International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online)
Vol. 10, Issue 1, pp: (125-131), Month: April 2022 - September 2022, Available at: www.researchpublish.com

Relative Importance Index for the Key Performance Indicators for the construction industry in Egypt

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DOI: https://doi.org/10.5281/zenodo.7079244

Published Date: 14-September-2022

Abstract: **The construction industry is considered one of the key economic sectors in Egypt. Since the construction industry in Egypt is very dynamic, its performance is influenced by several different factors. Therefore, it is necessary to have a standard performance benchmark and indicators to assess projects' success. This paper aims to identify the most critical Key Performance Indicators (KPIs) and determine their Relative Importance Index (RII). The methodology to achieve this aim included a thorough literature review and a survey on projects performance among construction professionals in Egypt. The results show that the most critical KPIs are: Cost, Profitability, Time, Quality, Client satisfaction, Safety, Productivity, and Team satisfaction. These results can be used to assess projects success for the benefit of all project parties. Evaluating project performance based on a standard benchmark and indicators helps the construction industry professionals in managing, controlling, and improving projects and in anticipating future projects success.**

Keywords: **Key Performance Indicators, Construction projects, Relative Importance Index.**

I. INTRODUCTION

Construction is one of the biggest industries in the world with very high level of employability and investment. However, this mega-industry has many uncertainties and risks that would affect projects' success. In Egypt, the construction sector is a significant contributor to the Egyptian economy and is considered one of the fastest-growing sectors. In addition to this economic contribution, it also plays a vital role in employing skilled and unskilled workers in private and public organizations such as renewable energy power plants, upgrading the roads and metro infrastructure, building the new administrative capital, and north coast holiday and tourism cities. Therefore, evaluating the performance of such large-scale projects needs a standard benchmark to ensure sustainable growth of the industry. The construction sector represents almost 5% of the Egyptian Gross Domestic Product (GDP) and employs about 8% of the Egyptian working force (Ghonamy & El-Mikawi, 2018). Egypt's average GDP from construction has been calculated as 23,047.06 EGP Million from the period 2007 to 2018, and reaching the highest amount of 59,846.30 EGP Million recorded in the fourth quarter of 2018, according to statistics from the Ministry of Planning (Trading Economics, 2019). However, one of the main problems facing construction in Egypt is the lack of controlling tools to measure projects' performance and the overall company performance (Ghonamy & El-Mikawi, 2018). Over the past years, research proved that the traditional ways to measure projects' performance are insufficient. For example, cost and time overruns are proved not to be the only indicators that can measure project success. Therefore, a standard benchmark and indicators need to be identified to enable measuring the performance of the projects using most critcal Key Performance Indicators (KPIs).

II. BACKGROUND

The UK construction industry was the pioneer in the revaluation of construction performance using KPIs. In the 1990s, the UK government commissioned two major reports: "Constructing the Team" Latham, M. (1994). and "Rethinking Construction" Egan, J (1998). Both reports led to understand the need for improvements within the industry. It led to the development of metrics and parameters by which the industry performance could be measured and improved. According to

Cox et al. (2003), key performance indicators are compilations of the data metrics used to determine a construction operation's performance. Ishaq Bhatti & Awan (2014) defined the key indicators as the physical values used to measure, compare, and control the overall organizational performance. Evaluating project success is a valuable tool for the construction industry in efforts to manage, control, and improve policies and to anticipate future project success.

According to the UK industry performance report (2018), KPIs have been considered essential for the construction industry. They allow firms to evaluate their performance against industry benchmarks and identify target areas for improvement to enhance performance. As a result, the construction industry uses these KPIs to boost customer satisfaction and increase profitability significantly. There are two kinds of KPIs; primary and secondary. The primary indicators used are: Cost, Time, and Quality indices. Many other secondary indices are not usually used in assessing projects such as: Delivery Reliability Index (Ishaq Bhatti & Awan, 2014) ; Innovation and improvement and improvement indices (Yeung et al., 2013), (Martens & Carvalho, 2016), and (Rankin er al. 2009); Billing indexes (Ishaq Bhatti & Awan, 2014) and (Nassar & Abourizk, 2014); Safety (Leon et al., 2018), (Nasser and Abourizk 2014) and (Ishaq Bhatti & Awan, 2014); Environmental (Leon et al., 2018) and Stockholder management (Martens & Carvalho, 2016).

