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Construction Labor Productivity Improvement Through Benchmarking

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ABSTRACT

Labor productivity is one of the main determinants of success for any construction project. As a result, project managers should draw upon effective methods to gauge productivity on their sites in order to compare it against acceptable baselines. This would be the first step towards controlling and eventually improving labor productivity on construction sites. This paper aims at to measure labor productivity of activities block masonry, sand-mix plastering and to study variability of construction labor productivity data of mentioned activities. The data were collected from two building projects in thane sharing similar exogenous conditions and being similar in scope, size of components, specifications, quality requirements and design features. Based on the two targeted projects, the baseline productivity of mentioned activities in m^2/mason-hr were found out. Loss of productivity was observed and reasons for the loss were found out.

KEYWORDS : Benchmarking, Construction industry, Labor productivity, Variability.

I. INTRODUCTION

Construction projects largely entail labor-intensive activities, thus enhancing the labor productivity of construction activities would immensely be advantageous for the economy of any country in micro and macro levels. This is because higher level of productivity facilitates utilizing the available resources more efficiently. Apart from the national level, higher labor productivity in a construction company makes the company more competitive in the market. The attempts have involved conducting studies focused on comparing labor productivity in one organization to that of others particularly leading corporations (Song & extensively deployed to measure, compare and eventually increase the level of productivity in the construction industry in project, corporate, and activity levels). As a developing country, Indian construction industry has always suffered from poor levels of productivity ending up in frequent delays and budget overruns.

Labor productivity estimates are often performed by individuals using combinations of analytical techniques and personal judgment namely, the worker hour estimates are usually obtained through direct interaction with a scheduler, the site manager or related sub-contractors who are knowledgeable enough to reflect the actual conditions of a project and its constituent activities. These individuals often have a library of basic productivity rates which are adjusted and recalculated for each project and always modify their productivity rates for each specific estimate. On the other hand, differences in these productivity rates are always likely and normal.

Many articles have described, in general terms, the variation in labor productivity and the evidence of complex variability in construction labor productivity, the decline in construction labor productivity, trends in construction lost productivity claims, benchmarking of construction productivity and explaining labor productivity differentials. However, few articles discussed quantitative issues relating the loss of productivity.

The primary objective of this paper is to measure labor productivity of activities block masonry, sand-mix plastering and to study variability of construction labor productivity. This will be done by analyzing a database collected from 2 construction sites, utilizing benchmarking methods for enhancing labor productivity would bring about many advantages for the Indian construction industry.

The specific objectives of this study are:

II. OBJECTIVE OF STUDY

1. To measure labor productivity or unit rate for an different activities (block masonry, plastering (sand-mix)) through live construction site data collection using daily time card.

2. Planning the solutions to improve labor productivity through benchmarking.

The achievement of these objectives would result in identifying some actions that may contribute to the labor productivity improvement in the construction industry.

III. RESEARCH METHODOLOGY

To meet the requirements of the objectives set above, the following approach was devised:

The initial stage of this research involved a literature review to confirm the research objectives. The need to develop a performance improvement and evaluation technique construction industry was identified. Modern management philosophies such as TQM were explored. Labor productivity was identified as a key performance indicator.

Labor productivity data had been gathered from live construction project site using timecards. Factors affecting labor productivity is also identified. Statistical tools are used to interpret the causes of loss of productivity and to take suitable corrective action to eliminate the causes of loss on-site labor productivity.

Data related to the labor productivity of following activities were collected:

1. Block work

2. Plastering (Sand-mix).

TQM philosophies like benchmarking, was identified as an effective problem solving approach towards the onsite labor productivity improvement.

IV. LITERATURE REVIEW

3.1 Labor Productivity: Productivity can be defined in many ways. In construction, productivity is usually taken to mean labor productivity, that is, units of work placed or produced per man-hour. The inverse of labor productivity, man-hours per unit (unit rate), is also commonly used. Productivity is the ratio of output to all or some of the resources used to produce that output. Output can be homogenous or heterogeneous. Resources comprise: labor, capital, energy, raw materials, etc.

3.2 Construction labor productivity measurement:

1. Activity-oriented models

At the project site, contractors are often interested in labor productivity. It can be defined in one of the following ways Labor productivity = Output / Labor cost or Labor productivity = Output / Workhour

2. Project-specific models

A more accurate definition that can be used by governmental agencies for specific program planning and by the private sector for conceptual estimates on individual projects is: Productivity = Output / Labor + Equipment + Materials Productivity = Square meter / rupees

3. Economic models

The department of Commerce, Congress, and other governmental agencies use a productivity definition in the following form:

Total factor productivity (TFP): = Rupees of output / Rupees of input

TFP is really an economic model measured in terms of rupees, since rupees are the only measure common to both inputs and outputs. Various agencies may modify above equation by adding maintenance costs or deleting energy or capital costs.

