Identification and Ranking of Key Performance Indicators in Building Construction Projects in Kenya

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Abstract-Building construction projects suffer from many dangers such as cost and time overruns. A major reason for the failure of such projects is the lack of measurements of the construction performance. There is usually a disparity of judgment among the stakeholders when it comes to the perception of failure and success of a building construction project because it is based on personal indices. The aim of this study is to identify and rank the key performance indicators in their relative importance as a way to assist in building construction performance. A thorough literature review was conducted and 10 key performance indicators were identified. A questionnaire survey and interviews were used to collect data and the results were analyzed using the analytical hierarchical process, pair-wise comparison. As a result, the highest prioritized key performance indicator was safety, followed by time effectiveness and client satisfaction. The least prioritized key performance indicator was the environmental performance. The results of this paper may serve as a guideline in improving building construction projects.

Keywords-key performance indicators; constrruction performance measurements; building; construction performance management

I. INTRODUCTION

Performance measurement is a continuous and systematic process of obtaining valid information about the performance of a project and of identifying the factors that affect performance while project performance management uses the generated information [1]. Performance measurement is the heart of a ceaseless improvement and it is utilized for many reasons including decision making, strategic reasons, and benchmarking [2, 3]. Traditionally, the main aspects of construction project performance measurements are cost, schedule, and quality [4]. This is not efficient and inevitably it led to a shift to a modern way of measuring performance. This has been the focus of research since the 1980's, where increased globalized competition forced companies to consider non-traditional measures [5]. The main reason for the fails of traditional performance is that it lags indicators, because it reports on decisions and results that cannot be improved. The performance should be identified with the ongoing basis also known as 'Leading' [5]. Authors in [6] emphasize on the need of balancing both financial and non-financial measures in the construction industry and the need to shift from product-oriented performance to process-oriented performance. Globally, the construction industry is generally considered to underperform when compared to other industries [6]. The lack of general agreement on measuring construction performance makes it hard for the construction top management to make the best decisions on the project [7]. This affects projects in Kenya as well, as Kenyan construction projects seldom go according to the implementation plan [8]. A project faces enormous challenges in quality assurance, cost, schedule, environmental performance, and safety [9]. Despite the high quality of training of consultants in the building industry and regulation of the industry in major urban areas in Kenya, construction projects do not always meet key performance goals. This is unfortunate and failure to try to resolve this key issue, may lead to more poorly performed construction building projects [10]. Authors in [6] recommend the implementation of a performance management framework which will motivate and assist the management team to achieve project success. The aim of this research is to identify and rank the Key Performance Indicators (KPIs) according to their priority weight. It can assist in bringing a standard performance measurement framework for building construction projects in Kenya.

II. KEY PERFORMANCE INDICATORS

Performance assessment remains a major problem of the construction sector [11]. Over the years, many industries have come up with effective ways to measure performance [12]. Thus, these methods have been tried to the construction industry. Construction is a complex organization that involves many people, hence it is assured that the degree of coordination is high when compared to other industries [13]. Performance indicators consist one of the ways to measure the performance in an industry. According to [6], most companies assume the financial measure as indicator which is a mistake because it only indicates the results of the past, it indicates when but not how. Indicators should also include non-financial measures such as employees' motivation, leadership, and many others.

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According to [14], the performance indicators are defined as factors that have a major influence on the success or failure of a construction project and should be identified in order to improve the project performance. They are also referred as critical success or failure factors. The criteria in which project success/failure has often been assessed have also been called key performance indicators or dimensions [15]. Models developed to measure construction project performance are the integrated performance index, and the KPI. Good examples of KPI are:

A. Balance Scorecard

Balance scorecard measures the performance with the main indicators which might affect the financial status of the company: customer service, internal and business processes, etc. [16].

B. European Foundation for Quality Management (EFQM) Excellence Model

This excellence model assists in understanding and managing the complexity in business. It gives a cause-and-effect relationship between what the companies do and what results they will achieve [17]. EFQM is based on 8 concepts which are meant to improve the business performance: Result orientation, customer focus, leadership and constancy of purpose, management by processes and facts, people development and involvement, continuous innovation, learning and improvement, partnership development, and corporate social responsibility [18].

