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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.

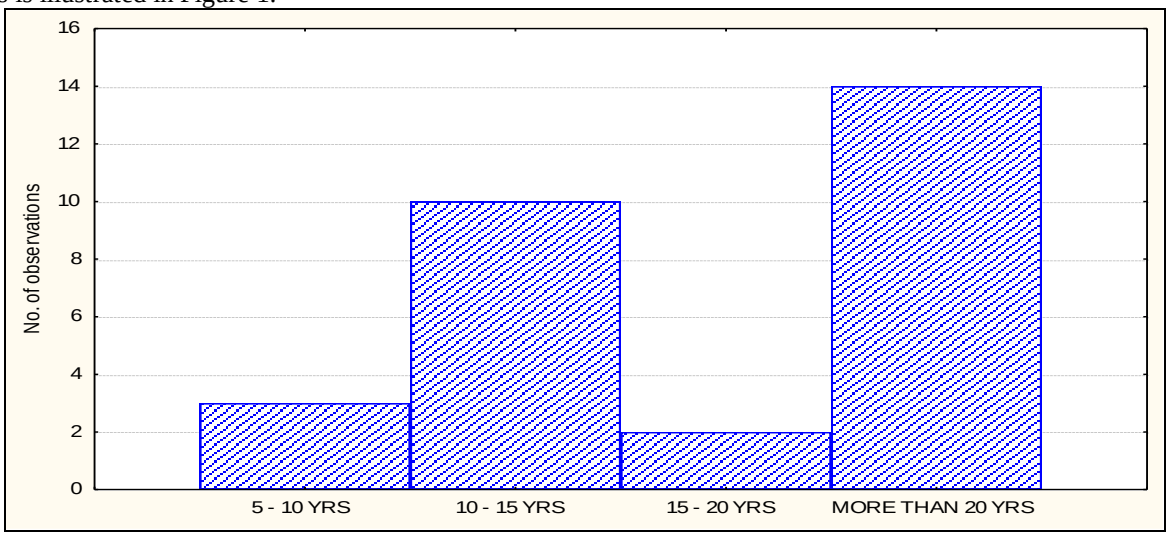

Figure 1: Respondents' years of experience in civil engineering consultancy

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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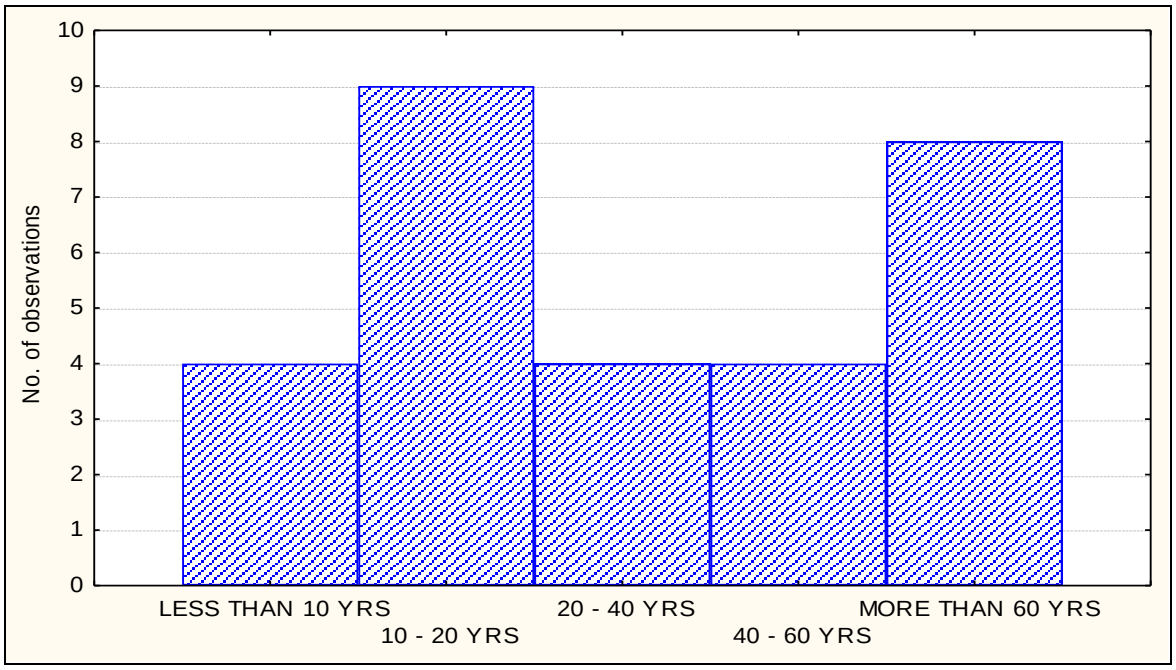

Figure 2: Responsive organisation's experience

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.

