

Assessment of Construction Labour Productivity in India

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Abstract: Labour productivity is very crucial for developing countries like India where major construction works are based on manual means. It is very much required to improve the efficiency of labour in Indian construction which can further lead up to saving cost as well as time. The aim of the paper is to study various factor which affects labour productivity and its impact on the overall cost of a residential projects. To achieve the objective, a questionnaire survey has been conducted with various stake holders of the construction industry like architects, civil engineers, and contractors etc. As per the results of the survey, important factors of the study were ranked according to RII method and further quantified to understand its impact on labour productivity. The findings of the survey have been applied on the construction of a residential project and the findings reveals a scope in improvising the labour productivity which can reduce the overall time and cost of construction projects.

Keywords: Productivity, Time saving, Cost Saving, Relative important index, management

1. Introduction

Construction is one of the major labour intensive industries in India, contributing to approximately 8-10% of the Country's Gross Domestic Product (GDP). Construction industry in India uses 40-50 % of its Capital expenditure on projects like buildings, infrastructure and irrigation etc. [6]. Construction industry needs higher quantities of various resources like material, machinery and man power etc. for its day to day activities. The percentage of the requirement of these resources during construction varies with the scale of the project. Even though there has been a tremendous advancement in technology, Construction industry is still a labour intensive industry next to only agriculture. Most of the quality and speed of the construction depends on its man power i.e. labour. For a small project like a residence, the contribution of labour will be up to 50% due to the limited scope of work and budgetary constraints for employing the machinery. For a project to be completed within the stipulated time and budget, the efficiency of the man power is very important and it can be measured in terms of labour productivity. Labour productivity can be defined as units of work produced per a man hour [2]. Two of the major components of productivity are human efforts applied and the quantum of work completed or goods produced in a given time. The total of these components with respect to time is defined as labour productivity. It is essential to measure labour productivity for defining an optimum time schedule and estimating overall project cost. The measurement of actual labour productivity varies with respect to different construction sites as it is dependent on various factors. Also, the impact of these factors varies for each construction project. There is no universal standard for measuring the impact of these factors on labour productivity. Due to this, the industry requires to measure the effect of these factors as per the project and site conditions. The improvisation of labour productivity can further lead up to reducing the overall cost and time duration of any project. The construction firm which offers lesser cost

and minimum time duration for completion of any project has a greater chance of success in a competitive market.

2. Back ground study

Productivity can be measured in many ways as Productivity is generally known as the ratio between output and input. Productivity is the ratio of the resources used for producing the output which can be either homogenous or heterogenous comprising labour, money, energy and resources etc. [7]. There are two methods which are commonly used to measure productivity in the construction. The first method is known as Total Factor Productivity (TFP) which is defined as the ratio between total output to total input, which involves equipment, labour, materials, and the capital. The formula for TFP is as follows:

$$TFP = \frac{\text{Total Output}}{(\text{Labour} + \text{Materials} + \text{Equipment} + \text{Energy} + \text{Capital})}$$

The second method is commonly known as Partial Factor productivity (PFP), which is the ration between outputs and input of a site item. Its terms of labour productivity, it can be generalized as the ratio of material produced or the work completed to the amount of time spend. The formula for PFP in terms of labour productivity is as follows:

$$PFP = \frac{\text{Output Quantity}}{\text{Labour Hours}}$$

The analysis of total factor productivity is very difficult but the assessment becomes easier and manageable for the partial factor productivity. The productivity of labour in the construction industry has been widely studied by various researchers. It has been found that there are so many factors which affect the productivity factor. The identification of these factors has been done on the basis of the previous researches conducted, interviews and the questionnaire survey.

2.1 Factors affecting lobour Productivity

Financial success of a construction project depends on completion of the work as per the scheduled time and with in the stipulated budget. This is the crucial factor influences the contractor's profit. There are many factors which influences the labour productivity. These factors of the productivity are grouped as per the literature study conducted into four major categories. These categories are (i) human factors, (ii) site conditions, (iii) availability of resources, (iv) project planning and Management. The motive of identifying the factors is to rank them based on their impact with the help of Relative Important Index (RII) method. Relative Important Index (RII) is used to calculate the relative importance of the various factors which affects the labour productivity [6]. Out of the identified factors, top ten factors were further analyzed to calculate the relative importance of them on labour productivity.

