Analysis of Labor Productivity in Indian Building Construction and Methods to Improve Productivity

[1]Apiha R. Sonawane, [2]Milind.M.Darade

[1]PG Student, [2]Professor
[1]Department of Civil Engineering,
[1]Dr. D. Y. Patil School of Engineering and Technology, Pune, India

***Abstract*— The objective of the study is to overview the productivity measurement practices in the Indian construction industry. It mainly aims to investigate and rank the critical factors affecting labor productivity in building construction projects according to the rate given by respondents and to compare the investigated critical factors affecting labor productivity in India to that of other studies in different countries. Furthermore, it describes approaches suggested by construction practitioners to improve labor productivity on building projects. The study result indicates that the performances of building construction projects are influenced by the effect of poor labor productivity; however, most of the contractors do not have experience of measuring labor productivity on their projects due to negligence, lack of awareness and believing that measuring productivity is difficult to implement. Hence, contractors are recommended to participate in trainings and workshops to increase their knowledge and level of awareness.**

***Index Terms*— Labor Productivity, Work Sampling, Factors Affecting, Analysis, Indian Building Construction**

I. INTRODUCTION

Range of construction projects is wide and divided into various segments usually residential buildings, commercial buildings, industrial buildings, road construction, utility construction etc. Construction involves various people, skills, organizations, technologies, contracting methods, financing arrangements and regulatory mechanisms and has different phases such as planning, designing and building, then they are used, maintained, repaired, renovated and eventually demolished or replaced in their life cycle. This diversity of construction projects makes it difficult to manage. In line with this adopt a common productivity measurement system. Now a big question is that how can we measure construction productivity considering all these segments, aspects and phases.

The construction industry is one of the few most labor intensive industries in the developing countries. Therefore it is very important to understand the concept of construction labor productivity. In different researches it was found that productivity measurement techniques could be perceived as theoretical, difficult and expensive for construction companies to adopt. Good project management in construction must strongly measure and monitor productivity on construction site. Construction productivity has got increased attention from different construction researchers. Researchers and practitioners around the world have provided several contributions on areas related to construction work productivity. In addition, the result of different researches indicated that productivity is a complex issue as many factors influence productivity such as labor, capital, material, equipment, tools and equipments, poor communication or relationship between workers and management, disorganized projects, poor supervision, lack of cooperation and communication between different workers, and unfair workloads are the some of the factors that affect productivity. Technical problems like inadequate designs or incomplete engineering work can also lead to a decrease in construction productivity. The main findings of previous studies indicate that the critical areas affecting construction productivity were related to materials, tools, equipment availability, and the workers' performance.

Increasing the construction work productivity benefits a contractor in several ways: projects can be completed more quickly, project cost will be lowered, the contractor can submit more competitive bids, the project becomes more profitable and in addition it makes the firm to be capable and also helps to have good will among different stakeholders. Therefore measuring productivity, identifying factors affecting productivity and use productivity improving approaches should be a major and continual concern for construction contractors to increase the probability of projects to be completed as per the budgeted cost and specified time.

II. OBJECTIVES

1. To Analyze the Labor productivity of construction activities.
2. To propose methods suggested by construction practitioners to improve productivity.

III. LITRETURE REVIEW

A project means doing something new. In the business world this usually means creating something that someone else wants and is prepared to pay for. According to Namho Kim et al (2007), the construction industry's core business is undertaking projects in generating new buildings or renovating existing ones for a variety of clients.

Since the construction industry is mostly project-oriented, the performance of the construction company is dependent on the performance of projects. Projects have targets, which mean they have to be built right, within a cost budget, and finished by a certain date. Project management is implying making sure that all these targets are met.

According to the Project Management Institute, the discipline of project management can be defined as follows: Project management is the art of directing and coordinating human and material resources throughout the life of a project by using modern management techniques to achieve predetermined objectives of scope, cost, time, and quality and participation satisfaction. Therefore project management aims to plan, organize and control to make a project successful. The simplest way of defining a project as successful is to show that three primary objectives have been met. These might possibly be called the three graces of project management and they are;

- Time: Delivery or completion on or before the date agreed with the customer.
- Cost: Completion within the budgeted cost.
- Quality: A building that meets the set standards of quality.

