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Application of fuzzy preference relation for evaluating success factors of construction organisations

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Abstract

Purpose – The purpose of this paper is to evaluate and rank the success attributes and success factors of the construction organisations.

Design/methodology/approach – The viewpoints of the experts engaged in Indian construction industry were used to apply factor analysis and fuzzy preference relation with the help of a questionnaire survey.

Findings – The findings indicate that project factor is the most important factor, whereas favourable market and marketing team is the least important factor. Among the success attributes, the availability of qualified staff is the most important attribute, and health and safety management plan is the least important attribute.

Research limitations/implications – Findings of this study are based on the viewpoint of the experts of construction organisations engaged in building projects in India.

Practical implications – The study can be used as a yardstick for the top management of construction organisations to manage their resources efficiently and to develop a strategy to be successful in this business.

Social implications – Indian construction industry provides direct and indirect employment to the people of India. Hence, the success of construction organisation will contribute to the development of the society and ultimately the nation.

Originality/value – In the earlier studies, researchers have used various statistical tools to identify and evaluate the alternatives for the success factors of construction organisations, but very few of them have tried to assign weights to those alternatives. The simple ranking of alternatives using various statistical analyses, such as mean and standard deviation, relative importance index, etc., is not much useful unless their relative weights are known. With the help of the present study, the authors have tried to overcome the shortcomings of the previous research works.

Keywords Organization, Construction, Methodology, Management, Questionnaire survey, Interview

Paper type Research paper

Introduction

The construction industry of India accounts for about 8 per cent of India's GDP. Being the second largest industry after agriculture, it provides direct and indirect employment to the people of India. It is estimated that about 100m inhabitants will get direct employment by the year 2022. Apart from the direct employment, it also provides indirect employment opportunity through other manufacturing industry like cement, iron and steel, bitumen, chemicals, bricks, tiles, paints, construction equipment, etc. The construction sector is one of the fastest growing industries in India which is growing at a compounded annual growth rate of about 11.1 per cent over the last few years. The aggregate output of the construction sector was likely to increase from US$0.12tr in 2012–2013 to US$0.21tr in 2016–2017 (US$1 = INR65) (Planning Commission of Government of India, 2013).

In the last few years, the Government of India has taken several steps to promote Indian construction industry. Indian regulations have removed the barrier of procuring a licence for foreign investors to operate in the Indian market in many sectors. For high-tech goods and machinery, import duties have been gradually reduced. In housing, township, hospitality, etc., up to 100 per cent foreign direct investment is allowed to attract foreign investors. In airport projects, 100 per cent tax exemption is permitted for ten years,

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whereas in road projects, 100 per cent tax exemption is permitted for the first five years and 30 per cent tax exemption for the next five years. The easy access to finance in terms of bank loan from various banks in India has made it easy to invest in property even for the middle-class people.

Under the "Make in India" programme launched by the Government of India, 100 cities are proposed to be developed as smart cities which will open various opportunities in the construction industry. It was projected that by 2017, US$1tn will be invested in the infrastructure sector, 40 per cent of which was likely to be funded by the private sector. Out of the total, 45 per cent will be invested in construction activity and 20 per cent for modernisation of the construction industry. Approximately, US$650bn will be required for urban infrastructure over the next 20 years (www.makeinindia.com/sector/construction).

Traditionally, the construction organisations were considered successful if they had a good track record of completing the projects successfully within the time, within the budget and meeting quality parameters (Abraham, 2003). However, it is not always necessary that the construction organisation will also be successful if the projects are successful. Every year, several new players are entering this business with a hope to grow in this sector, but because of one or more reasons, some of them fail or even go bankrupt due to the high risk involved (Jha, 2015). For example, the construction organisation will not be successful if the business requirements as expected are not met either financially (increased turnover, profit, etc.) and/or strategically (market share owned, etc.) even though the project is completed successfully to the satisfaction of various stakeholders. Therefore, it is necessary for a construction organisation to think about their success at a corporate level other than focussing only on success at the project level (Abraham, 2003). The success of an organisation can be defined as the degree to which its goals and expectations are met and, on the other hand, failure is the inability of an organisation to pay its obligations when they are due (Arslan and Kivrak, 2008). Success can be achieved if the activities are properly planned and resources are properly allocated, which require an investment of time and money. The top management must think about a particular factor that needs to be addressed first for their success. By making these difficult decisions, organisations are responding to the changing market and setting their goal for the future (Abraham, 2003).

Literature review

Like any other business, success is the ultimate goal of the construction organisations. There is a healthy competition in this industry due to the presence of a huge number of entrants. Achieving the success in such a competitive business environment is a very critical issue for an organisation (Arslan and Kivrak, 2008). There are many factors which lead to the success of an organisation; these are called success factors of the construction organisation. It is very tough for any construction organisation to concentrate on too many factors at a time due to their limited resources (Mbugua *et al.*, 1999). Hence, it is necessary to identify those factors which are highly significant for their success by focussing on a limited number of factors rather than focussing on too many factors.

The aim of the current study is to prioritise success factors and their attributes, already identified in the previous study by the authors, for the success of a construction organisation. Success attributes in this study refer to those success parameters which are directly identified and measured with the literature and/or questionnaire survey. The attributes when grouped together based on the pattern of correlation among them are referred as success factors. The grouping of attributes into factors is usually done either with exploratory factor analysis or on the basis of literature. Various researchers have proposed several statistical methods to prioritise success factors and their attributes. The work done by researchers in these areas is mentioned below in brief.

Butler *et al.* (2003) used an open-ended questionnaire to determine the factors leading to the success of the construction organisations in the USA by asking the respondents to prioritise the five things that contribute most to the success of their construction organisations. The factors with higher rank were as follows: quality workmanship, good employees, location of the product, customer service, effective sales and marketing, company reputation, fair pricing and value, and cost control effort. Chan *et al.* (2004) developed a framework to determine the success of construction project. They grouped the 44 identified success factors into five main categories, namely, human-related factors, project-related factors, project procedures, project management actions and external environment. It was hypothesised that the project success is a function of these factors. They concluded that the project would be executed more successfully if: the project is of low complexity; the duration of the project is shorter; managerial actions are effective; the private and experienced client is funding the project; the client is competent in decision making; team leaders are competent and experienced; and the project is executed with developed technology and appropriate organisational structure in a stable environment. While determining the factors leading to the success of construction organisations, based on questionnaire survey of the top 400 contractors identified by the ENR 200, Abraham (2003) concluded that the joint assessment of critical success factors at the level of project and an organisation both would be needed to compete in the construction industry successfully. Later, Flanagan *et al.* (2007) identified the mechanisms that enhance the competitiveness at different levels, i.e. industry, organisation as well as project level, and found that the overall improvement in construction cannot be accomplished without the combined efforts of all parties, i.e. the industry, organisations and the project team. On the other hand, Cheah *et al.* (2004) included failure factors in addition to success factors to develop a conceptual framework of construction organisation and found that success is derived from combinations of operational, financial, technological and human factors rather than a single condition. They also concluded that a firm might have performed tremendously well in some categories but failed just because it overlooked one or more critical factors. Further, Iyer and Jha (2005) identified six success factors of construction projects in India using factor analysis. These factors are project manager's competence; top management support; project manager's coordinating and leadership skill; monitoring and feedback by the participants; coordination among project participants; and owner's competence. Tabish and Jha (2012) studied the success factors of public sector projects in India and applied the structural equation modelling (SEM) technique to test the hypothesised positive relationships between success traits and project success. They found that the human factors such as project management competency, commitment of all project participants, owner's competence, proper coordination between project participants and availability of trained resources play a decisive role in making a project successful.

