International Journal of Construction Management

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tjcm20

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To cite this article: Neelu Nandan Vibhakar, Sparsh Johari, Kamalendra Kumar Tripathi & Kumar Neeraj Jha (2021): Development of financial performance evaluation framework for the Indian construction companies, International Journal of Construction Management, DOI: 10.1080/15623599.2021.1983929

To link to this article: https://doi.org/10.1080/15623599.2021.1983929

Published online: 07 Oct 2021.

INTERNATIONAL JOURNAL OF CONSTRUCTION MANAGEMENT
https://doi.org/10.1080/15623599.2021.1983929

Development of financial performance evaluation framework for the Indian construction companies

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ABSTRACT

The construction sector is a major contributor to economic activities in a developing country like India. Hence, it becomes inevitable to continuously monitor performance of the Indian construction companies to take adequate steps for their improvement. This study aims to develop a financial performance evaluation framework (FPEF) for construction companies based on the financial factors derived in the previous study, such as investor return, business efficiency, and operations management. A stratified sampling technique was adopted to select a sample of 100 Indian construction companies based on scope, sub-sectors, age, enlistment at the national stock exchange, and the availability of data of 20 financial ratios for each company in Capitaline database from 2008–17, which translated to a set of 1000 data records. Multi-Attribute Decision Making methods like Shannon-Weaver entropy and Simple Additive Weighting have been used to achieve the objective. As a result, the net financial performance score and performance grade of each company were determined to rank and designate them into five categories for assigning recommendations for improvement. The developed FPEF, including the financial performance equation, will help the concerned stakeholders to take adequate steps for improvement by providing company's financial trends with respect to time without adopting cumbersome methodology.

KEYWORDS
Entropy method; multicriteria decision making; performance grade; simple additive weighing

Introduction

India has retained its position as the fastest-growing major economy globally due to its strong economic fundamentals. These fundamentals include favourable demographics and reform momentum gained after various government initiatives such as Make in India, Digital India, Startup India, Skill India (Singh and Jaiswal 2018) along with Foreign Direct Investment (FDI) policy reforms and Goods and Services Tax (GST) (Nayyar and Mukherjee 2020). As per the Central Statistics Office (CSO) and International Monetary Fund (IMF), India's GDP grew by 6.81 per cent in 2018–19 (Economic Survey 2018). As per a Boston Consulting Group report, India is expected to be the third-largest consumer economy by 2025 because its consumption may triple to US$4 trillion, owing to a shift in consumer behaviour and expenditure pattern. Because of its significant role in the world economy and being home to a massive population of 1.3 billion, which is approximately 18% of the world's population, India has often deemed the leader of the developing economies. The Indian construction sector is a significant contributor to economic activity, often credited with providing employment to more than 52 million people and directly affecting more than 200 other industries. Further, it is estimated that it will require 100 million workforces by 2022 (Tripathi and Jha 2018a).

The construction sector is still recognized as an informal sector in India. The essence of informality in any sector is attributed to the absence of regulations. In the Indian construction sector, this absence of regulations is highlighted in four aspects: lack of regulation of enterprises, of the terms and conditions of employment, of the process of construction, and the product (Wells 2007). According to Tripathi et al. (2019), construction is recognized as a high-risk business. Also, it faces a higher proportion of business failure than other industries (Kangari 1988; El-Kholy and Akal 2019). This statement is further bolstered by the fact that the fluctuations in the share prices for construction companies are more comprehensive than the general market index (Hood et al. 2006; Wagle 2006).

Moreover, recent phases of global economic slowdown and the introduction of demonetization and GST have been further unsettling for the Indian construction industry. The present economic reform of demonetization has hit the construction industry badly with significant wage implications (Shirley 2017), which are indicated by the slump in the growth of the construction sector (CSO 2016–17). Also, the glitches received due to poor implementation of the GST had an impeding effect on small and medium scale enterprises (Baliyan and Rathi 2018). Hence, it becomes inevitable to monitor the performance of the Indian construction sector so that the concerned stakeholders may take adequate steps for its improvement (Tripathi et al. 2019).

The relevance of using financial ratios as a tool for assessing and comparing the financial performance of the companies is well established (Soewin and Chinda 2020). There are more than 50 financial ratios that cover various aspects of the business undertaken by the company (Charbaji 2001). However, some of them are more significant than others in determining the company's financial status. This significance varies from one industry to another and from one country to another due to various

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economic factors (Cinca et al. 2005; Vibhakar et al. 2020). Hence, it is very tedious and almost impractical to consider all the ratios every time to assess an industry's financial status due to many companies of a specific sector. Thus, there is a need to find out the significant ratios of the Indian construction industry and consequently identify critical financial factors that would influence the growth of the Indian construction industry.

According to Vibhakar et al. (2020), 20 financial ratios of 94 Indian construction companies for the last ten years (from 2008–2017) were identified, which govern the financial performance of the Indian construction industry. These financial ratios resulted in five SFPFs – investor return factor, business efficiency factor, operations management factor, activity efficiency and risk coverage factor, and assets management factor when subjected to factor analysis. These factors provide crucial information about the company's financial performance and help the company and the stakeholders plan its strategies and operations using these identified SFPFs. The key terms which are used in this study are described in the Appendix.

Most of the studies involving the development of performance evaluation models have employed financial ratios to predict the companies' performance. However, these financial ratios are bound to change due to various economic factors such as interest rates, inflation rates or the effect of multiple phases of business cycles. This instability of ratios will cause the alteration of results pertaining to the determination of a financial state or predictive ability of the models using specific cut-off points. Thus, it is required to develop a comprehensive framework that incorporates various financial ratios together while evaluating performance and addresses the problem of alteration of ratios and cut-off points with time. Carreras Simó and Coenders (2020) and Pinches et al. (1973) concluded that the factors representing the various groups of financial ratios obtained after factor analysis are found to be reasonably stable over time. Hence, to address selection, factor analysis of financial ratios has been performed by various researchers. However, the scope of most of these studies was limited to the identification of critical financial ratios and grouping them into a small number of factors that may be deemed significant in affecting the specific industry in a particular country. For the development of the performance evaluation model, many studies have combined the essential financial ratios identified due to various techniques such as factor analysis, DEA, Delphi, questionnaire survey, brainstorming, etc. But choosing financial ratios for model formation instead of significant factors leaves these models with the problem of altering ratios and cut-off points with time.

Hence, there is a need to develop a financial performance evaluation framework (FPEF) that combines all the identified SFPFs (Vibhakar et al. 2020), which are found to be reasonably stable over time (Carreras Simó and Coenders 2020), instead of individual financial ratios to evaluate the financial performance of the company. These SFPFs were – investor return factor, business efficiency factor, operations management factor, activity efficiency and risk coverage factor, and assets management factor. Subsequently, factor scores were obtained to develop the FPEF for ranking of the Indian construction companies.

In this study, an FPEF is developed for the companies based on the factor scores of the SFPFs identified in the previous research by authors (Vibhakar et al. 2020). The performance of 100 Indian construction companies was evaluated in this study which includes two objectives. First, the selected companies were ranked according to the financial performance scores. Second, the companies were categorized as per percentile scores formulated based on NFPS. For this purpose, a rich data set of corresponding SFPFs of these companies was used over ten years (2008–2017) obtained from Capitaline database. The individual financial performance score (IFPS) was then computed, by adopting Multi-Attribute Decision Making (MADM) method namely Shannon-Weaver entropy, to evaluate the performance of the companies for each year from 2008 to 2017. Using the IFPS values of 10 years, the net financial performance score (NFPS) was calculated for each company by using Simple Additive Weighing (SAW), representing the average score of each company for ten years. The companies were ranked based on their NFPS. Subsequently, the companies' performance grade (PG) was evaluated and accordingly, companies were categorized based on their relative performance in the Indian construction industry. Information regarding the company's financial status covering aspects such as the impending risk of default and bankruptcy, the status of management policies and strategies, and recommendations for actions required for improvement was provided for each category. Finally, FPE was derived, which can directly give the IFPS for any company helping in its evaluation as per the PG.

