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Impact of Construction Productivity Attributes Over Construction Project Performance in Indian Construction Projects

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Abstract

Performance of a construction project could be influenced by a number of attributes, especially large and complex projects lay additional focus on the success / failure attributes, because of the intensive amount of money invested, a high degree of uncertainty, the complexity of personnel's required, a multiplicity of goals and problems in coordination between different stakeholders encountered. In this research paper, the author intended to define and examine the relationship and impact of construction productivity (CP) over construction project performance (CPP). The author tests the proposition that there is a positive relationship/impact between both of them. And to test the effect of factors is affecting CP on CPP and to propose a conceptual model on the basis of the analysis. To validate the mathematical validity of factor analysis, Spearman correlation analysis has been performed on the factors. And to check the reliability of all the factors using reliability analysis, and finally test the hypothesis that construction productivity is having a positive impact on project performance using one sample t-test. The findings of the study concluded that there is a positive impact of construction productivity on project performance in Indian construction projects. This paper attempts to identify the relationship between CP and CPP and recommends the framework for the industry to grow sustainably and deliver projects successfully. This study is conducted using a structured questionnaire survey in India and to validate the results of the study similar kind of study is required to be conducted in the other regions of the country to have more reliable findings.

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Keywords

construction productivity, construction project performance, impact, attributes, project management

1 Introduction

The construction sector is the engine of growth for any country and contributes about 8-10 % to the GDP on an average. Provide employment to masses and create a flow of services and goods with other sectors. The measures to be done to improve the performance of construction projects has been identified as critical and troublesome problems (Iyer and Jha, 2005). The construction industry faced a number of issues and low rates of productivity growth and declining growth have entertained a number of researchers for many years (Jones and Slinn, 1956). The firms are aware of this issue and start investing to know the causes tend the productivity remains low (Dixit et al., 2017a; 2017b).

The construction industry is having a significant importance in the economic, social, and infrastructure development of any country. It provides employment to the masses, promotes growth, and acts as a linkage to all the other sectors and the economy. Therefore the growth in the construction sector has a significant impact on the economy of the nation. Gains from higher construction productivity flow through the economy, as all industries rely on construction to some extent as part of their business investment. The construction sector

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is the engine of growth for any country and contributes about 8-10 % to the GDP on an average (Iyer and Jha, 2005).

High productivity enables firms a sustainable advantage in comparison to their competitors and this is the main reason that a number of researchers study the concept and the attributes that affect construction productivity. The concept of productivity is the same in all countries but the findings of the one researcher can't be utilized to the different location or the country. There are some cultural, technological, political, policy, skills set and other issues that change from country to country. Productivity is been a vital issue of research since the time of industrialization. Productivity is considered to be one of the important measures of the economic growth of the nations (Singh et al., 2018). The construction industry having a significant contribution to the economy of the countries i.e. the contribution of the construction productivity to the productivity of the economy is to be considered significant in most of the economies.

Performance of a construction project is the measure of their health and at the end of the day, "the project is a successful project or a failed project". To answer this question either you have to track the project life cycle and draw the conclusions or either you can identify the success and failure cause for any construction project (this success or failure called attributes in this study). With the increase in the size of the project, the number of stakeholders associated with the project also increased. And the goals need not be the same of all the stakeholders associated with the project (Iyer and Jha, 2005). Performance of construction projects needed to be measured and improved. And the steps required to measure and improve the performance of projects are: first identify the attributes contributing to the success or failure of a construction project. A number of a researcher working in this area and mainly of them from developed countries. In developing countries a few articles or minor research papers been published on the performance of construction projects. The construction sector is the engine of growth for any country and contributes about 8-10 % to the GDP on an average. Provide employment to masses and create a flow of services and goods with other sectors. The measures to be done to improve the performance of construction projects has been identified as critical and troublesome problems (Iyer and Jha, 2005).

In this research paper, the author intended to define and examine the relationship between construction productivity (CP) and construction project performance (CPP). The author tests the proposition that there is a positive relationship between both of them.

The hypothesis proposed for the study:

- (H0): There is no significant relationship between construction productivity attributes and Project performance.
- (Ha): There is a significant relationship between construction productivity attributes and Project performance.