Chan et al. (2002) confirmed that Cost and Time are not enough for benchmarking in the construction industry and many other factors should be considered that may include: Time, Cost, Health and safety, Quality, Profitability, Functionality, Satisfaction, Environmental sustainability, Productivity, and the Technical performance. Chan & Chan (2004) aimed to assist project managers in controlling construction projects by developing a project performance and monitoring system. To achieve that, eight indicators were identified: Cost, Time, Quality, Safety and Health, Environment, Client satisfaction, and Communication project performance measurements. An overall Project Index is then determined based on the values of these indicators. In another research to evaluate construction projects in Chile, Alarco & Ramı (2004) identified these indicators for evaluation: Time, Cost, Safety, Labor productivity, Effectiveness of the planning, Procurement, Quality, Scope and Subcontractor' indicators.

On the other hand, Yeung et al. (2013) conducted a survey to choose the most critical indictors from a list of 20 indicators. The results showed nine indicators: cost performance, project team satisfaction, environmental performance, the effectiveness of planning, time performance, client satisfaction, functionality, the point of communication and leading measure, safety performance and quality performance. Then by using the Reliability Interval Method (RIM) to assign weight for each indicator, the most weighted indicators were: Cost, Time, and Safety. In another research, Bhuinyan et al. (2019) defined the most critical factors for evaluating project success based on a 5-scale Rate of Importance which resulted in: client satisfaction, productivity, time prediction, cost prediction, risk management, quality, safety, handling, and management.

In turkey, Gündüz et al. (2013) searched the factors that affect cost and time overrun. The factors were classified in relation to: contractor, owner, consultant, design, material, equipment, external, labor, material, owner, and project-related factors. Each factor has had sub-factors affecting it. A Relative Importance Index (RII) was used to define the relative importance of the different causes of delays. Rooshdi et al. (2018) also used a RII to identify factors for successful sustainable design and construction activities for green highway projects. The results showed that design to reduce the urban heat island was the most critical factor for sustainable design followed by providing a site maintenance plan to maintain the environmental quality and aesthetics of the roadway project.

In Egypt, limited research have focused on assessing project performance or KPIs. There is also research focused only on studying specific performance measures in projects. For example, Hafez et al. (2014) focused only on factors that affect labor productivity which were identified as: delay of payment and lack of labor supervision. To improve the performance of construction projects, Elhamid & Ghareeb (2011) used a RII to conclude that 'customer satisfaction and leadership' are among the top factors to improve project performance. In road construction, Aziz & Abdel-hakam (2016) used a RII to rate 293 causes of delay factors in order to define the most critical factors in road delays. El-Maaty et al. (2016) aimed to classify factors that affect the performance of highway projects in Egypt. For such purpose, a survey was conducted and 39 factors were identified and divided into three primary groups. The effective degree of each was determined using a Fuzzing Triangle Approach. Results showed that the most important and influential factors for highway construction projects are: (1) availability of experienced staff in the owner's and contractor's teams during the project execution, (2) efficiency of the owner's inspection team, (3) clarity of responsibilities and roles for each owner, consultant, and contractor. Dziekoński et al. (2018) studied six KPIs and found that there are differences in results among these indicators due to factors such as company size. For example, the time index was much more critical for small companies than for large ones. Similarly Aziz

& Abdel-hakam (2016) used RII to analyze the performance and causes of delays in road construction. As a result, 293 delay factors divided into 15 categories were identified and the most critical factors were: owner financial problems-client finance- the financial ability for the project- Shortage in equipment - insufficient numbers and bad contractor experience causing the error. Marzouk (2017) surveyed 35 indicators collected from previous research to identify the most critical performance indicators affecting construction projects in Egypt. The RII determined for these indicators showed that: Cost, Quality, Time, Productivity, Safety, Client's satisfaction and Effectiveness of cost control are the top critical indicators. An overall project indicator was then determined from these identified indicators. Ghonamy & El-Mikawi (2018) used a survey result to confirm that: Cost, Time, Quality, Safety, Cash flow and Customer satisfaction are the most effective indicators to benchmark construction industry performance.