C. Analytical Hierachial Process (AHP)

AHP is a multi-criteria decision-making method that was originally developed by Thomas Saaty. It is a tool with numerous applications in areas of planning and management [38]. AHP uses a pairwise comparison to generate weightings for criteria instead of listing and ranking their level of importance. AHP prioritizes the KPIs of a framework [38].

D. Literature Summary

KPIs are meant to be objective and can be easily measured. Identification of the suitable quantitative interpretations and requirements on all KPIs could reduce the degree of subjectivity and biasness [7]. It should also involve different stakeholders as different stakeholders value different indicators depending on their interests in the project [6]. Authors in [6] describe the construction industry as project-based and construction project managers need to devise mechanisms to measure performance. The identified KPIs could be combined to come up with a comprehensive model. This includes examining various indicators and evaluating their impact on performance. The proposed index could be customized depending on different building projects [7]. Several studies have been conducted to come up with KPIs in construction performance. Most common used indicators have been compiled into a list in the current study. These indicators were discussed among construction professional experts with more than 15 years of experience to check the relevance of each KPI in the Kenyan building construction. Some of the KPIs became performance metrics to the main KPI. The concluded list of the 10 KPIs is shown in Table I.

TABLE I. LITERATURE SUMMARY OF 10 KPIS AFFECTING BUILDING CONSTRUCTION PROJECTS IN KENYA.

KPIs	Performance metrics	Sources
Cost	Change in cost planning. Effectiveness of predictability of cost planning.	[19-24]
Time	Construction time. Construction speed. On time completion.	[7, 19-24]
Quality	Defects. Quality control. Quality assurance. Rework factor.	[7, 19-24]
Safety	Annual accident rate. Lost time accidents	[19-23, 26]
Client satisfaction	Client's responsiveness. Proper communication.	[19-23, 25]
Environment	Environmental protection measures. Energy saving. Extended building life cycle. Increased user comfort. Waste management. Environment friendly equipment.	[19, 20, 23, 27, 28]
Team satisfaction	Clear goals. Knowledgeable leadership. Appropriate management of internal conflicts. Effective communication. Matching employees to areas of expertise.	[20, 22, 23, 29-32]
Project leadership	Leader's professional qualification. Leadership style. Technical skills. Managerial skills. High employee relationship. Management of stakeholders Communication and collaboration.	[6, 19-23, 33, 34]
Productivity	Labor productivity. Machine productivity. Materials consumption. Utilization of advanced technology. Regular equipment maintenance.	[20, 22, 23, 28, 35]
Proper training and recruitment	Availability of skilled manpower. Knowledge and experience.	[11, 19, 22, 23, 36]

III. RESEARCH OBJECTIVES

The main objective of this research was to develop a performance index for construction building projects in Kenya. The specific objectives were:

- Identify and rank the KPIs in Kenya building construction industry.
- Integrate and quantify the KPIs in Kenya building construction Industry.

IV. RESEARCH METHODOLOGY

The distributed questionnaire was based on three sections:

- The respondent's profile, i.e. type of organization they work for and the respondent's position in the firm.
- The respondents' construction experience and their performing measurement tools.
- Measuring and prioritizing the KPIs in building construction project.

A pilot study was done with 5 experienced professionals with 5-10 years of experience in construction industry and then the questionnaire was revised to reduce the required respond time. Afterwards, it was distributed to the respondents via email, WhatsApp and messages. The target population of this study was professionals in the building construction industry with at least 5 years of experience on Kenya building construction firms. The sample size of this research was based on the number of the registered professionals in Kenya. According to [36], a construction project involves developers, contractors, consultants, and sub-contractors. The sampling method used was random stratified sampling, focused on contractors, consultants, and developers. The sample size was determined by the equation in [37] that provided 95% confidence level. The sample size was found to be 172 and the random stratum sampling was 40%, 20%, and 40% of the sample size, for consultants, developers, and contractors respectively. A developer is considered as a professional company who develops a land through building construction and sells the outcome for a profit. Consultants include construction managers, architects, structural engineers, quantity surveyors, and landscape architects. The pair-wise comparison and the linear Saaty scale on the KPIs [38] were used. The printed questionnaire was filled by 13 respondents while 49 completed the online questionnaire making a total of 62 respondents, representing a response rate of 36% which is accepted and sufficient for research [39]. The data collected were 58.26%, 29.57%, and 12.17% for consultants, contractors, and developers respectively. Incomplete pair-wise comparison occurred as some of the respondents missed a comparison or stopped filling the questionnaire when they were almost done. This did not affect the study as [40] proved that one can delete 50% of comparisons with no significantly affecting the results.

