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ANALYSIS OF EFFECTIVE PRODUCTIVITY MEASUREMENT IN CONSTRUCTION INDUSTRY

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ABSTRACT

The construction industry in India has a share of about 8% of its GDP and provides employment to around 5 million peoples. A lot of researches have been done to find & analyse workers productivity in Indian construction industry. The construction industry is labour intensive industry. In these studies, productivity of different construction activities are directly measured by measuring actual work done at site. The construction industry is characterised by the cost and time overrun. Whilst the causes are innumerable, labour productivity control, through use of effective work measurement techniques, is paramount as labour constitutes a considerable portion of any construction project. The study also focuses on how the effective measurement of productivity can be done by controlling the factors affecting productivity.

In this research, factors influencing construction labour productivity in construction industry was assessed. The aim of the research was to identify these factors that affect productivity in construction industry. This information will aid site managers and the construction professionals on decisions to take in-order to limit these controlling factors thereby leading to an improved level of efficiency in labour force, increase product labour productivity and reduce cost and time over runs on construction projects. The research adopted a quantitative research approach with the use of questionnaires as an instrument for data collection from site managers at construction sites. The Questionnaire sought to assess the perception of site managers on factors affecting construction labour productivity. This can be attributed to the fact that the site engineers can control site factors and human labour factors while the external factors cannot be really controlled by the site engineers. The survey also revealed that rain, conflict with project stakeholders, skill of labour, and financial crisis had a very high severity in affecting construction labour productivity on the construction sites.

Keywords: Effective Productivity, Construction Labour Productivity, Perception, Direct measurement of Productivity,

INTRODUCTION

Improvements in construction productivity have a significant impact in improving a country's gross domestic product. Moreover economic progress is dependent upon capital investment and economic stability is significantly affected by the rate of construction activity. In Zimbabwe, time overruns and high labour costs affected construction companies through reducing profitability and negatively impacting on the companies' reputation. Many researches are related to poor level of productivity and performance in construction industry.

Productivity of workers plays an important role in overall performance of onsite construction project. In India after agriculture construction industry has given second highest employment. Since construction projects are based on repetitive processes, for example bricklaying and plastering, successful planning of these processes can result in time and cost savings over the duration of the projects. To achieve this, companies have to undertake productivity measurement and improvements through implementation of various work measurement techniques.

Work measurement is the periodic or continuous application of different techniques designed to establish the time for a qualified skilled worker to undertake a task at a defined rate of working or at a defined level of performance, time and quality being critical elements. Increasing the overall productive use of labour hours, by application of process productivity measurement, analysis and improvement, results in accurate productivity standard output rates at task level.

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Productivity increases as the required skilled labour resources are minimized and non-productive time is reduced from the tasks within a construction project. However, a major challenge facing the industry is that it is difficult to obtain a standard method to measure labour productivity as construction projects are complex in nature, having their own unique characteristics.

Productivity, especially in the construction industry, has been very difficult to measure and control and every error in productivity estimation causes an inverse effect in the actual cost and time of labour to perform a scope of work. The average productivities are usually available as an aid for estimation, but these averages must often be modified in light of the special conditions of a job or site. Therefore, it is firmly believed that going back to the basics of effectively measuring labour productivity at the task level would be necessary in facilitating improvements and also deal with those factors that affect the specific sites.

PRODUCTIVITY AND PRODUCTIVITY MEASUREMENT

In construction projects, there are three basic planning elements: time, cost, and quality. These concepts are in a close relationship with each other. Lower labour performance is strongly related to the presence of change of work, disruptions and rework. On average 30% loss of efficiency occurs when changes are done. The most significant types of disruptions are lack of materials and information and having to perform the work out of sequence. These disruptions result in daily loss of Efficiency in range of 25% - 50%. Labour productivity is also one of the performance indicators to assess the success of the construction project. Because construction is a labour intensive industry, it can be argued that the work force is the dominant productive resource. Thus construction productivity is primarily dependent on human effort and performance. Labour productivity is important index because of concentration of labour needed to complete specific work.