Literature review

Need for monitoring financial performance

In earlier times, the success of the construction organizations was deemed synonymous with a good track record of successful project completion within the time, cost, and stipulated quality parameters (Johari and Jha 2021; Sinesilassie et al. 2018). However, in recent times, it has been observed that successful completion of the project does not always ensure the success of the construction organization. The construction organizations may even fail or go bankrupt despite the success of their projects due to the high risk involved in the business (Tripathi and Jha 2018b). Therefore, it is necessary to continuously monitor the financial performance of the construction organizations concerning other organizations in the construction industry.

Factors influencing financial performance of companies

The significant factors that influence the performance of construction companies have been identified in the previous study (Vibhakar et al. 2020), viz., investor return, business efficiency, operations management, activity efficiency and risk coverage factor, and asset management factor.

Investor return factor includes return on equity, return on capital employed, PBIDT/net assets, and sales/net assets. These four ratios provide important information about the returns on investments received by stakeholders (Kabajeh et al. 2012). This element might assist a company in determining its profit-making ability for the investments it has made. As a result, it can plan its future investments properly. Stakeholders can decide whether to use their own money or raise it through stock in the future based on a deeper examination of the constituent ratios.

Business efficiency factor includes the ratios of cash profit margin (CPM) and PBIDT/sales. CPM is depicted by the profit earned by the company (without excluding depreciation) in return for its sales. These two ratios, when combined, reflect the efficiency of the business. As a result, this component is known as the 'business efficiency factor (BEF)'. In the case of construction businesses, this component shows the firm's profit-making capability in relation to the overall work undertaken, i.e. sales.

Thus, a higher value for this component indicates that the firm is able to earn more profits from the projects it undertakes, i.e. the firm is wise in project selection and efficient in project execution. Operations management factor includes the ratios of sales per unit expenditure and net profit per unit expenditure. These ratios combined indicate how effectively the firm can use its operating expenditure to increase sales and profits. As a result, this group is known as the 'operations management factor (OMF)'. A higher value for this component indicates that the firm is employing its yearly operating expenditure efficiently in order to generate bigger profits and sales (Felder et al. 1996).

Activity efficiency and risk coverage factor includes the inventory turnover ratio and the interest coverage ratio. A higher score on this element indicates that the firm is efficient in using its inventory to generate sales while also producing enough profit to meet its interest charges on the loan used to carry out the operation and efficiently manage the risk of default (Dothan 2006; Banerjee et al. 2009; Ji 2019). If a firm intends to take out a loan to grow its inventory, this component may be used to determine if the firm is capable of increasing sales through greater inventory while still making enough profits to pay the interest charges. As a result, if the firm places a lesser value on this element, it should avoid taking out more loans.

Asset management factor includes fixed assets turnover ratio and current ratio. This component consists of ratios relating to a company's assets, such as the efficiency with which it generates revenues from its fixed assets (fixed asset turnover) (Dash and Ravipati 2009) and its capacity to meet its liabilities with current assets (current ratio) (Johnson and Mitton 2003, Chen et al. 2015). As a result, this component is known as the 'asset management factor (AMF)'. A higher value for this component indicates that the corporation is efficiently employing its fixed assets while still having adequate current assets to meet its liabilities.

Available financial performance evaluation models

Researchers have developed several performance evaluations models for assessing the financial status or predicting the bankruptcy of non-construction (Edmister 1972, Keasey and Watson 1986, Ohlson 1980) and construction companies (Mason and Harris 1979, Kangari 1988, Russell and Jaselskis 1992). In general, these models involved computation of a company's financial ratios and comparing it with the financial ratios of the other companies or industry's average to predict the danger of bankruptcy or the chances of financial failure looming soon. Construction clients typically use these models for the selection of contractors.

Mason and Harris (1979) devised a six-variable ratio model based on a multiple regression approach that helps assess the contractors' financial status by issuing the warning signals of looming financial dangers in the future. They introduced a combined Z-score for the construction firms, where a positive score indicated long-term solvency of the firms and vice versa for negative scores. However, the redundancy and inconsistency of the variables used in Mason and Harris (1979) model were pointed out by Edum-Fotwe et al. (1996).

Kangari (1988) compared the construction industry failure rate changes with five macroeconomic variables, viz. average prime interest rates, amount of construction activity, inflation, and new business entering the construction industry. Considering these factors, the study developed a model based on statistics for evaluating and forecasting these failures. Companies can use this model to determine the peak season of failure rates so that the management actions may be taken in advance and the chances of business failure may be lowered. A seven-variable model was developed by Abidali (1990) to predict the long-term solvency of companies during the tender evaluation process. The inconsistency of this model was highlighted by Edum-Fotwe et al. (1996).

Issues with the available financial performance evaluation models

Most of the above studies used financial ratios for predicting the performance of the companies. However, these financial ratios are bound to change due to various economic factors such as interest rates, inflation rates or the effect of multiple phases of business cycles. This instability of ratios will cause the alteration of results pertaining to the determination of financial status or the predictive ability of the models using specific cut-off points (Singh and Tiong 2006). The values of these cut-off points may also have changed within the development and prediction periods.

The selection of financial ratios has always been complex and problematic (Edum-Fotwe et al. 1996) due to the high probability of information overlaps. In case if all the ratios are considered, there will be a problem of redundancy. On the other hand, if only independent ratios are considered, it will lead to the omission of certain information from the process which will, in turn, result in insufficient information for determining the company's financial performance. The method of choosing critical ratios for the evaluation model might lead to losing some vital information. Thus, it is required that a comprehensive FPEF is developed that incorporates various financial ratios together while evaluating performance and addresses the problem of alteration of ratios and cut-off points with time. Since there is a large set of financial ratios available, the process of analyzing these ratios and comparing different companies and industries becomes a tedious task. Therefore, it is necessary to reduce the financial ratios into smaller numbers of factors so that information is not lost, and further analysis can be carried out on the smaller number of factors to form the performance evaluation framework.

For the formation of the performance evaluation model, many studies have combined the essential financial ratios identified as a result of various techniques such as factor analysis, DEA, Delphi, questionnaire survey, brainstorming etc. such as Kangari et al. (1992) for US construction companies; Singh and Tiong (2006) for Singaporean construction companies; Elyamany et al. (2007) for Egyptian construction companies; Chen et al. (2012) for Chinese construction companies; Balatbat et al. 2010 for Australian construction companies; Hsu (2013) for Taiwanese opt-electronic companies; Deng and Smyth (2013) for U.K.'s construction companies; Krivka (2014) for Lithuanian industries; Krivka and Stonkute (2015) for Lithuanian construction companies, etc. But choosing financial ratios for model formation instead of significant factors leaves these models with the problem of altering ratios and cut-off points with time.

