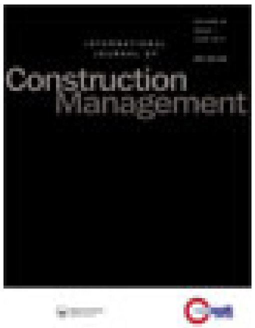

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Evaluating performance of construction organizations using fuzzy preference relation technique

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ABSTRACT

Evaluating the performance of construction organizations is of vital importance for their continuous improvement and long-term survival. Performance measurement enables organizations to compare their performance with that of others to remain competitive in the business. Consequently, identification and evaluation of relevant performance measurement factors is an important research agenda. Although performance measurement at the level of projects has been studied in depth, it has not been investigated properly at the level of organization. In an earlier study , the authors had identified 20 performance attributes based on existing literature and grouped them under six performance factors (PFs): *profitability and asset management; satisfaction of key stakeholders; predictability of cost and time; environment, health and safety (EHS); quality consciousness* and *staff turnover*. The present study uses consistent fuzzy preference relation (CFPR) to determine the relative weights of these factors and associated performance measurement attributes. The findings indicate that the satisfaction of the key stakeholders is the most important performance measurement factor whereas, staff turnover is the least important factor for performance evaluation. Based on the findings, a user-interface in the form of a user-friendly software has been developed. The interface will help construction organizations in assessing and improving their performance to remain competitive in a highly competitive business environment.

KEYWORDS

Performance attributes; performance factors; construction organizations; factor analysis; consistent fuzzy preference relation; questionnaire survey

Introduction

The construction industry makes significant contributions to both the economy and employment. However, it is often criticized for its low productivity and underperformance (Kagioglou et al. 2001). Because of dynamic and highly competitive construction environment, construction organizations often face uncertainties in terms of technological development, finance, development processes, regulations and profit margins (Lingard and Francis 2004; Gudiene et al. 2013). As a result, the chances of failure of companies are quite higher in the construction business (El-Mashaleh et al. 2007; Gudiene et al. 2013). In the recent past, the performances of the construction organizations have not been up to the mark. The organizations which used to be respected have also either failed or are on the verge of being declared bankrupt. In addition, the construction organizations in some countries now face strong competition and difficulties in maintaining a long-term profitable position due to the presence of new foreign competitors in the market (Rivas et al. 2011). Considering the high risks of failure, assessing the performance of construction organizations is essential to make continuous improvements and thereby to ensure their survival in the challenging global economic conditions. Against this background, the present study focuses on the performance measurement of a construction organization.

Performance measurement is a process of collecting and reporting information about the inputs, efficiency and effectiveness of an organization (Tripathi and Jha 2018a). It is also defined as the process of determining how successful an organization has been in attaining its objectives and strategies (Kagioglou et al. 2001). It is important that construction organizations understand and respond to the needs of the stakeholders in a better way to develop long-term relations and maintain their competitiveness (Kaplan and Norton 1996; Love and Holt 2000). Because of different priorities, performance measurement

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parameters could be different for different stakeholders. For example, for one stakeholder, achieving high profit could be the only yardstick to measure performance while for the other, customer satisfaction may hold the top priority. Therefore, judging the performance of a construction organization in terms of only annual turnover or profit without acknowledging the perceptions of different stakeholders may have little practical significance nowadays (Tripathi and Jha 2018a).

An effective performance measurement framework could help construction organizations in achieving their long-term objectives and the strategic view. Although there are many performance factors which can measure the performance, the construction organizations usually find it difficult to concentrate on many factors at a given time. Previous researchers have mainly focussed on the identification of various performance indicators such as schedule, cost, quality and dispute at the project level (Jha and Chockalingam 2011). In contrast, very few studies have investigated the performance measurement of construction organizations, particularly in the context of developing countries. Consequently, it necessitates the identification of the most relevant performance factors for measuring the performance of construction organizations.

Literature review

Performance measurement has drawn the enormous attention of both academicians and practitioners during the last two decades due to its significance in organizational planning and control (Tsolas 2011). Traditionally, researchers and practitioners have focussed primarily on direct financial parameters such as profit, turnover, return on investment, and sales per employee for the performance measurement of an organization (Tripathi and Jha 2018a). However, this approach has been criticized by many researchers due to some underlying shortcomings, such as over-reliance on financial parameters and its inability to reflect the stakeholder's interest (Kaplan and Norton 1996; Clarke and Clegg 1999). Moreover, the financial terms can measure only the past performance of the organizations to a certain extent; they do not consider the process through which the performance was achieved (Kagioglou et al. 2001; Kim and Arditi 2010). Bassioni et al. (2004) found that top management is mainly concerned about the current and mostly non-financial parameters to take better decisions. Performance measurement in financial terms alone cannot help the organization to cope with the dynamic nature of the construction industry due to continuous advancement in technology, increased focus on sustainability, more attention to customers' expectations and satisfaction and tougher competition in the business (Love and Holt 2000; Isik 2009). Because of these shortcomings, non-financial parameters were later introduced to develop more accurate performance measurement frameworks (Ali et al. 2013).

Non-financial parameters such as customer satisfaction and loyalty, process quality and employee motivation are considered as the leading indicators of financial performance. Any improvements in these non-financial parameters may lead to a better financial performance of the organization. While financial measures indicate the impact of organization's strategy implementation on shareholder's value, non-financial measures show organization's capabilities with the customers, processes, employees and systems for growth and profitability (Paulson Gjerde and Hughes 2007). The concept of a Key Performance Indicator (KPI) is often used to monitor both financial and non-financial performance parameters of an organization in a more systematic manner.