In this paper, the introduction is revised and a few more concepts of construction productivity and project

Table 1 The issues and challenges in construction productivity(Dixit et al., 2018)

Impacts	References
Construction industry experienced a downward trend in the productivity growth	(Abdel-Wahab and Vogl, 2011; Jones and Slinn, 1956; Chau, 2009; Ruddock and Ruddock, 2011)
The study pertaining to causes of time, cost overruns and low productivity in construction projects have been conducted worldwide	(Ameh and Osegbo, 2011; Chiang et al., 2012; Muhwezi et al., 2014; Zeithaml, 2000; Zouher Al-Sibaie et al., 2014)
The productivity of the UK's construction sector is declining and it is lower than as compared to a few European countries	(Ameh and Osegbo, 2011; Best, 2010)
Construction productivity has been affected by a number of factors, which tend to losses of revenues, delay in completion, poor quality and other issues in construction projects	(Dixit et al., 2017b)
The decline in productivity is one of the dangers to the economy, because it creates social conflict, and creates inflationary pressure	(Dyer et al., 2012; Xue et al., 2008)
The authors concluded that the growth in construction productivity is negative	(Sveikauskas et al., 2016)
The author's observed that the industry shifting is also the reason for low productivity	(Abdel-Wahab and Vogl, 2011; Dyer et al., 2012; Sveikauskas et al., 2016)
CP is one of the main drivers for completing projects within time and cost limitations	(Moselhi and Khan, 2010; 2012)
Appropriate estimation of CP is quite important for preparing construction schedules and budgets	(Panas and Pantouvakis, 2010; 2015; Rashid, 2015)

performance has been included in the introduction. And the research methodology and findings of the study were updated and the extended analysis has been performed using descriptive statistics to make it much more comprehensive and sound in terms of the quality of the paper.

2 Literature review

The success of any project is repeatable and it is possible to find out a set of certain success attributes for the success of a construction project and it requires a controlled discipline hardworking (Iyer and Jha, 2005). The productivity of construction projects is one of the measures for performance of the construction projects at the industry level based on its relationship with economic development. And most countries encounter the issue of low productivity as per the statistical data available. Whereas growth in construction productivity is low and do not continue progressively for a long span of time. In construction projects, the partial measure of productivity is the measure of labor productivity, machine productivity and consumption of materials. These investigations run from hypothetical work in view of understanding of scientist toward one side to organized research deal with the other end. The tools used by the past researchers are AHP (analytical hierarchy process), structures to collect data, simulation models to predict the productivity, framework to improve productivity, techniques to measure productivity, and neural networks systems.

Performance of a project can be considered as a result of the processes as well as the presence of processes. Iyer and Jha (2005) and Jarkas et al. (2012) stated that construction time is important because it often serves as a benchmark for assessing the performance categories such as people, cost, time, quality, safety and health. Completing projects in a predictable manner of time (within schedule) is one of the important indicators of project success. Cost overrun is one of the most frequent problems with construction projects and contractors are criticized for the common occurrence of cost overrun in construction projects. There are some other factors which also contribute to the cost overrun such as profit of the project, project design cost, and wastage of materials, construction productivity, cost of variation orders and cost of rework.

3 Research Methodology

The methodology adopted for the study is to identify the factors affecting project performance form

Table 2 Summary of attributes / variables identified by previous researchers in the field of construction productivity (Dixit et al., 2018)

Attributes / variables	References	Attributes / variables	References
Increases in land-use regulation	(Giandrea et al., 2008)	Project management, planning and scheduling, top management support, rework	(Ganesan, 1984; Jarkas et al., 2015; Wang et al., 2013)
Equipment, drawing, tools, availability of material, weather condition	(Abdul Kadir et al., 2005; Mahamid, 2013; Chalker and Loosemore, 2016; Ertürk et al., 2016)	Coordination among all team members, leadership, top management support, the flow of funds, budget update, coordination and communication, timely feedback, and owner's competence and favourable climatic condition.	(Iyer and Jha, 2005; Dixit et al., 2017a; Kisi et al., 2017)
Labor management, rework, material, confined working space, tools	(Jarkas et al., 2012; Mojahed and Aghazadeh, 2008)	Rework, Poor supervisor competency and Incomplete drawings	(Gosling et al., 2007; Mojahed and Aghazadeh, 2008; Tam et al., 2007)
Delays in inspection, decision making, material, rework, tools and equipment	(Durdyev and Ismail, 2016; Mojahed and Aghazadeh, 2008; Olomolaiye et al., 1987)	Decision making, planning and logistics, supply chain management, labor availability, budget and cash flow management, improper construction method, frequent changes in design, supervision delay, the sequence of activities, overcrowding a job location and scope of activities.	(Hiyassat et al., 2016; Kisi et al., 2017; Moselhi and Khan, 2012; Mahmood et al., 2014; Dixit et al., 2017a)
Absenteeism, Rework and lack of material	(Jarkas and Horner, 2015; Kaming et al., 1997)		
Shop drawings, equipment's, motivation and support, scheduling, material	(Halligan et al., 1994)		
Revision in drawings, delays in inspection, competency of supervisor, martial availability	(Mojahed and Aghazadeh, 2008)	Availability of material, the experience of labor, skill set and training, communication, the financial position of the client	(Loosemore, 2014; Mahamid, 2013; Moselhi and Khan, 2012)