Research gap

As per the discussions in the literature review, there is a need to develop a performance evaluation framework that combines all the identified SFPFs, which are found to be reasonably stable over time (Pinches et al. 1973; Carreras Simó and Coenders

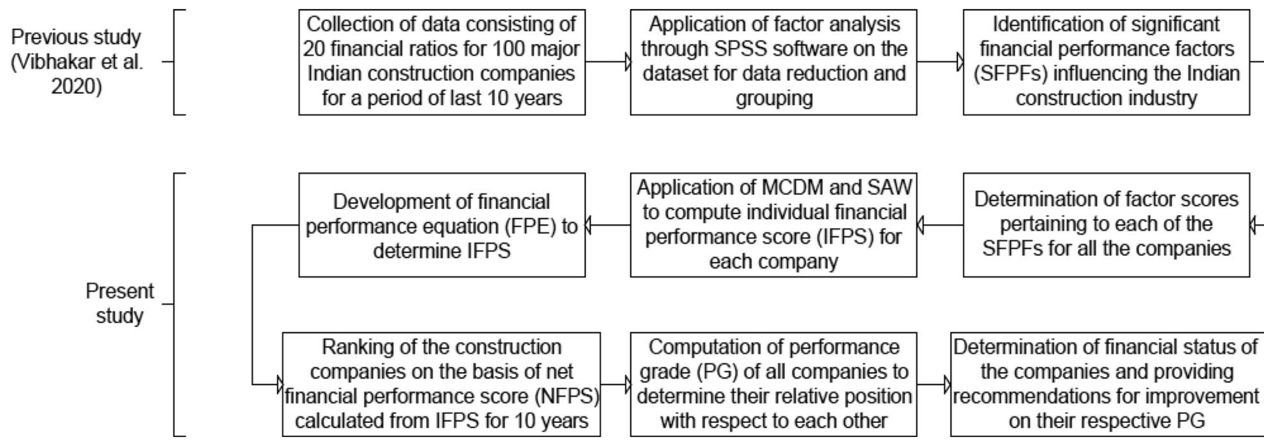

Figure 1. Research design.

2020), instead of individual financial ratios to evaluate the financial performance of the company (Edum-Fotwe et al. 1996). Apart from this, more literature review regarding the importance of financial ratios, factor analysis, use of factor analysis in a global context and Indian context has been provided in Vibhakar et al. (2020), which forms the basis of this study. There are reasonable number of studies where factor analysis has been employed to identify SFPFs for various industries including construction industry for countries such as Turkey, Australia, Taiwan, China, Malaysia, etc. but not for some prominent developing economies like India (Öcal et al. 2007, Balatbat et al. 2010, Hsu 2013, Chen et al. 2012, Chong et al. 2013). Though few studies have been conducted in the Indian context, however, they have been focused on certain other industries such as Cement industry, Sugar industry, etc. but not Indian construction industry (Javalagi and Bhushi 2014). This, combined with the literature review carried out in the present study, further strengthens its theoretical positioning.

Research aim and objectives

This study aims to formulate the performance evaluation framework for the Indian construction companies by incorporating all the identified SFPFs in Vibhakar et al. (2020) with a view to compare the financial performance of different companies with respect to time. This will help the relevant stakeholders to plan and execute necessary steps for the improvement of the financial performance of the companies This aim was achieved by fulfilling two objectives. First is to rank the companies based on financial performance scores. Second to categorize the companies as per the percentile calculated on the basis of financial performance scores. This, in turn, helps in providing recommendations for improvement and finally deriving the financial performance equation (FPE), which can directly help evaluate the companies' financial performance.

Research method and analysis

Identification of financial performance factors

In the previous study (Vibhakar et al. 2020), the authors have identified the significant financial performance factors (SFPFs) for the construction industry. A stratified sampling technique was adopted. The list of 100 construction companies of the construction industry was prepared based on scope, sub-sectors, age, enlistment at the national stock exchange, and most importantly, the availability of financial ratio data for the last ten years. The data of 20 financial ratios were available in the Capitaline database for the selected 100 companies for the previous ten years (2008–17). Therefore, a set of 1000 data records (100 companies for ten years) was compiled for each of the 20 financial ratios, which are defined in Table A1 (Appendix) of Vibhakar et al. (2020). In the previous study (Vibhakar et al. 2020), a mixed approach (qualitative and quantitative) has been used involving factor analysis on financial ratios. After pre-processing and data cleaning process, six companies were eliminated from the dataset because they had extreme outliers in their financial dataset. Thus, data from a total of 94 companies comprising of 940 usable cases were analyzed. After undergoing due processes of data reduction and grouping using factor analysis, five SFPFs were identified for the Indian construction industry, namely investor return factor, business efficiency factor, operations management factor, activity efficiency, and risk coverage and asset management factor. Further, the relative importance of each of these factors has been determined through percentage explanation of variance, respectively (Tripathi and Jha 2018b). The sequential process of research design used in Vibhakar et al. (2020) and the present study is depicted in Figure 1.

Determination of factor scores

After identifying factors and computing factor loadings of each variable, the company's score on each factor was calculated. This score is termed as factor score. The methods for computation of factor scores are broadly categorized under two heads, namely non-refined and refined (DiStefano et al. 2009; Field 2009; Chen et al. 2015).

Non-refined methods such as sum scores by a factor, sum scores above a cut-off value, and sum scores by standardized variables are relatively more straightforward and easier to calculate as well as interpret. However, refined methods use a more technical and sophisticated approach to provide a more accurate standardized score (DiStefano et al. 2009; Chen et al. 2015). Among the refined methods, there are three different methods available for calculating the factor scores (i) Regression method, (ii) Bartlett method, (iii) Anderson Rubin method.

In the present study, the Anderson Rubin method was applied to obtain factor scores. This is because this method addresses the limitations of the first two methods. In the first two methods, factor scores obtained may possess some amount of correlation with each other. The Anderson Rubin Method produces uncorrelated and standardized factor scores. The mean of these scores is

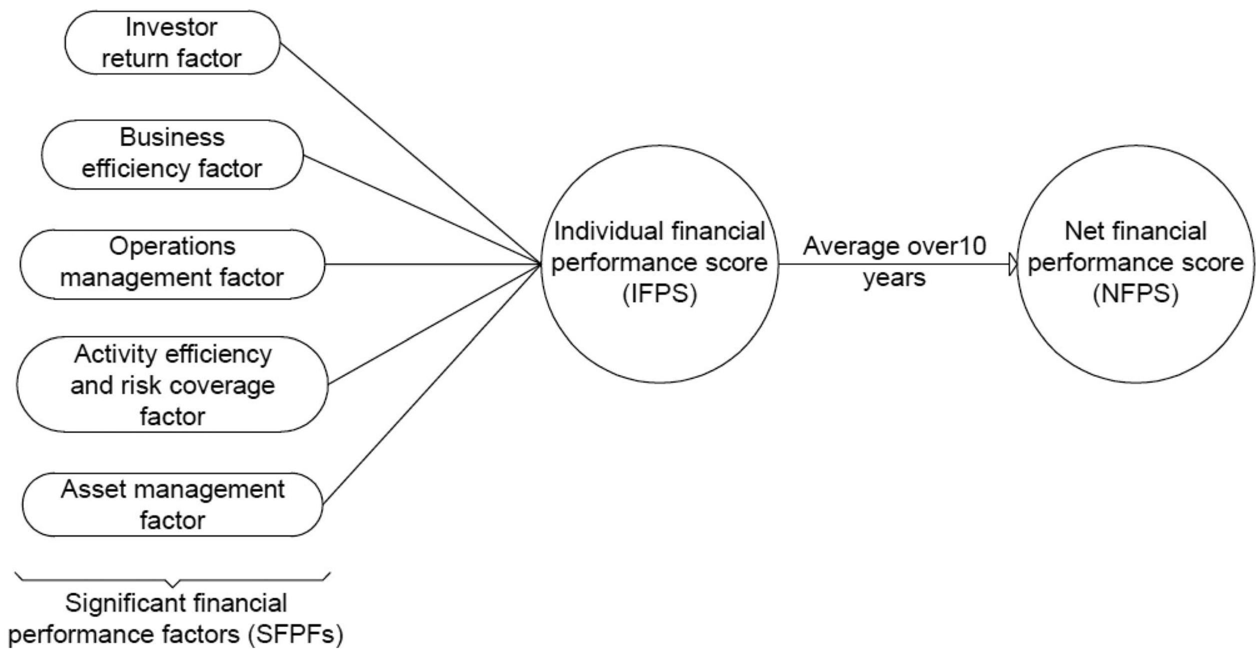

Figure 2. Computation of IFPS and NFPS by combined contribution of SFPFs.

zero, and the standard deviation is one. Tabachnick and Fidell (2007) concluded that the Anderson–Rubin method is the best when the objective is to obtain uncorrelated scores.