Pheng *et al.* (2004) studied the factors leading to the success of construction organisation in the global market. They compared the performance of the top British and Chinese contractors using the OLI+S model which incorporates the ownership (O), locational (L), internalisation (I) and speciality (S) factors. They found that all the OLI+S advantages of the top British construction firms were higher than that of their Chinese counterparts even though the rank of Chinese construction companies was greater than that of the British construction firms according to the US-based ENR top 225 international contractors. Similar research was carried out by Pheng and Hongbin (2004) on the top 225 international contractors listed in the ENR 2001 to estimate the global construction performance using the OLI+S model. They found that firms exhibit a very different pattern in the internationalisation process depending on their business strategies, domestic market situation, historical factors, etc. Gunhan and Arditi (2005) conducted Delphi survey and applied analytical hierarchy process (AHP) to evaluate the opportunities and threat

associated with the international business for construction companies willing to expand in the global market. They concluded that the most significant business strengths linked to global market were a track record, specialist expertise, project management capability and international network, whereas a loss of key employees, shortage of financial resources, inflation and currency fluctuation, and increase in interest rate were the most important company threats associated with the international market. The most significant opportunities available in the global market were increased long-term profitability, the ability to maintain shareholders' returns, and the globalisation and openness of the markets.

Isik *et al.* (2010) utilised SEM and investigated the impact of resources and strategy on the performance of the construction organisations. It was found that resources and strategy had a direct impact on company's performance, whereas project management competence and relationships with other parties had an indirect impact on company's performance. Abu Bakar *et al.* (2011) used relevant statistical methods such as frequency, relative important index (RII) and regression analysis to establish the factors determining the growth of construction organisations in Malaysia. The findings of the research reveal that proper management of the organisation, efficient organisational structure, new technology and automation, customer's satisfaction, market knowledge, bank loans and other credit facilities had a significant effect on the growth of the construction organisations. On the other hand, Tan and Ghazali (2011) studied the critical success factors for Malaysian contractors in international construction projects using AHP. They found that the top 10 ranked factors were: contractor's experience, decision-making effectiveness, contractor's cash flow, project manager's experience, overall managerial actions, project team experience, project team monitoring, site management and supervision, project delivery system, and ability to make and carry out decisions. Later, Jagofa and Wood (2012) used the input and output model designed by Koksal and Arditi (2004) to determine the failure factors instead of success factors. The study found that the top seven determinants of business failure in the construction industry were as follows: management incompetence, insufficient capital, lack of business knowledge, fraud, industry weakness, poor technical and technological capability, and poor relations with clients and government.

Ofori and Lean (2010) applied simple statistical analysis and factor analysis in their research and identified four factors influencing the development of contractors in Singapore. They found that the growth of the contractors is affected by contractor's role, governments and institutional help, practitioner's support, and financial assistance from outside the industry, and client's help. Instead of identifying success factors in general, Skrt and Antoncic (2004) developed a hypothesis on the relationship between strategic planning and growth of the small Slovenian firms and empirically tested the hypothesis using data collected via a questionnaire survey. The outcome of the study states that strategic planning can be considered important in driving small firm's growth. The study also suggested that the factors such as the precise formulation of vision and strategy, incorporation of the elements of internationalisation and networking in the company, accurate analysis of market and competition, and correct formulation of generic business strategies focussing on growth, profit and market are beneficial for a smaller firm's growth. Dikmen *et al.* (2005) applied the artificial neural network (ANN) and multiple regression techniques to rank the factors to achieve organisational effectiveness (OE). They found that the ability to benefit from market opportunities, capabilities and culture of an organisation, joint venturing, and appropriate organisational structure are the most useful parameters for OE. Lu *et al.* (2008) applied ranking analysis, i.e. total score, mean and standards deviation, to evaluate the critical success factor for the competitiveness of contractors in China and further grouped like critical success factors into eight clusters using factor analysis. These are project management skills, organisation structure, resources, competitive strategy, relationships, bidding, marketing and technology. Arslan and Kivrak (2008) used the Simple Multi

Attribute Rating Technique (SMART) to rank the critical success factors for Turkish contractors and found that business management, financial conditions and owner–manager characteristics are the most important factors to company success. Similarly, Thwala and Phaladi (2009) conducted their research on small and medium-size contractors in the North-West province of South Africa and tried to examine the problems faced by them. They found that the biggest problems faced by them were mainly unfavourable government policies such as late payment by the government, lack of access to finance, high-interest rate, lack of capital, difficulty in arranging guarantees, etc. The above studies are summarised in Table I.

From the above literature review, it is seen that several researchers have used various statistical tools, like simple statistical analysis such as mean and standard deviation (Ofori and Lean, 2010; Lu *et al.*, 2008), RII (Abu Bakar *et al.*, 2011), SMART (Arslan and Kivrak, 2008), ANN (Dikmen *et al.*, 2005), SEM (Isik *et al.*, 2010), etc., to identify and evaluate the alternatives for the success of construction organisations, but very few of them (Gunhan and Arditi, 2005; Tan and Ghazali, 2011) have tried to assign weights to those alternatives. The ranking of alternatives using various statistical analysis, such as mean and standard deviation, RII, etc., is not much useful unless their relative weights are known. The ranking of alternatives only provides the order of their preference over the other. For example, in the study of Abu Bakar *et al.* (2011), good management of the organisation was placed at first position, while good cash flow management plan was placed at the second position. It simply indicates that the first attribute is more important than the second one, but it does not specify the degree of importance of one over the other. To better understand the success factors, it is necessary to evaluate their degree of importance over the others. The level of importance of each success factors can provide valuable information for the allocation of various resources and develop the appropriate strategy to enhance the organisational success. With the help of the present study, the authors have tried to overcome the shortcomings of the previous research works. Accordingly, the objective set for the current study is to evaluate and rank the success attributes and success factors of the construction organisations.

