Identification of Critical Challenges in Construction projects through Factor Analysis

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Abstract
Construction projects are extremely multifaceted and dynamic. The dynamic nature of clients, the complexity of construction projects and continuous demand for improved and efficient project delivery have put pressure to construction managers, thereby creating a lot of challenges. As the demand for highly innovative construction projects is constantly increasing, Therefore, study aimed to identify the challenges faced by construction projects. Data was collected from residential, institutional and retail building construction projects. 237 valid responses were collected via questionnaire survey from the construction professionals. Exploratory factor analysis (EFA) was employed to extract the challenges factors of construction projects, where four factors of challenges were extracted. Study has contributed knowledge by providing new visions, such as various challenges do construction projects have faced? Moreover, study provides a clear and well understanding of " which are the most critical challenges in construction projects''. Further, it is anticipated that the results of study would be a guidebook for all the stakeholders to prevent any possible impact of challenges in their construction projects.

Keywords: Construction Sector, Project Management, Challenges, Exploratory factor analysis (EFA), Factor Analysis Approach.

1. Introduction

Real estate sector is at paradox situation. From one perspective it is significant growth driver of economy as it is second largest employment generator after agriculture sector. However, on the other hand it is blemished by various challenges and risks which are being faced by this sector (Bansal et al., 2011). Today, construction sector of most emerging economies, including India, witnessing sharp growth prospects but on the one hand, its in pressure to effectively and efficiently contribute to the national development on the other. The Indian construction industry is one of the major stimulates of the economic and social growth of the nation. However, construction projects are somewhat difficult to manage and challenging due to the nature of the industry, such as complex and unique nature, ingrained culture, working conditions, and project-based during diverse sub-contractors and suppliers.

Moreover, the sector is confronted by numerous issues, thereby reducing its efficacy and unhindered growth prospects. Currently, the construction sector is facing many issues, which it needs to resolve. India is facing multiple challenges such as applying highly advanced and complex construction technology (Ruikar and Anumba, 2008; Mok et al 2017), resistance of laborers to change their traditional practices (Williams et al

2007; Hwang and Ng 2013; Anil et al,. 2014), insufficient information about relevant issues (Ozumba and Shakantu 2018, Saini et al. 2019) and many more. The dynamic nature of clients, the complexity of construction projects and continuous demand for improved and efficient project delivery have put pressure to construction managers, thereby creating a lot of challenges. As the demand for highly innovative construction projects is constantly increasing, it has been acknowledged that management of construction projects from conception to disposal is difficult and accompanied with enormous challenges. The focus of this paper is to identify challenges in the construction projects. The primary statistical tool used for identifying challenges is factor analysis. But before it is applied various other tools were also used to check whether the data was reliable and valid for further analysis.

2. Literature Review

Real estate and construction sector everywhere faces challenges. By far, the most interesting area in real estate and construction projects is to identify challenges faced by this sector. Following are the relevant studies related with the challenges before the real estate projects.

Chileshe (2012), looking for challenges to deal multiple projects in Australia. Author classified the challenges into four classes such as (1)organizational culture (to make team members accountable and committed towards project development); (2) planning relating to allocation of assets (ability to make proper planning for the allocation of resources); (3) selection of competent project managers (Selecting skilled project managers for handling projects); and (4) organization culture : conflicts and communication, (challenge to manage conflict between the projects due to competing for the similar assets) confronted by the construction projects in Australia. Sawhney Agnihotri, & Paul (2014), identified challenges being faced by Indian construction projects. Study found that skills shortage, lack of professionalism, working with unfamiliar personnel in every different project, and managing human resources were the challenges before construction projects. Moreover, cumbersome project approval, ambiguity and complexity in the approval process promotes irregularities and corruption in the approval process and funding problems & lack of access to credit from banks were also found the challenges before construction projects. Okoye et al. (2015), studied the managerial challenges being faced by construction industry in Nigeria. Further, authors found that in management challenges, the industry faces the challenge of allocating assets namely, men, money, machines, and material in construction project. In addition, challenge of time management, challenge of quality management, and security management were viewed as the significant challenges faced by construction industry in Nigeria. Subramanyam & Haridharan (2017), studied the challenges before the construction projects. Data was collected with the help of questionnaire. Regression analysis was done to recognized significant challenges. Study found that resources availability and allocation, cost constraints, and top management support, technical skills and decision making skills, implementation of tasks according to the plan, no clarity in drawings and specifications, availability of technical staff and availability of skilled labour were the significant challenges. Mok, Shen, Yang & Li (2017), identified challenges being faced by Australian's construction sector. 247 responses were collected through questionnaire survey. Study found five major challenges which were; applying highly advanced and complex construction technology,