Multicriteria decision making

Once the factor scores were determined for all the 94 construction companies using each of the SFPFs - investor return factor, business efficiency factor, operations management factor, activity efficiency and risk coverage factor, and assets management factor, they were combined to develop the FPEF of the companies. Two multicriteria decision making (MCDM) methods – Shannon and Weaver entropy and Simple Additive Weighting (SAW) – were used to compute the objective weights of each SFPF and individual financial performance score (IFPS) of each company respectively for each year (2008–17). The net financial performance score (NFPS) of each company was computed by taking the average of IFPS over ten years (2008–17). The same has been depicted in Figure 2.

The multicriteria decision making (MCDM) technique is one of the most widely used techniques for ranking or selecting one or more alternatives (Abdel-Basset et al. 2020; Tirkolaee et al. 2020). It generally refers to making decisions in the presence of multiple criteria, which are usually conflicting in nature. The problems under MCDM are broadly classified into two categories: multiple attribute decision making (MADM) and multiple objective decision making (MODM). The MADM consists of problems associated with the selection of alternatives, whereas MODM consists of design problems. The MADM methods generally involve determining decision variable values in a discrete domain with a limited number of predetermined alternatives. They specify the methodology adopted to process the attribute information for arriving at a choice. These include both inter and intra attribute comparisons followed by appropriate explicit trade-offs. On the other hand, MODM methods aim to determine decision variable values in a continuous or integer domain with either infinite or many choices. The best possible options should satisfy the priorities and constraints of the decision-makers.

The assessment of the financial state and ranking of the construction companies is a complicated process that requires simultaneous consideration of multiple financial ratios and comes under the category of MADM problem. By factor analysis, the SFPFs have already been identified. These financial factors possess a specific score known as factor score to each company for each year. A total of five such scores were identified, and in general, none of the company performed better than all the other companies in terms of all the five SFPFs. This made the decision-making regarding the determination of financial performance and ranking of the companies a tedious task. Thus, the MADM approach provides a perfect framework for resolving the problem of evaluating the financial performance of the construction companies.

Shannon and weaver entropy method

MADM problems, past experiences, hunch feeling, empirical data, or individual preferences serve as the deciding factor in the real world. However, Akpinar et al. (2018) and Zeleny (1982) argued that the relative weight assigned to the decision attributes (DAs) must take both the subjectivity of the preferences, particularly to the decision-makers (DMs) and the objective characteristics of the DAs themselves into account. Since the perceptions of different DMs may vary with the importance of other DAs, it is always difficult to reach a consensus on the relative importance of a DA through the subjective weighting method adopted in processes like questionnaire surveys, Delphi technique, brainstorming approach etc.

Furthermore, to ensure an unbiased evaluation of the financial performance of the Indian construction companies, there is a need to find the relative importance values of the SFPFs through an objective weighting process that is free from the subjective preferences of the DMs. Rao (2007) summarizes various methods for calculating the weights of different attributes associated with the MADM, such as entropy method, standard deviation method, AHP method, etc. However, according to the nature of evaluation required, the objective weighting process of

Table 1. Performance rating matrix (xij) of ABC company with respect to each DA (Cj).

Year	Investor return factor	Business efficiency factor	Operations management factor	Activity efficiency and risk coverage factor	Assets management factor
2008	4.46136	2.87137	2.85774	2.83743	2.68427
2009	4.27623	2.91588	2.86496	2.74474	2.65016
2010	4.06848	2.9363	2.88467	2.75174	2.61533
2011	3.86722	2.93521	2.86075	2.75731	2.57739
2012	3.79627	2.93363	2.8549	2.84214	2.5849
2013	3.52533	2.95498	2.85041	2.7867	2.55859
2014	3.5389	2.95253	2.86273	2.8199	2.59266
2015	3.33881	2.96109	2.85404	2.80507	2.59203
2016	3.19798	2.95883	2.84274	2.79725	2.6437
2017	3.22158	2.96219	2.84459	2.80554	2.68933

Akpinar et al. (2018) and Zeleny (1982) was found apt for measuring the relative importance of the SFPFs for making the evaluation free from subjective preferences. It uses the entropy concept proposed by Shannon and Weaver (1949).

Entropy is a measure of uncertainty in the information formulated using probability (Rao 2007). Numerically, it represents the average amount of information incorporated in a set of DAs. According to this concept, a broader distribution represents more uncertainty as compared to a sharply peaked one.

Suppose the variation (entropy) in the values for an attribute, i.e. the SFPF, is more for all the response variables, i.e. the construction companies. In that case, that attribute is considered more important or dominant for others while comparing the financial performance of the companies. On the other hand, if the values of an attribute are similar for all the response variables. That attribute is considered relatively less important for others during the comparison of the financial performance of various companies. Accordingly, a higher relative weight is assigned to the former attribute, and a lower relative weight is assigned to the latter attribute. In a rare case, if the values of an attribute are found to be similar for all the response variables, then that attribute may be discarded as it transmits no information to the DMs (Zeleny 1982; Akpinar et al. 2018). The main underlying concept behind entropy is that the relative weight w_j assigned to an attribute C_j, which measures the relative importance of the attribute C_j, is a direct function of the information conveyed by the attribute for the whole set of response variables. The purpose of applying entropy in this study is to determine the objective weights of the independent variables or DAs (SFPFs) using Equations 1–5. Ej's entropy value measures the amount of decision contained in the normalized decision matrix a_{ij} is given by Equation 1 for the actual calculation. Here $i = m = 940$ (10 years' observations for 94 companies). Due to space constraints, a sample calculation of a leading construction company referred to in this study as the ABC Company is presented here. For sample calculation, $i = m = 10$.

$$E_j = -k\sum_{(i=1)}^{10} a_{ij} log(a_{ij}), \forall i \in [1{-}10] \text{ and} \forall j \in [1{-}5]. \tag{1}$$

Where k is a constant, which ensures that condition $0 \leq E_j \leq 1$ is fulfilled. k is calculated by Equation 2.

$$k = 1/\log(m). \tag{2}$$

Applying Equation 2, k = 1/log (10) = 1 and Equation 1, entropy value (Ej) is calculated for all the five DAs (SFPFs) for ABC Company.

The factor scores of the company for the five identified SFPFs of the last ten years (2008–17) were taken, and the transformation was carried out to ensure that all the scores are greater than zero. After conversion, Table 1 is obtained, which depicts companies' performance rating matrix (xij) for each DA (C_j).

The normalized decision matrix (a_{ij}) of companies is obtained by applying Equation 3 on the performance rating matrix (x_{ij}), as mentioned in Table 1.

$$a_{ij} = x_{ij}/\sum_{i=1}^{10} x_{ij}, \ \forall \ i \ \in \ [1-10] \ and \ \forall \ j \ \in [1-5]. \tag{3}$$

Here, x_{ij} is the performance rating, i.e. factor score of the company i on the DA (SFPF) j. It is transformed so that all $x_{ij} \geq 0$. The normalized decision matrix (a_{ij}) of companies is given in Table 2.

D_j measures the degree of divergence of the average information contained by each attribute. The higher the value of D_j of an attribute C_j, the more critical Cj is for the given problem (Zeleny 1982). Divergence (D_j) is calculated for all the five DAs (SFPFs) shown in Table 3 using Equation 4.

$$D_j = 1 - E_j \ \forall \ j \ \in \ [1-5] \tag{4}$$

The normalized objective weight (w_j) is calculated for all the five DAs (SFPFs) given in Table 3 using Equation 5.

$$w_j = D_j/\sum D_j, \ \forall \ j \ \in \ [1-5] \tag{5}$$

As per the calculation done by applying Equation 5, taking the dataset of 94 companies into account, the actual objective weights ($w_{j\ (actual)}$) of the five identified SFPFs were computed as mentioned in Table 3. These actual objective weights indicate the relative importance of the five SFPFs in determining the companies' financial performance. Thus, it may be observed that the Investor Return Factor (0.376 on a scale of 1) has the maximum impact on the financial performance of the company followed by Activity Efficiency and Risk Coverage Factor (0.293 on a scale of 1), Assets Management Factor (0.244 on a scale of 1), Operations Management Factor (0.055 on a scale of 1) and Business Efficiency Factor (0.032 on a scale of 1).