Productivity is a multidimensional term, the meaning of which can vary, depending on the context within which it is used. However, there are common characteristics that tend to be embraced by the term. In industrial engineering, productivity is generally defined as the relation of output (i.e. produced goods) to input (i.e. consumed resources) in the manufacturing transformation process. However, there are several variations on this basic ratio, which is often too wide a definition to be useful in practice.

IV. RESEARCH METHODOLOGY

The methodology going to adopt for the research work is as follows:

- A comprehensive literature review to understand the definitions and terminology related to productivity, work sampling and work measurement in construction projects.
- Studying various productivity measurement techniques.
- Selection of construction activities to be study.
- Critical examination, element breakdown and element breakdown of processes..
- Carrying work sampling on activities.
- Carrying out interviews with construction practitioners.

V. DATA COLLECTION

A.Site Details

Data were collected from two sites in Aurangabad. The reason behind choosing this sites were easily accessible and near to each other. Site conditions were similar and material and technique used for construction were similar. It is necessary for work sampling that data collected should be from same sites. First site selected for taking observation were Apartments at Deolai. It is G+7 residential building with parking at ground floor. It consist of 2BHK flats at all floors. Different activities were carrying on different floor. First floor was about to complete at time of data collection. Second site is also from same area in Aurangabad. It is G+3 commercial building for a Hotel. Different construction activities were going on different floor. On both site ground floors were used for material storage. This material is then transported to required places from ground floor.

B.Work Sampling

It is the statistical technique for determining the proportion of time spent by workers in various defined categories of activity. It is as important as all other statistical techniques because it permits quick analysis, recognition, and enhancement of job responsibilities, tasks, performance competencies, and organizational work flows. In a work sampling study, many observations were made on the workers over an extended period. For statistical accuracy, the observations must be taken at random times during the period of study, and the period must be representative of the types of activities performed by the subjects. The observer walks along the randomly selected predefined route, characterizing the activity of each worker seen. As the observer approached worker, they instantaneously identify the craft and activity category. This was done from a distance of 15–30 m because this is close enough to make an accurate recording but not close enough to cause worker discomfort. It is critical that the observation were made at first sight of the worker to ensure accuracy of the results. When the activity and craft is identified, the observer places a mark in the corresponding cell of the activity analysis data collection form.

C. Categorization of activity

Table No. 1: Categorization of Construction Activities

Activity	Direct Work	Support Work	No Work
Reinforcement	Placing Bars Tying Bars	Marking. Transportation of material. Material handling	Idle. Waiting. No contact
Form Work	Placing of shutters. Nailing/Taping. Finishing.	Transportation of material. Material handling.	Idle. Waiting. No contact.
Brick Work	Placing of brick. Placing of mortar. Finishing.	Mixing of mortar. Transportation of material, labor and equipment.	Idle. Waiting. No contact.
Plastering	Placing of mortar. Finishing.	Mixing of mortar Transportation of material. Material handling.	Idle. Waiting. No contact.

D. Sampling Size

Determining an adequate sample size is critical to the accuracy of the activity analysis study. In most industries, an error of 5% at a confidence level of 95% is generally acceptable. Many construction and industrial engineering journals provide the following for determining sample size on the basis of desired error and anticipated category percentages.

$$n = \frac{(Z_{\alpha/2})^2 p(1-p)}{d^2}$$

Typical industry values include Zα/2 = 1.96 the standard normal variable corresponding to a confidence level 95%, p = 50% worst case category percentage, and d = 0.05 the error between the true percentage and the estimated. By using these typical values, a total minimum sample size of 384 observations was determined. Interval for sampling is 30 second and sampling done for 1 h.