Research method

A questionnaire survey approach was adopted in two stages. The viewpoints of the experts engaged in Indian construction industry were used to apply factor analysis and the fuzzy preference relation (FPR). As the present study is quantitative in nature, the methods used to establish the trustworthiness of the study include internal validity, external validity, reliability and objectivity (Guba, 1981; Krefting, 1991). Internal validity ensures that the observed effect of the independent variable is real and not caused by extraneous factors. External validity indicates the extent to which the results from the research sample can be generalised to the larger population. Reliability test is conducted to verify the reliability of tools used for the study. Objectivity ensures that the interpretation of phenomenon under study is based on facts and is unbiased. For minimising the threat of internal validity and maximising the external validity, the authors randomly selected the samples (respondents) from a distinct population and collected the responses of the questionnaire in the standard condition which is discussed in detail in Step 2 of the research method. Cronbach's α test was performed to test the reliability of data and internal consistency within the attributes, which is discussed in Step 3 of the research method. The reliability and validity of research instrument, research statements and interpretation of results were also ensured by discussing with a small group of experts having more than three decades of experience. For retaining the objectivity in the research, the authors maintained distance from the research so that the findings are based on the data collected and not on the values, beliefs or opinions of the authors. The overall research method adopted in this study is depicted in Figure 1 and described in the following sections.

Table I. Summary of literature review

Researcher's name	Tools used	Country	Research area	Attributes/factors identified
Butler *et al.* (2003)	Descriptive statistics	USA	Construction organisation	Quality workmanship, good employees, location of the product, customer service, effective sales and marketing, company reputation, fair pricing and value and cost control effort
Chan *et al.* (2004)	Conceptual framework	Global	Construction project	Human-related factors, project-related factors, project procedures, project management actions and external environment
Abraham (2003)	Descriptive statistics	Global	Construction project and organisation	Structure of industry, competitive strategy, market conditions, political environment, organisational structure, employee enhancements and process benchmarking
Cheah *et al.* (2004)	Conceptual framework	Global	Construction organisation	Combinations of operational, financial, technological and human factors
Iyer and Jha (2005)	Factor analysis	India	Construction project	Project manager's competence, top management support, project manager's coordinating and leadership skill, monitoring and feedback by the participants, coordination among project participants and owner's competence
Tabish and Jha (2012)	SEM	India	Construction project	Project management competency, commitment of all project participants, owner's competency, good coordination between project participants and availability of trained resources
Gunhan and Arditi (2005)	AHP	USA		Track record, specialist expertise, project management capability and international network
Abu Bakar *et al.* (2011)	RII	Malaysia	Construction organisation	Proper management of the organisation, efficient organisational structure, new technology and automation, customer's satisfaction, market knowledge, bank loans and other credit facilities
Tan and Ghazali (2011)	AHP	Malaysia	Construction organisation	Contractor's experience, decision-making effectiveness, contractor's cash flow, project manager's experience, overall managerial actions, project team experience, project team monitoring, site management and supervision, project delivery system and ability to make and carry out decisions
Ofori and Lean (2010)	Descriptive statistics	Singapore	Construction organisation	Contractor's role, governments and institutional help, practitioner's support, and financial assistance from outside the industry and client's help
Skrt and Antoncic (2004)	Hypothesised model	Slovenia	Construction organisation	Strategic planning, precise formulation of vision and strategy, incorporation of the elements of internationalisation and networking in the company, accurate analysis of market and competition, correct formulation of generic business strategies focussing on growth, profit and market
Dikmen *et al.* (2005)	ANN and MR	Turkey	Construction organisation	Ability to benefit from market opportunities, capabilities and culture of an organisation, joint venturing and appropriate organisational structure
Lu *et al.* (2008)	Descriptive statistics	China	Construction organisation	Bidding strategy, management skills, organisation structure, resources, competitive strategy, relationships, bidding, marketing and technology
Arslan and Kivrak (2008)	SMART	Turkey	Construction organisation	Business management factors, financial conditions and owner–manager characteristics
Isik *et al.* (2010)	SEM	Turkey	Construction organisation	Resources, strategy, project management competence and relationship with other parties

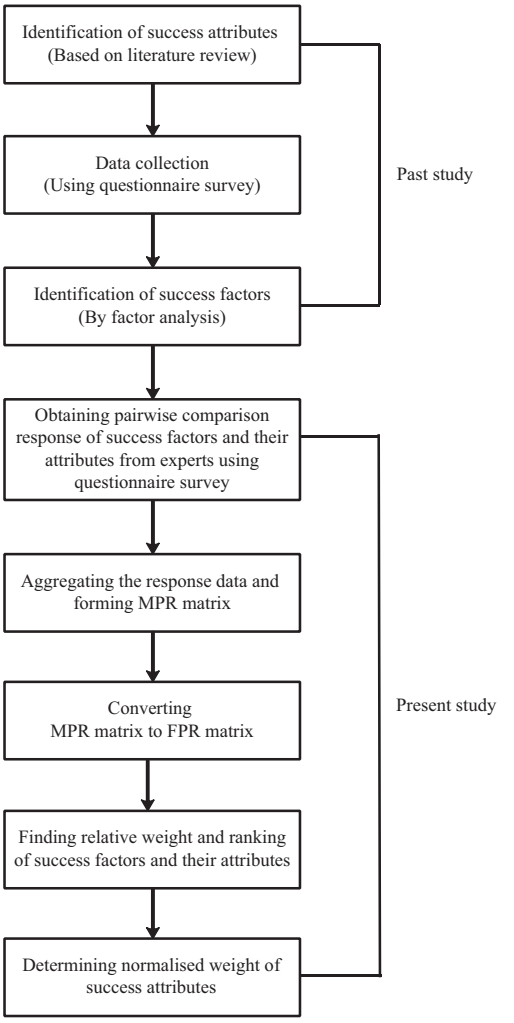

Figure 1.
Research method

Step 1: identification of success attributes

From the literature, 30 success attributes for the success of construction organisations were identified. The list of success attributes was discussed in detail personally with three experts in the construction industry, having more than three decades of experience, to check the applicability and validity of these attributes for Indian scenario. All experts were satisfied with the identified list of attributes, and therefore, no further changes in the attributes were suggested. Table II shows the list of success attributes along with their sources.