KPIs is one of the many terms such as Performance Measures (PMs), Performance Metrics (PMCs), Performance Indicator (PIs) etc. frequently used in the performance management field. Different researchers have used these terms differently with varying and overlapping meanings (Barr 2014). As per Morrison (2009), KPIs are the financial and non-financial measure used to help an organization measure progress towards a stated organizational goal or objective. Whereas, Parmenter (2010) defined KPIs as a set of measures focussing on those aspects of organizational performance that are the most critical for the current and future success of the organization. On the other hand, PIs are non-financial parameters generally tied to specific activities or teams. Thus, PIs complement the KPIs and are evaluated on a short-term basis i.e. daily, weekly, monthly, or quarterly basis (Star et al. 2016). Similarly, PMs are different from KPIs and PIs. PMs are more precise than indicators and they help in quantifying the efficiency and effectiveness of particular aspects of organizational performance (Mbugua et al. 1999). However, in most cases of performance measurement, it is not practical to obtain an accurate measurement and thus, performance indicators are usually referred. In short, PMs or PIs are used to track performance and progress of a specific process of the organization not the overall performance of the organization. Hence, all

PMs or PIs are PMCs, but not all PMCs are PMs or PIs (Bibey 2017). In the current study, the term performance attributes/factors are synonymous to KPIs because the latter includes both financial and non-financial performance measurement parameters.

For evaluating the performance of an organization, the identification of proper KPIs which include the key financial and non-financial parameters is considered an essential task in developing a robust performance measurement framework (Lin et al. 2011). The review of existing literature shows that various conceptual and theoretical frameworks have been proposed to quantify, manage and compare the performance of the construction organizations. The following paragraphs briefly discuss the relevant studies on performance factors by previous researchers.

Mbugua et al. (1999) introduced non-financial measures such as leadership, management, customer's satisfaction, human resources, and impact on society whereas, Kagioglou et al. (2001) added two valuable perspectives, of the project and supplier, in their proposed performance management framework based on the balanced scorecard. Cox et al. (2003) correlated quantitative and qualitative performance indicators to determine the most extensively used indicators for measuring construction performance and found that cost, on-time completion, quality control, safety and productivity are highly significant performance indicators. However, many important corporate-level indicators such as the financial standing of the organization, market condition and relationship with external agencies were not considered in their study. Tang and Ogunlana (2003) modelled the dynamic performance of construction organizations in Malaysia based on interactions between the construction market and the organization's financial, technical and managerial capabilities.

Considering the project-oriented nature of the construction industry, Yu et al. (2007) presented an implementation model to compare the performance of the construction organizations using an integrated method to measure the performance of both projects and the organization simultaneously. Skibniewski and Ghosh (2009) also identified company-level performance indicators (e.g. profitability) in addition to project performance indicators (e.g. construction cost) in the context of the United States (US). In contrast, the study performed by Horta et al. (2010) was purely at the organization level. The indicators used in their study were mainly organizational performance indicators (e.g. profitability, productivity and hanging invoice) and operations performance indicators (e.g. contractor satisfaction and cost predictability).

Bassioni et al. (2004, 2005) developed frameworks using balance scorecard and business excellence model to measure the performance of the construction organizations in the United Kingdom (UK). These frameworks included both performance driving factors (e.g. resource management, leadership and work culture etc.), and performance result factors (e.g. customer, people and society result etc.). Based on data collected from the Egyptian construction companies, Elyamany et al. (2007) used financial ratio, economic factors and industrial factors as inputs in their performance evaluation model which also considered the effect of the size of the organization on performance evaluation. El-Mashaleh et al. (2007) developed a benchmarking model to determine the criticality of the performance measures in the overall success of the construction firms and to identify particular areas for improvement.

From the above literature review, it can be seen that previous researchers have adopted different approaches to examine the performance of construction organizations. However, many important parameters such as environment, health and safety, and employee satisfaction have been largely ignored in previous studies (Lai and Lam 2010; Jha and Chockalingam 2011). Moreover, most of the studies are based on the opinion of contractors only. For the long-term survival of a construction organization, its performance should be evaluated from the perspectives of other major stakeholders as well. Furthermore, in comparison to developed countries such as USA and UK, only a few studies have focussed on developing countries. To address these gaps in the body of knowledge, this study presents a more holistic approach to performance measurement by including the perspectives of other stakeholders such as the clients and project management consultants, in addition to contractors. Moreover, it attempts to assign a relative weight to each performance factor to establish their importance in the performance measurement of construction organizations.

Research method

Multi-Criteria Decision-Making (MCDM) approach is used to identify an optimal alternative for a given set of competing for objectives (Saaty 1980; Fong and Choi 2000). There are different mathematical methods available under the umbrella of MCDM. The Analytical Hierarchy Process (AHP), proposed by Saaty, is one of the most prevalent methods used in MCDM processes using the pairwise comparison of alternatives based on expert's opinion (Fong and Choi 2000). The AHP decomposes a multi-criteria decision problem into a hierarchical structure consisting of a goal, criteria, sub-criteria and alternatives (Saaty 1980; Tan and Ghazali 2011). The decision maker can easily model a complex problem into a hierarchical structure consisting of a goal, criteria, sub-criteria and alternatives (Tan and Ghazali 2011). The advantage of using AHP is that it allows qualitative as well as quantitative evaluation. Consequently, the objective of obtaining relative weights of different performance factors was achieved through the construction of an AHP model. The AHP technique allows subjective as well as objective factors to be considered in the analysis and provides a flexible and easily understood way to analyze subjective performance factors (Mustafa and Al-Bahar 1991). The overall research method is explained in the following paragraphs.

First of all, the authors identified 20 performance attributes based on existing literature in their earlier study (Tripathi and Jha 2018a). These performance attributes have been shown in Table 1. These attributes were reviewed by three industry experts to establish their suitability in the Indian context. These experts held senior management positions in their organizations. Subsequently, a questionnaire was designed based on 20 performance attributes and its wordings and understanding were tested by another group of three senior construction professionals, each having more than three decades of experience. Based on their feedback, the layout and presentation of the questionnaire were modified to improve its quality and interpretation (Enshassi et al. 2013).

