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KEY PERFORMANCE INDICATORS IN THE CONSTRUCTION INDUSTRY IN KHARTOUM, SUDAN

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Abstract

Purpose

The aim of this study is to elaborate the significance, role and types of Key Performance Indicators (KPIs) in the construction industry in Khartoum, Sudan.

Design/Methodology/Approach

An industry-wide survey employing a questionnaire was conducted and a stratified sample comprising 79 respondents was selected. To determine the most significant KPIs in the construction sector, 32 key performance indicators at the construction project phase and 38 key performance indicators at the construction company phase were studied.

Findings

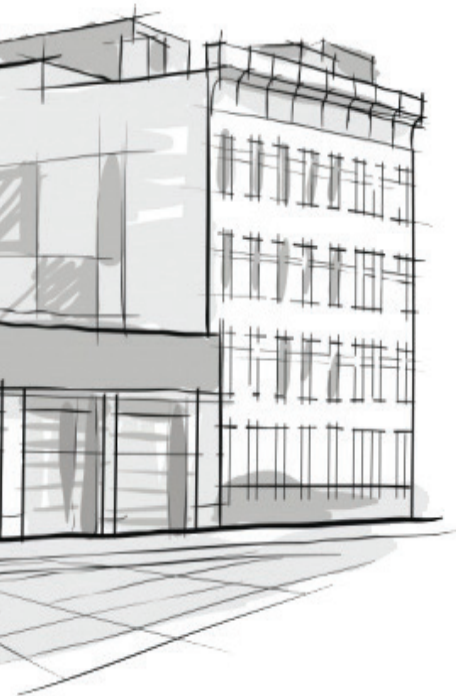
The results indicated that the top ten KPIs at the project level were team experience, customer satisfaction, safety, training, time and cost deviation, budget, resources, risks, cost of implementation and planning period. In addition, the top ten key performance indicators at the company level were stability, employee satisfaction, customer satisfaction, safety, continuance training, quality, work efficiency, renewal and education, system efficient and work review.

Originality/Value

The paper identified the suitable key performance indicators at the project and company level.

Practical

The use of performance indicators to measure the performance of construction projects in Sudan.



Keywords

Construction industry, performance, indicators, Sudan

Introduction

Construction is the process of constructing a building or infrastructure, and differs from manufacturing in that manufacturing typically involves mass production of similar items, while construction typically takes place on location for a known client. As an industry, construction comprises 6-9% of the gross domestic product (GDP) of developed countries. It starts with planning, design and financing, and continues until the project is built and ready to use. Large-scale construction requires collaboration across multiple disciplines. The construction team on a project consists of various tradespeople including owner, construction manager, design engineer, construction engineer, architect, consultant, prime contractor, subcontractor, and sub-subcontractor and materials' suppliers; this will be discussed in more detail later in this paper. The construction industry in Sudan faces many problems and difficulties in meeting the constructions' objectives; this is because of the lack of implementation of key performance indicators (KPIs), leading to deviation in a project's time, cost and quality.

The aim of this paper is to study the concepts of KPIs, how to apply them in the construction industry, and establish a set of appropriate KPIs to be used within the construction industry in Khartoum, Sudan.

Literature Review

KPIs are a measurable value that demonstrate how effectively a company achieves key business objectives. Organisations use KPIs at multiple levels to evaluate their success at reaching targets. High-level KPIs may focus on the overall performance of the enterprise, while low-level KPIs may focus on processes or employees in departments, such as sales, marketing or a call centre (Toor and Ogunlana, 2010). Projects clearly become a central activity in most organisations and companies who are rapidly increasing their investment resources in projects such as new product development, process improvement, or building new services (Humaidi and Said, 2011). However, many studies indicated that most projects do not meet time and budget goals, or fail to satisfy customer and company expectations. Notwithstanding, other factors also contributed to the failure of projects, such as weaknesses in project mission and planning, lack of project knowledge, a breakdown in communications, lack of resources, political issues, control issues, lack of top management support, lack of technical expertise, etc. (Eigbe et al., 2015). KPIs are a measure of performance of an activity critical to organisational and project success (Construction Excellence, 2009). In construction, KPIs enable the measurement of project and organisational performance throughout the industry (KPI working group, 2000). KPIs have been used to introduce many construction firms to performance measurement (Beatham et al., 2004)