Step 2: data collection using questionnaire survey

In the first stage, a questionnaire survey using a five-point Likert scale was conducted with questions based on the above-mentioned 30 success attributes. The sample selection of construction organisations used in this study was done from two groups. The first group consisted of 154 members of the Builders Association of India (BAI) and 209 members of the

Sl. No.	Success attributes	Sources
1	Availability of qualified staff in the organisation	Abraham (2003), Arslan and Kivrak (2008), Butler *et al.* (2003), Gunhan and Arditi (2005), Lu *et al.* (2008), Mbugua *et al.* (1999), Peter *et al.* (2011), Shen *et al.* (2006)
2	Availability of cost control measures in the organisation	Arslan and Kivrak (2008), Butler *et al.* (2003), Isik *et al.* (2010), Jalaliyoon *et al.* (2012), Lu *et al.* (2008), Shen *et al.* (2006)
3	Efficient supply chain management	Isik *et al.* (2010), Lu *et al.* (2008), Mbugua *et al.* (1999), Tan and Ghazali (2011)
4	Availability of effective cash flow management plan	Arslan and Kivrak (2008), Peter *et al.* (2011), Tan and Ghazali (2011)
5	Good relationship with local bodies, government organisation, suppliers, sub-contractors and client	Butler *et al.* (2003), Dikmen *et al.* (2005), Isik *et al.* (2010), Lu *et al.* (2008), Mbugua *et al.* (1999), Shen *et al.* (2006)
6	Financial soundness of the organisation	Arslan and Kivrak (2008), Chittithaworn *et al.* (2011), Gunhan and Arditi (2005), Dikmen *et al.* (2005), Isik *et al.* (2010), Jasra *et al.* (2011), Lu *et al.* (2008), Mbugua *et al.* (1999), Shen *et al.* (2006)
7	Efficient sales and marketing team in the organisation	Al-Mahrouq (2010), Arslan and Kivrak (2008), Butler *et al.* (2003), Jasra *et al.* (2011), Lu *et al.* (2008), Raravi *et al.* (2012)
8	Favourable market conditions in which organisation operates	Abraham (2003), Abu Bakar *et al.* (2011), Chittithaworn *et al.* (2011), Gunhan and Arditi (2005)
9	Favourable external environment	Chittithaworn *et al.* (2011), Lu *et al.* (2008), Tan and Ghazali (2011)
10	Favourable government policies in support of the project	Butler *et al.* (2003), Gunhan and Arditi (2005), Isik *et al.* (2010), Jasra *et al.* (2011), Lu *et al.* (2008), Peter *et al.* (2011), Shen *et al.* (2006), Tan and Ghazali (2011)
11	Country's economic conditions	Arslan and Kivrak (2008), Peter *et al.* (2011), Tan and Ghazali (2011)
12	Experience in construction business (number of years in construction business)	Arslan and Kivrak (2008), Butler *et al.* (2003), Dikmen *et al.* (2005), Isik *et al.* (2010), Peter *et al.* (2011), Shen *et al.* (2006), Tan and Ghazali (2011)
13	Company's reputation/track record in completing the project in time with good quality and fair pricing	Arslan and Kivrak (2008), Butler *et al.* (2003), Gunhan and Arditi (2005), Isik *et al.* (2010), Lu *et al.* (2008), Mbugua *et al.* (1999), Shen *et al.* (2006)
14	Client's satisfaction in terms of product and services	Abu Bakar *et al.* (2011), Arslan and Kivrak (2008), Butler *et al.* (2003), Mbugua *et al.* (1999)
15	Customer satisfaction in terms of product and services	Abu Bakar *et al.* (2011), Butler *et al.* (2003), Mbugua *et al.* (1999)
16	Receipt of timely payment of bills as per contractual provision	Arslan and Kivrak (2008), Peter *et al.* (2011)
17	Implementing technological innovation plans in the organisation	Abu Bakar *et al.* (2011), Arslan and Kivrak (2008), Butler *et al.* (2003), Isik *et al.* (2010), Lu *et al.* (2008), Mbugua *et al.* (1999), Raravi *et al.* (2012)
18	Implementation of health and safety management plan	Butler *et al.* (2003), Isik *et al.* (2010), Peter *et al.* (2011), Shen *et al.* (2006)
19	Developing an appropriate organisational structure	Abraham (2003), Abu Bakar *et al.* (2011), Al-Mahrouq (2010), Dikmen *et al.* (2005), Lu *et al.* (2008), Shen *et al.* (2006), Tan and Ghazali (2011)
20	Technical competencies of the organisation in terms of latest technology and technical staff	Abraham (2003), Arslan and Kivrak (2008), Dikmen *et al.* (2005), Isik *et al.* (2010), Jalaliyoon *et al.* (2012), Jasra *et al.* (2011), Peter *et al.* (2011), Shen *et al.* (2006), Tan and Ghazali (2011)
21	Effective risk management capability in the organisation	Arslan and Kivrak (2008), Gunhan and Arditi (2005), Isik *et al.* (2010), Lu *et al.* (2008), Shen *et al.* (2006)
22	Competitive strategy used by the organisation	Abraham (2003), Chittithaworn *et al.* (2011), Dikmen *et al.* (2005), Isik *et al.* (2010), Lu *et al.* (2008)
23	Effectiveness of project management in improving schedule, cost and quality of the construction project	Abu Bakar *et al.* (2011), Arslan and Kivrak (2008), Butler *et al.* (2003), Gunhan and Arditi (2005), Isik *et al.* (2010), Shen *et al.* (2006), Tan and Ghazali (2011)

(*continued*)

Table II. List of success attributes and their sources

Table II.

Sl. No.	Success attributes	Sources
24	Availability of dynamic leadership in the organisation	Arslan and Kivrak (2008), Isik *et al.* (2010), Lu *et al.* (2008)
25	Effectiveness of human resource (HR) in its functioning	Dikmen *et al.* (2005), Isik *et al.* (2010), Jalaliyoon *et al.* (2012), Lu *et al.* (2008), Mbugua *et al.* (1999), Raravi *et al.* (2012)
26	Number of competitors in the market/industry	Arslan and Kivrak (2008), Gunhan and Arditi (2005), Dikmen *et al.* (2005), Peter *et al.* (2011)
27	Proper selection of the project type	Dikmen *et al.* (2005), Isik *et al.* (2010), Peter *et al.* (2011)
28	Professionalism/culture of the organisation	Butler *et al.* (2003), Gunhan and Arditi (2005), Dikmen *et al.* (2005)
29	Availability of equipment, material and labour as per requirement of the project	Gunhan and Arditi (2005), Peter *et al.* (2011), Shen *et al.* (2006)
30	Effectiveness of information flow in the organisation	Dikmen *et al.* (2005), Lu *et al.* (2008), Tan and Ghazali (2011)

Confederation of Real Estate Developers Association of India (CREDAI). The size of the organisations ranged from medium to large. Apart from the above-identified professionals, some project management consultants who were neither the member of CREDAI nor the member of BAI but had a very high experience in the construction industry were also requested to participate in the survey. The sample size that represents the population was calculated using the following formula (Ali *et al.*, 2013):

$$n = \frac{n'}{\left[1+\frac{n'}{N}\right]}, \tag{1}$$

where:

$$n' = \frac{p \times q}{V^2}, \tag{2}$$

where n = the required sample size, n' = the first estimate of sample size, N = the population size, p = the proportion of the characteristic being measured in the target population, $q = 1-p$, V = standard error of sampling population. In order to get the maximum sample size, the values of p and q were taken as 0.5. The standard error used in determining the sample size was kept at 5 per cent (maximum standard error allowed is 10 per cent). Based on the above formula, the required sample size was 78.