V. RESULTS AND DISCUSSION

A. Construction Completion within the Proposed Time and Cost

The data collected show that 43% of the construction stakeholders indicated that all their building projects were completed within the proposed time and cost while 54% of them indicated the opposite, as shown in Table II.

B. Construction Performance Tools

As can be seen in Table III, 59% of the respondents indicated that they use performance measurement tools and 41% did not. The performance measurement tools include earned value-based management, project management software, proposed cost vis-à-vis the actual cost of the project, proposed time the vis-à-vis actual time of the project, contractor experience, and client satisfaction.

TABLE II. CONSTRUCTION COMPLETIONS WITHIN PROPOSED TIME AND COST RESULTS

Were the construction completed within the proposed time and cost?	Frequency	Percentage
Yes	46	42.99%
No	58	54.21%
Can't remember	3	2.80%

TABLE III. CONSTRUCITON PERFORMANCE TOOLS RESULTS

Response	Frequency	Percentage
Yes	61	59.22%
No	42	40.78%

C. An Evaluation of Priorities of Key Performance Indicators

The priority of KPIs was informed by the aggregation of individual judgments. Authors in [41] define the aggregation of individual judgment as aggregation on the individual pair-wise comparisons to obtain a new judgment matrix. The aggregation of individual judgement was achieved through the geometric mean method of what each individual respondent selected as suggested in [42]. This assists group systematic decision making with a holistic vision of reality and subjacent ideas of literal thinking [41]. Table IV is the pairwise comparison matrix and total column summation was conducted for the normalization of the indices.

D. Matrix Normalization

Matrix normalization was done by total summation of each column with judgment values. Then, each judgment value was divided by the summation. This yields the normalized score of Table IV. The average is also known as the eigen vector and it gives the priority weight of each KPI. When all the averages are added up, the summation is 1. Using the eigen value, the ranking of the KPI is achieved with the highest value being the most prioritized KPI as shown in Table V. The consistency index for this study was 0.04 which is acceptable as the acceptable consistency index should be less than 0.1 [38]. The ranking of the KPIs is shown in Table VI.

TABLE IV. COMPARISON MATRIX OF KEY PERMORMANCE INDICES

	Q	CE	TE	Saf	PL	EP	Prod	TS	CS	PT
Quality	1	1.3445	1.5188	0.6936	1.0998	1.3542	1.268	1.3514	0.8593	0.9766
Cost effective	0.7438	1	0.9209	0.8996	0.5223	1.9982	1.1443	0.484	0.8191	1.2153
Time effective	1.9275	1.0859	1	1.0805	1.6763	1.8709	1.1068	1.7076	0.7883	0.6357
Safety	1.4418	1.1116	0.9255	1	1.82	2.1419	2.364	2.8962	1.696	1.6144
Project leadership	0.9093	1.9146	0.5966	0.5495	1	0.8717	0.5293	0.646	1.1795	1.1236
Environmental performance	0.7384	0.5005	0.5345	0.4668	1.1472	1	0.7497	0.938	0.5861	1.0508
Productivity	0.7886	0.8739	0.9035	0.423	1.8893	1.3339	1	1.7797	0.8599	1.9461
Team satisfaction	0.74	2.0661	0.5856	0.3453	1.548	1.0661	0.5619	1	0.6791	1.0993
Client satisfaction	1.1637	1.2209	1.2686	0.5896	0.8478	1.7062	1.1629	1.4725	1	1.6303
Proper training	1.024	0.8228	1.5731	0.6194	0.89	0.9517	0.5138	0.9097	0.6134	1
Total	10.4771	11.9408	9.8271	6.6673	12.4407	14.2948	10.4007	13.1851	9.0807	12.2921

Q:quality, CE: cost effective, TE: time effective, Saf: safety, PL: project leadership, EP: environmental performance, Prod: productivity, TS: team satisfaction, CS: client satisfaction, PT: proper training and recruitment