Materials and Methods

Data collection

Data were gathered through a questionnaire administered to owners, contractors and consultants who were asked to answer questions pertaining to their experience with construction projects and their opinions about KPIs. The participants consisted of 16 engineers working in government entities representing owners, 40 engineers from contractors' companies, 16 were engineers working in consultant firms and 5 were engineers working in other areas. The questionnaire was divided into three sections. Section 1 included the information about respondents. Section 2 included a list

comprising 32 KPIs at the construction project phase, and Section 3 included 38 KPIs at the construction company phase. These KPIs were selected from previous studies and highlighted as the most important to be discussed.

Pilot study

A pilot study could help to refine data collection plans with respect to both the content of the data and procedure to be followed (Mahmoud and Elshaikh, 2019). Therefore, piloting the questionnaire with a small representative sample ensures the effectiveness of the questionnaire (Kombo and Tromp, 2006). In this case, a judgement sample of 18 respondents with a good spread of respondents' characteristics was chosen for the preliminary testing of the questionnaire. Questionnaires were administered to contractors, consultants, owners and project managers and they were contacted in person. However, only four valid responses were received from respondents constituting a 22.3% response rate; this was considered adequate for validation. Based on the feedback, minor corrections were made to improve the format, layout, questions and the overall content of the questionnaire. Through this process, the questionnaire was validated and provided the authors with the opportunity to improve the questionnaire prior to the main survey.

Data analysis

The analysis of the data was carried out with the help of the Statistical Package for Social Sciences (SPSS) version 21.0. Data were carefully analysed statistically using reliability test, frequencies and factor analysis, and importance index.

Reliability

Reliability is described as a measure of the degree to which a research instrument yields consistent results or data after repeated trials. Reliability in research is influenced by random errors: as random errors increase, reliability decreases (Mahmoud and Elshaikh, 2019). This provides a commonly accepted rule of thumb for describing internal consistency using Cronbach's alpha, as shown in Table 1.

Table 1: Cronbach's Consistency Alpha

Cronbach's Coefficient Alpha	Internal Consistency Remarks
$\alpha \geq 0.9$	Excellent
$0.7 \leq \alpha < 0.9$	Good
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Source: Mahmoud and Elshaikh, 2019

Importance index

The data were presented in an ordinal scale. This scale was transformed into an interval scale by assigning a weight to each interval. Considering intervals from 'never' to 'very often' as an interval scale from 1-5 (Very often = 5, Often = 4, Sometimes = 3, Seldom = 2 and Never equals = 1). The Importance Index for each KPI was then calculated according to equations (1) and (2) (Mohammed et al., 2017).

$$\text{Importance index} = (WixXi)/N. \quad (1)$$

Where *Wi* the weight is assigned to the IT option of the factor; Xi is the number of respondents who selected the IT option of factor; and N is the total number of respondents. To better understand the Importance Index:

$$\text{Importance index} = (5(x5) + 4(x4) + 3(x3) + 2(x2) + 1(x1) / (N) \quad (2)$$

Results Analysis and Discussion

Reliability

A reliability test was carried out to determine whether the questionnaire was capable of yielding similar scores if the respondents used it twice. The test was conducted using SPSS version 21.0. The determined Cronbach's alpha coefficient value for the questionnaire is shown in Table 2. This value indicates that the questionnaire items form a scale that has reasonable internal consistency reliability. Impliedly, the survey instrument used was good, reliable and acceptable, and an agreement exists between construction industry participants.

Table 2: Results of Cronbach's Consistency Alpha

Questionnaire section	Number of Items	Cronbach's Alpha
Project level	32	0.79
Company level	38	0.93

Source: Constructed by authors from fieldwork research

Sample configuration

The configuration of the participants was as presented in Figure 1: 20.3% of the respondents were owners, 50.6% were contractors, 20.3% were consultants, and 8.3% were others.

