

A Paper on Methodology Used in Tools for Measuring Construction Material Management Practices and Predicting Labor Productivity in Multi-Storey Building Projects for Akola City

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Abstract— Materials management is a process that consists of the people, organizations, technology, and procedures used to effectively identify, acquire, expedite, inspect, transport, receive and preserve the materials, equipment, and Data across the life cycle of the project. The goal is to achieve a correct quality and quantity of materials and equipment procured in an effective manner, available at a reasonable cost, and availability of them when needed. This paper describes a study in which we developed a tool for scoring materials management practices for building projects and, on that basis building a tool for predicting productivity of labor. The research was carried out in two phases. During Phase I, in-depth interviews were conducted with 10 experts (civil professionals) and specific materials management practices were identified. During Phase II, questionnaires were used to collect quantitative data from 10 contractors. Based on the analysis, tools for measuring and planning the materials management practices and probability-based regression models were developed. This research contributes to the body of knowledge by developing construction materials management practices measuring, planning, monitoring, and evaluating tools in the context of building projects.

Keywords: Regression Models, Materials Management, Management Practices, Labor Productivity

I. INTRODUCTION

Materials management is a critical component of the construction industry. As such, organizations need to understand the effects of proper materials management techniques on the effectiveness of project execution. Extensive literature and reports deplore the lack of efficiency and productivity in the construction industry. Two of ten, construction projects suffer from delays, budget overruns, and claims. A properly implemented materials management program can achieve the timely flow of materials and equipment to the job-site, and thus facilitate improved work face planning, increased labor productivity, better schedules, and lower project costs.

Construction is one of the country's biggest ventures of the world and has been assuming a critical part in financial improvement, and additionally in lessening unemployment. Profitability is one of the essential viewpoints for the organizations in the development business. Change in the efficiency of the development business is accordingly of basic significance thinking about its huge commitment to the GDP (Gross Domestic Product).

The construction company with the most efficient operations has a greater chance to make more money and deliver faster construction project to the project owner. Improving labor productivity can alleviate the shortage of

skilled craft-workers, enhance the working conditions, and enhance the overall quality of a product. For every project, productivity, cost, quality and time have been the main concern.

Construction performance & productivity improvement are enter centre regions in development industry for any country. Indian construction industry frames a necessary piece of economy. Constructions constitutes 40% to half of India's capital consumption on ventures in different areas, for example, roadways, streets, railroads, vitality, airplane terminals, water system, and so forth and is the second biggest industry in India after farming. It represents around 11% of India's GDP. Improving productivity is significant worry for any benefit arranged association. When all is said in done terms productivity is named as ratio between input & output. Appropriate administration of accessible resource can help in enhancing productivity. Labor is the most imperative resource for a construction company. 30% to half of aggregate cost of venture is spent on labors. Nature of the development to a great extent relies on the nature of work done by labor. Labor productivity specifically influences development efficiency; it is essential to know the factors influencing work efficiency.

II. METHODOLOGY

This research adopted exploratory sequential mixed-methods research design, which involves the collection and analysis of the quantitative and qualitative data in two phases (Creswell 2013). Therefore, this study was carried out, first, by collecting and analysing qualitative data which were obtained from interviews during Phase I. On the basis of the qualitative data, appropriate materials management practices were identified, and their levels of implementations were refined to suit the building construction projects. To investigate the relationship between productivity and the practices, assign the weights to the materials management practices, validate the materials management practices' scoring tool for building projects, and develop as well as validate the productivity predicting tools, the quantitative data were collected and analysed during Phase II. During Phase I, the participants interviewed were 10 professionals having work experience in the construction of multistorey buildings in the Akola city, Maharashtra, India. The expert's have 2-10 years experience. Their positions include construction manager, general manager, project manager, project engineer, project coordinator, site engineer, architect and contract administrator. These experts were chosen on the basis of their experience in working for sub-contractors as well as principal contractors that have been delivering multistorey building projects in Akola city.

The employees who were responsible for the construction of multistorey building projects by these companies were then contacted. Site managers, project managers, and project coordinators were the respondents. The questionnaire consists of three parts. In the first part, the respondents were asked to provide information on a specific building project which they have completed within the last 5 years. The information includes project cost and project time among other things. In the second part of the questionnaire, the respondents were requested to rate the relative importance of the materials management practices which were identified during the first phase of the research. A scale of 1–5 is recommended to get better validity and reliability (Lozano et al. 2008; Jamieson 2004). Accordingly, to rate the practices, this research used a scale of 1 for not important; 2 for slightly important, 3 for somewhat important, 4 for very important, and 5 for extremely important. On that basis, a new instrument (un-weighted scoring tool) was developed and validated through interviews with local experts during Phase I of the study. The clarity, language, format, and the contents of the levels of the practices have been discussed during the validation process of the questionnaire.