Simple additive weighting (SAW)

There are many MADM methods reported in the literature (Zanakis et al. 1998; Gal 1999; Triantaphyllou and Sánchez 1997; Figueira et al. 2004), such as Simple Additive Weighting (SAW), Weighted Product Method (WPM), Analytic Hierarchy Process (AHP), Revised Analytic Hierarchy Process (RAHP), Multiplicative Analytic Hierarchy Process (MAHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) etc. However, out of these, SAW was adopted because of its simplicity and the distinction of being the most exhaustive MADM method still used (Singh and Tiong 2006; Rao 2007). In previous studies of MCDM, SAW has been widely used in ranking for performance evaluation (Ginevičius et al. 2008; Žvirblis and Buračas 2010; Podvezko 2011). The fact that it yields incredibly close results to the much more complicated aggregation methods

Table 2. Normalised decision matrix (a_{ij}) of ABC Company.

Year	Investor return factor	Business efficiency factor	Operations management factor	Activity efficiency and risk coverage factor	Assets management factor
2008	0.001623	0.001031	0.001053	0.001033	0.00099
2009	0.001556	0.001047	0.001056	0.001	0.000978
2010	0.001481	0.001055	0.001063	0.001002	0.000965
2011	0.001407	0.001054	0.001054	0.001004	0.000951
2012	0.001381	0.001054	0.001052	0.001035	0.000954
2013	0.001283	0.001062	0.00105	0.001015	0.000944
2014	0.001288	0.001061	0.001055	0.001027	0.000957
2015	0.001215	0.001064	0.001052	0.001022	0.000956
2016	0.001164	0.001063	0.001047	0.001019	0.000975
2017	0.001172	0.001064	0.001048	0.001022	0.000992

Table 3. Entropy (E_j), divergence (D_j) and normalised objective weight (w_j) calculation for the DAs (SFPFs).

	Year	Investor return factor	Business efficiency factor	Operations management factor	Activity efficiency and risk coverage factor	Assets management factor
	2008	−0.00453	−0.00308	−0.00314	−0.00309	−0.00298
	2009	−0.00437	−0.00312	−0.00314	−0.003	−0.00294
	2010	−0.00419	−0.00314	−0.00316	−0.00301	−0.00291
	2011	−0.00401	−0.00314	−0.00314	−0.00301	−0.00287
	2012	−0.00395	−0.00314	−0.00313	−0.00309	−0.00288
	2013	−0.00371	−0.00316	−0.00313	−0.00304	−0.00286
	2014	−0.00372	−0.00315	−0.00314	−0.00307	−0.00289
	2015	−0.00354	−0.00316	−0.00313	−0.00306	−0.00289
	2016	−0.00341	−0.00316	−0.00312	−0.00305	−0.00294
	2017	−0.00344	−0.00316	−0.00312	−0.00306	−0.00298
$\sum a_{ij}\log(a_{ij})$		−0.03888	−0.03142	−0.03135	−0.03046	−0.02913
k		1				
E_j		−0.03888	−0.03142	−0.03135	−0.03046	−0.02913
D_j		1.038876	1.031417	1.031352	1.030455	1.029133
w_j		0.201284	0.199839	0.199827	0.199653	0.199397
$w_{j\ (actual)}$		0.376	0.032	0.055	0.293	0.244

on applying certain close approximations further supports its application (Edwards 1977, Bell et al. 1977).

The simple additive weighting (SAW) method is also referred to as the weighted sum method (Fishburn 1967). In this method, each attribute is assigned a weight based on its relative importance subject to the constraint that the aggregate sum of all the weights of all the attributes in consideration must be one. Here, all the attributes are taken into consideration to assess each alternative, i.e. the company. The total or net performance score of an alternative is given by Equation 6 in case the measurement units are the same for all the attributes:

$$P_i = \sum_{j=1}^{M} w_j m_{ij} \tag{6}$$

Where w_j represents the weights assigned to the j^{th} DA (SFPF), m_{ij} represents the score of each alternative for the j^{th} DA (SFPF), and P_i is the total or net performance score of the alternative A_i (company). The alternative with the highest value of P_i is considered as the best alternative and vice versa.

If the measurement units for DAs (SFPFs) are different, the DAs (SFPFs) need to be normalized by Equation 7.

$$P_i = \sum_{j=1}^{M} w_j (m_{ij})_{normal} \tag{7}$$

Where $(m_{ij})_{\ normal}$ is the normalized value of m_{ij}, and P_i is the overall or net score of the alternative Ai.

Since these scores are zero and the standard deviation is one, SAW can be easily used. The SAW has been used to aggregate the performance ratings of the companies concerning each attribute to produce the overall IFPS for each company(i) of each year (k) as given by Equation 8.

$$IFPS_{\ i,k} = \sum_{j=1}^{5} x_{ij,k}\ w_j\ \forall\ \mathrm{i}\ \in\ [1-94],\quad \forall\ \mathrm{j}\ \in\ [1-5]\ and\ \forall\ \mathrm{k}\ \in\ [1-10] \tag{8}$$

This score represents the relative financial state of each response variable, i.e. construction company (i ∈ [1-94]) considering all the DAs (SFPFs) for all the individual years of the period (2008–17). The IFPS is calculated for each year from 2008–17 and presented in Table 4. Also, the arithmetic average has been applied to the IFPS of each year over ten years (2008–17) to compute the NFPS of each company as per Equation 9.

$$NFPS_i = \sum_{k=1}^{10} IFPS_{\ i,k}/10\ \forall\ \mathrm{i}\ \in\ [1-94]\ and\ \forall\ \mathrm{k}\ \in\ [1-10] \tag{9}$$

This score depicts each construction company's net financial performance evaluation based on individual performance scores of ten years (2008–17). NFPS is calculated for each company and presented in Table 4. A higher NFPS reflects the better financial performance of a company and vice versa. To ensure the stability of the SFPFs and account for the effect of adopting different accounting methods and managerial effectiveness in the formulation of various alternative strategies for improving the financial performance of the company, a healthy duration of ten consecutive years was selected so that all the discussed aspects are well covered in the analysis.

From Table 4, the yearly financial performance of the company may be ascertained over ten years (2008–17). This is invaluable to get the required financial trends of the construction

Table 4. IFPS and NFPS computation for the companies.

Year	Investor return factor	Business efficiency factor	Operations management Factor	Activity efficiency and risk coverage factor	Assets management Factor	IFPS $= \sum xij\ wj$
2008	4.46136	2.87137	2.85774	2.83743	2.68427	3.14658
2009	4.27623	2.91588	2.86496	2.74474	2.65016	3.09312
2010	4.06848	2.9363	2.88467	2.75174	2.61533	3.05372
2011	3.86722	2.93521	2.86075	2.75731	2.57739	3.00196
2012	3.79627	2.93363	2.8549	2.84214	2.5849	3.00556
2013	3.52533	2.95498	2.85041	2.7867	2.55859	2.93730
2014	3.5389	2.95253	2.86273	2.8199	2.59266	2.95560
2015	3.33881	2.96109	2.85404	2.80507	2.59203	2.91188
2016	3.19798	2.95883	2.84274	2.79725	2.6437	2.88914
2017	3.22158	2.96219	2.84459	2.80554	2.68933	2.90555
					NFPS =	2.99004

companies with respect to time. Moreover, the financial performance of each company may be compared year wise for the other companies by the IFPS. The NFPS depicts the overall financial state of the company based on ten years of data. Both IFPS and NFPS considers the relative importance values of the five SFPFs as described by the actual objective weights ($w_{j\ (actual)}$) of the five identified SFPFs mentioned in Table 3.