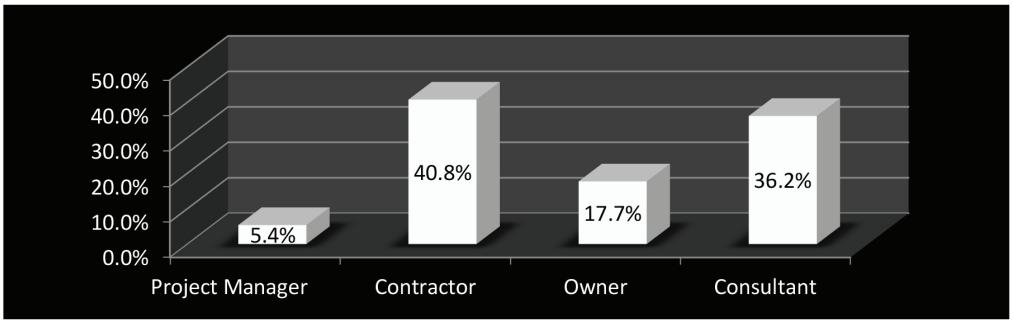


Figure 1: Participants' work area

Source: Constructed by authors from fieldwork research

The academic qualifications of the overall participants were as presented in Figure 2. The highest percentage of participants (78.5%) had a bachelor's degree, while 16.5% had a Master's degree and 5.1% a PhD. This gives an indication that the sample covers participants with a wide range of qualifications.

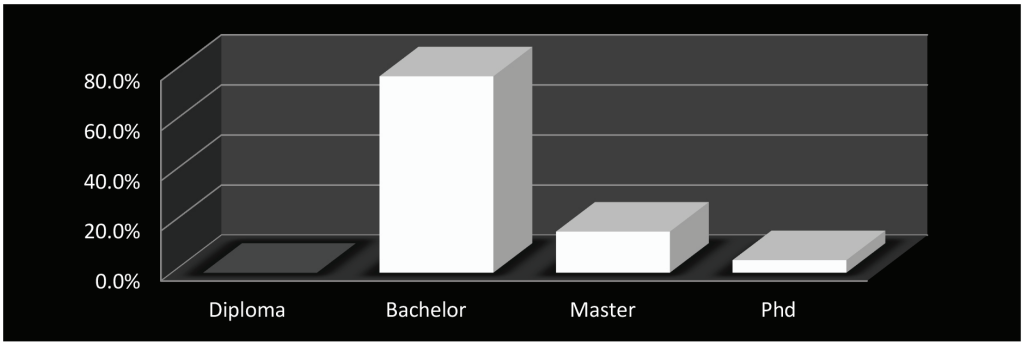


Figure 2: Participants Academic Qualifications

Source: Constructed by authors from fieldwork research

Regarding the work area, the results showed that 31.6% classified themselves as public sector organisations, while 68.4% were private sector organisations, as shown Figure 3.

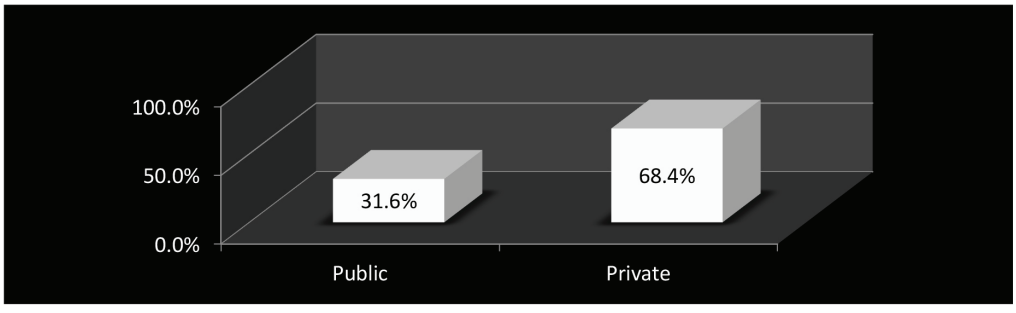


Figure 3: Participants' Work Sector

Source: Constructed by authors from fieldwork research

When participants were asked to specify their area of specialisation, 79.7% were recorded as civil engineers while 20.3% were architects, as shown in Figure 4.