Productivity is generally ratio of output to input. In form of equation it can be shown as follows:

Productivity = Output ÷ Input
= Total output ÷ Total work hour

Different measures of productivity serve different purposes. Thomas etal.defined different aspects of measures as follows:

a) Economic Model: Total Factor Productivity (TFP)

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

b) Project Specific Model:

$$\text{Productivity} = \frac{\text{Output}}{\text{Labour +Material +Equipment}}$$

c) Activity Oriented Model:

$$\text{Labour Productivity} = \frac{\text{Output}}{\text{Labour cost}}$$

or

$$\text{Labour Productivity} = \frac{\text{Output}}{\text{Work hour}}$$

Different work measurement methods are as follows;-

1. Historical data

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2. Time study
3. Work sampling
4. Estimating
5. Synthesis

All these methods mostly concern with time study. This study was the basic work measurement and other methods developed from it. The basic steps were necessary for effectively carrying out the work measurement.

METHODOLOGY

Data required to carry out the research was collected by Questionnaire Survey. On basis of previous studies on labour productivity & suggestions from Local Industry Professionals, factors were identified which are having influence on construction labour productivity. The Questionnaire prepared was distributed amongst respondents. Respondents were required to rate using their experience how all factors affects labour productivity. In this study activity oriented model shall be used to calculate the productivity. Various construction site shall be visited to calculate the work done by the crew of labours at site. Also the factors that influences the average output of the labour are point out. The output of various construction activities shall be compared to the task work of each activity. Remedial measure to control the factors that influences the productivity shall be find out to improve the productivity.

Task Work

The capacity of Doing work by skilled labor in the form of quantity per day is called task or out turn work.

Some of the task of major construction activities has been listed below:

	Particulars of Item	**Qty**	**Unit**	**Per Day**
A.	**Brickwork**			
1	Brickwork in Lime or Cement Mortar (Foundation & Plinth)	1.25	Cum	Per Mason
2	Brickwork in Lime or Cement Mortar (Super structure)	1	Cum	Per Mason
3	Brickwork in Mud Mortar (Foundation & Plinth)	1.5	Cum	Per Mason
4	Brickwork in Mud Mortar (Super structure)	1.25	Cum	Per Mason
5	Brick in Cement or lime mortars in arches	0.55	Cum	Per Mason
6	Brick in Cement or lime mortars in Jack arches	0.55	Cum	Per Mason
B.	**Stone Work**			
8	Course Rubble Stone Masonry in lime/cement mortar + dressing	0.8	Cum	Per Mason
9	Random Rubble Stone Masonry in lime/cement mortar + dressing	1	Cum	Per Mason
10	Ashlar Masonry in lime/cement Mortar	0.4	Cum	Per Mason
11	Stone Arch Work	0.4	Cum	Per Mason
C.	**Concrete Work**			
12	Lime concrete in foundation/ floor	8.5	Cum	Per Mason
13	Lime concrete in roof terracing	6	Cum	Per Mason
14	Cement concrete (1:2:4)	5	Cum	Per Mason
15	R.B. work	1	Cum	Per Mason

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16	R.C.C work	3	Cum	Per Mason
D.	**Plastering work**			
17	Plastering (12mm) with cement/ lime mortar	8	Cum	Per Mason
18	Pointing with Cement/ Lime mortar	10	Cum	Per Mason
E.	**Whitewashing or Painting**			
19	Whitewashing or Colour Washing - 1 coat	200	sqm	per White Washer
20	Whitewashing or Colour Washing - 3 coats	70	sqm	per White Washer
21	Door / Windows painting or varnishing- 1 Coat	25	sqm	per painter
22	Painting large surface -1 Coat	35	sqm	per painter
23	Distempering - 1 coat	35	sqm	per painter
F.	**Flooring**			
24	2.5 cm (1 inch) C.C. floor	7.5	sqm	Per Mason
25	Flagstone floor laying with lime/cement mortar excluding L.C.	10	sqm	Per Mason
26	Terrazzo flooring (6mm thick mosaic work) over 2 cm thk Cement concrete (1:2:4)	5	sqm	Per Mason
27	Brick on edge in floor lime/cement mortar excluding L.c.	7	sqm	Per Mason
28	Brick flat floor lime/cement mortar excluding L.c.	8	sqm	Per Mason
G.	**Door Frame**			
29	Timber Framing (Sal/ Teak wood)	0.07	cum	per carpenter
30	Timber Framing (Country wood)	0.15	cum	per carpenter
	D/W Shutters			
31	Door/ window shutters panelled or glazed	0.15	sqm	per carpenter
32	Door/ window shutters battened	0.8	sqm	per carpenter
33	Sawing Hard wood	4	sqm	per pair of sawers
34	Sawing Soft wood	6	sqm	per pair of sawers
H.	**Tiling**			
35	Single Allahabad/ Mangalore tiling	6	sqm	Per Tile layer
36	Double Allahabad tiling	4	sqm	Per Tile layer

