowledge

(After Nickols, 2010)

c) Other methods

Many other methods for categorizing knowledge have emerged and have been used within the knowledge management literature as a response to the growing interest in managing knowledge and the increasing awareness of its usefulness and importance. For example, Musgrave (1993) proposed a method to distinguish three different kinds of knowledge, i.e., knowledge of things and objects, knowledge of how to do things, and knowledge of statements or propositions.

Collins (1993) provided a different way of classification by distinguishing between codified and non-codified knowledge, and proposed four categories of knowledge including symbolic-type knowledge that can be transferred without loss such as in books and documents, embodied knowledge that cannot be easily transferred because it is held within the body of humans, embrained knowledge which is normally held within the brain, and encultured knowledge which relates to society and social groups.

For management purposes a number of classifications have been proposed to overcome the difficulty and inaccuracy of older methods. Lundvall (1996), for example, proposed four knowledge categories, i.e., know-what that is described as the knowledge that can be easily codified, know-why that includes principles and laws, know-how that refers to skills and capabilities to perform a given task successfully, and know-who which includes details about who knows how to do what.

Furthermore, Blumentritt and Johnston (1999) categorized knowledge into four types by distinguishing between codified knowledge and other forms real knowledge. The knowledge types proposed by that research are: codified knowledge, which refers to knowledge captured or written in an explicit transferable format; common knowledge, which includes routines and practices learned through working in a particular context without capturing them in formal explicit formats; social knowledge refers to cultural issues and interpersonal relationships such as cooperation and coordination; and lastly, embodied knowledge, which includes experiences, skills and backgrounds of

individuals that affect the way a person deals with a given set of information to build and create appropriate knowledge to solve problems.

KCIM opportunities and challenges

The most valuable form of knowledge for civil engineering organisations is tacit, the accumulated experience of professionals, which manifests itself through social interaction (Kazi *et al.*, 2005). Yet the project-based nature of the industry inhibits participation in, and limits contact between different projects (Knauseder *et al.*, 2005). It is noteworthy that there exists no literature that attempts to discuss knowledge creation (KC), knowledge integration (KI) and knowledge management (KM). The integration of KC, KI and KM into KCIM could prove to have more benefits to organisations. Below, the paper highlights the benefits of implementing KM practices as well as the challenges that would be encountered as a basis for which KCIM practices would be modelled.

a) Opportunities/ Benefits

Civil engineering projects are in knowledge-intensive environments where many interrelated components work together in a complex manner. The main benefit from adopting KM is to enable firms to complete projects at reduced costs and within time while improving quality. By re-using and sharing previous experiences and knowledge, employees can find solutions to their problems without spending extra time, effort and resources on re-inventing solutions that have already been invented elsewhere in the organization or industry (Ahmad *et al.*, 2007).

With successful capturing, sharing and creation of useful knowledge, companies can improve the process of organisational learning to enhance performance and create more possibilities to gain competitive advantages for the organisation (Ahmad and An, 2008; KLICON, 1999;). Li and Gao (2003) argue that companies can enhance organisational learning through knowledge generation and sharing, which not only enriches the knowledge of employees and organisations, but also leads to increased strategic innovations. Improving organisational learning means enhancing the ability of the organisation to collect and use knowledge so that members exploit it to improve performance (KLICON, 1999). Organisational learning can create possibilities to gain competitive advantage, which involve the ability of a company to perform projects and activities at lower cost and less time and of higher quality than competitors.

KM Systems provide the tools and services for end-users to capture, share, re-use, update, and create new experiences, find solutions to problems and best practices to aid employees in processes such as problem solving, decision making and innovation and to enhance the total performance of the organisation (Ahmad *et al.*, 2007).

b) Challenges and factors affecting KCIM

Many challenges to KM implementation in the civil engineering industry such as the complexity of the industry, diversity of players, adversarial relationships and non-repetitive nature of work are all causes for much wastage and difficulties in accessing important knowledge (KLICON, 1999). The complex nature of knowledge and project context increases the difficulty for organisations to plan and implement formal KM initiatives.