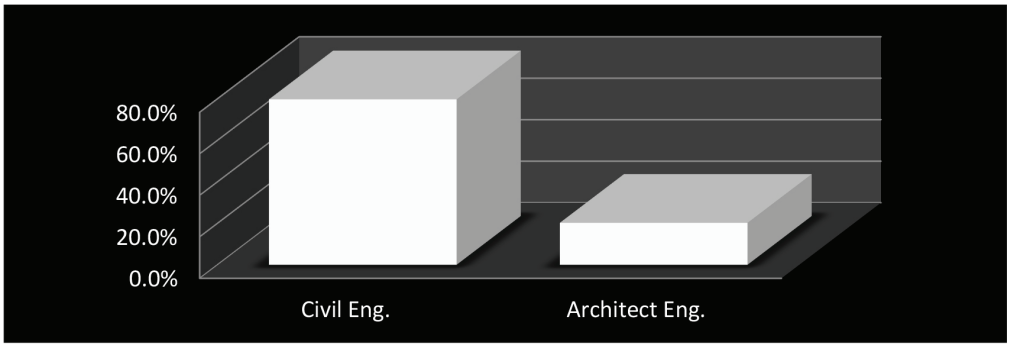


Figure 4: Participants' Work Specialisation

Source: Constructed by authors from fieldwork research

To evaluate the areas in which respondents had gained their experience, 69.6% worked on building projects, 16.5% worked in highways projects, 11.4% worked in infrastructure projects, and 2.5% worked in other projects, as shown in Figure 5.

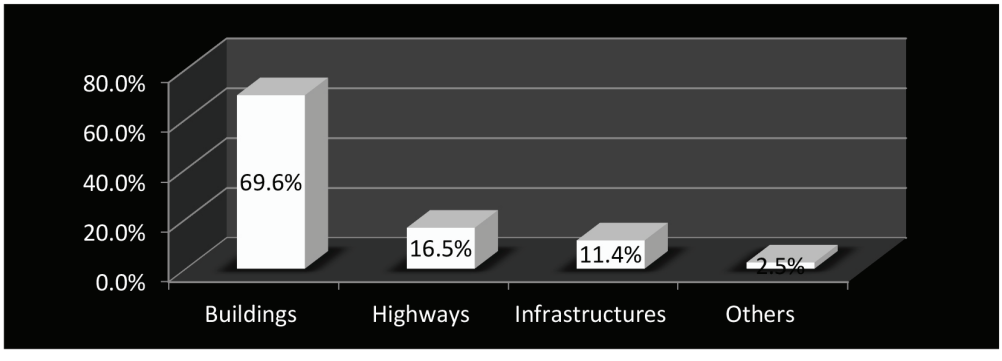


Figure 5: Participants' Types of Projects

Source: Constructed by authors from fieldwork research

To evaluate the respondents' experience, 31.6% admitted they had worked in the field for less than 5 years, 26.6% for 5-10 years, 20.3% for 10-15 years, and 21.5% for more than 15 years. This confirms that 41.8% of participants had been working in the research area for at least 10 years; this implies the respondents had gained sufficient experience to give reasonable responses to the questionnaire (see Figure 6).