VI. DATA ANALYSIS

Table No.1: Analysis of Work Sampling

Activity	Category of work	No of observation		Percentage of observation		Average Percentage
		Site 1	Site2	Site 1	Site2	
Reinforcement	Direct work	115	95	30	25	27.5
	Indirect Work	145	137	37	35	36
	No work	130	153	33	40	36.5
Total		390	385	100	100	100
Form work	Direct work	136	120	35	30	32.5
	Indirect Work	145	141	38	36	37
	No work	105	135	27	34	30.5
Total		386	396	100	100	100
Brick work	Direct work	150	140	39	36	37.5
	Indirect Work	165	166	42	42	42
	No work	95	98	23	24	23.5
Total		410	304	100	100	100
Plastering	Direct work	155	186	38	46	42
	Indirect Work	140	149	35	37	36
	No work	110	67	27	17	22
Total		405	402	100	100	100

Table No.1 shows number of observation and their percentage in each category of work for each activity. These percentages of each category of work show time spend by worker performing various categories of work. This percentage of various work categories when compare with onsite productivity data. It shows relationship between direct work and productivity. Support work or indirect work remains inert. On site one percentage of direct work is greater than on site two for reinforcement. Percentage of no work is greater on site two than site one for reinforcement. Which is reason for higher productivity on site one. Same behavioral pattern can be observed for all activities in Table no 1 and Table no.2. Direct work content is directly proportional to productivity and no work percentage is indirectly proportional to productivity. Also figure 4.1 shows that direct work and no work are inversely proportional. Activities which show high percentage of direct work also show low percentage of no work. For plastering direct work is 46% and no work is 13% which is highest and lowest percentage of direct wok and no work respectively. It is also seen from table no.1 direct work percentage increase with decrease in no work percentage. Direct work percentage increases with decrease in no work percentage and it helps in increasing productivity. This productivity data shown in Table No.2 had been collected from site. It is taken for period for which observation was taken. It is an amount of work done by number of worker in observation time.

Table 4.2: Result of workers' productivity measure at different job sites

Activity	Unit	Productivity		Average
		Site I	Site II	
Reinforcement	Kg/man day	55	47	51
Form work	Sqm/man day	6	5.40	5.7
Brick work	Cum/man day	0.69	0.60	0.645
Plastering	Sqm/man day	9.52	11.25	10.385

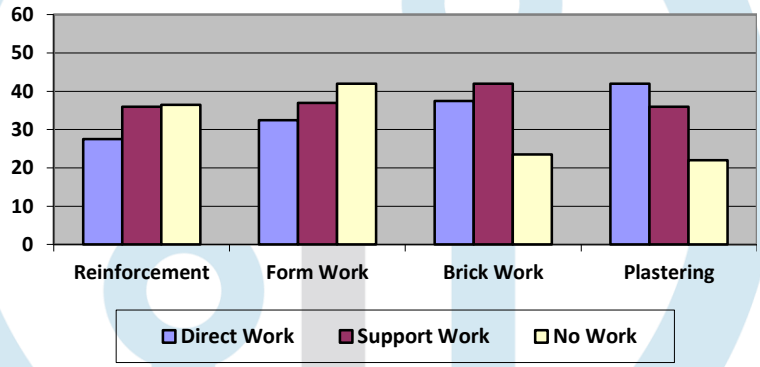

Figure.1 shows relation between direct work and no work. The graph shows average percentage of direct work, indirect work and no work for activities reinforcement, form work, brick work and plastering. It is observed from graph that direct work percentage increase with decrease in no work percentage. In Plastering direct work percentage is highest among all four activities and no work percentage 22 percentage. In reinforcement direct work 27.5% which is lowest and no work 36.5% which is highest. In order to improve direct work content no work content should reduce. It ultimately helps in improving productivity.

VII. RESULTS

1. Work sampling was carried out for activities reinforcement, form work, brick work and plastering. Percentage of direct work, indirect work and no work are calculated and shown in the following table.
2. It is observe that reduction in direct work causes increase in no work conditions reverse is also true. Percentage of direct work ranges between 27-42%, Support work 36-42% and no work 22-36.5%.
3. Activities with high percentage of direct work shows more productivity than those with lower percentage of direct work. Direct work percentage influences the productivity directly.
4. The reason for high no work percentage was In-appropriate crew size, project layout, lack of materials, low skill to unskilled labor ratio, low quality of materials, absenteeism, lack of tool and equipment.