Table 2 shows an extract of the questionnaire of stage 1. The respondents were asked to indicate the importance of attributes for performance measurement of construction organizations using a five-point Likert scale where '1' indicated *very low importance* and '5' indicated *very high importance*. The five-point Likert scale has been widely used in determining various performance factors of construction organizations (Luu et al. 2008; Radujković et al. 2010; Ali et al. 2013). A total of 106 construction professionals from 90 different construction organizations, operating across different states in India, participated in the survey. The population selected for the study consisted of 209 members of Confederation of Real Estate Developers Association of India (CREDAI) and 154 members of Builders Association of India (BAI). The members of the CREDAI are largely real estate developers, and the members of the BAI are contractors. The size of the organizations ranged from medium to large. In addition to the members of CREDAI and BAI, few other professionals who possessed high experience in the Indian construction industry were also invited to participate in this study.

A total of 106 complete questionnaire responses were received via email (29 responses) and personal interviews (77 responses). The demographics of the respondents in terms of their professional experience and role is shown in Table 3. The age of the participating construction organizations in the survey varied from five years to over 30 years.

The mean values of performance attributes were calculated. Only the performance attributes having mean values 3.5 and above were considered as the purpose of the study was to identify the most relevant performance factors for measuring the performance of a construction organization. One sample t-test was performed to test the statistical significance of the attributes at the mean value 3.5. Finally, 17 performance attributes (A2-A7, A9-A16, A18-A20) were selected for further analysis. However, it would be quite difficult to utilize all the 17 performance attributes at a time for measuring the performance of a construction organization. Therefore, exploratory factor analysis was carried out on these 17 attributes so that the number of attributes could be reduced into a manageable number of factors. The factors were extracted by principal components method of extraction by specifying the minimum initial eigenvalue of 1.0. As the sample size in this study was 106, the attributes with a factor loading of more than 0.5 were retained (Hair et al. 2010). The Kaiser Meyer Olkin (KMO) was 0.793 (> 0.5), which indicates that the sample was adequate for factor analysis (Field 2009). The probability associated with Bartlett's test of sphericity was 0.001, which is less than the significance level of 0.05. Six performance factors extracted using varimax rotation are *(1) profitability and asset management (F1), (2) satisfaction of key stakeholders (F2), (3) predictability of cost and time (F3), (4) environment, health and safety (F4), (5) quality consciousness (F5)* and *(6) staff turnover (F6)* (Tripathi and Jha 2018a). The results of factor analysis are shown in Table 4.

The reliability of data for the application of factor analysis was checked by Cronbach's alpha ($C\alpha$) test. It is most widely used reliability test which measures the internal consistency within the variables which is based on the average correlation among them and

Table 1. List of performance attributes and their sources.

Sl. no.	Performance attributes	Attribute's Id	Sources
1	Size of the organization (measured in terms of turnover, market share, number of employees, etc.)	A1	Mbugua et al. (1999), Chan (2009)
2	Productivity of employees (value added per employee)	A2	Mbugua et al. (1999), Cox et al. (2003), Chan (2009), Skibniewski and Ghosh (2009), Horta et al. (2010), Rimbalova and Vilcekova (2013), Yu et al. (2007), Kagioglou et al. (2001), Bassioni et al. (2004)
3	Good track record of timely completion of the projects (number of projects completed in time)	A3	Cox et al. (2003), Chan (2009), Luu et al. (2008), Skibniewski and Ghosh (2009), Rimbalova and Vilcekova (2013), Menches and Hanna (2006), Kagioglou et al. (2001), Bassioni et al. (2004)
4	Health and safety consciousness (number of accidents/100,000/year and worker's fatality/100,000 workers)	A4	Cox et al. (2003), Chan (2009), Luu et al. (2008), Skibniewski and Ghosh (2009), Horta et al. (2010), Rimbalova and Vilcekova (2013), Menches and Hanna (2006), Kagioglou et al. (2001), Bassioni et al. (2004)
5	Customer satisfaction in terms of product and services (measured as rating provided by the customers after project completion)	A5	Mbugua et al. (1999), Luu et al. (2008), Rimbalova and Vilcekova (2013), Menches and Hanna (2006)
6	Client satisfaction in terms of product and services (measured as rating provided by the client after project completion)	A6	Chan (2009), Skibniewski and Ghosh (2009), Rimbalova and Vilcekova (2013), Kagioglou et al. (2001), Bassioni et al. (2004)
7	Cost performance of projects (% of projects completed within the tender cost)	A7	Cox et al. (2003), Luu et al. (2008), Skibniewski and Ghosh (2009), Menches and Hanna (2006), Kagioglou et al. (2001), Bassioni et al. (2004)
8	Impact on society (measured in terms of low noise pollution, less disturbance to the occupants in nearby area due to vehicle movement, etc.)	A8	Mbugua et al. (1999), Rimbalova and Vilcekova (2013)
9	Impact on environment (measured in terms of use of low natural resources, low production of waste, preservation of plants and trees, etc.)	A9	Rimbalova and Vilcekova (2013)
10	Optimum liquidity ratio (measured in terms of current ratio = current asset/current liability)	A10	Mbugua et al. (1999), Elyamany et al. (2007), Balatbat et al. (2010)
11	Higher profitability ratio (measured in terms of gross profit margin, return on assets (ROA), return on equity (ROE), return on invested capital (ROIC))	A11	Mbugua et al. (1999), Chan (2009), Luu et al. (2008), Skibniewski and Ghosh (2009), Horta et al. (2010), Rimbalova and Vilcekova (2013), Yu et al. (2007), Menches and Hanna (2006), Balatbat et al. (2010), Kagioglou et al. (2001) Bassioni et al. (2004)
12	Higher annual growth rate of the organization (measured in terms of sales growth %, EPS (Earning per share), growth %, P/E ratio))	A12	Mbugua et al. (1999), Chan (2009), Luu et al. (2008), Horta et al. (2010), Yu et al. (2007), Balatbat et al. (2010)
13	Predictability of cost in construction (Predictability of cost measures the change between the actual construction cost and the estimated construction cost, and expressed as a percentage of the actual construction cost)	A13	Chan (2009), Skibniewski and Ghosh (2009), Horta et al. (2010), Rimbalova and Vilcekova (2013), Kagioglou et al. (2001), Bassioni et al. (2004)
14	Predictability of time in construction (Predictability of time measures the change between the actual construction time and the estimated construction time, and expressed as a percentage of the actual construction time).	A14	Chan (2009), Skibniewski and Ghosh (2009), Rimbalova and Vilcekova (2013), Kagioglou et al. (2001), Bassioni et al. (2004)
15	Rework or defect rectification (number of man-hours and material used for repairing work expressed as a percentage of total man-hour for the entire project and total contract amount)	A15	Mbugua et al. (1999), Cox et al. (2003), Luu et al. (2008), Rimbalova and Vilcekova (2013), Menches and Hanna (2006), Kagioglou et al. (2001), Bassioni et al. (2004)
16	Adopting learning and growth culture in the organization (measured in terms of amount spent for learning and growth as a percent of total turnover of the company	A16	Mbugua et al. (1999), Chan (2009), Luu et al. (2008), Rimbalova and Vilcekova (2013)
17	Higher wages of the employees	A17	Rimbalova and Vilcekova (2013)
18	Staff turnover (percent of employees leaving the organization)	A18	Chan (2009), Rimbalova and Vilcekova (2013), Yu et al. (2007)
19	Good relationship with client (in terms of repeat business, low dispute and litigation, timely payment, etc.)	A19	Mbugua et al. (1999), Menches and Hanna (2006)
20	Annual construction demand/market share (yearly order received)	A20	Chan (2009), Luu et al. (2008), Yu et al. (2007)