mitigating project disruptions to the environment and marine ecology, conducting public and community consultation during construction phase, site constraints due to nearby air and marine traffic, and meeting government standard on the quality of new materials and equipment faced by construction projects.

Many researchers (Bansal et al., 2011; KPMG, 2015; Madan & Shukla, 2015) put light on the challenges relating to unavailability of reasonable and suitable land, and inadequate funding channels were the real challenges before the real estate sector. Yadollahi et al. (2014) identified the critical challenges namely, technical challenges (unfamiliar with new technology) and psychological challenges (pressure of tight timing of work) in construction projects in Malaysia. However, these challenges were found in different segments of real estate sector in different countries and fewer studies were conducted in India which explores the various challenges before residential and retail real estate segment of this sector. Accordingly, to cater different needs of customers and market, reach at expected quality, and to survive in growing competitive market it is an important to identify the challenges before this segment of real estate sector. Hence, an attempt shall be made to put more light to identify challenges before real estate and construction projects in Indian context.

3. Research Methods

3.1 Measures

Measures are established on the basis of existing questionnaires developed by researchers. Literature review was done including theoretical and empirical literature in the construction project areas. The items used to identify challenges were based on the questionnaires developed by (MOK et al. 2017,. The content of items was revised for the purpose of the development of a questionnaire. So, a total of 24 items were added to the questionnaire. Afterwards, structured interviews were conducted with two academicians, three researchers with research knowledge and with three project experts in the construction sector which facilitated in generation of items of challenges in construction projects and evaluated the items in formal preliminary tests.

3.2 Questionnaire Design and questionnaire dissemination

The questionnaire consists of two sections. Section first involved statements about the respondent's profile. Section second comprised items of challenges variables. Likert scale (five-point) was employed, (where 1 = strongly disagree and 5= strongly agree) to answer each item.

A pilot study was conducted prior to the final survey, to test the items of questionnaire, its comprehensibility and reliability. Pilot study's main purpose is to verify the comprehensiveness of the items in the questionnaire and to know whether they are valid and relevant to the Indian construction projects. Twelve construction experts participated to make sure that respondents could understand items in the questionnaire. These professionals have extensive academic knowledge and experience in the field of construction project management in India. Experts were asked to check the relevance of the items, and answer them to give their contributions. Experts suggested much and made some improvements. Their feedback helped to correct

errors and make improvements. Based on feedback, we restructure and reform the content of the questionnaire. After pilot-testing, the questionnaire was modified as needed before it was finally distributed. Respondents were taken from a list of registered construction projects in India, which we got from the ministries, regulatory bodies of India i.e., Real Estate Regulatory Authority (RERA). The key target respondents for the survey were project managers, junior engineers, architects, and designers in construction projects. The final questionnaire was distributed via online mode using the platform i.e., Google Forms and personally administered to construction experts including a cover message which shows the purpose of the research, making sure they were kept secret. The questionnaire was sent to 450 respondents. 237 valid responses taken to the data analysis, which gave a response rate of 52.7%. Moreover, response rate of 52.7%, that is adequate as per (Flynn et al. 1990), as he states that a minimum response rate of 50% can be taken as adequate. Response frequency of these questionnaires in this area of research differs, for instance, Aibinu and Odeyinka (2006), 51%, Kaliba et al. (2009), 43%; and in Olawale and Sun (2010) 44%. So, in present study, a response rate of 52.7% is good enough to make further analysis of collected data and to get more accurate results.