While much of the literature has been concerned with discrete projects, project integration has proved to be a major challenge for construction management. This is so because it goes beyond conventional systems integration that is largely concerned with technical integration of software, hardware and communication protocols. Project integration has to include coordination and management of the different activities necessary for the successful completion and delivery of the project as a whole (Alderman *et al.*, 2001; Rudolph, 1998; Winch *et al.*, 1998).

The challenges for KM become more difficult when dealing with tacit knowledge because individuals normally regard this type of intellectual property as a source of strength and personal rather than organisational property (Carrillo *et al.*, 2000). A vast amount of knowledge in project-oriented organisations resides in the heads of numerous individuals who may belong to different companies with different professional backgrounds. On the other hand, many of these companies are unstable and can be completely changed during the period of the project life cycle. This causes difficulty for people to collect, share and manage their knowledge within limited time and budget of the projects (Carrillo *et al.*, 2000).

Within organizations, employees are often reluctant to share their knowledge with others and changing this behavioural pattern is exigent (Nonaka, 2007; Lin *et al.*, 2006; Egbu, 2004). Many individuals regard their knowledge as personal property and source of strength and most typical existing civil engineering organisations find it difficult to encourage the culture of knowledge sharing (Carrillo *et al.*, 2000).

The non-repetitive nature of civil engineering projects is another important challenge to the management of knowledge in within the industry. A solution to a problem or best practice in a project may confuse other users having similar challenges in different projects with different characteristics and contexts. In their study, Fong and Wong (2005) argued that despite the importance of KM in reducing the risk of 're-inventing the wheel', it is sometimes difficult for individuals in a project to re-use and re-apply knowledge of other projects. The reason is that it is difficult for employees in a project to understand the context and the reasons for decisions that were made in other projects simply by using reports or drawings kept after the completion of those projects (*ibid*).

The ability of KM initiatives to deliver desirable results for individuals and organisations can be affected by environmental factors such as organisational culture and management support (Burgess and Singh, 2006). Davenport *et al.* (1998) argued that in order to obtain successful KM Systems, organisations need not only to improve KM processes and technological contents but also to enhance the knowledge environment through practices attempting to change behaviours of employees that relate to knowledge such as building KM awareness and cultural acceptability.

The lack of employee and management awareness of the importance and future benefits of KM to their organisations is a significant challenge to KM application in SMEs and a result they suffer many problems in applying KM and lack awareness of many important issues associated with knowledge capturing and its benefits for construction organisations (Hari *et al.*, 2005; KLICON, 1999).

Conclusion

The civil engineering industry is recognised as being poor in its approach to learning and performance improvement and is notoriously slow in adapting to change (Chen and Johnson, 2002, KLICON, 1999). On the other hand, knowledge is said to be the number one source of competitive advantage and as such adoption of KCIM practices is imperative for civil engineering consulting firms. There has been increased competition for consultancy services since they can be sourced from virtually anywhere in the world. The local civil engineering consulting firms, therefore, have to learn quickly and adapt to changes whilst managing and integrating their existing knowledge if they are to remain competitive within the industry.

To assure sustainability of the local civil engineering consulting sub sector of the economy, the challenges and barriers associated with knowledge creation, integration and management have to be addressed. As illustrated in the previous section, the challenges for KM implementation are many. These problems can be addressed through the introduction of appropriate KCIM measures which would not only concentrate on managing the existing resource but creating and integrating the much needed knowledge resource. Creation of awareness of KCIM benefits and challenges amongst the civil engineering consulting firms would be a starting point in ensuring that appropriate KCIM measures are adopted within the local industry.

One sure way of igniting the KCIM process is to promote linkages between industry and the academia. Educational institutions are vital in a more knowledge intensive economy both as creators and consumers of knowledge. As creators of knowledge, educational institutions are fundamental to creating the ‘intangible assets’ – knowledge, skills and innovation – that have become the source of competitive advantage for thriving businesses. They are critical to the creation of intellectual and knowledge assets in the national and local economies through transfer of academic knowledge and expertise to improve productivity and to create new products and services. They also develop the human capital that fuels the economy (Williams *et al.*, 2008). On the other hand, strengthening the Continuous Development Programme for professionals would help promote knowledge integration within and across the industry.

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