While a number of indicators have been identified to assess construction performance in Egypt, a standard benchmark to measure performance considering the variation in ranking these indicators is missing. This standard is key to reflect the various views of project teams when determining project success. Therefore, this paper aims to identify the most critical KPIs to measure performance of construction projects in Egypt as the first step to develop a standard benchmark for construction industry performance considering variation in indicators ranking.

III. RESEARCH METHODOLOGY

A. Initial data collection

A thorough literature review has been conducted which helped in the identification of a list of common KPIs used in the construction industry. Table 1 shows the list of the identified KPIs as essential indicators that affect project evaluation.

Table 1: Common Key Performance Indicators used in the Construction Industry

Indicator	Description
Cost	is a measure of the financial effectiveness and efficiency of a project; it represents the amount of completed work for every unit of charge spent
Time	shows how you are progressing compared to the planned project schedule
Safety	The measure of the number of accidents and fatalities on the project
Client satisfaction	Measure how much the client is satisfied with contractor work
Team satisfaction	For which degree your team is satisfied form the project (salaries- number of working hours)?
Scope	how correct is the scope management of a specific project?
Productivity	Did the workers perform the work required of him at the time specified previously?
Profitability	The amount of money gained from the project (net profit)
Innovation	New techniques are used or new project kind
Quality	Measure quality improvements from the start of a project
Environmental	Did the project affect badly on the environment?
Sustainability	The ability of an organization to continue its mission or program Far into the future

B. Primary data collection

A questionnaire survey was then conducted to verify this collected data within the Egyptian industry to establish the most significant key performance indicators for construction projects. Professionals contacted included: architects, structural engineers, civil engineers, construction managers, project managers, construction project manager, quantity surveyors, electrical engineers, and mechanical engineers. The respondents expressed their opinion on the importance level of each indicator on a five-point Likert scale ranged from 1 (very low important) to 5 (very high important).

The survey was carried out from December 2020 to April 2021. Offline and online surveys were used targeting experts from all over Egypt and covered professionals working in key national projects such as the new Mansoura city and the new administrative capital. In total, 160 were distributed and 112 responses were collected from private and public sectors (a response rate of 70%). For certain experts, 40 interviews were conducted to get further information about assessing projects performance.

IV. DATA ANALYSIS

A. Respondents Profiles

The respondents have years in experience from 1 to 38 years, with an average of 6.3 years. The respondent's experience level was a key factor that influenced their opinion on the most important KPIs. The respondent's experience level was classified into four categories as shown in Figure 1 (in Numbers, and in Percentages to the total number of responses).

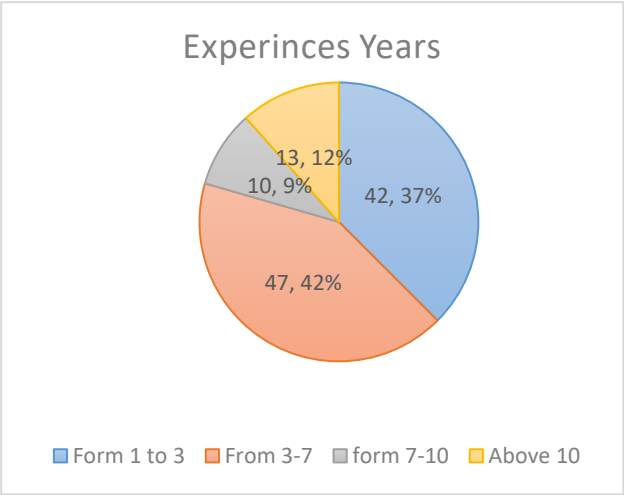

Figure 1:Years of experiences of the respondents

B. The respondents' feedback

The feedback from the respondents have been analyzed and the Relative Importance Index technique was used for ranking the KPIs. The five-point Likert scale ranging from 1 (very low important) to 5 (very high important) was adopted and transformed to Relative Importance Indices (RII) for each factor as shown by Eq. 1.

$$RII = \frac{\sum W}{AN} \qquad \text{Eq. 1}$$

Where:

W is the weighting given to each indicator by the respondents (ranging from 1 to 5),

A is the highest weight (i.e., 5 in this case), and

N is the total number of respondents.

