



# Validation of a Formal Framework Model to Improve On-site Construction Productivity: Indian Scenario

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## Abstract

Validation can be carried out in many ways, as with most of the research work model validation is usually carried out in five main ways: retrospective project analysis, use of archival data, alternative data collection methods, replication of studies, and experimental implementation. Given the complexity of the data used to propose a framework model for on-site construction productivity, three separate validation methods have been used to verify accuracy and reliability. The validation of the framework model (structure equation model) and the hypothesis using statistical validation measures (quantitative experimental studies are ideal testing tools such as GOF, TLI, and CFI), secondly the validation of the model is by validating the seven main hypotheses using an expert panel of top management industry professionals from the Indian construction industry (using an expert panel of project managers from 13 different construction project in India). The results of the accuracy and effectiveness of the framework model were compared in both different validation processes and the findings of the study suggest that the framework model developed using the structural equation model is valid and that the model could be used by the Indian construction industry.

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**Keywords:** validation process, framework model, construction productivity, construction management, structure equation model

## 1. Introduction

Each construction project is unique and complex. Each project begins with unique parameters, massive investment with good effort and planning (Abdul Kadir, Lee, Jaafar, Sapuan, & Ali, 2005). But as planned, only a few projects succeed. Poor productivity performance is the main problem with the unsuccessful project. Growth and improvement in construction productivity are not constant over time and tends to be low compared to productivity growth in other sectors, such as manufacturing, services, etc (Bröchner & Olofsson, 2012; Kuykendall, 2007). The construction sector is considered to be the engine of growth for a country's economy, providing links and job opportunities to other industries. On average, the contribution of the construction sector to the global economy has been around 7-10 per cent over the last five years (S. Dixit, Pandey, Mandal, & Bansal, 2017). Whereas the contribution of the construction sector to Indian GDP has been around 8-9% over the last five years. "India's economy is one of the fastest-growing economies in the world (Olomolaiye, Wahab, & Price, 1987). Productivity has been one of the most critical and significant issues in the Indian construction industry in recent decades (Saurav Dixit & Sharma, 2020; Saurav Dixit, Sharma, & Singh, 2020). Factors affecting productivity may have a short-term or long-term impact on the company, with productivity being affected for a short time. Productivity consists of different attributes such as labour, capital, utilities, services, plant and equipment, etc. Various experiments have been carried out

in different countries to determine the factor affecting labour productivity”(Abdel-Wahab & Vogl, 2011; Gatti, Migliaccio, Schneider, & Fierro, 2010; Ma & Liu, 2014; Moselhi & Khan, 2012).

The Indian construction industry has an average annual turnover of 3.85crores(Loganathan & Kalidindi, 2015). But every year the industry faces huge revenue losses due to a variety of issues, conditions, and delays due to poor productivity are one of the main challenges (Rami Hugues 2014). Nevertheless, productivity losses in India are still more than 30%, which is a major area of concern for construction workers(Loganathan & Kalidindi, 2015) (S Dixit, Mandal, Thanikal, & Saurabh, 2019; Shah, Dixit, Kumar, Jain, & Anand, 2019). Successful completion of any work in time generally depends on the quality of the projects, resources and processes involved. Authorized bodies such as CPWD, Bureau of Indian Standards, etc. have made several standards to set the quality guidelines for various construction-related activities. The Construction Industry in India is very complex, fractured, and largely unorganized. The professional and productive labour force has always been one of the most complex issues for the construction industry(Guntuk & Koehn, 2010; Kirmani, 1988; Mani, Kisi, Rojas, & Foster, 2017; McKinsey and Company, 2010). The objective of the study is to validate the SEM framework model using expert judgement analysis and respondent’s data analysis to check the applicability of the factors affecting the construction productivity in the Indian construction industry fig 1.

## 2. Research methodology and analysis

The methodology adopted for the study is to validate an SEM model for improving on-site construction productivity using an expert panel of respondent’s (Beguería, 2006; Hallowell & Gambatese, 2010; Patt, 2004). And for this purpose, a two-sheet handout of the conceptual model and final framework model and seven statements about the impact and effectiveness of the hypothesis and findings of the SEM model was asked on a Likert scale of 1-5. Please provide your inputs for the below-mentioned statements on a scale of 1 to 5. Where,

- 1= Agree but perceive the impact to much lesser than the assigned value in the model.
- 2= Agree, but perceive the impact to lesser than the assigned value in the model
- 3= Agree, and perceive the impact to equal the assigned value in the model
- 4= Agree, but perceive the impact to higher than the assigned value in the model.
- 5= Agree, but perceive the impact to much higher than the assigned value in the model.