TABLE V. NORMALIZATION MATRIX OF KEY PERFORMANCE INDICES

	Q	CE	TE	Saf	PL	EP	Prod	TS	CS	PT	Total	Avg
Quality	0.095	0.113	0.155	0.104	0.088	0.095	0.122	0.102	0.095	0.079	1.048	0.105
Cost effective	0.071	0.084	0.094	0.135	0.042	0.140	0.110	0.037	0.090	0.099	0.901	0.090
Time effective	0.184	0.091	0.102	0.162	0.135	0.131	0.106	0.130	0.087	0.052	1.179	0.118
Safety	0.138	0.093	0.094	0.150	0.146	0.150	0.227	0.220	0.187	0.131	1.536	0.154
Project leadership	0.087	0.160	0.061	0.082	0.080	0.061	0.051	0.049	0.130	0.091	0.853	0.085
Environmental performance	0.070	0.042	0.054	0.070	0.092	0.070	0.072	0.071	0.065	0.085	0.692	0.069
Productivity	0.075	0.073	0.092	0.063	0.152	0.093	0.096	0.135	0.095	0.158	1.033	0.103
Team satisfaction	0.071	0.173	0.060	0.052	0.124	0.075	0.054	0.076	0.075	0.089	0.848	0.085
Client satisfaction	0.111	0.102	0.129	0.088	0.068	0.119	0.112	0.112	0.110	0.133	1.085	0.108
Proper training	0.098	0.069	0.160	0.093	0.072	0.067	0.049	0.069	0.068	0.081	0.825	0.083
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	10.000	1.000

Q:quality, CE: cost effective, TE: time effective, Saf: safety, PL: project leadership, EP: environmental performance, Prod: productivity, TS: team satisfaction, CS: client satisfaction, PT: proper training and recruitment

TABLE VI. KEY PERFORMANCE INDICES RANKING

KPI	Ranking	Priority weight
Safety	1	0.154
Time effective	2	0.118
Client satisfaction	3	0.108
Quality	4	0.105
Productivity	5	0.103
Cost effective	6	0.090
Team satisfaction	7	0.085
Project leadership	8	0.085
Proper training and recruitment	9	0.083
Environmental performance	10	0.069
Total		1.000

Safety is the most and environmental performance is the least prioritized KPI. Notably, this research result is not consistent with the traditional iron triangle (cost, time, and quality) as the primary indicators for building construction performance. The top three indicators include only one factor from the iron triangle, time effectiveness. This is in contrast with the findings in [7] and is an indication that the building construction industry in Kenya has already incorporated non-financial measures in performance measurement and this needs to be reflected in the current methodologies. The least three prioritized indicators are project leadership, proper training and recruitment, and environmental performance which are non-financial measures. This results supports most research studies that have identified non-financial measures as the least prioritized [7]. Productivity was ranked as the 5th important indicator, contradicting the findings in [6], which show that productivity has insignificant impact on project performance. The KPIs are similar to the UK KPI report that has been globally used to measure construction performance as it includes cost, time, safety, productivity, client satisfaction, and quality [43]. The current study added more KPIs such as environmental performance, proper training and recruitment, and project leadership, because over the past 10 years, Kenya has been promoting clean and sustainable environment and this has led to authorities such as the NEMA (National Environment Management Authority) to be involved in building construction project approvals. The boards that regulate construction professionals in Kenya have also increased in the last 20 years while currently there is a draft bill that regulates construction professionals. The prioritized KPIs can be integrated to come up with a proposed index that could be used as a guideline in assessing the final outcome of KPIs and the general performance of a building construction project [7].

VI. CONCLUSION AND RECOMMENDATIONS

The current study confirmed that most construction professionals based the performance of building projects on their opinion which is subjective, biased, and varying across all stakeholders in the same project. This was evidence of the need of this research and the knowledge gap it fills. Safety, time effectiveness, and client satisfaction were most important to most professionals, differentiation the results from traditional performance measurements which focus on the financial measure as the most important KPI. The results support the need to explore modern performance measures, including the reported leading indicators. Quality, which belongs to the iron triangle, was ranked only fourth, below client satisfaction and safety, while proper training and environmental performance were among the KPIs ranked least. These KPIs are social factors, they affect the community and society at large. Most construction professionals (57%) have ways of measuring their performance, however most tools are personal indices or just focus on one indicator in the project. And though this is a big percentage, 41% is also a big number of construction professionals who need to be able to measure their performance. A performance that cannot be measured, cannot be improved.