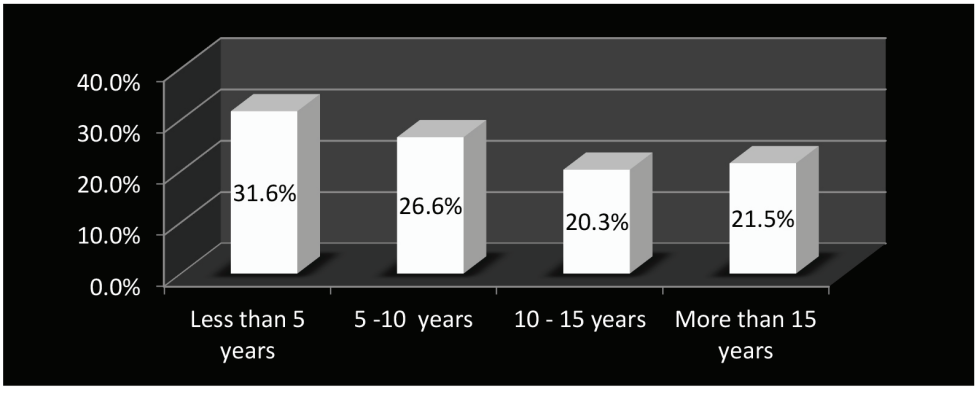


Figure 6: Participants' Work Experience

Source: Constructed by authors from fieldwork research

Occurrence and Importance Index

The results from Figure 7 show that 60% of respondents confirmed that all 32 outlined KPIs for construction projects could be used in Khartoum state, Sudan.

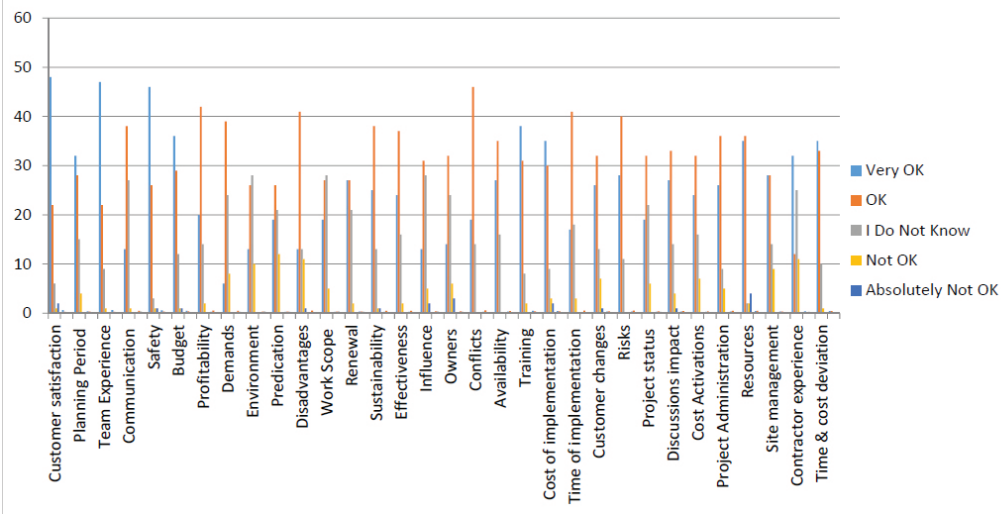
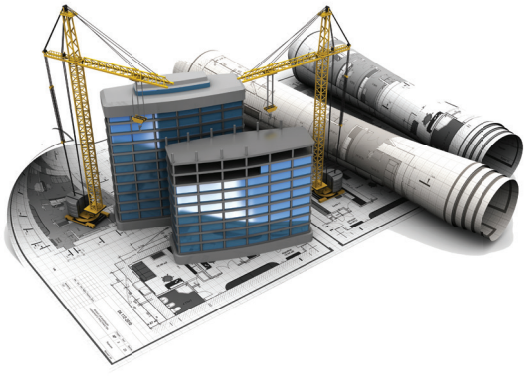


Figure 7: Occurrence of KPIs for Construction Projects

Source: Constructed by authors from fieldwork research

The results indicated that the top ten KPIs at the project level were team experience, customer satisfaction, safety, training, time and cost deviation, budget, resources, risks, cost of implementation and planning period, as shown in Figure 8.