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37	Breaking of brick ballast			
a	40 mm Gauge	0.75	Cum	Per Labor
b	25 mm Gauge	0.55	Cum	Per Labor
38	Breaking of Stone ballast			
a	40 mm Gauge	0.4	Cum	Per Labor
b	25 mm Gauge	0.25	Cum	Per Labor
I.	**Dressing Work**			
43	Ashlar Stone dressing	0.7	cum	Per stone cutter
44	Flag stone dressing	1.5	sqm	Per stone cutter
J.	**Earth Work**			
45	Earthwork in excavation in ordinary soil	3	cum	per labor
46	Earthwork in excavation in hard soil	2	cum	per labor
47	Excavation in rock	1	cum	per labor
48	Sand filling in plinth	4	cum	per labor

CASE STUDY

At this site, productivity of column casting, brickwork, slab casting and plastering is studied. The number of masons and labours deployed at the work is noted down and the work done by the crew of labours is measured as on site. Here to calculate the productivity activity oriented model is used. The work done by the crew of labours and time required to complete the work in hours is measured.

CASE STUDY 1: A small house of 450 sqft is taken for the case study. The house is proposed to be constructed at Motinagar, Amravati. At this site the productivity of column casting with footing is studied and various factors than influences the productivity are identified.

Here column size 0.3mx0.3mx4.3m with footing of size 1.2m x 1.2m x 0.8m is constructed by one mason and 2 labours. The total time required by the crew is measured is 24 hours (3 days of 8 hours working). The work also consist of reinforcement bending, hooking, binding, placing in position with line and level, centring and formwork, etc. There were 9 number of columns with footing. The quantity of 9 column with footing is measured out to be 4.527 cum. Thus the productivity of the casting column with footing is work out to be 0.189 cum/hour.

CASE STUDY 2: The bank building situated at Shegaon-Rahatgaon road, Amravati. Name of bank is Mahatma Phule Co-operative Bank Ltd. Amravati. The total are of construction is about 3200 sqft. At this site the productivity of casting of Slab with beams is studied and various factors than influences the productivity are identified.

For the construction of slab area of 3050 sqft area out of total 3200 sqft construction area is casted by 3 mason and 15 labours. Ready mix concrete were used to construct the slab with beams. The total time required by the crew is measured is 56 hours (7 days of 8 hours working). The work also consist of reinforcement bending, hooking, binding, placing in position with line and level, centring and formwork, etc. The quantity of slab with beams is measured out to be 39.26 cum. Thus the productivity of the casting column with footing is work out to be 0.701 cum/hour.

CONCLUSION AND RECOMMENDATION

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Labour productivity is one of the least studied areas within the construction industry in India. Despite of time consuming techniques Work study and work measurement are the techniques useful for data collection of labour and improvement in labour productivity. In this study, it has been seen that techniques used for the construction is highly affects the productivity. Also the size and type of work also has impact on productivity. Further study needs to identify which responsible for variation in the productivity in construction industry. More case studies shall be study to compare the same size and pattern of work to find out actual comparison for the productivity calculations. Analysis questionnaire showed that top ten ranked factors affecting labour productivity are Labour Supervision, Skilled Labour, Scheduling of work, Training of labour, Payment, Communication between site management and labour, Climatic condition, Expectations out of labour performance, Unscheduled extra work, Construction method, Availability of material, Availability of tools, Numbers of labours on site, Temperature on site, Safety conditions on site, Meetings with labour contractor, Motivation to labour, Project manager's leadership, Miscommunication between site management. The factor that influences the productivity shall be determined and the methods to control the factors influencing the productivity to improve the effective productivity.

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