Table 1

Summary of Responses and respondents' profiles

Sr. No.	Features	Parameters	Frequency	Percentage
1.	Type of Project Involved	Residential/Housing Buildings	133	56.11%
		Institutional	37	15.61%
		Retail buildings	67	28.27%
		Total	237	100.00
2.	Education Qualification	Diploma in Civil	17	7.17%
		Graduate/B.tech	35	14.76%
		Post Graduate/M.tech	176	74.26%
		Others /Phd	9	3.79%
		Total	237	100.00
3.	Designation of Respondents/Professional	Project Manager	93	39.24%
		Junior Engineer	68	28.69%
		Designer	20	8.43%
		Architect	56	23.62%
		Total	237	100.00
4.	Working Experience	1-5Years	44	18.56%
		6-10 Years	56	23.62%

		11-15 Years	78	32.91%
		15 above	59	24.89%
		Total	237	100.00

The summary of respondent's profile obtained is given in Table 1. From the 237 responses, 75% of respondents had experience of 15 years in project management. Additionally, 74.26%, had a degree in civil engineering, and maximum were project managers in their respective area. It implies that respondents had sufficient knowledge with experience to comprehend the questionnaire to respond accordingly. Thus, the collected data is supposed to be adequate to get accurate results.

4. Data Analysis

Exploratory Factor Analysis (Factorial validity, reliability, and discriminant validity)

Based on the extensive literature review conducted to identify the challenges which are being faced by construction projects, afterwards, various statements were developed. The analysis of such large number of statements is very complex, so in order to make it concise, factor analysis is applied to club all these statements into related groups called factors. EFA was conducted to analyse the relationships among correlated variables and to reduce the data, To reduce the list of major challenges into more manageable numbers, factor analysis was conducted into the major challenges.

Exploratory Factor Analysis**(**EFA) using Principal Component Analysis (PCA) was applied for the computation of factors. Varimax rotation was used to get the factor loading of minimum 0.5 or more and factor extraction was based on the Eigen value of 1 or higher as suggested by Teo (2001) and Hair et al. (2010).

The prior requirements for the appropriate statistical tests (correlation matrix, Kaiser-Meyer-Olkin, (KMO) Bartlett's test of sphericity) for the satisfactory use of factor analysis were achieved for this study. Owing to this, it can be concluded that factor analysis is therefore considered appropriate for this study and hence proceed with full confidence and reliability.

Prior to the factor analysis, Bartlett's test of sphericity and a Kaiser-Meyer-Olkin (KMO) test was conducted to help assess the factorability of the data. Initial item purification was conducted using principal component analysis with factor analysis in SPSS 20. All the items loaded on their respective factor and no cross loading of any item was found. According to Dillon and Goldstein (1985) that factor loading value of an item should be at least 0.60, all item loadings were found to be above 0.70 of each construct; except four problematic items, were omitted/dropped from the data file which failed to meet the cut-off factor loading, and all these items were deleted due to eigen value less than one and Cronbach alpha of individual statements less than 0.60 as suggested by Hair et al. (2010).

KMO and Bartlett's Test of Sphericity

The Kaiser-Meyer-Olkin (KMO) is calculated to measure the sampling adequacy which indicates that the sample size is big enough for conducting research or not. The value of KMO should be more than 0.5 and values between 0.5 and 0.7 are considered as mediocre, value between 0.7 and 0.8 are good, values between 0.8 and 0.9 are great values and above 0.9 are superb; which indicates that sample is adequate for applying factor analysis. The Bartlett's test of sphericity defines that whether the correlation matrix is an identity matrix or not, which could indicate that the variables are unrelated. The multicollinearity among the variables are checked using Bartlett's test of sphericity. The value derived from Bartlett's test should be less than 0.05 (Field,2009). The KMO and Bartlett's test values of the objective have been found to be above the defined standard as shown in table 3. The KMO value of the sample data is calculated at 0.806 and the Bartlett's test is found to be significant ($p<0.001$), which shows that the data set is appropriate for factor analysis.