A total of 106 construction professionals from 90 different construction organisations participated in the survey. Out of 106 responses, 29 responses were received via e-mail for which 58 questionnaires were distributed, and 77 responses were received via personal interview. Out of the total 106 professionals, 49 were developers, 46 were contractors, while the remaining 11 were project management consultants. The average experience of respondents was 20 years. On the other hand, the average age of the participating organisations was 21 years.

Step 3: identification of success factors

Eight success factors were extracted when factor analysis using principal components method of extraction along with varimax rotation was performed on 28 success attributes out of 30 having mean value 3.5 and above. These success factors were experience and performance, top management competence, project factor, supply chain and leadership, availability of resources and information flow, effective cost control measures, favourable market and marketing team, and availability of qualified staff. Table III depicts the result of factor analysis.

Goal	Success factors	Success attributes
Success of construction organisations	SF-1: experience and performance (15.771%)	SA-1.1: client's satisfaction in terms of product and services (0.765)
		SA-1.2: implementation of health and safety management plan (0.764)
		SA-1.3: customer satisfaction in terms of product and services (0.728)
		SA-1.4: developing an appropriate organisational structure (0.621)
		SA-1.5: implementing technological innovation plans (0.617)
		SA-1.6: company's reputation/track record (0.583)
		SA-1.7: experience in construction business (0.557)
		SA-1.8: good relationship with local bodies, government organisations, etc. (0.512)
	SF-2: top management competence (8.730%)	SA-2.1: effective risk management capability (0.677)
		SA-2.2: professionalism/culture in the organisation (0.633)
		SA-2.3: proper selection of project type (0.628)
		SA-2.4: financial soundness of the organisation (0.584)
	SF-3: project factor (7.125%)	SA-3.1: availability of effective cash flow management plan (0.675)
		SA-3.2: effectiveness of project management (0.660)
		SA-3.3: receipt of timely payment of bills (0.595)
	SF-4: supply chain and leadership (6.904%)	SA-4.1: efficient supply chain management (0.792)
		SA-4.2: availability of dynamic leadership (0.704)
	SF-5: availability of resources and information flow (6.766%)	SA-5.1: effectiveness of information flow (0.730)
		SA-5.2: availability of equipment, material, and labour (0.605)
	SF-6: effective cost control measures (6.515%)	SA-6.1: favourable government policies (0.816)
		SA-6.2: favourable government policies (0.513)
	SF-7: favourable market and marketing team (6.268%)	SA-7.1: favourable market conditions (0.751)
		SA-7.2: efficient sales and marketing team (0.625)
	SF-8: availability of qualified staff (4.844%)	SA-8.1: availability of qualified staff (0.781)

Table III. Results of factor analysis

Reliability test

α test was performed on all the attributes with mean values 3.5 and above to check the reliability of data and internal consistency within the attributes. The value of α ranges from 0 to 1. Higher the value of α, greater is the internal consistency or the greater inter-criteria correlations and vice versa. As a rule of thumb, $\alpha > 0.7$ is acceptable (Doloi, 2009; Pongpeng and Liston, 2003). In this analysis, the value of α is 0.873, which indicates a good overall internal consistency of the attributes.

Step 4: obtaining pair-wise comparison response using questionnaire survey

In the second stage, 18 experienced construction professionals from 18 different construction organisations participated in the survey. All responses were collected via personal interviews. Out of the total 18 professionals, 8 were developers, 7 were contractors,

while the remaining 3 were project management consultants. The average experience of respondents was 24 years. On the other hand, the average age of the participating organisations was 23 years. The procedure followed for the selection of sample in the second stage of questionnaire survey was same as that of the first stage. The questionnaire was carefully designed and tested with the help of a pilot survey. Three experts with more than three decades of working experience participated in the pilot survey. Based on the feedback from the experts, minor corrections were carried out to improve the quality of the questionnaire. The questionnaire consisted of three parts: questions on success attributes; questions on success factors; and questions on respondents and their organisations.

The respondents were asked to indicate their preference of one criterion (factors/attributes) over the other while comparing two criteria based on a nine-point scale, as suggested by Saaty (1980).

Step 5: forming multiplicative preference relation (MPR) matrix

MPR matrix, $R = [r_{ij}]$, where $r_{ij} \in [(1/9), 9]$, was constructed for each success factor and its attributes. For n number of criteria (factors/attributes), only $(n-1)$ preferences such as r_{12}, r_{23}, ..., $r_{(n-1)(n)}$ were required. The responses of the experts were aggregated using geometric mean as given in the following equation (Patel *et al.*, 2016):

$$r_{ij} = \left(r_{ij}^{1} \times r_{ij}^{2} \times r_{ij}^{3} \times \ldots\ldots\ldots\ldots \times r_{ij}^{m}\right)^{\frac{1}{m}} \text{where } i, j \in (1, 2, 3, \ldots\ldots\ldots n), \tag{3}$$

where m is the number of respondents and r_{ij}^{m} is the evaluation of criteria i on criteria j by the mth respondent.

The MPR matrix for success factors and the MPR matrix for attributes of success factor SF-1 are shown in Tables IV and V, respectively. The MPR matrices for attributes of rest of the success factors were calculated in a similar fashion but have not been demonstrated due to space constraints.

Table IV. MPR matrix for success factors

	SF-1	SF-2	SF-3	SF-4	SF-5	SF-6	SF-7	SF-8
SF-1	1.00	0.38						
SF-2		1.00	0.63					
SF-3			1.00	2.35				
SF-4				1.00	0.44			
SF-5					1.00	2.17		
SF-6						1.00	3.06	
SF-7							1.00	0.24
SF-8								1.00

Table V. MPR matrix for attributes of SF-1

	SA-1.1	SA-1.2	SA-1.3	SA-1.4	SA-1.5	SA-1.6	SA-1.7	SA-1.8
SA-1.1	1.00	2.71						
SA-1.2		1.00	0.44					
SA-1.3			1.00	2.00				
SA-1.4				1.00	0.64			
SA-1.5					1.00	0.32		
SA-1.6						1.00	2.22	
SA-1.7							1.00	0.51
SA-1.8								1.00

Step 6: converting MPR matrix into FPR matrix

MPR matrix was converted to an FPR matrix $P=[p_{ij}]$, where $p_{ij} \in [0, 1]$, using the following equation (Chiclana *et al.*, 2001; Herrera-Viedma *et al.*, 2004; Patel *et al.*, 2016):

$$p_{ij} = \frac{1}{2}(1+\log_9 r_{ij}), \tag{4}$$

In Equation (4), $\log_9 r_{ij}$ is used since r_{ij} lies in the interval [1/9, 9]. In other words, if r_{ij} lies in the interval $[1/n, n]$, then $\log_n r_{ij}$ will be used.