Results and discussion

The method which is explained before is applied to all 94 companies, and both IFPS and NFPS are computed based on the objective weights of the SFPFs. These companies were then ranked based on NFPS and represented in Table 5. The analysis based on IFPS gives insightful comparisons of the company's financial performance concerning time and other companies. However, the absolute value of the IFPS or NFPS is irrelevant unless it is used for the comparison for time, other companies, or the construction industry in general. To make these scores more relevant to the industry, a term called Performance Grade (PG) has been used here. The PG concerning a company is generally defined as the percentage of construction companies possessing NFPS lower than that of the company under consideration. It may also be understood as the percentile scored by the construction company regarding the Indian construction industry in general. In other words, a cumulative distribution function of NFPS is equivalent to the PG. PG may be computed for each company by applying Equation 10.

$$PG = [(94 - No.\ of\ companies\ having\ lower\ NFPS\ than\ the\ company\ under\ consideration)/94]*10 \quad (10)$$

Figure 3 represents the curve obtained on plotting the values of NFPS on the X-axis against the corresponding values of PG on the Y-axis. It may be used to determine the relative position of the company in the Indian construction industry.

According to the five ranges of PG, all the companies may be broadly categorized from the best to the worst financial condition. Kangari et al. (1992) gave information about the current economic state, the shape of management policies and strategies and the impending risk of bankruptcy or default for the US construction companies for these five categories. The ideation and format of Table 6 have been taken from Kangari et al. (1992). These five categories, as per PG, were then discussed in detail with four experts possessing more than 30 years of experience at the top management level in the Indian construction industry to check the appropriateness of the categorization, financial status, and recommendations in the Indian scenario. As per suggestions received from them, the generalized information and recommendations provided by Kangari et al. (1992) have been modified and presented in Table 6.

It may be easily observed from Tables 5 and 6 that a total of 19 companies belonged to the first category out of 94 companies considered for the study. This category was spearheaded by the top Public Sector Undertakings (PSUs) such as C1, C2, C3, C4 etc., because of strong financial fundamentals.

After applying IFPS and NFPS to provide ranking and develop PG for the companies in the previous sections, it is required that the relative position of any particular construction company within or outside the list of these 94 companies may be determined easily for the Indian construction industry. The upcoming process deals with developing a generic Financial Performance Equation (FPE) applied to any particular construction company. Further, it illustrates the implementation of the developed Financial Performance Evaluation Framework (FPEF) through a case study of ABC Company.

The factor scores for each company is known for each year (2008–17) for all the five factors from the previous study (Vibhakar et al. 2020). Also, from this study, the IFPS is known for each company pertaining to each year (2008–17). Thus, multiple regression is applied to take IFPS as the dependent variable and scores as independent variables for ten years' data. The IFPS is computed by Equation 11, called FPE.

$$IFPS = 2.917 + 0.376\ F1 + 0.0325\ F2 + 0.055\ F3 + 0.293\ F4 + 0.244\ F5 \quad (11)$$

A case study of ABC Company has been taken as an example to illustrate the implementation of the FPEF to compute the IFPS for the year 2010. The factor analysis done in the previous study (Vibhakar et al. 2020) gives the component score coefficient matrix shown in Table 7. In the previous study (Vibhakar et al. 2020), 12 financial ratios were found as significant out of the 20 ratios that were initially considered for study after factor analysis. The descriptive statistics, i.e. mean and standard deviation, have been already computed for these 12 financial ratios from the dataset comprising 94 companies for ten years (2008–17), as given by Table 8. The data of these 12 significant financial ratios may be computed for any company from its financial statements such as balance sheet, income statement, and cash flow statement; or databases such as capitaline and moneycontrol. These financial ratios' values for ABC Company have been given in Table 9. Now, these 12 ratios were grouped under five factors which were termed as SFPFs. Therefore, factor scores need to be calculated for all these five SFPFs.

The standardized financial ratio (y) for ABC Company may be calculated using Equation 12, as shown in Table 9.

Table 5. Ranking of companies on the basis of NFPS and PG.

		IFPS											
Rank	Company name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	NFPS	Grade
1	C1	3.58	4.06	4.40	4.58	7.92	7.21	5.74	4.82	4.62	4.29	**5.21**	**98.94**
2	C2	4.40	4.90	4.32	4.28	4.36	4.33	4.25	4.33	4.35	4.40	**4.39**	**97.87**
3	C3	2.70	2.34	2.50	4.98	4.38	4.72	4.52	4.26	3.49	3.46	**3.76**	**96.81**
4	C4	3.91	3.89	3.49	3.48	3.83	3.73	3.37	3.28	3.36	3.64	**3.59**	**95.74**
5	C5	5.62	3.64	3.64	3.65	3.62	2.96	2.70	2.78	3.22	2.90	**3.54**	**94.68**
6	C6	3.75	3.45	3.25	3.28	3.65	3.28	3.31	3.44	3.52	2.64	**3.44**	**93.62**
7	C7	4.41	4.38	2.97	3.28	3.13	2.88	2.78	3.25	2.84	2.83	**3.33**	**92.55**
8	C8	3.07	3.47	3.67	3.41	3.26	3.23	3.18	3.11	3.19	3.14	**3.29**	**91.49**
9	C9	2.92	3.07	3.09	3.21	3.20	3.50	3.78	3.70	3.31	2.94	**3.31**	**90.43**
10	C10	3.77	3.33	3.37	3.15	3.16	2.81	3.01	2.87	3.07	3.16	**3.17**	**89.36**
11	C11	2.95	3.03	3.54	3.40	3.56	2.96	2.98	2.89	2.97	3.43	**3.14**	**88.30**
12	C12	3.72	3.94	3.42	3.28	3.09	2.88	2.83	2.85	2.78	2.77	**3.20**	**87.23**
13	C13	3.04	3.05	2.99	2.92	2.97	3.65	3.02	3.11	3.28	3.38	**3.11**	**86.17**
14	C14	3.47	3.26	3.40	3.33	3.10	2.98	2.88	2.98	3.10	2.90	**3.16**	**85.11**
15	C15	2.88	4.16	3.26	3.57	2.95	2.82	2.95	2.90	2.77	2.90	**3.14**	**84.04**
16	C16	4.53	3.74	3.47	3.04	2.75	2.76	2.69	2.68	2.74	2.71	**3.16**	**82.98**
17	ABC Company	3.41	3.31	3.23	3.14	3.14	3.02	3.04	2.96	2.92	2.94	**3.13**	**81.91**
18	C18	3.00	2.75	3.12	3.85	3.47	2.96	2.94	2.94	2.64	2.99	**3.07**	**80.85**
19	C19	3.10	3.14	3.19	3.11	3.03	2.92	2.92	2.91	3.11	3.10	**3.05**	**79.79**
20	C20	2.93	3.10	3.34	3.14	3.04	2.97	2.94	2.89	2.97	3.06	**3.03**	**78.72**
–	————————————	—	—	—	—	—	—	—	—	—	—	—	—
–	————————————	—	—	—	—	—	—	—	—	—	—	—	—
83	C83	3.04	2.73	2.75	2.74	2.61	2.61	2.54	2.54	2.54	2.55	**2.68**	**11.70**
84	C84	2.88	2.89	2.94	2.84	2.76	2.74	2.47	2.37	1.99	2.71	**2.65**	**10.64**
85	C85	2.71	2.37	2.86	2.81	2.81	2.71	2.65	2.45	2.66	2.51	**2.67**	**9.57**
86	C86	2.85	2.84	2.83	2.75	2.74	2.64	2.59	2.41	2.45	2.41	**2.68**	**8.51**
87	C87	3.25	2.95	3.06	2.92	2.80	2.31	1.91	2.38	2.40	2.39	**2.67**	**7.45**
88	C88	2.93	2.94	2.74	2.62	2.66	2.66	2.65	2.15	2.38	2.48	**2.64**	**6.38**
89	C89	2.99	2.94	2.91	2.80	2.61	2.67	2.61	2.38	2.24	1.97	**2.68**	**5.32**
90	C90	3.30	2.59	2.60	2.58	2.51	2.52	2.44	2.36	2.38	2.38	**2.59**	**4.26**
91	C91	3.08	2.33	2.13	2.50	2.46	2.57	2.67	2.36	2.94	2.47	**2.56**	**3.19**
92	C92	3.30	2.04	2.35	2.39	2.55	2.55	2.50	2.58	2.63	2.57	**2.54**	**2.13**
93	C93	2.77	3.10	2.70	2.14	2.70	2.34	2.36	2.40	2.42	2.42	**2.55**	**1.06**
94	C94	2.46	2.53	2.50	2.49	2.50	2.37	2.44	2.51	2.58	2.68	**2.49**	**0.00**