Shows the procedures used in preparing the un-weighted and weighted scoring tools. First, the qualitative data were analysed, and materials management practices which are suitable to enhance productivity in building projects were identified. Then the levels of implementation for the identified practices were prepared based on the existing tools developed by the Construction Industry Institute for industrial and infrastructure projects. Thus, the practice and its levels of implementation were excluded. Consequently, the un-weighted scoring tools were prepared and validated by conducting interviews with local experts during Phase I of the study. The validated and un-weighted scoring tool (third part of a questionnaire) was used to collect the data regarding the implementation levels of the identified practices. During Stage I of the quantitative data analysis, the weight computed for each practice was used in the preparation of the weighted scoring tool. The weights were computed using the relative importance index (RII) technique. According to Lam et al. (2007), the mean value and the RII could be used for ranking variables. However, the RII technique is suitable for deriving relative indices between 0 and 1. Thus, it would be easy to compare various variables. Hence, the following RII equation is adopted (El-Gohary and Aziz 2014)

$$RII = \frac{5(n5) + 4(n4) + 3(n3) + 2(n2) + n1}{5(n1 + n2 + n3 + n4 + n5)} \quad (1)$$

Where n1 = number of respondents who selected not important;
n2 = number of respondents who selected slightly important;
n3 = number of respondents who selected somewhat important;
n4 = number of respondents who selected very important;
And n5 = number of respondents who selected extremely important.

The weights obtained using this equation was proportionally distributed among the five levels of the practices, and the weighted scoring tool was developed. During Stage II of the quantitative data analysis, the data collected from the building construction projects were transformed into equivalent scores using the weighted scoring tools, and projects scores were computed. The analysis was then conducted to validate the weighted scoring tools. Thus by calculating Productivity factor (PF), RII and weighted scoring tool for all the management practices we can conclude for the labour productivity depending upon the weights we get using the below formula.

$$\text{Level } (N + 1) = \text{Level } N + RII/5$$

A. Findings and Discussion:

Materials Management Practices for Improving Labor Productivity of the Building Construction Projects: Interview results are summarized in Table 1. The practices which were not considered suitable for improving the productivity of the multi-storey building construction projects by all interviewees were rejected. Accordingly, on-site materials tracking technology, procurement team, and post receipt preservation and maintenance were not found to be significant to enhance productivity in multi-storey building projects. However, six materials management practices which can increase the productivity of multi-storey building construction projects were identified. These practices comprise long-lead materials identification, procurement plans for materials, materials delivery schedule, material inspection process, materials inspection team, and materials status database.

Thus from the Questionnaire survey we came to know about the suitable and non suitable management practices and thus by considering only suitable practices further research was carried out.

Construction materials Management practices	Summary of the interview responses	Conclusion
Procurement plans for materials	Materials procurement plan is right on the front end. The potential suppliers are identified; the required materials are estimated upfront; the tracking sheets and charts are prepared; different stages of the procurement are represented using different colours on the chart; and any changes made during the procurement process are tracked.	Suitable

Long-lead materials identification	Usually the long lead items are façade materials, tiles and services such as lifts, generators, and boilers. All these key primary elements have long lead time. These items are identified earlier and tabulated. The approximate lead times for these materials are also estimated; for example, item = tiles, duration = 2-4 weeks. Most items imported from outside city are categorized as long lead items.	Suitable
Materials status database	The contractor's project manager get information regarding the work progress from supervisors or subcontractors and prepare the material status report which comprises the percentage of the materials utilized and the estimates of the quantities of materials required to complete the remaining works. The supervisors then monitor the work on a regular basis; they identify the remaining items and request the procurement of these materials if any.	Suitable
Materials delivery schedule	The materials delivery schedule is prepared based on the construction work program; the principal contractor's supervisors discuss the materials delivery dates with respective subcontractors/ suppliers and prepare the schedule. The schedules are written on a whiteboard, and the materials delivery is tracked every day. Some materials such as façade are tracked during the manufacturing process; when they are on-site; and after their installation.	Suitable
Material inspection Process	The inspection is made up front, the consultants are engaged in the inspection, and sometimes materials are inspected during the manufacturing stage. Inspection is made for various items such as reinforcement, formwork, glass, and concrete. The materials should be inspected before being installed. The subcontractors or suppliers provide the quality assurance documents for all items they bring to a site and the principal contractor's project management team conducts quality assurance checks.	Suitable
Materials inspection Team	The project coordinators and specialist consultants are involved in the inspection process. For instance, façade expert and project coordinator or manager inspect the façade, and structural engineers take part in the inspection of reinforcement bars. Other consultants are also involved depending on the type of the materials or works.	Suitable

Table 1: Summary of the interview results of construction materials management practices

III. CONCLUSION

From the above methodology it is concluded that there are many methods of increasing productivity in construction industry. By proper use of construction management practices productivity as well as proper use of labor force can be easily done and managed. There is enormous study on the methods which improve the productivity which consists of material tracking, healthy and safe working condition and effective management systems.

Practices which are suitable as per responses we received in our survey are mentioned in the table no. 1 and thus considering those management practices weighted scoring tools are made and thus by those values we came to conclusion for the labor productivity by taking into consideration the obtained values.

By applying proper score and weighted tools for construction management practices we have predicted the labor productivity on the construction site in our project.

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