As the consistency of the FPR matrix is based on additive transitivity, rest of the elements of the matrix were calculated using the following equations (Chen and Chao, 2012):

$$p_{ij}+p_{ji} = 1, \forall i, j \in (1, 2, ..., n), \tag{5}$$

$$p_{ij}+p_{jk}+p_{ki} = 3/2, \forall i \lhd j \lhd k, \tag{6}$$

$$p_{i(i+1)}+p_{(i+1)(i+2)}+.....+p_{(i+k-1)(i+k)}+p_{(i+k)i} = \frac{(k+1)}{2}\forall i \lhd j. \tag{7}$$

The FPR matrix for success factors and the FPR matrix for attributes of SF-1 are shown in Tables VI and VII, respectively. The FPR matrix for attributes of rest of the success factor was calculated in a similar manner but could not be shown here due to space constraints.

In few cases, some of the elements in the FPR matrix do not fall in the interval [0, 1] but fall in the interval $[-k, 1+k]$, $k > 0$. Then, the FPR matrix is transformed by a function, called transform function, in which the elements fall within the interval [0, 1], preserving the reciprocity and additive consistency. The matrix $P' = f(P)$ is called a consistent fuzzy preference relation matrix.

	SF-1	SF-2	SF-3	SF-4	SF-5	SF-6	SF-7	SF-8
SF-1	0.50	0.28	0.18	0.37	0.18	0.36	0.62	0.29
SF-2	0.72	0.50	0.39	0.59	0.40	0.58	0.83	0.51
SF-3	0.82	0.61	0.50	0.69	0.51	0.69	0.94	0.61
SF-4	0.63	0.41	0.31	0.50	0.31	0.49	0.75	0.42
SF-5	0.82	0.60	0.49	0.69	0.50	0.68	0.93	0.60
SF-6	0.64	0.42	0.31	0.51	0.32	0.50	0.75	0.43
SF-7	0.38	0.17	0.06	0.25	0.07	0.25	0.50	0.17
SF-8	0.71	0.49	0.39	0.58	0.40	0.57	0.83	0.50

Table VI. FPR matrix for success factors

	SA-1.1	SA-1.2	SA-1.3	SA-1.4	SA-1.5	SA-1.6	SA-1.7	SA-1.8
SA-1.1	0.50	0.73	0.54	0.70	0.59	0.34	0.52	0.37
SA-1.2	0.27	0.50	0.31	0.47	0.37	0.11	0.29	0.14
SA-1.3	0.46	0.69	0.50	0.66	0.56	0.30	0.48	0.33
SA-1.4	0.30	0.53	0.34	0.50	0.40	0.14	0.32	0.17
SA-1.5	0.41	0.63	0.44	0.60	0.50	0.24	0.42	0.27
SA-1.6	0.66	0.89	0.70	0.86	0.76	0.50	0.68	0.53
SA-1.7	0.48	0.71	0.52	0.68	0.58	0.32	0.50	0.35
SA-1.8	0.63	0.86	0.67	0.83	0.73	0.47	0.65	0.50

Table VII. FPR matrix for attributes of SF-1

The transform function is computed using the following equation (Chen and Chao, 2012; Patel *et al.*, 2016):

$$f: [-k, 1+k] \rightarrow [0, 1],$$

$$f(p) = \frac{(p+k)}{(1+2k)}. \tag{8}$$

Where p is the element in the FPR matrix falling in the interval $[-k, 1 + k]$.

Step 7: relative weight and ranking of success factors and their attributes
The relative weight and rankings of the success factors and their attributes were computed using the following equation (Chen and Chao, 2012):

$$w_i = \frac{\sum_{j=1}^{n} p_{ij}}{\sum_{i=1}^{n}\left(\sum_{j=1}^{n} p_{ij}\right)}. \tag{9}$$

The results are shown in Tables VIII and IX.

Step 8: determining normalised weight of success attributes
A comparison matrix of success factors and their attributes was prepared to calculate the normalised weight of the success attributes (W) using the following equation (Patel *et al.*, 2016):

$$W = W_i \times W_j, \tag{10}$$

Table VIII. Relative weight and ranking of success factors

Success factors	Row average	Weightage	Rank
SF-1	2.78	0.087	7
SF-2	4.53	0.141	3
SF-3	5.37	0.168	1
SF-4	3.81	0.119	6
SF-5	5.30	0.166	2
SF-6	3.89	0.122	5
SF-7	1.85	0.058	8
SF-8	4.47	0.140	4

Table IX. Relative weight and ranking of attributes of SF-1

Success attributes	Row average	Weightage	Rank
SA-1.1	4	0.134	3
SA-1.2	2	0.077	8
SA-1.3	4	0.124	5
SA-1.4	3	0.085	7
SA-1.5	4	0.110	6
SA-1.6	6	0.175	1
SA-1.7	4	0.129	4
SA-1.8	5	0.167	2

where W_i = weight of success factors and W_j = weight of success attributes. Table X shows the normalised weights of success attributes.

The success attributes were ranked as per their normalised weight in the descending order. For example, the success attribute with the highest weight of 0.140 was given rank 1, while the success attribute with the next higher weight of 0.102 was given the second position and so on.

The Spearman's rank correlation coefficient (SRCC) test was conducted to analyse the ranking results of the success attributes using FPR with that of using simple statistical analysis during the first-stage questionnaire. The SRCC is used to investigate the strength of the relationship between two different sets of data.

The SRCC, R, is calculated using following two formulae:

(1) When data do not have tied ranks:

$$R = 1 - \frac{6\sum_{1}^{n} d_i^2}{n(n-1)^2} \tag{11}$$

where d_i = difference in paired ranks and n = number of cases.

(2) When data have tied ranks:

$$R = \frac{\sum_{1}^{n} (xi - \overline{x}) \times (yi - \overline{y})}{\sqrt{\sum_{1}^{n} (xi - \overline{x})^2 \times \sum_{1}^{n} (yi - \overline{y})^2}} \tag{12}$$

where i = rank.

Success factors	Weight of the success factors (W_i)	Rank of the success factors	Success attributes	Weight of the success attributes within the factor (W_j)	Normalised weight of the attributes ($W_i \times W_j$)	Overall rank of the attributes
SF-1	0.087	7	SA-1.1	0.134	0.012	19
			SA-1.2	0.077	0.007	24
			SA-1.3	0.124	0.011	21
			SA-1.4	0.085	0.007	23
			SA-1.5	0.110	0.010	22
			SA-1.6	0.175	0.015	17
			SA-1.7	0.129	0.011	20
			SA-1.8	0.167	0.014	18
SF-2	0.141	3	SA-2.1	0.200	0.028	15
			SA-2.2	0.261	0.037	12
			SA-2.3	0.224	0.032	14
			SA-2.4	0.314	0.044	11
SF-3	0.168	1	SA-3.1	0.295	0.050	9
			SA-3.2	0.394	0.066	4
			SA-3.3	0.311	0.052	8
SF-4	0.119	6	SA-4.1	0.450	0.054	7
			SA-4.2	0.550	0.066	5
SF-5	0.166	2	SA-5.1	0.384	0.064	6
			SA-5.2	0.616	0.102	2
SF-6	0.122	5	SA-6.1	0.602	0.073	3
			SA-6.2	0.398	0.048	10
SF-7	0.058	8	SA-7.1	0.418	0.024	16
			SA-7.2	0.582	0.034	13
SF-8	0.140	4	SA-8.1	1.000	0.140	1

Table X. Normalised weight of attributes

The correlation coefficient R was found to be 0.607, and the two-tailed value of P was 0.002 (< 0.05). Hence, the strength of correlation between the responses of two sets of respondents would be considered statistically significant.