3.3 Benchmarking:

'Benchmarking is a systematic and continuous measurement process; a process of continuously measuring and comparing an organization's business process against business leaders anywhere in the world to gain information which will help the organization to take action to improve its performance.

3.4 Types of benchmarking:

Classifications have mainly been based on approaches to benchmarking as follows;

1. **Internal benchmarking**: Performed within one organization by comparing performance of similar business units or business processes.

2. **Competitive benchmarking**: A measure of an organization's performance compared to competing organizations; studies that target specific product designs, process capabilities or administrative methods used by a company's direct competitors; practices or services.

3. **Functional benchmarking**: An application of process benchmarking that compares a particular business function in two or more organizations irrespective of the industry type.

4. **Generic benchmarking**: Benchmarking that is aimed at uncovering best practices that can be applied in own business process irrespective of the source or type of industry.

V. DATA COLLECTION

Data collection focused on quantity of work done by mason, time required to complete that particular work and also documented factors that may affect the work of each crew. Measurements were made once daily at the end of the workday.

The data were collected from two building projects in thane sharing similar exogenous conditions and being similar in scope, size of components, specifications, quality requirements and design features.

S.N	Project Name	Type of Project	Location
1	Wood-stock	Residential building basement + stilt + 18 floors) and podium including basement.	Thane
2	Woodpark	Residential building basement + stilt + 18 floors) and podium including basement.	Thane

Table (1) - Details of site

In order to evaluate construction site performance on-site labor productivity is most important for which 2 months (October and November) data were collected in time cards. Labor productivity is evaluated for following activities is using time card :

Block work and Plastering (sand-mix).

	TIME CARD		DATE :	
	ACTIVITY NAME			
	BLOCK WORK		PLASTER (SAND-MIX)	
	PLANNED	ACTUAL	PLANNED	ACTUAL
Total Quantity Of work Done (m^2)				
No. of Masons				
Productivity (m^2/worker-hr)				
Reason for loss. (if there)				

Table (2)-Time Card

Description Of activities:

Specifications of block work:

- Types of blocks used : Hollow blocks, Solid blocks
- Size of blocks : 400*120/90*200 (l*b*h)
- Bond size: 9mm to 12mm.

Specifications of plastering (sand-mix):

Where to use: External plastering.

Internal plastering: 1) At Staircase area

2) At Lobby.

Mortar specification : C:M = 1: 6

Thickness of :
1st coat: 12mm on brickwork and 6mm on RCC.
2nd coat: 12mm.

Leveling pads at 3'00" C/C are prepared.

Flexicrete which is used as adhesive is applied with brush on RCC member.

Frequency distribution of productivity data:

Graphical Method – Histograms

The purpose of summarizing the principal characteristics of a frequency distribution is to ease interpretation and comparison with other distribution.

Frequency distribution of productivity data for both activities is shown in Fig (1) and Fig (2).

particular project when there are few or no disruptions. Disruptions are associated with lower productivity; however, the baseline is unaffected by disruptions. The baseline productivity for each project was calculated by determining the range of random variability in daily productivity values when a project is satisfactorily managed. The boundaries for this range are the Upper Control Limit (UCL) and the Lower Control Limit (LCL). The UCL and LCL can be calculated by applying the following steps:

1. For both project, calculate the average for the daily productivity values. Call this average X.

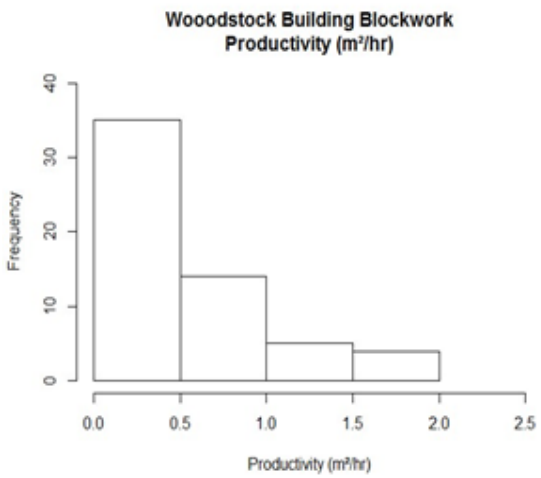
2. Calculate standard deviation (σ).