The received responses were collected and stored in excel spreadsheets. And the final data analysed using the mean, standard deviation, and standard error of the data.



Figure 11. Factors selected for the study

### 2.1. Hypothesis

- Project change management (PCM) having a significant impact over productivity (PR) of construction projects.
- Leadership & Financial management (LF) is having a significant impact on productivity (PR) of construction projects.
- Project coordination & Claim management (CS) is having a significant impact on productivity (PR) of construction projects.
- Site management (SM) factors are having a significant impact on productivity (PR) of construction projects.
- Project Risk management (PRK) factors having a significant impact on the on productivity (PR) of construction projects fig. 2.

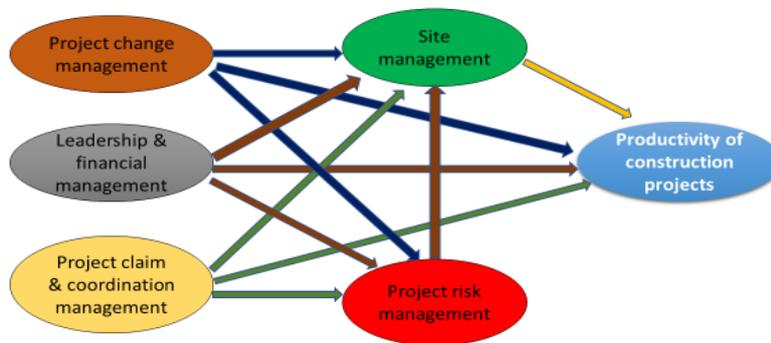


Figure 2. Causal model derived from the hypothesis

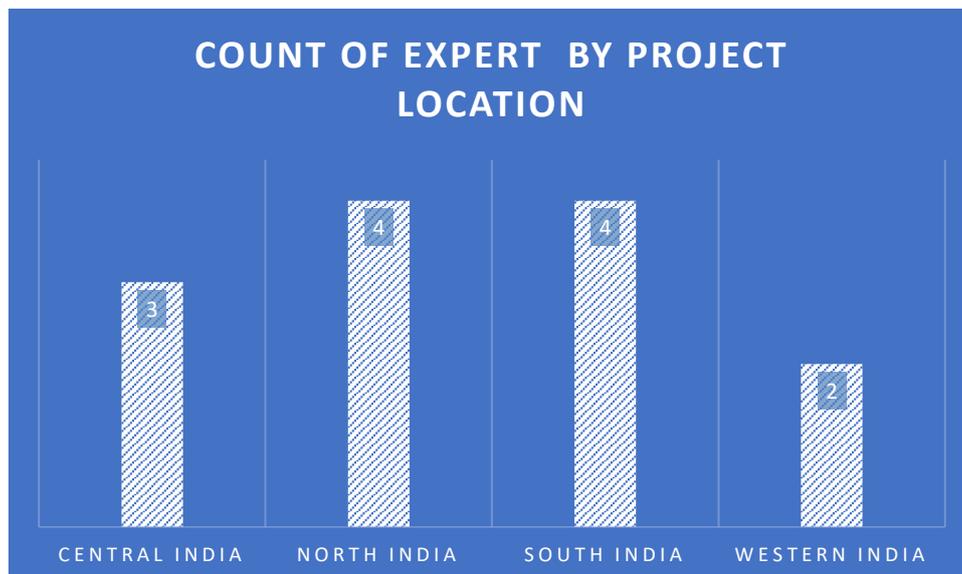


Figure 12. Location of the projects of the respondent

### 3. Research findings

Table 1. Respondent main data analysis table

| Sr. No. | Designation   | Senior Manager | AD GM    | PM       | AGM      | Senior Manager | Senior Manager | AGM      | Senior Manager | Project Incharge | PM        | AGM-Construction | AGM-Projects |           |
|---------|---|----------------|----------|----------|----------|----------------|----------------|----------|----------------|------------------|-----------|------------------|--------------|-----------|
|         |   | Expert 1       | Expert 2 | Expert 3 | Expert 4 | Expert 5       | Expert 6       | Expert 7 | Expert 8       | Expert 9         | Expert 10 | Expert 11        | Expert 12    | Expert 13 |
| 1       | Project change management (PCM) having an impact on the productivity (PR) of construction projects.   | 4              | 1        | 4        | 3        | 2              | 4              | 1        | 4              | 3                | 1         | 2                | 4            | 3         |
| 2       | Leadership & Financial management (LF) is having an impact on the productivity (PR) of construction projects.   | 3              | 2        | 5        | 2        | 3              | 2              | 3        | 5              | 4                | 2         | 5                | 3            | 2         |
| 3       | Site management (SM) factors are having an impact on the productivity (PR) of construction projects.  | 4              | 5        | 5        | 4        | 3              | 5              | 4        | 4              | 3                | 3         | 3                | 2            | 4         |
| 4       | Project change management (PCM) is having an impact - on Site management (SM) factors projects.   | 4              | 2        | 3        | 3        | 2              | 4              | 2        | 4              | 4                | 2         | 4                | 3            | 4         |
| 5       | Leadership & Financial management (LF) is having an impact on Site management (SM) factors projects.  | 3              | 4        | 5        | 3        | 3              | 5              | 4        | 1              | 3                | 3         | 2                | 3            | 3         |
| 6       | Leadership & Financial management (LF) is having an impact on the Project Risk management (PRK).  | 2              | 1        | 5        | 4        | 3              | 1              | 2        | 3              | 4                | 3         | 3                | 2            | 3         |