Results

From Table X, project factor (SF-3) received the highest weight, i.e. 0.168, and was placed at the first position. Thus, the respondents agreed on the importance of the project factor. The availability of effective cash flow management plan, the effectiveness of project management in improving schedule, cost and quality of the construction project, and receipt of timely payment of bills as per contractual provision are measured at the construction project level and support the success of the project, and hence the name project factor. Effective cash flow management plan and receipt of timely payment are crucial for a construction organisation to run their businesses efficiently. As the project is the core of the construction business, the competency of the project management plays a vital role in the overall success of the construction organisation. Effective project management ensures better schedule, cost and quality performance of the project.

The availability of resources and information flow (SF-5) was placed at the second position with the average weight of 0.166. If the resources like materials, workforce and equipment are available as per the project requirement, it is more likely that the project will be successful if handled appropriately, and hence the organisation will also be successful. The findings of Dikmen *et al.* (2005) also highlight the importance of resources as a driver of OE. An efficient information flow system highly affects construction business as it keeps the organisation updated about the new project, price information about labour, materials and equipment. It also keeps the construction organisations updated about the price and the range of services offered by other organisations to compete in the market.

Top management competence (SF-2) received an average weight of 0.141 and was placed at the third position by the respondents. The organisations should possess the adequate risk management capability to increase the probability of higher profit margin in riskier projects. Professionalism/culture in the organisation should be such that every employee should have freedom to express their thoughts and implement their ideas so that they can enjoy working in the organisation. Appropriate culture enhances the dedication of the employee which plays a vital role in the success of the organisation. Financial soundness of the organisation indicates its capability to execute the projects. The credibility and reputation of the organisation increase in the market among their clients and suppliers with an increase in financial strength. The finding is in line with Cheah *et al.* (2004) and Dikmen *et al.* (2005).

The availability of qualified staff (SF-8) was placed at the fourth position with the average weight of 0.140. Qualified staff in the organisation is the key to success for the organisation which directly affects the schedule, cost and quality performance of the projects. Qualified staff has a direct implication on the technical competency of the organisation which is measured by its construction methods, experience and productivity of their employees, the speed of activities and the quality of the products. A company's capability in terms of qualified staff is considered as an important factor in the assessment of potential bidders in the international construction business (Gunhan and Arditi, 2005).

Effective cost control measures (SF-6) received an average weight of 0.122 and was placed at the fifth position. Effective cost control measures ensure the lowest possible project cost in the organisation, keeping in view the owner's investment objectives. Favourable government policy also contributes to the overall cost of the organisation indirectly. Cost control measure was among top five determinants for the success of construction organisation in the research of Butler *et al.* (2003).

Supply chain and leadership (SF-4) received the sixth rank with an average weight of 0.119. Efficient supply chain management ensures the delivery of right materials in the right

quantity at the right time at the right price by the supply chain management team. Lu *et al.* (2008) also found efficient supply chain management as a significant factor in the success of construction organisation. Dynamic leadership involves developing and communicating mission, vision and values to the members of an organisation. It is expected to create an environment for empowerment, innovation, learning and support by a successful leadership (Isik *et al.*, 2010).

Experience and performance (SF-1) appeared to influence the success of the construction organisation slightly. The respondents have given an average weight of 0.087, and it was ranked at the seventh position. The experience is highly related to a company's knowledge management competency. Learning in an organisation can be effective only when the lessons learned in the past could be utilised in future (Isik *et al.*, 2010). Client's and customer's satisfaction in terms of product and services is an important parameter which affects the construction business in terms of repeat business from the client. Relationships with customers, material suppliers, sub-contractors, etc., are also important, and they can help the organisation in arranging and managing the additional source of finance in the form of credit arrangement.

Favourable market and marketing team (SF-7) received the last rank with an average weight of 0.058. The market, in which the organisation operates, should be favourable in terms of a number of competitors and the market's growth rate to run the construction business smoothly. Analysis of the market in which construction organisation operates or has an interest in developing its position is very important. Developing a sales and marketing plan is critical to the success of the construction organisation. Every organisation should have a dedicated department to analyse the market in which it operates (Abraham, 2003).

Among the success attributes, the availability of qualified staff (SA-8.1) is the most important attribute with the highest weight 0.140 followed by availability of equipment, material and labour as per requirement of the project (SA-5.2) with a weight of 0.102. The implementation of health and safety management plan (SA-1.2) and developing an appropriate organisational structure (SA-1.4) are the least important attributes with the lowest weight of 0.007.

Discussion

The purpose of this study was to evaluate and rank the success factors and their attributes already identified through the previous research of the authors, which affect the success of the construction organisations.

The findings of ranking analysis using FPR indicate the following top 10 significant success attributes: availability of qualified staff in the organisation; availability of equipment, material and labour as per requirement of the project; availability of cost control measures in the organisation; effectiveness of project management in improving schedule, cost and quality of the construction projects; availability of dynamic leadership in the organisation; effectiveness of information flow in the organisation; efficient supply chain management; receipt of timely payment of bills as per contractual provision; availability of effective cash flow management plan; and favourable government policies such as tax exemptions on projects, various taxes on construction materials, low bank interest rate, easy access to finance, etc., in support of the project.

Out of the total 24 success attributes, above 10 success attributes alone account for a total weight of 0.714. Similarly, out of the eight success factors, five success factors namely project factor (SF-3), availability of resources and information flow (SF-5), top management competence (SF-2), qualified staff (SF-8) and effective cost control measures (SF-6) account for a total weight of 0.735. Hence, it is wise to focus on these success attributes/success factors rather than paying attention to all success attributes/success factors to achieve maximum benefit from the available limited resources.

When the authors tried to correlate the success factors for the Indian construction organisation with the success factors of construction projects in India, it was observed that the top management competence and their leadership were significant factors for the success of construction organisations, whereas the project manager's competence and their leadership were significant for the success of project (Iyer and Jha, 2005, 2006; Jha and Iyer, 2007). It indicates that its business unit head highly influences the success of the business at any level. The finding is supported by Suleman (2013) stating that "the strong managers are one of the most critical components of employee success as employees leave managers, not companies" and Peter Ferdinand Drucker's quote "The productivity of work is not the responsibility of the worker but of the manager".

