Proceedings of International Structural Engineering and Construction, 9(2), 2022
Achieving Technical Excellence with Data Analytics
in Materials, Structural Engineering and Construction
Edited by Vimonsatit, S., Askarinejad, H., Singh, A., and Yazdani, S.

ISSN: 2644-108X
www.doi.org/10.14455/ISEC.2022.9(2).CON-12

USING KEY PERFORMANCE INDICATORS IN CONSTRUCTION PROJECT LITERATURE

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Key performance indicators (KPIs) are one of the prominent concepts used for performance measurement, which is an integral part of project management. KPIs are widely and effectively used to monitor, measure, and evaluate the performance and production of project management team in the construction industry. It is therefore necessary for construction projects to complete the project in the budget, time, quality, safety, and satisfaction specified in the contract. This paper provides a review to explore KPIs used in construction project management to measure the performance of construction projects. A comprehensive review was performed to compile KPIs proposed by relevant studies from the Scopus database. Based on the comprehensive literature review, performance of cost, time/schedule and quality, client satisfaction, and effective communication were identified as the most important KPIs in the construction project management domain. Overall, this study presents insights into KPIs and can give an idea to identify trends of KPIs, which is of great importance for the construction project management in terms of effectiveness, efficiency, and quality.

Keywords: Construction management, Journal, Article, Performance measurement, Project management.

1 INTRODUCTION

The construction industry is a challenging and dynamic industry (Rehman *et al*. 2020) and the way construction projects are management varies each day due to the utilization of new technologies and innovative solutions (Dawood 2010). In spite of the advancements in technology and innovation for construction companies to keep up with the competition, the construction industry has contended chronic performance issues such as delays, cost overrun, and quality defects (Enshassi *et al*. 2012, Rathnayake and Ranasinghe 2020). Therefore, performance measurement of construction projects can be an effective and better way of boosting the performance in the construction industry. In this regard, key performance indicators (KPIs) have widely been used to evaluate the performance of construction projects, since vital statistics provided by KPIs are of a great benefit in reflecting the quality of outputs and outcomes of a project (He *et al*. 2021). KPIs are not universal; and thus, can change from organization to organization (Dwivedi and Madaan 2020).

In the construction management literature, many researchers have widely used both qualitative and quantitative KPIs to evaluate the performance of projects. Bingol and Polat (2017), for instance, developed KPIs to measure the managerial capabilities of subcontractors. Cox *et al*. (2003) and Yeung *et al*. (2012) identified KPIs for the construction industry to measure

performance and monitor productivity during construction phase. He *et al*. (2021) proposed a list of KPIs specific for mega construction projects, and determined 23 key indicators and grouped them into five categories. Dawood and Sikka (2009) developed nine KPIs for 4D-based performance measurements within the construction industry by focusing on project stages, while Mahmoud *et al*. (2020) identified KPIs indicating safety performance in the construction industry. Madushika *et al*. (2020) listed suitable KPIs for value management according to value management techniques. Similarly, Lin *et al*. (2011) explored KPIs of value management and divided them into three groups such as predicting indicators, process performance indicators, and outcome performance indicators.

The purpose of this study is to explore KPIs used in the construction industry to measure the performance of construction projects. To achieve this purpose, Scopus database was utilized to show trends in KPIs adopted in the construction industry. The reviewed papers were investigated based on journal name, publication year, adopted KPIs, and main categories of KPIs. In addition, the interactions of the most widely used KPIs with each other were discussed.

2 METHODOLOGY

The search engine Scopus was used to achieve the study objective and 190 articles were identified using the following search code: TITLE-ABS-KEY ("kpi*" OR "key performance indicator*") AND TITLE-ABS-KEY ("construction"), and additional filtering (only research articles and only English-written articles). After a detailed review of each article's title, keywords, and abstract, 55 relevant articles were determined. The selected 55 research papers were investigated on a full-paper basis and 21 articles suitable to this research were found for further analysis. The flowchart of the research steps adopted in this study is illustrated in Figure 1.

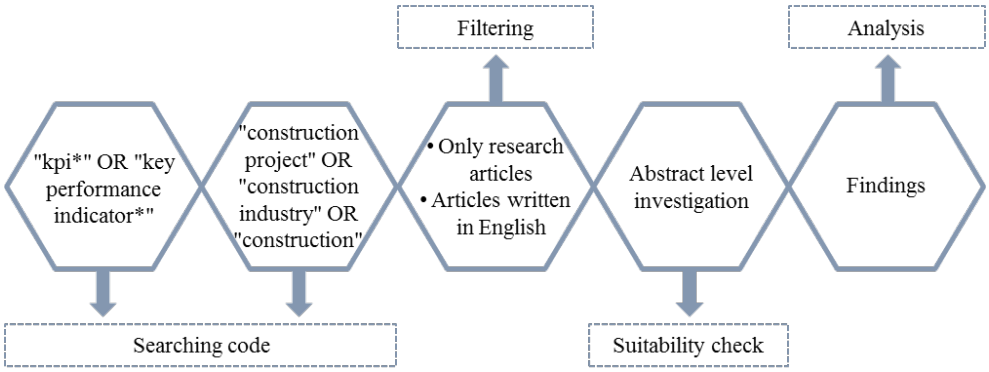

Figure 1. Research flowchart.