the literature review (to be specific from the paper "Construction Productivity and Construction Project Performance in Indian Construction Projects" (Dixit et al., 2018)) and the factors have been analyzed and explained in detail in this paper. This paper is the extended version of the previous paper and the statistical test applied to the paper are: correlation between the factors has been calculated and the factors have been analyzed, and the reliability analysis table for all the factors has been prepared to check the applicability of factor analysis, and one sample *t*-test is performed using SPSS 23 to check the hypothesis testing.

3.1 Reliability analysis

The value of reliability is in between 0 to 1, the more near to 1 is more the reliable results (Iyer and Jha, 2005). Reliability analysis provides us with the confidence level that the data collected for the study is reliable and shall be used to generalize the findings of the study. The overall value of reliability for all the attributes is 0.765 (refer to Table 3) which is considered good to validate the findings (Singh et al., 2018).

3.2 Factor analysis

Factor analysis enables us to reduce the number of dimensions of the data and to draw a table on the basis of variance explained by the constructs / factors, and factor loading of the different attributes in factors. For the current study, the attributes having a factor loading of equal and more than 0.4 has been considered. The factor analysis reduced 26 attributes into 8 factors explain a cumulative variance of 62.3 % in Table 4 (Dixit et al., 2018).

3.3 Validating factor analysis

The validation of factor analysis has been checked using the correlation in-between the attributes grouped to factor. The results of the correlation analysis conclude that

Table 3 Reliability / Cronbach's alpha for the attributes

Reliability Cronbach's alpha for the attributes	
Attributes	Cronbach's alpha
All attributes selected for the study	0.765
Factor 1	0.79
Factor 2	0.67
Factor 3	0.605
Factor 4	0.75
Factor 5	0.714
Factor 6	0.742
Factor 7	0.735
Factor 8	0.68

Table 4 Factor analysis (Dixit et al., 2018)

Attribute / Variable name	Factor loading	% age of variance explained
Pre-construction management		*14 %*
Inadequate formulation of the project in the start	0.65	
Contractual disputes	0.85	
Design capability and frequent design changes	0.80	
Obsolete construction equipment, and technology	0.85	
Labor and human resource management	0.67	
Financial management		*10.3 %*
PM authority to make financial decisions	0.48	
Willingness to adopt change	0.57	
Availability of training and development to enhance skills	0.57	
Use of inappropriate planning tools and techniques	0.54	
Claim geniuses	0.46	
Socio-economic management		*9.1 %*
Quality	0.55	
Supply chain	0.79	
Political and economic environment	0.61	
Social environment	0.55	
Coordination and communication		*7.1 %*
Scope clarity of the project	0.49	
Coordination between all stakeholders	0.63	
Developing and maintaining communication	0.49	
Project coordination meetings	0.40	
Management of resources		*6.3 %*
Timely payment of completed works	**−0.61**	
Availability of resources	0.40	
Commercial management		*6 %*
Regular budget update	0.60	
Conflict of interests among team members	**−0.40**	
Top management support to PM	0.57	
Site management		*5.0 %*
Site clearance / availability	0.62	
Rework		*4.3 %*
Rework	**−0.57**	
Total variance explained		*62.3 %*

the attributes grouped under factors having a minimum value of 0.4 or above. If the attributes were grouped in a factor they should be significantly correlated (Dixit et al., 2017b). The value of Pearson correlation has been tabulated in Tables 5-10. The Pearson correlation is calculated using SPSS 23.