Total Variance Explained

By applying Exploratory Factor Analysis, the twenty statements were clubbed into four factors regarding challenges. These four factors were those factors whose Eigen value were more than one. The total variance explained by the four factors was 73.275% which is considered to be good value for optimum factor analysis results. The eigenvalues represent the variance that is explained by particular component. Only those factors were considered whose Eigen value is more than one. PCA conducted on twenty four identified challenges of construction projects. The cumulative variance explained by the four extracted factors is 73.27 %, which is considered to be good value for optimum factor analysis results. The results of factor analysis concluded that the present data has four primary dimensions, which explained 73.27% of total variance for challenges in construction projects, which is higher than the 60% recommended by Hair et al. (2010). The results also show that the percentages of variance explained by each and every factor has been optimized by rotating the extracted sums of squares loadings. All the factors have factor loadings more than 0.7. This indicates that all the factors are considered significant in contributing to the interpretation of the constructs.

Factor Loading, Communalities and Reliability Results

Factor analysis helps in identifying the variables that are related to each other and club them together to make the further analysis appropriate. The results of factor analysis needs to be within defined standards. For that purpose, the factor loadings and communalities of every variable is needed to be checked and Cronbach's Alpha value should be calculated for each factor to check the reliability of the data.

Table 2 Results of the Reliability and Principal Component Analysis for Challenges in Construction Projects

Items	α	CR	AVE	1	2	3	4
Factor 1: Managerial Challenges	.934	.942	.730				
MC12				.905			
MC21				.875			
MC3				.870			
MC10				.853			
MC17				.838			
MC7				.781			
Technical Challenges	.950	.957	.816				
TC2					.929		
TC15					.915		
TC1					.895		
TC22					.889		
TC13					.887		
Communication and Coordination	.838	.876	.587				
CCC18						.838	
CCC6						.779	
CCC20						.769	
CCC23						.727	
CCC24						.710	

HRM Challenges HRC9 HRC5 HRC4 HRC14	.857	.885	.658				 .868 .803 .787 .785
Eigen Value				4.563	4.216	3.076	2.800
Percentage Variance				22.816	21.082	15.379	13.998
Cumulative Variance				22.816	43.898	59.277	73.275
Kaiser-Meyer-Olkin Measure of Sampling Adequacy=0.806, Bartlett's Test of Sphericity (Chi-square=4.1634.258, df=190, sig.=0.000)							

The rotation matrix converged in seven iterations.

Table 2 represented the factor loading and communalities of each statement of the four factors that have been extracted from factor analysis. The factor loading is the correlation coefficient for the variable and the factor. The communalities indicates the amount of variance in each variable that is accounted for. Both the factor loadings and communalities for every statement was found to be above the threshold limit of 0.5 as suggested by Hair et al. (2010). The results confirm reliable degree of internal consistency among al the dimensions as all the Cronbach's alpha values are above the limit of 0.7 as suggested by Nulnally and Bernstein (1994). All the items of the data are loaded strongly on their respective factors and the data reduction process was conducted to address the issue of construct validity.

Naming of Factors

The four factors which have been extracted form the factor analysis, need to be given names that represent what each factor consists of. In this objective each factor represents a specific feature that the challenges possesses. The results showed the four factors of challenges which are being faced by construction projects. The factor analysis has classified the twenty statements into four groups.

Naming the principal factors was done in line with () recommendations, which suggests that the factor names should be brief (one or two words) and communicate the nature of the underlying construct. This was done by looking for patterns of similarity between items that load on a factor. The four factors which has been extracted from the factor analysis has been given names by considering all the variables loaded into the factors and also based on the previous research studies in the context of challenges faced by construction projects. the following table represents the four factors that have been extracted from factor analysis and also represents the name given to these four factors.