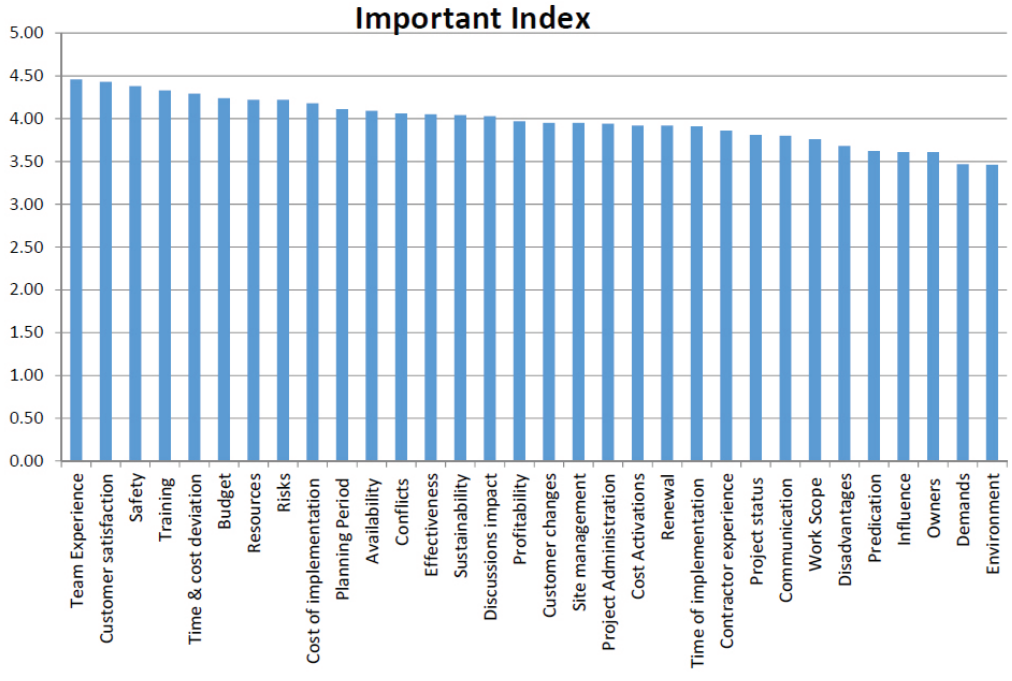


Figure 8: Importance index of KPIs for Construction Projects

Source: Constructed by authors from fieldwork research

The results from Figure 9 show that 60% confirmed that all 38 outlined KPIs for construction companies could be used in projects in Khartoum state, Sudan.

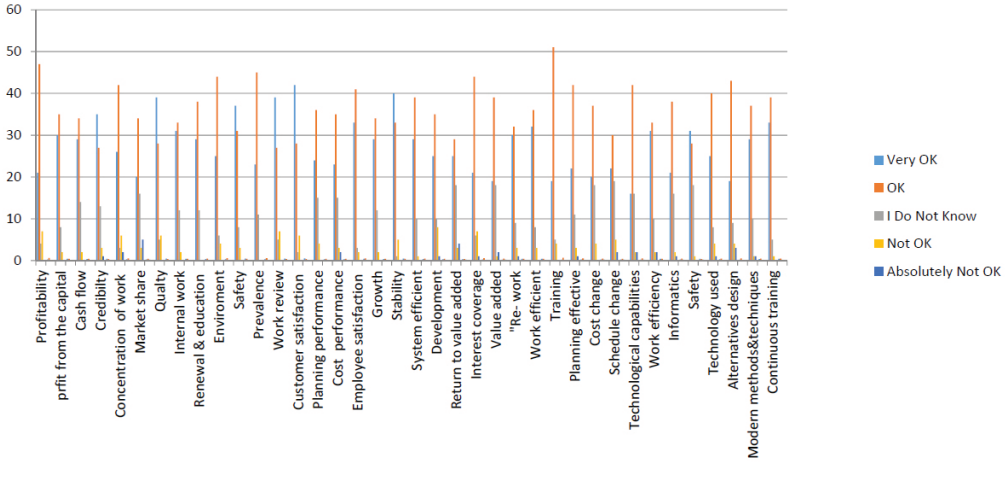


Figure 9: Occurrence of KPIs for Construction Companies

Source: Constructed by authors from fieldwork research

The results indicated that the top ten key performance indicators at the company level were stability, employee satisfaction, customer satisfaction, safety, continuance training, quality, work efficiency, renewal and education, system efficient and work review, as shown in Figure 10.