4 Conclusion and Recommendation

The findings of independent one sample *t*-test having a value of (*p*-value is 0.0) which is less than the significant value assigned for the hypothesis (0.05). So the null hypothesis rejected, which concluded that; there is a significant relationship between construction productivity attributes and Project performance in Indian construction projects. The findings of the study conclude that the attributes / factors affecting / impacting construction productivity are directly impacting the performance of the project. This study provides a better understanding of the relationship between construction productivity and project performance in Indian construction projects. The future scope of the study is to propose a framework model using SEM (structural equation modelling) to improve construction productivity and to validate the model on different construction sites throughout India. The final results shall be the comparison between the productivity of projects before applying the model and the productivity after applying the model, and the conclusions to be drawn on the basis of variance in both samples.

5 Limitation

This paper attempts to identify the relationship between CP and CPP and recommends the framework for the industry to grow sustainably and deliver projects successfully. To validate the results of the study similar kind of study is required to be conducted in the other regions of the country to have more reliable findings.

Table 5 Pre-construction management

	R1	R4	R5	R6	R8
R1	1				
R4	0.41	1			
R5	0.43	49	1		
R6	0.39	0.47	0.5	1	
R8	0.45	0.42	0.47	46	1

Table 6 Financial management

	R10	R17	R20	R25	R9	R19
R10	1					
R17	0.51	1				
R20	0.45	0.44	1			
R25	0.44	0.48	0.49	1		
R9	0.51	0.52	0.43	0.38	1	
R19	0.43	0.46	0.47	0.39		1

Table 7 Socio-economic management

	R13	R14	R15
R13	1		
R14	0.44	1	
R15	0.46	0.41	1

Table 8 Coordination and communication

	R2	R3	R7
R2	1		
R3	0.47	1	
R7	0.49	0.48	1

Table 9 Management of resources

	R21	R22
R21	1	
R22	0.57	1

Table 10 Commercial management

	R26	R18
R26	1	
R18	0.55	1

Table 11 Hypothesis testing

Attributes / Variables	*t*	*df*	Sig. (2-tailed)	Mean Difference	95 % Confidence Interval of the Difference	
					Lower	Upper
Inadequate project formulation in the beginning	19.223	124	0	2.128	1.9089	2.3471
Scope clarity of the project	45.973	124	0	3.872	3.7053	4.0387
Coordination between all stakeholders	40.209	124	0	4.096	3.8944	4.2976
Contractual disputes	19.409	124	0	2.648	2.378	2.918
Design capability and frequent design changes	21.856	124	0	2.104	1.9135	2.2945
Obsolete construction equipment's, methods and technology	22.976	124	0	2.424	2.2152	2.6328
Developing and maintaining a short and informal line of communication	44.845	124	0	3.688	3.5252	3.8508
Human resource and labor strike	25.135	124	0	3.232	2.9775	3.4865
Project managers authority to take financial decisions and selecting key team members	43.962	124	0	3.624	3.4608	3.7872
Timely payment of completed works	42.196	124	0	3.816	3.637	3.995
Rework	18.048	124	0	1.96	1.7451	2.1749
Site clearance / Availability	38.147	122	0	3.357	3.1835	3.532
Quality	29.866	124	0	3.432	3.2046	3.6594
Supply chain	30.666	124	0	3.528	3.3003	3.7557
Political and economic environment	25.545	124	0	3.296	3.0406	3.5514
Social environment	34.6	124	0	3.528	3.3262	3.7298
Willingness to adopt change	25.686	124	0	3.264	3.0125	3.5155
Conflict of interests among team members	28.34	124	0	2.304	2.1431	2.4649
Claim genuine	20.644	124	0	2.376	2.1482	2.6038
Availability of training and development for enhancing of skills	35.596	124	0	3.808	3.5963	4.0197
Project coordination meetings	50.362	124	0	4.192	4.0272	4.3568
Regular budget update	44.32	124	0	3.72	3.5539	3.8861
Availability of resources	69.47	124	0	3.816	3.7073	3.9247
Top management support to pm	44.124	124	0	4.064	3.8817	4.2463
Use of inappropriate planning tools and techniques	41.164	124	0	2.952	2.8101	3.0939
Availability of accurate historical information	44.25	124	0	3.312	3.1639	3.4601

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