Managerial Challenges : the first factor extracted from the rotation matrix is considered to be the most important factor among all the factors extracted. This factor accounts for 22.81 per cent of the total variance which is highest among all factors. It contains six variables representing the significant loadings of this factor. The factor loadings of the factor varies from .905 to .781. This factor explains the challenges related to resource allocation, lack of client involvement in decision making, meeting government standard on the quality of new materials and equipment, stakeholders change project requirements at later stages of the project life cycle, conducting public and community consultation during construction phase, and challenges regarding site selection and landscaping.

Technical Challenges : This is the second factor accounting for 21.08 per cent of the total variance. This factor includes five variables which are lack of flexibility in technology, unfamiliar technology/ lack of awareness of technology availability, applying highly advanced and complex construction technology, challenges regarding utilization of technologies, and the rapid advancement of information and communication technologies/ unclear technological specification and work instructions. The factor loading of this factor varies from .929 to .887.

Communication and coordination: this factor accounting for 15.37 per cent of the total variance. Five variables represented the significant loadings of this factor. It is composed of : insufficient information about relevant issues, language and cultural barrier lead to poor communication and coordination interface management between project stakeholders, inadequate communication at all levels and poor coordination interface management, lack of familiarity of community where project is established is challenges of communication, and ensuring that the right information gets to the appropriate person at the right time.

HRM Challenges: This is the fourth factor accounting for 13.99 per cent of the total variance. Four variables represented the significant loadings of this factor, lack of qualified technical practitioners to accept critical roles / lack of professionalism, resistance of laborers to change their traditional practices, manpower planning due to fluctuations in demand and supply, and lack of adequate allocation of staff.

5. Discussion

The discussion section provides an in-depth details regarding investigation on challenges and their root causes and includes recommendations to tackle these problems in future.

The objective of this study was to identify the challenges which are being faced by construction projects. This objective was achieved in two parts. Firstly, review was performed to identify the challenges before construction projects. Statements regarding the challenges were developed based on the review of literature, and structured questionnaire was developed. Data was collected from 237 respondents. The reliability and validity of the data collected were checked to see if the data was fit for analysis. The reliable and valid data was then used to apply Exploratory Factor Analysis (EFA) to identify the factors of challenges. Four factors were extracted from factor analysis, 20 challenges grouped into four factors. Study revealed the four key challenges in construction projects including: managerial challenges which being experienced the most by respondents, followed by technical, and communication and coordination and, human resource management challenges.

The managerial challenge comes out to be the most important factor due to the resource allocation, lack of client involvement in decision making, meeting government standard on the quality of new materials and equipment, stakeholders change project requirements at later stages of the project life cycle, conducting public and community consultation during construction phase, and challenges regarding site selection and landscaping. These findings are consistent with the previous studies.

Second most important challenge is technical challenges which includes lack of flexibility in technology, unfamiliar technology/ lack of awareness of technology availability, applying highly advanced and complex construction technology, challenges regarding utilization of technologies, and the rapid advancement of information and communication technologies/ unclear technological specification and work instructions. Various prior studies (Yusof and Othman 2013,Atkins 2015; Mok et al. 2017), also found that technical challenge is the challenge faced by construction projects. The results of all these studies were in accordance with the results found in our study. Due to lack of advanced technology and skilled manpower, the overall project economics is not achieved. Many of the on-going affordable housing projects are still adopting conventional construction techniques.

Third challenge which is communication and coordination is also found important and This challenge was mainly due to the insufficient information about relevant issues, language and cultural barrier lead to poor communication and coordination interface management between project stakeholders, inadequate

communication at all levels and poor coordination interface management, lack of familiarity of community where project is established is challenges of communication, and ensuring that the right information gets to the appropriate person at the right time. the above findings were consistent with a number of previous studies. The fourth and the last challenge is human resource management was mainly due to the lack of qualified technical practitioners to accept critical roles / lack of professionalism, resistance of laborers to change their traditional practices, manpower planning due to fluctuations in demand and supply, and lack of adequate allocation of staff.

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