3. 5% Deviation allowed from mean. Therefore,

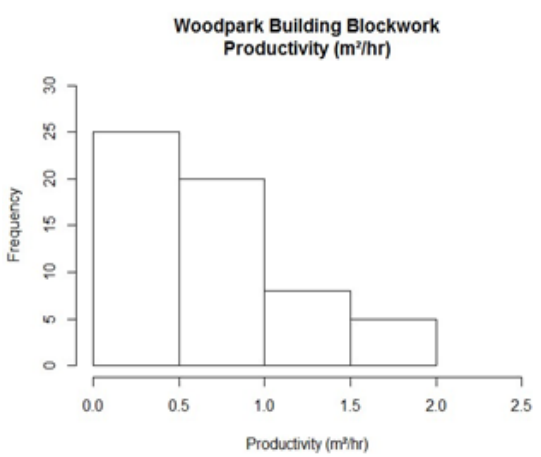
4. UCL: X + σ.

LCL: X – σ.

Based on the above criteria, an abnormal workday is defined as any workday where the daily productivity statistic value below LCL; thus, abnormal workdays refer to days with significantly below average productivity. Productivity that is exceeds UCL has the highest daily production or output. The baseline productivity for each project is the average of the daily productivity values that falls exceeds UCL.



Figure(1) - Daily productivity frequency Distribution wood stock



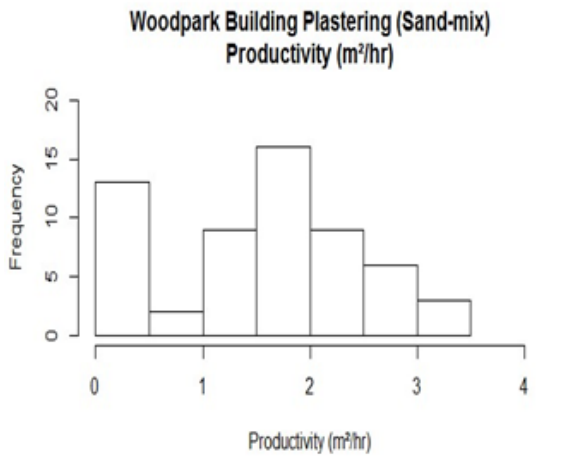


Figure (2) - Daily productivity frequency Distribution wood park

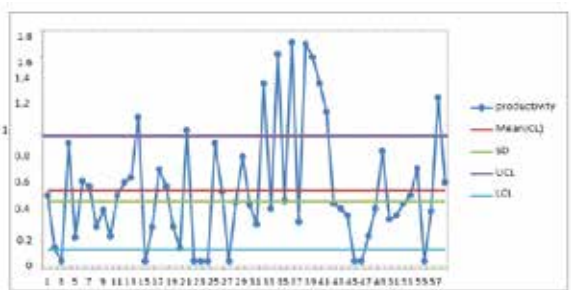


Fig.(3)- Variability in daily productivity value of Woodstock building Block work

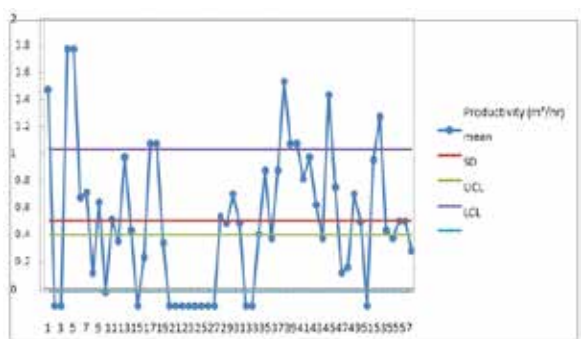
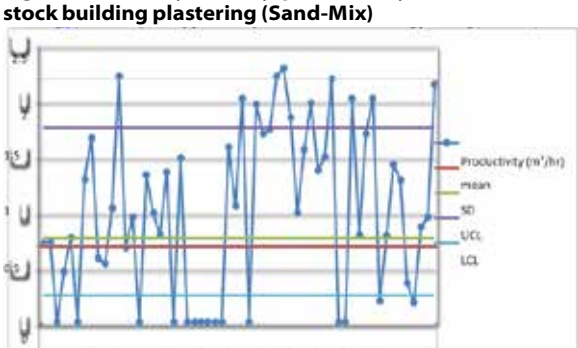
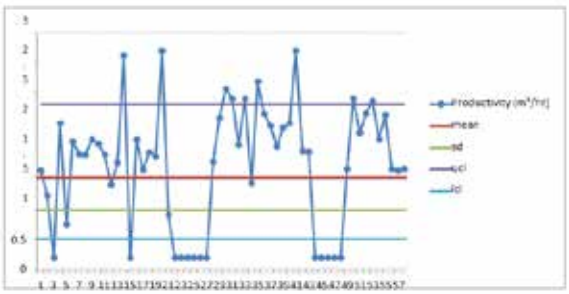