the number of total variables in the sample (Pongpeng and Liston 2003). The value of $C\alpha$ ranges from 0 to 1 in which 0 indicates no internal consistency and 1 indicates perfect internal consistency. Leung et al. (2008) suggest that the value of $C\alpha > 0.6$ is acceptable. In the current study, the value of $C\alpha$ ranges from 0.630 to 0.856 which indicate that all the attributes grouped under a factor have high internal consistency and hence can be considered reliable (see Table 4).

In the second stage of the survey which forms the basis of the current paper, 18 highly experienced construction professionals from 18 different construction organizations participated in the survey via personal interviews. Of these18 professionals, 7 were contractors, 8 were developers while the remaining 3 were

Table 2. An extract of the questionnaire of stage 1.

Please put a tick mark (√) or highlight the relevant cell to rate the following parameters (on a five-point scale from very low importance = 1 to very high importance = 5) on the degree of their importance in the measurement of the success of the construction organizations.

Sl. no.	Performance attributes	Very low importance 1	Low importance 2	Moderate importance 3	High importance 4	Very high importance 5
1	Size of the organization (measured in terms of turn over, market share, number of employees, etc.)					
2	Productivity of employees (value added per employee)					
3	– –Attributes as given in Col. 2 of Table 1					

Table 3. The demographic of the respondents.

	Categories of respondents				
Experience (Years)	Developer	Contractor	Project management consultant	Total by experience	Percent experience
< 10	6	7	0	**13**	**12**
10–20	19	12	4	**35**	**33**
20–30	21	24	5	**50**	**47**
> 30	3	3	2	**8**	**8**
Total by category	**49**	**46**	**11**	**106**	**100**
Percent by category	**46.0**	**43.5**	**10.5**	**100**	**–**

Table 4. Result of factor analysis.

Sl. no.	Performance factors	Variance explained (%)	Performance attributes	Factor loading	Cronbach's Alpha
1	Profitability and asset management (F1)		Higher annual growth rate (A12)	0.801	0.729
			Higher profitability ratio (A11)	0.742	
		13.893	Optimum liquidity ratio (A10)	0.637	
			Productivity of employees (A2)	0.609	
2	Satisfaction of key stakeholders (F2)	12.688	Customer's satisfaction (A5)	0.830	0.756
			Client's satisfaction (A6)	0.816	
3	Predictability of cost and time (F3)	11.698	Predictability of cost (A13)	0.876	0.856
			Predictability of time (A14)	0.862	
4	Environment, health and safety (F4)	11.161	Impact on environment (A9)	0.806	0.647
			Health and safety consciousness (A4)	0.734	
5	Quality consciousness (F6)	10.581	Rework or defect rectification (A15)	0.769	0.630
			Adopting learning and growth culture (A16)	0.719	
			Annual construction demand/market share (A20)	0.525	
6	Staff turnover (F6)	7.427	Staff turnover (A18)	0.673	–

project management consultants. The respondents who participated in this survey were also members of CREDAI and BAI but different from those who participated in the first stage questionnaire. The average experience of respondents participating in the survey was 24 years whereas, the average experience of the participating organizations was 23 years. A pilot survey was conducted with three experts with more than thirty years of working experience at senior management levels. After minor corrections, as suggested by experts, the final questionnaire consisted of three parts: (1) questions on organizational performance attributes, (2) questions on organizational performance factors and (3) questions on respondents and their organizations. The respondents were asked to express their preference between each pair of attribute/factor as equal, moderate, strong, very strong and extremely important. These preferences can be interpreted into numerical values on a 9-point scale (Saaty 1980; Hasan 2016). Table 5 shows an extract of the questionnaire of stage 2. The Fuzzy Preference Relation (FPR) technique was then used on the responses collected from the experts to determine the relative weights and ranking of performance factors and their attributes. The reliability and applicability of FPR along with the various steps involved in determining the relative weights and ranking of performance factors and their attributes have been discussed in detail in Appendix 1.