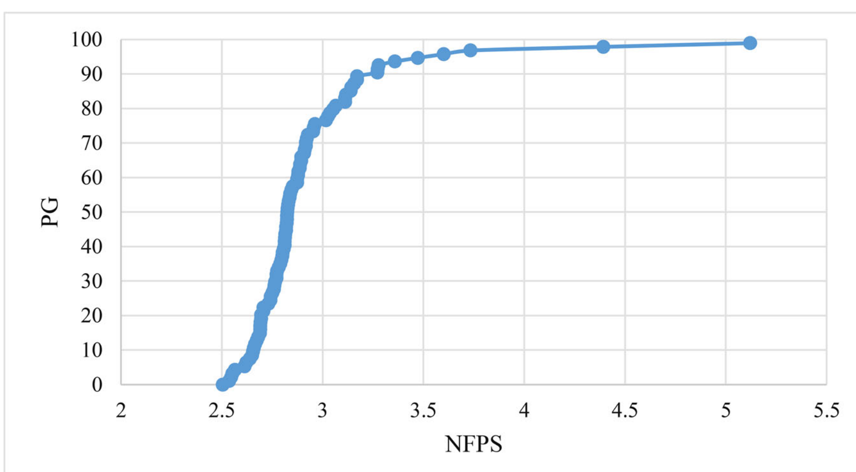

Figure 3. Performance Grade Function.

$$Standardized\ ratio\ (y) = \left[Ratio\ (x) - Mean\ of\ ratio\right] / Standard\ deviation\ of\ ratio \quad (12)$$

Mean, and Standard deviation are obtained from Table 8 as derived from factor analysis.

For e.g. the standardized ratio for the current ratio $= (1.21 - 2.0825)/2.85373 = -0.305725$

Similarly, standardized ratios are computed for all the 12 financial ratios. The individual factor score (f1) may be ascertained as per Equation 13. In this equation, the corresponding values of the component score coefficient (C1) may be taken from Table 7.

$$Individual\ factor\ score\ (f1) = Component\ score\ coefficient\ (C1) * Standardized\ ratio(y) \quad (13)$$

For e.g. the individual factor scores for Investor return factor (f1) for the current ratio $= -0.078 * (-0.305725) = 0.023827$

Similarly, the individual factor scores (f1 to f5) are computed for all the 12 significant financial ratios. The final factor scores for each SFPFs are calculated as the aggregate sum of all the individual factor scores as per Equation 14.

Table 6. Recommended management action as per PG (Modified Kangari et al. 1992).

S. No.	Performance Grade (G)	Recommended management action
1	$80 < PG \le 100$	Management policies and strategies are competitive and commendable. Company growth trajectory is set on the ideal track with respect to the Indian construction industry. No urgent actions related to the adjustment of operations are required.
2	$60 < PG \le 80$	No risk of default or bankruptcy anticipated in near future. Management policies and strategies are satisfactory. Some minor adjustment actions related to financial operations may be required.
3	$40 < PG \le 60$	Company's performance is within the average range with respect to the Indian construction industry. It may be difficult to carry on the business maintaining optimum profitability. Constant monitoring of the financial trends needs to be performed and considerable changes must be incorporated in the management policies and strategies governing the business.
4	$20 < PG \le 40$	The company is in critical financial condition. Impending risk of default and bankruptcy looming in the future. Reasons may be underlined as lack of proper financial management followed by lack of flexibility in incorporating changes according to the rapidly changing and competitive construction industry. Immediate changes need to be incorporated into the strategies and policies of the company in order to ensure a quick recovery. The management should be changed if it fails to implement these immediate changes. In case of lack of adequate steps, the company may fail in the upcoming year.
5	$0 < PG \le 20$	Company's financial performance may be ascertained as the most critical with respect to the Indian construction industry. The very high probability of risk of default and bankruptcy in the future. Very fewer chances that the company can survive in the highly competitive market of the Indian construction industry. Hence, it should explore options of safely moving out of business by salvaging its assets and paying all its short- term and long-term obligations.

Table 7. Component score coefficient matrix.

		Component				
Sl. No.	Significant Financial Ratios	Investor return factor	Business efficiency factor	Operations management factor	Activity efficiency and risk coverage factor	Assets management factor
1.	Current Ratio	−.078	.026	.001	.029	.652
2.	Fixed Assets	.064	−.026	−.005	−.041	.627
3.	Inventory	−.071	.138	−.025	.742	−.048
4.	Interest Cover Ratio	−.017	−.172	.010	.481	.061
5.	CPM (%)	−.024	.463	−.025	.110	.018
6.	ROCE (%)	.293	−.007	−.003	.107	.000
7.	PBIDT/Sales (%)	−.018	.468	−.015	.048	.007
8.	Sales/Net Assets	.265	−.062	−.019	−.210	−.033
9.	PBDIT/Net Assets	.335	.038	.002	−.044	−.061
10.	ROE (%)	.304	−.030	.018	.005	.074
11.	Net Profit/Expenditure	−.001	−.006	.509	−.012	.007
12.	Sales Turnover/Expenditure	−.002	−.043	.515	−.020	−.012

$$\text{Final factors score for each SFPF} = \sum Individual\ factor\ scores \tag{14}$$

For e.g. the Final factor score (F1) for Investor return factor for ABC Company is:

$$0.023827 + (-0.00854) + 0.010849 + 0.00129 + (-0.00128) + 0.308121 + (-0.00048) + 0.100307 + 0.436969 + 0.280276 + 0.0000409 + 0.000109] = 1.150193$$

Similarly, the factor scores for the other four SFPFs are calculated as under:

$$F2 = 0.019299,\ F3 = -0.03233,\ F4 = -0.16526 \text{ and } F5 = -0.30167.$$

Now the IFPS for ABC Company is calculated by Equation 11 developed in this study as follows:

$$IFPS = 2.917 + 0.375675\ F1 + 0.032485F2 + 0.054534F3 + 0.293325F4 + 0.24398F5 = 2.917 + 0.375675 * 1.150193 + 0.032485 * 0.019299 + 0.054534 * (-0.03233) + 0.293325 * (-0.16526) + 0.24398 * (-0.30167) = 3.23$$

This value of IFPS matches the IFPS value of ABC Company for the year 2010 mentioned in Table 5. The PG for this value of IFPS may be readily ascertained from the graph mentioned in Figure 3. Subsequently, it may be observed that the company falls in the first category of $80 < PG \le 100$, the generalized recommendations given in Table 6 will be applicable.

A onetime factor analysis of financial ratios was performed to find specific results such as– i) 12 significant financial ratios for the construction industry, which were grouped under five factors termed as SFPFs, ii) objective weights of SFPFs to calculate IFPS for 94 Companies for each of the ten years so that regression may be applied to develop the FPE iii) component score coefficient matrix for the construction industry (Table 7), iv) descriptive statistics, i.e. mean and standard deviation for these 12 financial ratios from the dataset comprising of 94 companies for ten years (2008–17) as given by Table 8, and v) the PG of the construction industry. These five results remain constant and provide the base for calculating the IFPS for any construction company for any particular year without again undergoing

Table 8. Descriptive statistics of the significant financial ratios.