VIII. CONCLUSION

1. Work sampling method shows that percentage of direct work was lowest in reinforcement on site 2 (25%) and highest in plastering on site 2 (46%). Percentage of no work was highest in reinforcement on site 2 (40%) and lowest in plastering on site 2 (17%).
2. Indirect work contributes major percentage (average of 38%) which is essential for any activity. It may not be consider as contributing directly to productivity but it is an essential part of an activity. It is clearly observed from results that productivity is directly proportional to direct work.
3. Productivity increases with increase in direct work proportion and decreases with increase in no work proportion. In order to improve productivity focus should be on improving direct wok percentage and decreasing no work percentage.
4. Optimization of labor source should be done in order to reduce no work condition and increase.

5. While interviewing it come to know that there are many factors responsible for no work condition such as lack of materials, lack of tools, lack of co-ordination, poor communication, low quality of material, absenteeism, lack of security, high skill to unskilled labor ratio, poor layout planning etc.,
6. High skill to unskilled labor ratio and absenteeism found to be major cause of rise in no work condition. In order to decrease no work condition and increase productivity this two factors need to be focus.
7. Training program for newly joined worker should be held or skill labor should be hire so that ratio of skill to unskilled labor should be maintained.
8. Worker should be encouraged to come regularly by providing regular job, better working environment, on time wages etc.
9. Productivity of construction projects improves by optimizing human resources.

IX. ACKNOWLEDGEMENT

I have a great pleasure to express my deep sense of gratitude and sincere regards to my guide Mr. Milind M. Darade, for his guidance and friendly discussion which helped me immensely in selecting this topic. His generous encouragement throughout my and helped me in completing this dissertation work.

I would like to thank our Head of Civil Engineering Department Dr. Sanjay K. Kulkarni for allowing me to do this dissertation work. He has immensely helped in providing all opportunities and facilities for the dissertation work.

I would also like to thank Dr. Ashok S. Kasnale Principal, Dr. D. Y. Patil School of Engineering and Technology, for providing all facilities at the right period of time. I am thankful to all the faculty members of Civil Engineering and library staff for helping me in this work.

Finally, I would like to thank all those who directly or indirectly helped me during my dissertation work.

REFERENCES

[1] Casey Jo Kuykendall (2007), Key Factors Affecting Labour Productivity in the Construction Industry, University of Florida.

[2] Chan, A.P.C. and Chan A.P.L.(2004), Key performance indicators for measuring construction success, Benchmarking: An International Journal 11(2), 203-21.

[3] Chris Hendrickson (2000), Project Management for Construction, Fundamental Concepts for Owners, Engineers, Architects and Builders, Department of Civil and Environmental Engineering, Carnegie Mellon University, Pittsburgh.

[4] Dennis Lock (2004), Project Management in Construction, England.

[5] Dozzi, S.P. and AbouRizk, S.M.(1993), Productivity in Construction, Institute for Research in Construction, National Research Council, Ottawa, Ontario, Canada.

[6] Hanna, A. S., Taylor, C. S., and Sullivan, K. T. (2005), Impact of extended overtime on construction labor productivity, ASCE Journal of Construction Engineering Management, Canada.

[7] Mistry S. and Bhatt R. (2013), Critical Factors AffectingLabor Productivity in Construction Projects: Case Study of South Gujarat Region of India. India

[8] Namho Kim, Hyun-Soo Lee, Moonseo Park and SeungjunRoh (2007), Performance Management Method for Construction Companies, 24th International Symposium on Automation and Robotics in Construction(ISARC 2007), Department of Architecture, Seoul National University, Korea.

[9] Stefan Tangen (2001), Professional Practice Demystifying Productivity and Performance, Sweden.

[10]]Thomas, H. R. (1991), Labor productivity and work sampling: The bottom line, Journal of Construction Engineering and Management, Texas

[11] Ward, S.C. Curtis, B. & Chapman, C.B. (1991), Objectives and Performance in Construction Projects, Journal of Construction Management and Economics.

BIOGRAPHY

Apiha R. Sonawane
PG Student, Department of Civil Engineering,
Dr. D. Y. Patil School of Engineering and Technology,
Pune, India
sonawaneapiha5@gmail.com

Milind.M.Darade
Professor, Department of Civil Engineering,
Dr. D. Y. Patil School of Engineering and Technology,
Pune, India
milind.darade04@gmail.com