Fig.(4)- Variability in daily productivity value of Woodstock building plastering (Sand-Mix)



Fig(5)- Variability in daily productivity value of Woodpark building Blockwork



Fig(6)- Variability in daily productivity value of Woodpark building plastering.

VI. RESULTS AND DISCUSSION

Daily labor productivity rates were calculated. Mean productivity of the activities are as follows:

Activities	Mean productivity (m^2/hr)		% difference in productivity
	Woodstock	Woodpark	
Block work	0.542	0.64	15.31
Plastering (Sand- Mix)	0.995	1.56	36.21

Table (4) - Mean Productivity Comparisons.

There is significant difference in mean productivity rates for plastering (Sand-mix) but for Block work it insignificant. The mean productivity rates for Woodstock building are lower than woodpark building.

Baseline productivity reflects the best productivity value that a contractor can achieve on a particular project in a case where there are few or no disruptions.

Difference in baseline productivity values from one database to another is due mainly to work method and skills

used. Productivity that is exceeds UCL has the highest daily production or output. The baseline productivity for database representing the chart's upper control limit is the average of the productivity values that represent the upper control limits of 2 projects.

Daily productivity that falls between the LCL and UCL is within normal variation due to work environment factors. A variety of work environment factors may lead to a loss of labor productivity.

However, the work environment factors frequently cited as causing loss of productivity include adverse weather, unavailability of material, lack of equipment and tools, out-of-sequence work, congestion, dilution of supervision, rework and fatigue due to scheduled overtime. The open conversion system associated with construction is complex, influenced by many factors. The work environment factors will always be present, may act alone or in groups and may interact to cause a loss in productivity without being cited. The chart proposes that daily productivity that falls between the LCL and UCL is within normal variation, and construction managers don't need to panic Nonetheless, variability in the daily productivity data was found to be an important delineator between good and poor performing projects. Poor performing projects have much higher variability (range of normal variation above baseline) than well-performing projects do.

Based on the chart, an abnormal day is where the daily productivity value falls below LCL. In this case, the loss o f productivity is due to the work environment factors as within the normal variation, and in particular to certain significant influential factors that can be cited during that day. This is where the construction manager should focus to identify the major work environment factors that led to the loss and take action to reduce their future impact.

Project Name	Activities	No. of work Days	Total work hours	Total Quantities m^2	UCL	LCL	No. of abnormal days	% of abnormal days
Woodstock	Blockwork	58	1904	1048.62	0.99	0.085	9	15 %
	Plastering (Sand-Mix)	58	3056	3610.7	1.75	0.24	15	26 %
Woodpark	Blockwork	58	1328	1111.92	1.16	0.11	15	26 %
	Plastering (Sand-Mix)	58	2488	4693.3	2.59	0.54	13	22 %

Table(5) – Calculation Results

VII. CONCLUSION

This research proposed to study variability of masonry and plastering labor productivity. The data were collected

using standardized data collection procedures, and the work performed was similar in scope, size of components, specifications, quality requirements and design features. The findings of this research are discussed below emphasizing the on benchmark the labor productivity, identify benchmarking gap and suggest way to close that gap.

The daily productivity values that fall between LCL and UCL indicate a loss of productivity within normal variation due to work environment factors that may act alone or in groups and may interact to cause a loss in productivity without being cited. Hence; construction managers don't need to panic.

When daily productivity values fall below LCL, the loss of productivity is due to the work environment factors as within the normal variation, and in particular to certain significant influential factors that can be cited during that day. This is where the construction manager should focus to identify the major work environment factors that led to the loss and take action to reduce the future impact.

Most significantly, this study made its most important contribution in the application of a methodology that reliably quantifies comparable measures of productivity. The strength of this approach lies in its ability to compare productivity level and the impacts of contributing factors among projects.

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