The relative weights and ranking of performance factors, as well as performance attributes, are shown in Table 6. The factors or attributes were ranked as per their relative weight in the descending order. For example, the factor with the highest weight of 0.241 was given rank 1, while the factor with the next higher weight of 0.187 was given the second rank and so on.

The Spearman's Rank Correlation Coefficient (SRCC) test was performed to compare the ranking

Table 5. An extract of the of questionnaire of stage 2.

Among each pair of given performance parameters, which is more important for measurement of the performance of construction organizations and how much more important? Please highlight the relevant cells. Scale used is 1 for equally important, 3 for slightly more important, 5 for strongly more important, 7 for very strongly more important, 9 for most important and 2,4,6 and 8 for intermediate values).

Example: (1) If you feel that A is slightly more important than B, then put a tick mark (√) in the cell just after A and cell having number 3 as shown below (2) If you feel that C is strongly more important than B, then put a tick mark (√) in the cell just after C and cell having number 5 as shown below. If you feel that the importance is between the scale 1 and 3 then put a tick mark (√) in the cell having number 2 and so on.

Sl. no.	Performance parameters	Importance	Performance parameters	Importance	1	2	3	4	5	6	7	8	9
1	A	√	B				√						
2	B		C	√					√				
Sl. No.	**Attributes/Factors**	**Importance**	**Attributes/Factors**	**Importance**									
1	Profitability and asset management (F1)		Satisfaction of key stakeholders (F2)										
2	Satisfaction of key stakeholders (F2)		Predictability of cost and time (F3)										
3	—Attributes/factors as given in Table 4.		—Attributes/factors as given in Table 4.										

Table 6. Ranking of performance factors and performance attributes.

Factors	Weight of factors (Wi)	Rank of factors	Attributes	Weight of attributes (Wj)	Normalized weight of attributes (Wi* Wj)	Overall rank of attributes
Profitability and asset management (F1)	0.187	2	Higher annual growth rate (A12)	0.269	0.050	10
			Higher profitability ratio (A11)	0.161	0.030	14
			Optimum liquidity ratio (A10)	0.255	0.048	13
			Productivity of employees (A2)	0.315	0.059	9
Satisfaction of key stakeholders (F2)	0.241	1	Customer's satisfaction (A5)	0.460	0.111	2
			Client's satisfaction (A6)	0.540	0.130	1
Predictability of cost and time (F3)	0.176	4	Predictability of cost (A13)	0.450	0.079	5
			Predictability of time (A14)	0.550	0.097	3
Environment, health and safety (F4)	0.116	5	Impact on environment (A9)	0.420	0.049	11
			Health and safety consciousness (A4)	0.580	0.067	7
Quality consciousness (F5)	0.186	3	Rework or defect rectification (A15)	0.261	0.048	12
			Adopting learning and growth culture (A16)	0.327	0.061	8
			Annual construction demand/market share (A20)	0.412	0.076	6
Staff turnover (F6)	0.096	6	Staff turnover (A18)	1.000	0.096	4

of the performance attributes using FPR technique in this study with that of using mean and standard deviation during first stage questionnaire. The value of SRCC was found to be 0.741 with the two-tailed value of $p = 0.002$ (< 0.05). Therefore, the correlation between the responses of two different group of experts will be considered statistically significant.

The structure of performance factors in AHP is depicted in Figure 1 in which, level 0 represents the final goal of the organization, level 1 represents the performance factors of the organization, and level 2 contains 3 alternatives (the construction organizations A, B and C were chosen for illustration purpose). This structure can be utilized to compare the performance of these organization according to their performance score calculated using Table 6.

Based on the structure of performance factors as depicted in Figure 1, a user- friendly simple user-interface was developed in VB.Net. Using this interface, the users can evaluate the performance of their organizations based on the current levels of the performance factors prevailing in the organizations. Based on their inputs on a scale of 1 to 5, the program will perform the calculations and provide a total performance score of the organization. Because the total performance score ranges from 0 to 5 which is not a whole number, hence for interpretation purpose, the various effects may be considered to lie between mid-points of two adjacent scales (Tripathi and Jha 2018a). Thus, the organizations can be categorized from very low performer to very high performer based on total performance score as shown in Table 7. If the performance of the organization is not satisfactory, it needs improvement in success factors to improve its performance.

Illustration of the user interface

If an organization wants to evaluate its performance, it needs to evaluate the current level of performance factors prevailing in the organization on a scale of 1 to 5 based on various performance measures taken in the organization. Let us assume that performance factor F1 of an organization is at level 2, F2 is at level 3, F3 is at level 1, F4 is at level 3, F5 is at level 4 and F6 is at level 3. Once these inputs are provided, the

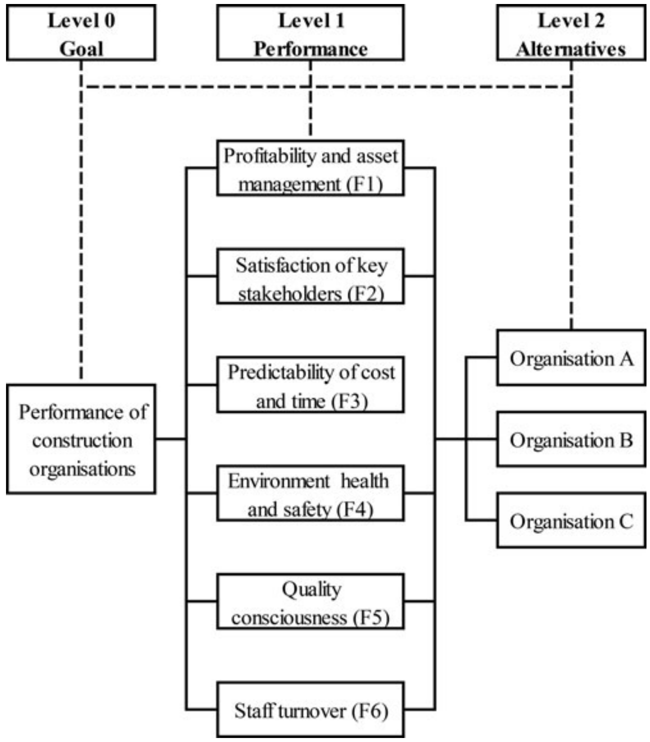

Figure 1. Structure of performance measurement in AHP.