S.No.	Significant Financial Ratios	Mean	Std. Deviation	Analysis N
1	Current Ratio	2.0825	2.85373	940
2	Fixed Assets	8.4304	19.66017	940
3	Inventory	40.9326	231.68907	940
4	Interest Cover Ratio	15.0501	88.80668	940
5	CPM (%)	−28.1407	697.62106	940
6	ROCE (%)	11.4016	11.85491	940
7	PBIDT/Sales(%)	6.0908	472.57661	940
8	Sales/Net Assets	.8322	1.74048	940
9	PBDIT/Net Assets	.1184	.12369	940
10	ROE(%)	8.5333	14.05682	940
11	Net profit/Expenditure	.198092746097606	1.947794607937180	940
12	Sales Turnover/Expenditure	1.266391672588760	1.719369001179160	940

Table 9. Calculation of factor scores from financial ratios for ABC Company.

S.No.	Significant Financial ratios	Ratio (x)	Standardized ratio (y)	Investor return factor (f1)	Business efficiency factor (f2)	Operations management factor (f3)	Activity efficiency and risk coverage factor (f4)	Assets management factor (f5)
1	Current Ratio	1.21	−0.305725	0.023827	−0.00797	−0.0003	−0.00885	−0.19927
2	Fixed Assets	5.82	−0.132778	−0.00854	0.003503	0.000723	0.005459	−0.08328
3	Inventory	5.52	−0.152846	0.010849	−0.02105	0.003897	−0.11338	0.007338
4	Interest Cover Ratio	8.24	−0.076685	0.00129	0.013155	−0.00077	−0.03691	−0.00471
5	CPM (%)	9.87	0.0544862	−0.00128	0.025216	−0.00137	0.006003	0.001005
6	ROCE (%)	23.85	1.0500613	0.308121	−0.00766	−0.0033	0.112838	0.000354
7	PBIDT/ Sales (%)	18.85	0.0269993	−0.00048	0.012624	−0.00041	0.001292	0.000186
8	Sales/ Net Assets	1.49	0.3779591	0.100307	−0.02328	−0.00709	−0.07929	−0.01236
9	PBDIT/ Net Assets	0.28	1.3062626	0.436969	0.050184	0.002504	−0.05811	−0.07909
10	ROE (%)	21.48	0.9210251	0.280276	−0.02785	0.016789	0.004262	0.067735
11	Net profit/ Expenditure	0.137777	−0.030966	0.0000409	0.000173	−0.01578	0.000383	−0.00021
12	Sales Turnover/ Expenditure	1.175471	−0.052881	0.000109	0.002254	−0.02722	0.001054	0.000633
Factor Scores				1.150193	0.019299	−0.03233	−0.16526	−0.30167

complex processes such as factor analysis, MCDM, entropy, and SAW. Accordingly, the PG of the company may be determined from the graph mentioned in Figure 1. Also, generalized information regarding the company's current financial state and recommendations for improvement may be ascertained from Table 6 according to the respective PG.

Conclusions

The present study provides an FPEF for the companies based on the factor scores of the five SFPFs, viz. investor return factor, business efficiency factor, operations management factor, activity efficiency and risk coverage factor, and assets management factor, which were identified in Vibhakar et al. (2020). Shannon-Weaver entropy method has been used to calculate the objective weights of the factor scores. These objective weights establish the relative importance of the five SFPFs showing that the investor return factor has the maximum impact on the financial performance of the Indian construction companies, followed by the activity efficiency and risk coverage factor and assets management factor. This provides the companies' management with the order of preference for undertaking the strategic actions aimed towards improving the company's financial performance. SAW, an MCDM method, has been used to calculate individual financial performance score (IFPS) for accessing the relative performance of the companies concerning time for any year from 2008 to 2017.

Also, to provide the net ranking taking all the financial performances of the last ten years into account, the net financial performance score (NFPS) was calculated for each company by taking the average of the IFPS over the previous ten years. This NFPS was used for ranking the 94 major Indian construction companies listed on the National Stock Exchange (NSE). The Public sector undertakings (PSUs) such as C1, C2, C3, C4, etc., topped the ranking list because of their strong financial fundamentals and commendable management strategies and policies.

Subsequently, to provide recommendations for improvement, performance grade (PG) was computed for all the companies, and they were designated into five categories ranging from the best to the worst. Generalized information regarding the company's financial status covering aspects such as the impending risk of default and bankruptcy, the status of management policies and strategies, and recommended actions required for improvement is provided for each category.

In addition, a financial performance equation (FPE) has been developed based on multiple regression analysis of the IFPS and factor scores of the five SFPFs. The FPEF may be employed to determine the relative position of any construction company other than the 94 companies considered in this study for the Indian construction industry.

However, in the present study, only those 20 financial ratios have been considered for which data was available. Further, only those companies were selected for analysis for the last ten years' financial data. These may be deemed as the limitations of this study. A more exhaustive financial ratio analysis may be performed by taking more financial ratios, and more companies into an account provided the required data. Future recommendations based on this work include an in-depth analysis of the relative performance of the companies. This analysis may be carried out depending on various classification criteria such as based on membership pattern – public/private/government; liabilities of members and directors – limited/unlimited liability; business activities – general contractor, owner-builder, real estate developer etc.; control over the management – holding/subsidiary.

Contributions

The information regarding NFPS and the subsequent ranking may be used to discover the company's financial trends with respect to i) time and ii) other companies. This aspect will help the construction companies to plan and undertake adequate steps for improvement. These financial trends may be used for forecasting future trends and may become the basis for investing in a company for another. Hence it may prove beneficial for the economy by attracting domestic and foreign investments.

All the information regarding the company's financial status with recommended actions required for improvement provided for each category in the PG helps the company and stakeholders plan its strategies and operations. This is highly relevant for the Indian construction sector, a significant contributor to the economic activity often credited with providing employment to more than 52 million people and directly affecting more than 200 other sectors. This aspect highlights the scope of policy implementation of the framework.

The developed FPE may be used to find the IFPS of any company without adopting the cumbersome method involving factor analysis, entropy method, MCDM methods such as SAW etc. Only information regarding the 12 critical financial ratios is required to ascertain the relative position of any Indian construction company for any year from 2008–2017, which can be easily assessed from financial statements such as balance sheet, income statement, cash flow statement, etc. or databases such as capitaline, moneycontrol, etc. Therefore, this study provides a scientific tool to the government authorities, business analysts and related stakeholders to analyze the financial condition of any company for the Indian construction industry and take adequate steps for improvement. Hence, it contributes to the knowledge and may also be applied practically to gain significant insights in a less cumbersome and easy way.

Recommendations for future research

Due to the lack of research in this area, especially in the Indian context, this research can be the point of reference for further studies and business applications. Related research may also be taken up towards the failure modelling of the companies by determining the zone of discrimination by applying various models such as the Z-score bankruptcy model. This may lead to the development of a systematic alert system in case of upcoming crisis for the Indian construction companies, enabling the concerned stakeholders to foresee the probability of failure of the firm and undertake preventive action for improvement. India is classified as a lower-middle-income developing country as per World Bank, and it serves as home to about 18% of the world's population. Hence, it may be deemed as a good representative of developing countries. Thus, the FPEF devised here may assist in providing a good point of reference for the financial analysis of construction industries, especially in developing countries. These aspects emphasize the recommendations for further study.

Disclosure statement

No potential conflict of interest was reported by the authors.

Data availability

Some Or All Data, Models, Or Code That Support The Findings Of This Study Are Available From The Corresponding Author Upon Reasonable Request.

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