3 RESULTS AND DISCUSSIONS

The articles identified through literature review were analyzed based on the adopted KPIs, main categories of these KPIs, year of the publications and journal names. This study identified main categories that grouped different KPIs for assessing the selected articles related to construction projects (Figure 2). The list of project KPIs of the studies is given in Table 1. The findings indicate that cost performance and schedule/time performance were the most widely used indicators with 15 publications, followed by quality/high quality performance and client satisfaction with 12 publications. It is noteworthy that the 15 publications that adopted the cost performance indicator also considered the schedule/time performance indicator since these indicators could be considered

in parallel for performance measurement (Cox *et al*. 2003). The KPIs developed are mostly based on time, cost and quality indicators (Tuffaha *et al*. 2020), therefore, they can be regarded as the main performance indicators of projects. Additionally, other KPIs such as staff turnover, rework, and inefficient project planning can directly or indirectly increase overall project cost (Cox *et al*. 2003). On the other hand, the satisfaction of the project stakeholders, especially the client satisfaction, which is one of the significant critical success factors (He *et al*. 2021), should also be considered as another important indicator. Among those KPIs presented in Table 1, communication efficiency and open communication play a crucial role in sustaining project success (Forcada *et al*. 2017); thus, increasing the effectiveness of communication could greatly reduce the occurrence of claim, dispute and litigation (Yeung *et al*. 2007).

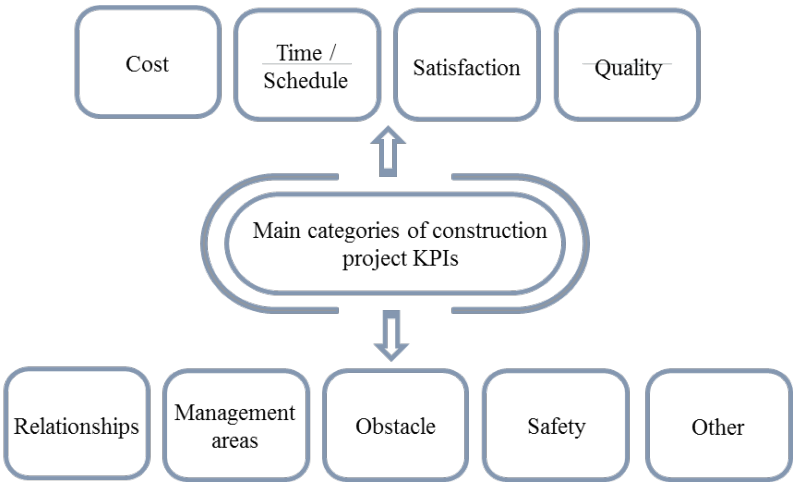

Figure 2. Categorizing KPIs in selected articles.

Figure 3. Distribution of selected articles based on publication year.

Table 1. Numeric distribution of KPIs in the selected articles related to construction project.

Categories	KPIs	Number of studies
Indicators related to cost	Cost performance	15
	Cost predictability	4
	Project cost growth	3
	Change cost factor	2
	Project budget factor	2
Indicators related to time/schedule	Schedule/time performance	15
	Time predictability	4
	Project schedule growth	1
Indicators related to quality	Quality/high quality performance	12
	Rework	10
	Defects and quality errors	6
Indicators related to satisfaction	Client satisfaction	12
	User satisfaction	4
	Project team satisfaction	3
	Contractor satisfaction	1
Indicators related to safety	Safety performance/accident rate	11
	Lost time rate	1
Indicators related to management areas	Efficiency quality management system	2
	Effective risk management	1
	Effectiveness of material management and resource management	1
	Management of internal and external stakeholders	1
Indicators related to relationships	Communication efficiency / effective information management	11
	Harmonious working relationships	2
	Long-term business relationships	2
Indicators related to obstacles	Claim occurrence	3
	Dispute occurrence	2
	Litigation occurrence	2
Other indicators	Productivity performance	9
	Innovation and improvement	5
	Profitability and financial objectives	5
	Effective of planning	3
	Top management support	3
	Environmental performance	2
	Attitude of employees	2
	Professional image establishment	2
	Staff turnover	1

The distribution of the 21 articles published between 2003 and 2022 is shown in Figure 3, and the highest number of publications was reached in 2020. Table 2 presents top five journals that published the included articles. Accordingly, the results show that about 72% of the articles published in five of the journals as *Engineering, Construction and Architectural Management* (4 studies), *Construction Management and Economics* (3 studies), *Journal of Construction Engineering and Management* (3 studies), *Journal of Management in Engineering* (3 studies) and *International Journal of Construction Management* (2 studies).

Table 2. Top five journals about the subject.

Journals	Number of studies
Engineering, Construction and Architectural Management	4
Construction Management and Economics	3
Journal of Construction Engineering and Management	3
Journal of Management in Engineering	3
International Journal of Construction Management	2

4 CONCLUSION

KPIs of construction projects are essential for more effective performance and productivity measurement. This study is an attempt to figure out the trend of KPIs in terms of effectiveness, efficiency, and quality to monitor, measure and evaluate the performance of construction projects. The findings highlight that cost and time related KPIs were generally more relevant indicators in the pertinent literature. In addition, KPIs of construction projects such as risk management, resource management, staff turnover and working relationships can be considered by researchers as they can affect other indicators. Identified KPIs adopted in the existing construction project management literature is expected to contribute to the enhancement of project performance, which can be used by researchers and practitioners in the construction industry.

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