| 7       | Project change management (PCM), Leadership & Financial management (LF), and Project coordination & Claim management (CS) is having an impact on the productivity (PR) of construction projects mediating Site management (SM) factors. | 4              | 3        | 4        | 3        | 3              | 4              | 2        | 1              | 4                | 3         | 3                | 3            | 3         |

The majority of the responses were in the average range of 2.8 to 3.2, with one exception in case of site management factors having an impact on the productivity of construction works (shows a value of 3.8), which is on the higher side. The standard deviation of the data is in the range of 0.9 to 1.2 for all the seven statements. The cumulative average value of all the seven statements and 13 expert responses is more than 3 i.e. (agree, and perceive the impact to equal the assigned value in the model) table 1. The respondents selected for the study represents the major and significant construction zones of the country fig. 3. The findings of the study conclude that the main significant factors affecting construction productivity are site management (SM), Project change management (PCM), Leadership & Financial management (LF),

Project coordination & Claim management (CS), and Project Risk management (PRK) factors having a significant impact on the on productivity (PR) of construction projects. Furthermore, the study also validates the conceptual model developed by the authors and validates its applicability in the Indian construction industry.

#### 4. Discussion and conclusion

This study provides a new insight towards the validation of SEM framework models and conceptual models using the participation of industry expert panel. The findings of the study also demonstrate the significant importance of site management and project change management practices on the productivity of construction projects. Productivity in the construction sector is less due to various difficulties and factors affecting the industry's growth and economic growth. Analysis cannot focus only on one customer point of view, as the building industry is a multiparty business, the customer, the contractors, the subcontractor and the contractor also need to be examined. In this study, the authors have validated the conceptual model is a first step towards the more detailed analysis of different SEM models and their applicability on the construction projects.

Furthermore, Validation is a comparison of the proposed model predictions with a set of real-world data to assess their accuracy and to predictive their effectiveness (Ghanem, Doostan, & Red-Horse, 2008; Henriksen et al., 2003; Lucko & Rojas, 2010; Pesämaa, Eriksson, & Hair, 2009). Validation enables the trust of the model to be developed, which is extremely important for the transmission of the findings to the final users. Results for effective decision-making should be monitored before research that may have an impact on health, cultural, political climate, economy, and the environment (Thorne and Giesen 2002).

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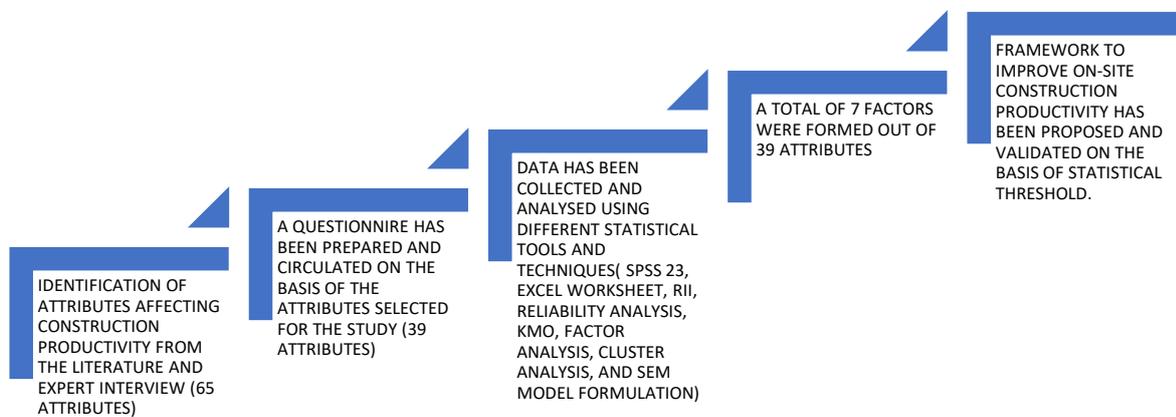
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## Appendix A. VALIDATION OF FRAMEWORK TO IMPROVE ON-SITE CONSTRUCTION PRODUCTIVITY: INDIAN SCENARIO