Table 7. Scale used for performance evaluation.

Sl. no.	Ranges of performance score (S)	Performance status
1	$S \geq 4.5$	Very high performers
2	$4.5 > S \geq 3.5$	High performers
3	$3.5 > S \geq 2.5$	Medium performers
4	$2.5 > S \geq 1.5$	Low performers
5	$1.5 > S$	Very low performers

software displays the total performance score for the organization, which is 2.653 (see Table 7), indicating medium performance. The screenshot is presented in Figure 2. If the organization wants to improve its performance from medium to high or very high, it is required to improve the current level of success factors implemented in the organization. However, the success factor, which is part 2 of the user interface, is not part of the current study.

Results

From Table 6, it can be seen that the *satisfaction of key stakeholders* (F2) received the highest weight i.e. 0.241. It shows that the satisfaction of key stakeholders such as client and customers is the most important factor for the performance measurement of construction organizations. This outcome is supported by the findings of previous studies (Sanvido et al. 1992; Luu et al. 2008; Chan 2009). Therefore, construction organizations must deliver high-quality products and services in a timely and cost-effective manner to ensure that the expectations of the clients and customers are met successfully. Client satisfaction can be defined as a function of product quality, service quality and quality of manner to customers (Tang et al. 2003). It measures the quality of services rendered by a construction organization from the perspective of the end user or a customer (Tripathi and Jha 2018a). *Profitability and asset management* (F1) was placed in second position with an average weight of 0.187. This factor includes a higher annual growth rate, higher profitability ratio, optimum liquidity ratio and productivity of employees which are an important consideration in the performance measurement of construction organizations. An effective asset management strategy will involve cost-effective processes to deploy, operate, maintain, upgrade and dispose of an asset. *Quality consciousness* (F5) was placed in the third position with an average weight of 0.186. In modern construction projects, clients and customers have become more quality conscious. Therefore, quality consciousness has emerged as an important parameter for measuring construction organizations' performance. Pheng and Teo (2004) recommended the implementation of total quality management (TQM) in construction to ensure better quality, improved customer satisfaction and higher market share.

Predictability of cost and time (F3) received an average weight of 0.176 and was placed in the fourth

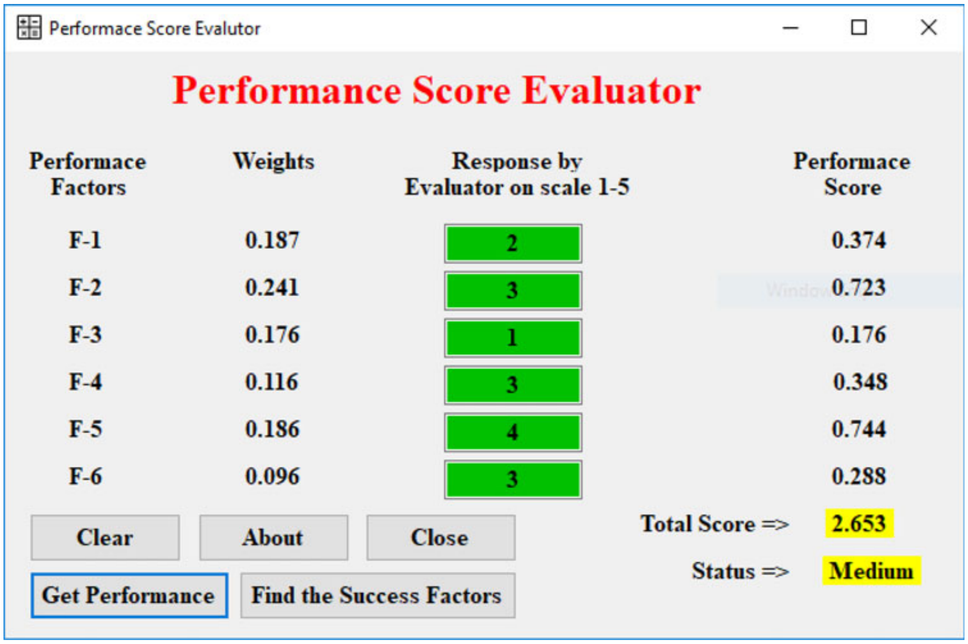

Figure 2. Screenshot of the user interface.

position by the respondents. Predictability of project cost and time may create a positive psychological impression and a sense of trust and reliability among the stakeholders due to an assurance towards cost-effective and on-time delivery of construction projects. On the other hand, uncertainties regarding completion time and project cost could discourage the clients from doing business with the organization in future. Surprisingly, due to a low average weight of 0.116, *environment, health and safety* (F4) was placed in the fifth position. It reflects relatively less focus on the environment, health and safety by construction organizations in developing countries. Considering the enormous amount of resources used by construction organizations, display of social and moral responsibilities to take necessary steps in the direction of sustainable construction seems to be at a low level. The use of environment-friendly and energy-efficient construction materials not only reduces environmental pollution but may also reduce the life-cycle cost of facilities. Furthermore, in the absence of proper focus on the environment, health and safety management practices at project sites, more safety incidents and environmental degrading activities could take place in construction projects, which in turn may result in financial loss and poor reputation. According to Patel and Jha (2016), the minimum number of people that would have died annually in the Indian construction sector from 2008 to 2012 was 11,614. This is equivalent to 38 fatal accidents per day and in terms of fatality rate (fatal accidents per 1000 workers) it works out to be 0.22.