S. No.	Factor	Description
Human Factors		
1.	Age	The productivity of individual labour starts to decline over a certain age.
2.	Skilled and Unskilled	Skilled Labour: Mastered in specific skills, Unskilled Labour: A person with little or no training.
3.	Linguistic difference	If the labour is not able to communicate in the local language can create difficulties.
4.	Education	Educated labour can understand the work in an effective manner
Site Conditions		
1.	Climatic condition	Harsh temperature, rainfall, snowfall etc. can cause hindrance in working of labour.
2.	Method of construction	Either working with the traditional method of construction or using an innovative system to enhance the quality and reduce the overall time and cost of project.
3.	Physical Constraints	A confined space may be difficult for labour to execute the work.
4.	Insufficient Lighting	The lack of daylight/artificial may create hindrance in executing any critical task at site.
5.	Site Layout	The working conditions may vary with respect to a different site, its scale and location etc.
6.	Material Storage	The location of material storage to the working area may increase or decrease the time for any activity at site.
7.	Safety issue at site	Working at a construction site always creates lots of hazards which need to be prevented for creating a safe environment for labour.
Resources Availability		
1.	Material availability	The material should be available at site as per planned activity for smooth working.
2.	Tools & equipment	Appropriate tools and equipment as per the const. activity
3.	Number of labour	Every activity requires an optimum number of manpower for execution
4.	Payment	The periodical and timely payment of labour salaries.
5.	Incentives	An additional payment or bonus to labour for extra work.

Table.1 Factors affecting the labour productivity

Project Planning and Management		
1.	Scheduling	Effective scheduling can improve the handling of resources like material, labour, capital etc.
2.	Training of Labour	The regular training of labour towards safety, operating tools etc.
3.	Site Meetings	Periodical meeting with labour contractors can provide usexact situation at site and can also help to update overall time schedule.
4.	Communication	The mode of communication at site is an effective tool to utilize the available resources.
5.	Extra work	Any extra work or unplanned activity can cause hindrance to ongoing activity at site.
6.	Supervision of labour	Guiding or assigning work to the labour at construction site.
7.	Delay in inspection	Any activity requires inspection periodically. The delay may stop the progress of work.
8.	Miscommunication	The miscommunication at site can lead up to misuse of resources and sometimes also require to redo the work.

Table.1 Factors affecting the labour productivity

2.2 Questionnaire Survey

The questionnaire was prepared on the basis of identified factors. The sample size of survey was limited to the person who is related to the field of constructions like architects, civil engineers, project managers & site supervisors. The questionnaire is divided into five different groups. The first group collected the basic information about respondent like name of the organization, year of experience, location etc. The rest four groups are based on each category of factors which were identified from the literature review. A Likert scale of 1-5 was used to provide an effective rating for each of the factors.

Likert Scale Index	Level of productivity Rating
One	Very Low
Two	Low
Three	Average
Four	High
Five	Very High

Table 1.2: Likert Scale Index

2.3 Relative Importance Index (RII)

The collected data from the questionnaire survey was analyzed with the help of RII method. Each factor was further ranked according to their respective RII value.

$$RII (\%) = \Sigma W / A * N$$

Where,

RII = Relative Important Index

W= weightage given to each statement by the respondent and ranges from 1 to 5
 A = Higher response integer N = total no. of respondents.

The factors which majorly affects the labour productivity amongst all identified factors are insufficient lighting conditions, skilled & unskilled labour and incentive and bonus (Table 1.3). Project planning and management could be considered as a major impact group.

Rank	Factor	RII	Impact
1	InsufficientLighting	0.914	+9.99%
2	Skilled & unskilled labour	0.909	+9.86%
3	Incentives or bonus schemes	0.903	+9.74%
4	Supervision of labour	0.886	+9.37%
5	Communication	0.874	+9.13%
6	Project complexity	0.811	+7.87%
7	Site Meetings	0.777	+7.21%
8	Payment	0.771	+7.11%
9	Scheduling	0.766	+7.00%
10	Availability of tools & Equipment	0.760	+6.90%

Table 1.3: List of top ten factors which affects labour productivity

2.4 Predicting productivity with multiple factors

The impact percentage is predicted for the identified top ten factors (H. Randolph Thomas, Jr & Gary R Smith, 1990) which affects labour productivity. The impact percentage (Table 1.3) for the top ten identified factors ranges from 10 % to 6.9%.

$$E(P_r) = P_{norm} \times \{1 + \sum_{i=1}^n (f_i \times R_i)\}$$

$E(P_r)$ = Expected Productivity P_{norm} = Unimpacted Productivity

R_i = Relative average impact of factor i

n = Number of factors in change analysis f_i = Relative frequency of factor i
 (f_i based upon field observation)

3 Case Study

The research paper has considered brick masonry as a sample study to analyze labour productivity and its impact on time and cost in a residential project across various states of India. It has analyzed the actual labour productivity at site with respect to multiple factors and compared them with the existing productivity standards available in analysis of rate (DSR 6.4.1) of CPWD. The site area of selected case studies was in the range of 100 to 250 square meters. The measurement of labour productivity is limited to brick masonry at ground floor and labour were categorized into skilled and unskilled based on their daily wages. The details of the data collected in various case studies is tabulated in table 3.