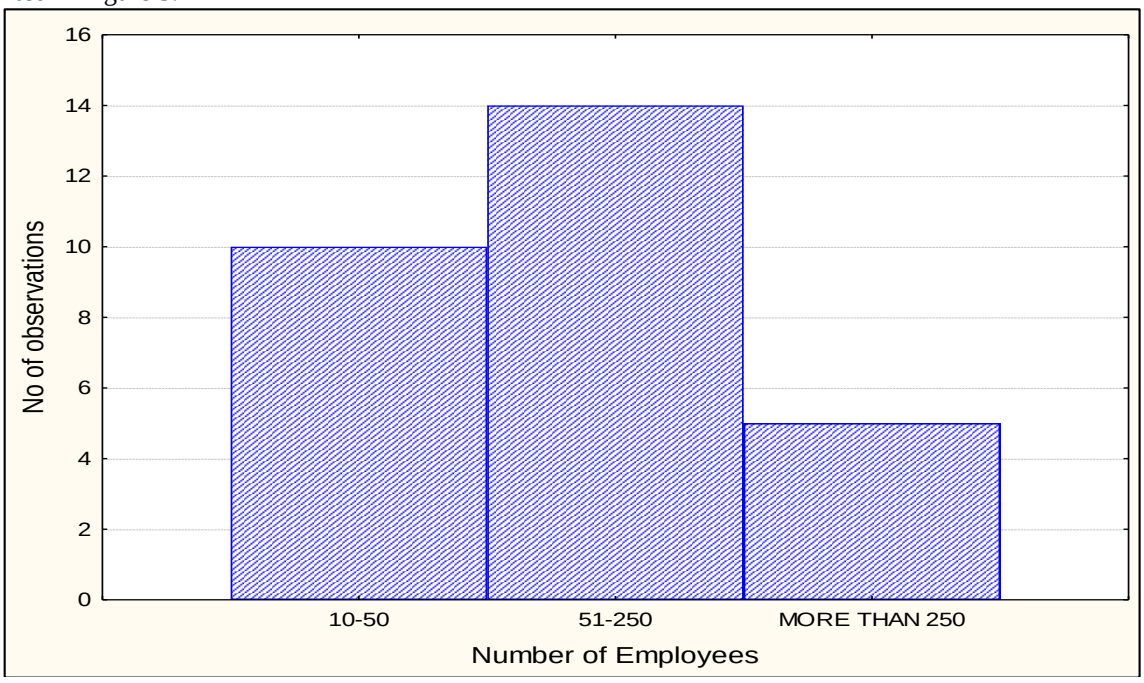

Figure 3: Distribution of the employee base of surveyed firms

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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.