Staff turnover (F6) received the lowest rank with an average weight of 0.096. It is defined as the percentage of the employees leaving the organization in a given year (Tripathi and Jha 2018a). The construction organizations should try to maintain a low staff turnover rate to retain the talent and to reduce the administrative cost and time spent on finding suitable replacements. High staff turnover not only incurs additional cost to the companies because of new appointments and training but also affects the morale of other employees. Therefore, low staff turnover reflects the better performance of an organization. Previous studies have found various reasons for high turnover of the employee such as dissatisfaction with the nature of the job, low salary, poor working conditions, long working hours and poor policies (Greenhaus 2011). Among the performance attributes, *client satisfaction* (A6) was found as the most important attribute with the highest weight of 0.130, followed by *customer satisfaction* (A5), the *predictability of time* (A14), *staff turnover* (A18) and *predictability of cost* (A13). On the other hand, financial performance attributes, *higher profitability ratio* (A11) and *optimum liquidity ratio* (A10) were placed at the last two positions by the respondents.

Discussion

The lower ranking of financial performance attributes, higher profitability ratio (A11) and optimum liquidity ratio (A10), in this study appears to be in contrast to that of previous studies undertaken in Korea and

Saudi Arabia where higher profitability ratio was identified as one of the most significant performance measures (Yu et al. 2007; Ali et al. 2013). On the other hand, non-financial performance attributes such as customer satisfaction, client satisfaction, the predictability of cost and the predictability of time were considered more important in the current research, as evident from their higher rankings. It shows that the satisfaction of key stakeholders is necessary to ensure the success of construction organizations considering the client and customer-oriented nature of this business and a highly competitive market. These results are consistent with that of studies conducted in other developing countries such as Vietnam (Luu et al. 2008) and Malaysia (Chan 2009). In addition, research studies based on data from the developed countries have also recognized the significance of the attributes such as client satisfaction in terms of product and services, the predictability of cost in construction, the predictability of time in construction and productivity of employees (Kagioglou et al. 2001; Bassioni et al. 2004). However, few other attributes such as rework or defect rectification and higher profitability ratio which were high-ranked in the UK received the lowest ranks in this study. The experts opined that on several occasions, minor rework or defect rectification are ignored to save both time and cost in construction projects in India.

The attributes such as health and safety consciousness and impact on the environment were found to be relatively less important attributes by the respondents. In a study by Enshassi et al. (2013) in Palestine also, health and safety received a very low rank. On the other hand, these attributes were considered highly important for assessing the performance of the construction organizations in the United Kingdom (Mbugua et al. 1999; Cox et al. 2003). Therefore, it can be inferred that attributes such as quality consciousness and environment, health and safety are considered significant in developed countries whereas they are usually ignored in developing countries such as India. The low rankings of these attributes do not mean that these attributes are not important while measuring the performance, rather it shows a lack of awareness on the importance of health, safety and environment among Indian construction organizations.

The results of this study demonstrate that due to rapidly changing and increasingly challenging business environment in the construction industry, the use of traditional financial parameters only may not be enough in warranting satisfactory results for performance measurement of construction organizations from the perspectives of different stakeholders. Although high financial performance is an essential criterion for good performance, it is not the most important condition. Therefore, in addition to traditional financial performance measures such as higher profitability ratio and growth rate, construction organizations must consider long-term non-financial performance criteria such as the satisfaction of key stakeholders, the predictability of cost and time and so forth. The use of both financial and non-financial performance measures, as found in this research, could project an accurate picture of construction organizations' performance.

Conclusion

This study was performed to examine various factors and attributes required for performance measurement of construction organizations operating in developing countries such as India. Analysis of questionnaire survey on performance attributes and performance factors using FPR indicated the following top 10 performance attributes: (1) client satisfaction, (2) customer satisfaction, (3) predictability of time, (4) staff turnover, (5) predictability of cost, (6) annual construction demand/market share, (7) health and safety consciousness, (8) adopting learning and growth culture, (9) productivity of employee and (10) higher annual growth rate. Out of the total 14 performance attributes, the above ten performance attributes accounted for a total weight of 0.83. Similarly, out of six performance factors, four performance factors viz. satisfaction of key stakeholders, profitability and asset management, quality consciousness and predictability of time and cost carried a total weight of 0.790. Therefore, construction organizations should pay more attention to these factors while measuring their performance.

It was also found that traditional financial parameters are no longer perceived as a comprehensive measure of organizational performance in the construction industry. The non-financial measures, such as client and customer satisfaction, and predictability of time and cost have emerged as important measures in this study. Therefore, construction organizations must focus on the client and customer satisfaction in order to remain successful in the modern construction business. This study contributes to the knowledge of construction professionals not only in India but also elsewhere. It provides a new dimension and a better understanding of the existing theory and practices on performance measurement. Also, the user-interface, developed in the form of software, will help the construction professionals to evaluate the current level of performance of the construction organization and will suggest the remedial measures to improve their performance if not satisfactory. It is believed that knowledge of the relative importance of various performance factors can provide a guideline for clients and customers while examining the performance and suitability of a particular construction organization. Although this research was undertaken by the organizations in the Indian construction industry, its findings should apply to other developing countries where the construction industry operates in similar work environments and socio-economic conditions. Moreover, it is projected that improvements in construction organizations' performance will ultimately lead to a country's growth considering major contributions of the construction industry to both employment and Gross Domestic Products (GDP).