S. No.	Qty. (Cum)	No. of Labours (Per Day)		Total No. of Days	Labour Cost (Per Day in Rs.)		Labour prod. (Cum. per day)	
		Skilled	Unskilled		Skilled	Unskilled	Skilled	Unskilled
1	32	3	2	25	400	200	0.427	0.640
2	93.5	6	4	65	650	500	0.240	0.360
3	80	4	2	52	700	550	0.385	0.769
4	45	3	2	33	550	400	0.455	0.682
5	62	4	3	45	550	400	0.344	0.459
6	30	3	2	24	600	350	0.417	0.625
7	55	4	3	40	800	600	0.344	0.458
8	90	6	3	70	750	350	0.214	0.429
9	28	3	2	22	500	350	0.424	0.636
10	64	4	3	45	500	300	0.356	0.474
Average					600	400	0.36	0.553

Table 3 Analysis of labour productivity based on case studies.

Labour productivity and labour cost per cum of work has been calculated for both skilled and unskilled labour working in the case studies. The obtained values were compared with the standard values of CPWD. The analysis labour productivity is shown in Fig 1. The productivity of skilled and unskilled labour is much lower than the CPWD standards with skilled labour has achieved 0.36 against the CPWD standard of 0.47. whereas unskilled labour productivity is 0.553 against the CPWD standard of 1. The achieved labour cost values are also lower than the CPWD standards. The cost of skilled and unskilled labour were 216.27 and 221.29 respectively. Whereas the CPWD standards for skilled and unskilled labour were 282 and 400 respectively. In both the cases the obtained values were lower than the CPWD standards.

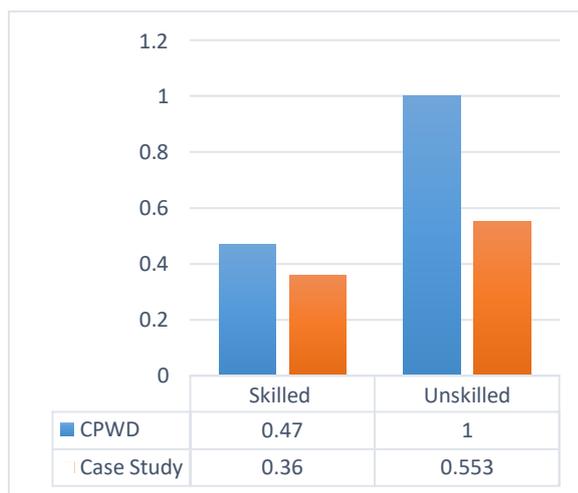


Fig 1. Labour Productivity Per Cum

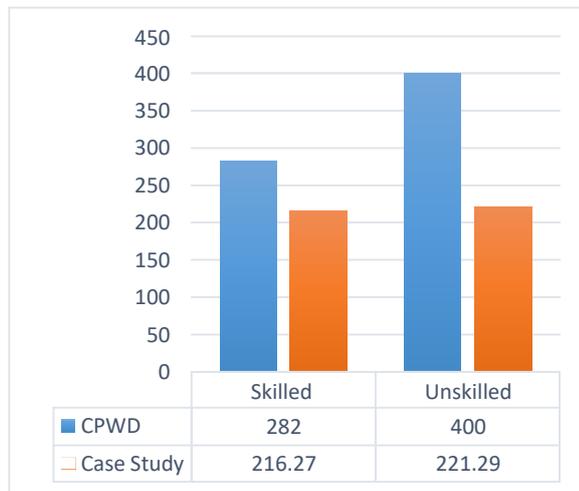


Fig 2. Labour Cost Per Cum

4 Conclusions

Labour productivity in the construction sector in India requires further studies which may help in predicting an optimum time duration and cost for any project with respect to various productivity factors. The paper identified and analyzed the top ten factors which affects the labour productivity. The factors are insufficient lighting, skilled and unskilled labour, incentives, supervision of labour, communication, project complexity, site meetings, payment, scheduling, and availability of tools & equipment. The impact of these ten factors on labour productivity ranges from $\pm 10\%$ to $\pm 7\%$ approximately. This paper analyzed the case studies and ~~the~~ the difference with respect to CPWD standards for labour productivity are 23% and 45% for skilled and unskilled labour respectively. The contribution of total ~~hour~~ cost for residential project can be reduced up to 35% if the higher productivity of labour is achieved on construction site. As the contribution of labour in a small-scale project is higher, the effectiveness of labour productivity will decrease the overall estimated time duration and cost of a project.

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