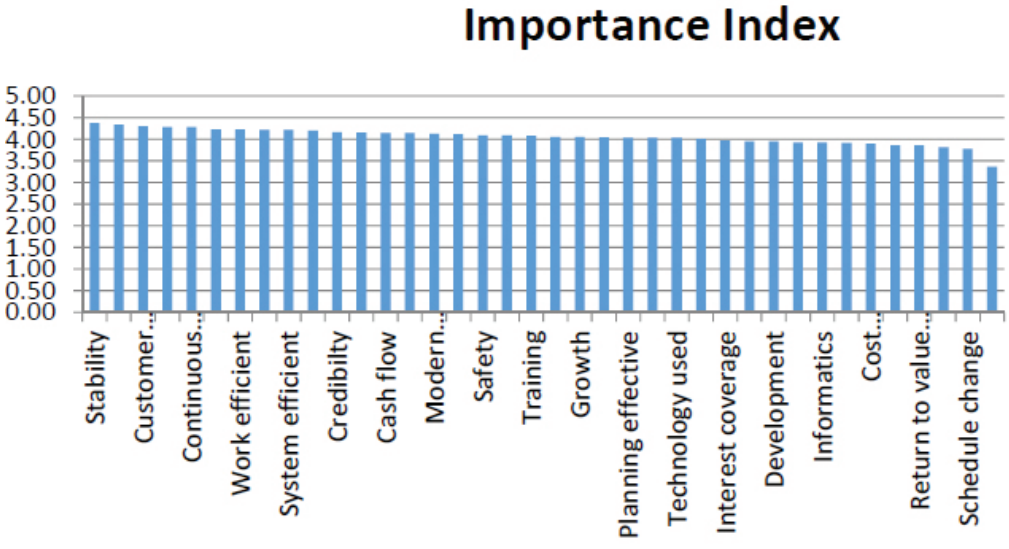


Figure 10: Importance Index of KPIs for Construction Companies

Source: Constructed by authors from fieldwork research

Conclusions

Key performance indicators (KPIs) are a major factor in construction industry performance management. Therefore, it is worth spending time and effort in choosing areas to calculate the indicators.

The top ten key performance indicators at the project level were stability, employee satisfaction, customer satisfaction, safety, continuance training, quality, work efficiency, renewal and education, system efficient and work review.

The top ten key performance indicators at the project level were, team experience, customer satisfaction, safety, training, time and cost deviation, budget, resources, risks, cost of implementation and planning period.

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Biography

Dr Eltahir A.M. Elshaikh is an Assistant Professor of Construction Engineering and Management, and Dean of Admission and Registration at Sudan University of Science & Technology, Sudan. He is PMP and RMP certified, and currently works as an academic staff member and consultant engineer in Construction Engineering and Management. He has participated in many scientific conferences in Sudan and abroad, and has several publications related to construction management, and building materials and sustainability. Current research interests are geared towards sustainability as related to construction materials, construction management, and legal issues in construction with specific focus on claims and variation orders and real estate. Dr

Elshaikh is a member of the Sudan Engineering Society (since 2008), Sudan Engineering Council (since 2008), the Sudanese Association for the Evaluation of Assets and Real Estate (since 2012), and the Sudanese Sustainable Building Council (since 2017).

Dr Salma Y.M. Mahmoud is an Associate Professor of Construction Engineering and Management, and Head of the Civil Engineering Department at the University of Science & Technology, Sudan. As an academic staff member, her research interests and efforts have lately been geared towards legal aspects relevant to construction contracts, claims, conflicts and disputes, and the investigation of possible sustainable options for building materials. She has supervised many undergraduate and postgraduate students in the same field of study. She has a number of contributions in national and international conferences presenting collaborative research results.

Ahmed Omar, **Audi Noureldin** and **Khalid Alkamil** are Construction Engineers at different companies in Sudan. They graduated from the Construction Engineering Department at Sudan University of Science and Technology. Their current research interests are in construction management and legal issues in construction with a specific focus on Key Performance Indicators in Sudan.