Because the construction industry is huge and very complex, and the scope of the present study was limited to medium and large construction organizations engaged in the real estate business only, the result might not be representative of the construction organizations working in other sectors such as infrastructure or industrial projects. For the construction organizations involved in other sectors, different sets of performance attributes, factors, and evaluators could be identified based on the focus of their stakeholders. Future studies may consider research based on particular professional groups and similar sizes of the firms. Similarly, more region-specific and longitudinal studies could provide useful insights into the dynamic nature and evolutionary trends of performance measurement metrics in different contexts and at different points of time. In addition, more studies can be conducted to check if companies that actually pay attention to these indicators perform better compared to those who do not pay attention to these indicators. Despite the above limitations, the present study provides some useful insights into the performance measurement of the construction organizations in developing countries such as India.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix 1

Application of Fuzzy preference relation (FPR)

The AHP was proposed by Saaty and is one of the most popular methods used in MCDM processes using the pair-wise comparison of alternatives based on the expert's opinion (Fong and Choi 2000). In the AHP, to determine the importance of one alternative over the other alternatives in terms of their weights, multiplicative preference relations (MPR)is used. This has two drawbacks. It requires (1) $\frac{n(n-1)}{2}$ comparisons and (2) consistency check. The number of comparison questions increases with an increase in the number of attributes. The increase in the number of comparison questions decreases the chances of respondents replying with accurate judgment resulting in inconsistent results (with a consistency ratio of more than 0.1). In the case of the inconsistent result, experts are asked to review their decision which is a lengthy process.

To overcome the drawbacks of MPR, FPR can be used. The FPR does not require consistency check in comparison (Herrera-Viedma et al. 2004). The FPR also minimizes the number of pair-wise comparisons to (n – 1) as compared to $\frac{n(n-1)}{2}$ in the case of MPR. Hence, FPR is more expedient and effective as compared to MPR. The elements of the MPR matrix is stated as a_{ij} which indicates the dominance of alternative i over j where $1<a_{ij}<9$ and $a_{ij}*a_{ji}=1$. Whereas, the elements of the FPR matrix is stated as a_{ij} which indicates the dominance of alternative i over j, where $0<a_{ij}<1$ and $a_{ij}+a_{ji}=1$ (Girsang et al. 2015).

In this study, FPR has been used in the structure of criteria in AHP. The FPR has been widely used by various researchers Wang and Chen (2007), Boran (2011), Wang and Chang (2007), Chen and Chao (2012), Kuo and Lu (2013), Ibadov (2015), Ilieva and Dimitrov (2015), Tripathi and Jha (2018b) and Patel et al. (2016). Thus, the reliability and applicability of FPR in this study are supported by the existing literature. The various steps involved in FPR are discussed below:

Step 1: Formation of MPR matrix

MPR matrix, $R=[r_{ij}]$ where $r_{ij}\in\left[\frac{1}{9},9\right]$, was prepared for each performance factors and their attributes. The responses of the construction professionals were combined using Equation (1).

$$r_{ij}=(r_{ij}1*r_{ij}2*r_{ij}3*\ldots\ldots\ldots..*r_{ij}m)^{\frac{1}{m}}$$
$$where, i,j\in(1,2,3,\ldots\ldots\ldots.n) \tag{1}$$

where m is the number of respondents and $r_{ij}{}^{m}$ is the dominance of ith factor/attribute on j^{th} factor/attribute by m^{th} respondent.

Step 2: Transforming MPR matrix into FPR matrix

MPR matrix was transformed into the FPR matrix $P=[p_{ij}]$ where $p_{ij}\in[0,1]$ using Equation (2) (Herrera-Viedma et al. 2004; Patel et al. 2016).

$$p_{ij}=\frac{1}{2}\left(1+\log_{9}p_{ij}\right) \tag{2}$$

In Equation (2), $\log_9 p_{ij}$ is used, as r_{ij} lies in the interval [1/9, 9]. If r_{ij} lies in the interval [1/n,n], $\log_n p_{ij}$ should be used. Other elements of the matrix were calculated using Equations (3)–(5) (Chen and Chao 2012) because the consistency of the FPR matrix is based on additive transitivity.

$$p_{ij}+p_{ji}=1,\forall i,j\in(1,2,\ldots\ldots..,n) \tag{3}$$
$$p_{ij}+p_{jk}+p_{ki}=3/2,\forall i<j<k \tag{4}$$
$$p_{i(i+1)}+p_{(i+1)(i+2)}+\ldots\ldots\ldots\ldots+p_{(i+k-1)(i+k)}+p_{(i+k)i}=\frac{(k+1)}{2}\forall i<j \tag{5}$$

Sometimes, some of the elements of FPR matrix fall in the interval [−k, 1 + k], $k>0$ instead of the interval [0,1]. Then a function, called transform function, is applied to the FPR matrix to transform it in such a way that each element of transformed matrix falls in the interval [0, 1] so that the reciprocity and additive consistency of the matrix are preserved. The transformed matrix $P' = f(P)$ is called consistent fuzzy preference relation (CFPR) matrix. Equation (6) is used to calculate the transform function (Patel et al. 2016).

$$f(p)=\frac{(p+k)}{(1+2k)} \tag{6}$$

where the element p of the FPR matrix falls in the interval $[-k,1+k]$.

Step 3: Determining relative weights and rankings

Equation (7) was used to calculate the relative weights and rankings of the performance factors and its attributes (Chen and Chao 2012).

$$w_i = \frac{\sum_{j=1}^{n} p_{ij}}{\sum_{i=1}^{n}\left(\sum_{j=1}^{n} p_{ij}\right)} \tag{7}$$

Step 4: Determining normalized weights

Equation (8) was used to calculate the normalized weight of performance attributes (W) (Patel et al. 2016).

$$W = W_i * W_j \tag{8}$$

Where, W_i = Weight of performance factors, and W_j = Weight of performance attributes.