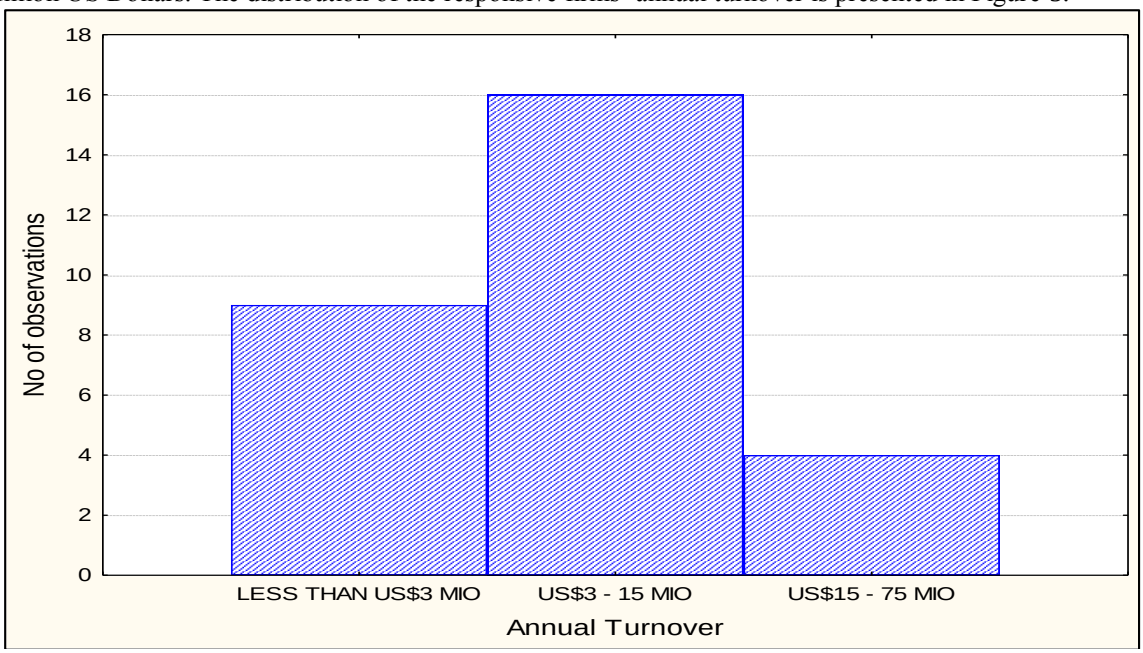

Figure 4: Distribution of annual turnover of surveyed firms

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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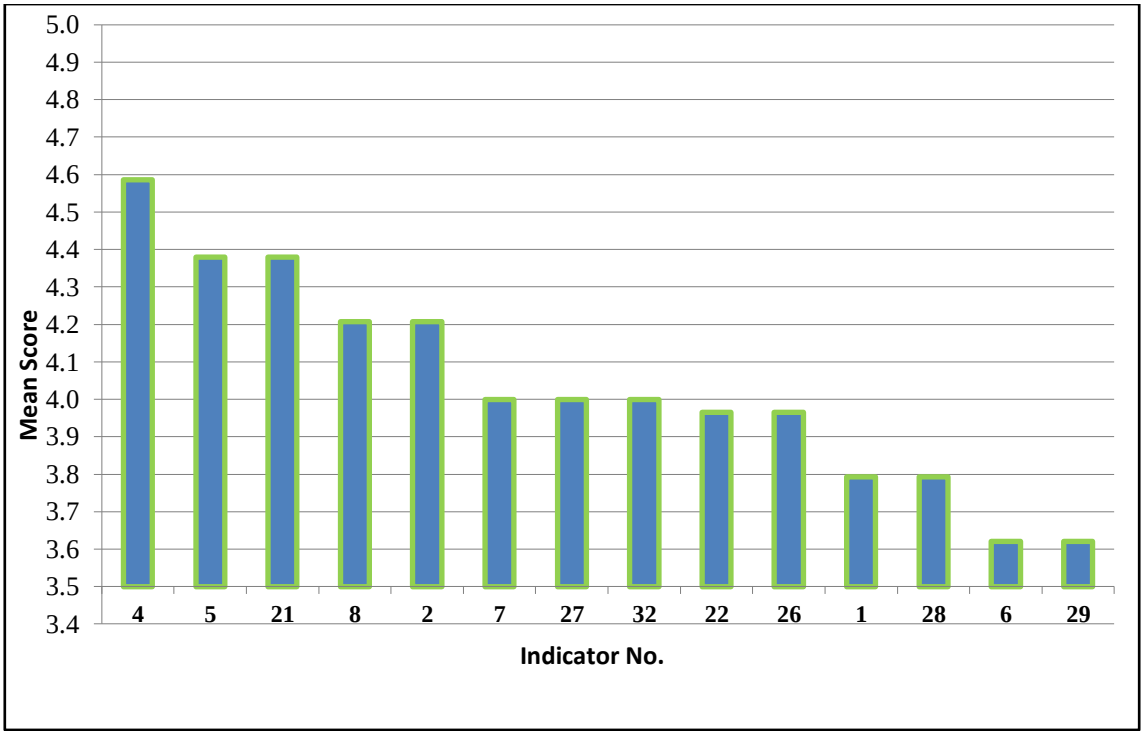

Figure 5: Indicators of KC having an overall mean score greater than 3.5

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.

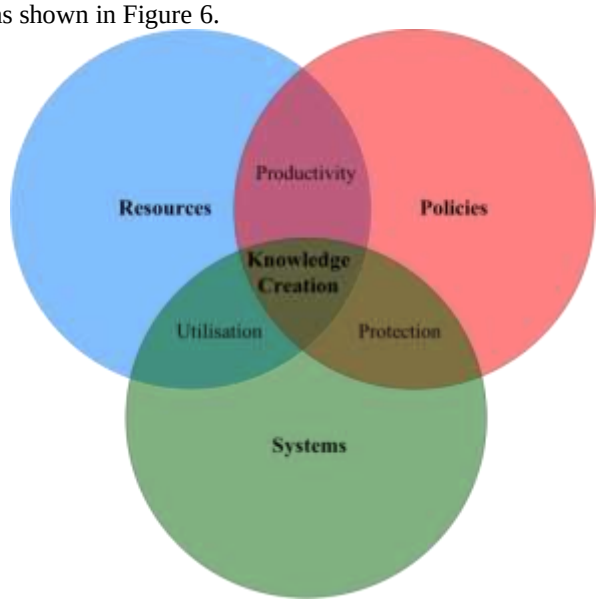

Figure 6: Key KC Factor Indicators within a Civil Engineering Consulting Firm

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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