While comparing the findings of this research with that of other research across the world, it was found that some of the success attributes which were significant in India were also found to be significant in countries like China, Malaysia, Turkey, etc. These attributes are: availability of equipment, material and labour as per requirement of the project (Isik *et al.*, 2010); availability of effective cash flow management plan (Arslan and Kivrak, 2008); effectiveness of project management in improving schedule, cost and quality of the construction project (Isik *et al.*, 2010; Tan and Ghazali, 2011; Gunhan and Arditi, 2005); availability of dynamic leadership in the organisation (Arslan and Kivrak, 2008; Isik *et al.*, 2010); efficient supply chain management (Isik *et al.*, 2010); cost control measures in the organisation (Butler *et al.*, 2003; Lu *et al.*, 2008); and receipt of timely payment of bills as per contractual provision (Arslan and Kivrak, 2008). But the success attributes, namely financial soundness of the organisation, efficient sales and marketing team in the organisation, company's reputation/track record, experience in construction business, customer satisfaction in terms of product and services, developing an appropriate organisational structure, implementing technological innovation plans in the organisation and so forth, were found to be significant in these countries, whereas these success attributes were not considered significant in India. On the other hand, the availability of qualified staff in the organisation, favourable government policy and the effectiveness of information flow were not found to be significant in these countries, whereas these success attributes were considered significant in India.

In India, experts believe that qualified staff in the organisation can directly affect the schedule, cost and quality performance of the construction. Company's technical competency is measured by analysing the company's construction methods, experience and productivity of their staff, the speed of activities and the quality of the products. Government policies, such as tax exemptions on various projects, various taxes on construction materials, low bank interest rate, easy access to finance, etc., play a significant role in terms of financial support and ease to do the business which encourages the sustainability of construction organisations in the business. Effective information flow keeps the organisation updated about the new project, price information about labour, materials and equipment. It also keeps updated about the price and the range of services offered by other organisation to compete in the market due to high competition in Indian construction industry. To maintain a positive cash flow and to repay short-term liabilities, such as labour payments, material payments and other financial liabilities, timely payments of the bill is critical. Sometimes, non-payment of the bill forces the construction organisations, with the poor financial background, to stop the work, causing a dispute between contractors and client and delay in the project. It has also been found that a construction organisation had to close the business due to non-payment of bills at several projects at a time.

For the top management of Indian construction organisation, these success attributes/factors can be used as a yardstick for their success. Most of these success attributes/factors

form the basis of contractor selection by several clients. Many clients prefer to select a contractor who fulfils these parameters so that the risk of time overruns, budget overruns, low quality of work, workforce scarcity, lack of supervision, etc. could be reduced. The construction organisations can improve their performance by meeting these criteria, thus improving the chances of getting more business.

Although this research was undertaken by the professionals engaged in construction organisations in India, the perception of construction organisation operating in other countries might be different. However, the study may be useful for the South Asian countries, such as Pakistan, Afghanistan, Bangladesh, Nepal, Sri Lanka, Bhutan, and Maldives, and other developing countries due to the similarity in work environment and other conditions.

Conclusion

The construction business is considered as one of the riskiest businesses in the world, and the goal of any business is to achieve success. There are several factors which affect the success of construction organisation. It is tough for any organisation to concentrate on too many factors for achieving success due to their limited resources. Hence, it becomes necessary to identify those factors which are critical to the success of the organisation. By doing so, an organisation can focus on a limited number of factors rather than focussing on too many factors. This study attempts to use FPR to find the relative weights of a set of success factors and their attributes affecting the success of a construction organisation engaged in real estate business. A questionnaire survey approach was adopted to evaluate the eight success factors and their attributes identified in the past study by authors.

Application of the FPR and their finding reveals that project factor is the most important factor for the success of construction organisation followed by availability of resources and information flow, top management competence, qualified staff and effective cost control measures. It is recommended that improvements in these areas by construction organisations would increase the chances of their success in the construction business. It is interesting to note that the success factors, namely, favourable market and marketing team and experience and performance, were placed at the last and second last position in the ranking analysis. Experts believe that favourable market and marketing team and experience and performance are not always the basis of success. The organisation needs to thoughtfully consider how to create value to clients and customers during planning process which can be achieved by strategic thinking. Strategic thinking identifies the need for the clients, customers, organisation and the staff in the process. Benchmarking is also incorporated in planning to ensure that the industry best practices are included in the vision of the organisation. Strategic thinking evaluates the strengths and weaknesses of the organisation and looks for new and better ways to improve. It is the top management and leader in the organisation who ensure that the business is strategically planned.

Findings of this study are based on the viewpoint of the experts of construction organisations engaged in building projects in India. However, the perspective of construction organisations involved in other sectors might be different. For the construction organisations involved in other areas, different sets of success attributes/factors and evaluators would have to be identified based on their focus. Hence, the study may further be extended by including a diversified group of construction organisations. Consequently, the factors leading to the success of construction organisation engaged in building projects could be compared with that of the construction organisation involved in other sectors operating in India as well as other similar countries which might be a valuable research.

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Appendix

Application of FPR

The AHP, proposed by Saaty, is one of the most popular techniques used in multi-criteria decision-making processes using a pair-wise comparison of alternatives based on expert's judgement (Fong and Choi, 2000; Al-Harbi, 2001; Vaidya and Kumar, 2006). Two statistical models are commonly used to determine the relative importance of two or more alternatives in terms of their weight. These are MPR and FPR (Wu, 2009). The element of comparison matrix of MPR is stated as a_{ij} which defines the dominance of alternative i over j, where $1 < a_{ij} < 9$ and $a_{ij} = (1/a_{ji})$. On the other hand, the element of comparison matrix of FPR is stated as a_{ij} which defines the preference of alternative i over j, where $0 < a_{ij} < 1$ and $a_{ij}+a_{ji} = 1$ (Girsang *et al.*, 2015).

The AHP uses the MPR method which requires $\{n(n-1)\}/2$ comparisons to prepare pair-wise comparison matrix. As the number of attributes increases, the number of comparison questions increases. As the comparison questions increase, the possibility of respondents replying with inaccurate judgement increases, which gives an inconsistent result with consistency ratio more than 0.1. This method requires the experts to review their decision which is time consuming. FPR can be used to overcome the problem of inconsistency (Herrera-Viedma *et al.*, 2004). The FPR drastically reduces the number of pair-wise comparisons from $\{n(n-1)\}/2$ to only $(n-1)$ comparisons. Hence, the process becomes more convenient and efficient. The decision makers take less time and effort in making the pair-wise comparisons of criteria (Chen and Chao, 2012).

This study utilises the structure of criteria in AHP using FPRs. The FPRs have been used in various areas of research such as implementation of knowledge management (Wang and Chang, 2007), partnership selection (Wang and Chen, 2007), facility locality selection (Boran, 2011), supplier selection (Chen and Chao, 2012), risk assessment for construction projects (Kuo and Lu, 2013), contractor selection in construction (Ibadov, 2015), financial analysis in construction (Ilieva and Dimitrov, 2015) and hazard assessment for construction projects (Patel *et al.*, 2016). Thus, the existing literature reveals the soundness and applicability of FPRs in this study.

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