### Grouping of attributes into Factors

|   |     |  |
|---|-----|--|
| <b>Productivity of construction works (PR)</b>        | RE  | Rework   |
|   | C3  | Cost   |
|   | C4  | Quality  |
| <b>Project coordination and claim management (CS)</b> | CS1 | Site clearance/availability                                      |
|   | CS2 | political and economic environment                               |
|   | CS3 | Interest and inflation rates                                     |
|   | CS4 | Working hours  |
| <b>Leadership and financial management (LF)</b>       | L1  | Project coordination meetings                                    |
|   | L2  | Regular budget update  |
|   | L3  | Leadership qualities   |
|   | L4  | Timely payment of completed works                                |
|   | L5  | Availability of training and development for enhancing of skills |
| <b>Project change management (PCM)</b>                | P1  | Obsolete construction equipment's, methods and technology        |
|   | P2  | Human resource and labour strike                                 |
|   | P3  | Supply chain   |
|   | P4  | Social environment   |
|   | P5  | Climate conditions   |
|   | P6  | Social skills of key team managers                               |
|   | P7  | Interpersonal skills   |
|   | P8  | Top management support to pm                                     |
| <b>Project risk management (RK)</b>                   | RK1 | Conflict of interest among team members                          |
|   | RK2 | Selection of pm with proven track record                         |
| <b>Site management factors (SM)</b>                   | S1  | Use of inappropriate planning tools and techniques               |
|   | S2  | Willingness to adopt change                                      |
|   | S3  | Urgency emphasized by the owner while issuing tender             |

|  |     |   |
|--|-----|---|
|  | S4  | Inadequate project formulation in the beginning                                       |
|  | S5  | Coordination between all stakeholders   |
|  | S6  | Contractual disputes  |
|  | S7  | Design capability and frequent design changes   |
|  | S8  | Ability to delegate authority   |
|  | S9  | Project managers authority to take financial decisions and selecting key team members |
|  | S10 | Availability of resources   |

Please provide your inputs for the below mentioned statements on a scale of 1 to 5. Where,  
 1= Agree, but perceive the impact to much lesser than the assigned value in the model.  
 2= Agree, but perceive the impact to lesser than the assigned value in the model  
 3= Agree, and perceive the impact to equal the assigned value in the model  
 4= Agree, but perceive the impact to higher than the assigned value in the model.  
 5= Agree, but perceive the impact to much higher than the assigned value in the model.

| Sr. No. | Statements for the validation of Model (Factors affecting construction productivity)  | 1 | 2 | 3 | 4 | 5 |
|---------|---|---|---|---|---|---|
| 1       | Project change management (PCM) having an impact 29% on the productivity (PR) of construction projects.   |   |   |   |   |   |
| 2       | Leadership & Financial management (LF) is having an impact 64% on the productivity (PR) of construction projects.   |   |   |   |   |   |
| 3       | Site management (SM) factors are having an impact 32% on the productivity (PR) of construction projects.  |   |   |   |   |   |
| 4       | Project change management (PCM) is having an impact -37% on the Site management (SM) factors projects.  |   |   |   |   |   |
| 5       | Leadership & Financial management (LF) is having an impact 88% on the Site management (SM) factors projects.  |   |   |   |   |   |
| 6       | Leadership & Financial management (LF) is having an impact 69% on the Project Risk management (PRK).  |   |   |   |   |   |
| 7       | Project change management (PCM), Leadership & Financial management (LF), and Project coordination & Claim management (CS) is having an impact 32% on the productivity (PR) of construction projects mediating Site management (SM) factors. |   |   |   |   |   |

Final SEM proposed framework model to Improve on-site productivity of construction project.