National Construction Authority (NCA) is the regulatory board for contractors in Kenya, and has categorized contractors based on the cost of the projects they have done, with the lowest cost being NCA grade 8 and the highest cost being NCA grade 1. It could be an opportunity for the NCA to increase transparency within the construction industry by grading them according to their performance within the building construction industry. This could enhance the fair competition among the contractors and build confidence of the clients on what the contractors can achieve within their projects. The limitation of this research was that although the number of respondents was acceptable to carry out the analysis, it was rather low. Further research should be conducted on the way KPIs relate to each other and the impact each can cause to the others.

APPENDIX

Questionnaire

This questionnaire aims to collect information related to indicators that have an important impact on perceptions of building project success. This will help in developing a performance index framework for building construction projects in Kenya.

Kindly answer the following questions according to the instructions.

Section A: Respondent Profile

Respondents' position in the firm

Consultant [ ] Contractor [ ] Developer [ ]

What type of organization do you work for?

Government [ ] Non- Government Organization [ ] Private Firms [ ]
Other (specify)…….

How long have you been involved in building construction projects?

Less than 5 years [ ] between 5 to 20 years [ ]
above 20 years [ ] don't remember [ ]

Section B: Respondent's construction experience

How many construction projects have you or your firm been involved in?

Less than 2 [ ] Between 2 and 5 [ ] Between 5 and 10 [ ]
More than 10 [ ] Can't remember [ ]

Were all these construction projects completed within the initial contract period and sum?

Yes [ ] No [ ] Can't remember [ ]

Do you have any method in measuring the construction performance of your project?

Yes[ ] No[ ] If yes, which method is it?

Section C: Ranking of Key Performance Indicator

To what extent do the following factors affect performance management in comparison to each other in building construction in Kenya? Table I explains the intensity of importance against the scale used.

EXPLANATION OF THE SCALE USED IN THE QUESTIONNAIRE

Intensity of importance	Definition	Illustration/ example
1	Equal importance (equal)	Element a and b are equally favored
3	Moderate importance of one over the other (slightly favors)	Slightly favor element a over b
5	Essential importance (strongly favors)	Strongly favor element a over b
7	Demonstrated importance (very strong favors)	Element a is favored very strongly over b
9	Absolute importance (extreme favor)	The evidence favoring element a over b is of the highest possible order of importance

Example:

Quality (9) (7) **(5)** (3) (1) (3) (5) (7) (9) Cost effective

Quality is very strongly favored compared to cost effective

Time effective (9) (7) (5) (3) (1) **(3)** (5) (7) (9) Quality

Quality is slightly favored compared to time effective.

This is the scale that was used to compare the KPIs below.

Quality vs Cost effective, Quality vs Productivity, Quality vs Time effective, Quality vs Safety, Quality vs Team satisfaction, Quality vs Client satisfaction, Quality vs Environmental performance, Quality vs Project leadership, Quality vs Proper training, Cost effective vs Time effective, Cost effective vs Environmental performance, Cost effective vs Client satisfaction, Cost effective vs Team satisfaction, Cost effective vs Project leadership, Cost effective vs Safety, Cost effective vs Productivity, Cost effective vs Proper training, Time effective vs Safety, Time effective vs Project leadership, Time effective vs Productivity, Time effective vs Proper training, Time effective vs Environmental performance, Time effective vs Client satisfaction, Time effective vs Team satisfaction, Safety vs Team satisfaction, Safety vs Client satisfaction, Safety vs Proper training, Safety vs Environmental performance, Safety vs Project leadership, Safety vs Productivity, Project leadership vs Productivity, Project leadership vs Client satisfaction, Project leadership vs Proper training, Project leadership vs Environmental performance, Project leadership vs Team satisfaction, Environmental performance vs Productivity, Environmental performance vs Client satisfaction, Environmental performance vs Team satisfaction, Environmental performance vs Proper training, Productivity vs Proper training, Productivity vs Client satisfaction, Productivity vs Team satisfaction, Team satisfaction vs client satisfaction, Team satisfaction vs Proper training, Client satisfaction vs Proper training

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