The RII value has a range from 0 to 1 (0 not inclusive) and has been categorized into five levels of importance as shown in Table 2.

Table 2: Relative Importance Index values

RII value	**Importance level**	
From 0.8 to 1	High	**(H)**
From 0.6 to 0.8	High-Medium	**(H-M)**
From 0.4 to 0.6	Medium	**(M)**
From 0.2 to 0.4	Medium-Low	**(M-L)**
From 0 to 0.2	Low	**(L)**

for determining the reliability of the scale used to measure the construct of interest, the reliability estimate for items on a Likert scale is calculated using the reliability method known as Cronbach Alpha. Cronbach alpha coefficient is weighted standard variations mean, obtained by dividing the total of the k items in the scale by the general variance as shown in Eq 2. Table 3 shows the reliability level of acceptance for Cronbach alpha coefficient and Table 4 shows that the results of this analysis.

$$A = \left[\frac{K}{K-1}\right] * \left[\frac{\sum S^2Y}{\sum S^2X}\right] \quad \text{Eq. 2}$$

K: Number of items

S^2Y: Sum of Items Variances

S^2X: Total Variances of the total score

Table 3: Coefficient of Cronbach's alpha and its reliability level

No.	Coefficient of Cronbach's Alpha	Reliability Level
1	More than 0.90	Excellent
2	0.80-0.89	Good
3	0.70-0.79	Acceptable
4	0.6-.69	Questionable
5	0.5-0.59	Poor
6	Less than 0.5	Unacceptable

Table 4: Cronbach alpha result

Variables	Values	Internal consistency
K	12	
S^2Y	7.748883929	
S^2X	24.12883	***Acceptable***
α	**0.74056765**	

C. RII and reliability analysis test

The Relative Importance Index (RII) was calculated for the most critical key performance indicators. Table 5 shows the values of RII and the ranking of each indicator.

Table 5: Ranking KPI by RII

		Respondent scores						
		1	2	3	4	5		
NO	Key performance indicators	very low	low	moderate	high	very high	RII	Rank
1	Cost	0	0	0	27	85	0.952	1
2	Time	0	0	2	38	72	0.925	3
3	Safety	0	1	22	52	37	0.823	6
4	Quality	0	0	3	48	61	0.904	4
5	Productivity	0	4	34	49	25	0.77	7
6	Profitability	0	0	4	26	82	0.939	2
7	Innovation	22	32	43	9	6	0.502	10
8	Environmental	12	40	48	10	2	0.511	11
9	Sustainability	22	36	38	10	6	0.496	12
10	Client satisfaction	0	3	17	50	42	0.836	5
11	Team satisfaction	2	16	44	38	12	0.675	8
12	Scope	18	38	41	9	6	0.505	9

V. CONCLUSION

A standard performance benchmark indicators to assess projects' success is required for the Egyptian construction industry. This paper aimed to identify the most critical Key Performance Indicators (KPIs) and determine their Relative Importance Index. The methodology included a thorough literature review and a survey on projects performance among construction professionals in Egypt. The analysis of the survey results showed an acceptable reliability with a level of 0.74 The survey results show that the most critical KPIs are: Cost, Profitability, Time, Quality, Client satisfaction, Safety, Productivity, and

Team satisfaction. The study results are considered a first step to develop a standard performance benchmark that considers the variation of ranking indicators by various project teams. This can be used to assess projects success for the benefit of all project parties. The proposed standard benchmark can help construction professionals in managing, controlling, and improving projects and in estimating future projects performance.

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