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PRODUCTIVITY ANALYSIS IN LEAN CONSTRUCTION

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Abstract

Performance of the construction industry have been affected for many years due to their low productivity rates and cost overruns and time overruns. There is a wide increase in number of dissatisfied customers who requests for change in the conventional practices of construction management. Lean construction is one such concept aimed at providing solution to these issues.Labour productivity is defined as the amount of goods and services produced by a productive factor in a unit time. Productivity is the physical relationship between the quantity of goods produced and the quantity of goods used for the production. Productivity measurement is very essential in civil engineering because it helps in goal setting, cost reduction, resource allocation etc. This research deals with comparative analysis of standard productivity vs productivity after using lean principles.

Key words- Lean construction, productivity

1. INTRODUCTION

Labour productivity: It is defined productivity as amount of goods and services produced by a productive factor in a unit time. Measurement of goods produced and human effort is two basic elements of labour productivity. The ratio of work hours to units of output is labour productivity, the ratio of labour cost to units of output as unit rate and the ratio of scheduled or planned to actual work hours as productivity factor. The productivity could be measured at various levels, but there are three main measures of productivity are industry or sector level, project level, and activity or process level measurement. [1]

Productivity refers to the physical relationship between the quantity produced (output) and the quantity of resources used in the course of production (input). Productivity measurement includes partial or factorial productivity and overall productivity. Measurement of productivity is a very difficult task because it depends on so many factors. It can be measured separately for each factor of production such as men, machines, materials etc. Productivity measurement is helpful in goal setting, cost reduction, resource allocation, motivation for improvement, forecasting output and national income An increase in productivity means an increase in output that is proportionately greater than an increase in inputs. If a concern is engaged in the production of a single product, output can be measured in physical terms, ex : number of units produced, volume, weight etc. [2]

1.1NECESSITY TO STUDY LABOUR PRODUCTIVITY

- Decreased total cost and duration of production.
- Improved quality.
- Providing management with an effective tool to direct and control the productivity performance of a construction site.
- Offering feedback to employees on their productivity performance.
- Creating the basis for sharing the gains of higher productivity.

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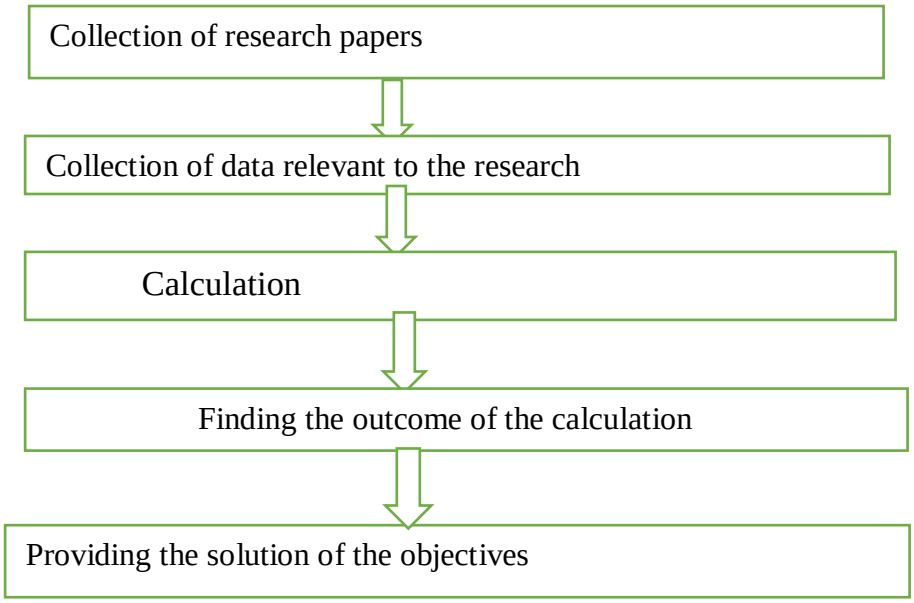
- Productivity measurement at construction site level enables companies to monitor their own performance against their site performance.
- Productivity at construction site level can be grouped under various activities like productivity in concrete, steel work and shuttering, masonry etc.
- Efficient productivity of labour in construction industry can play a vital role in increasing the benefits to the stakeholders and contactors.
- Labor productivity has a remarkable impact on the level of socio-economic development and it is closely related to the competitiveness of the country's economy
- Labor productivity is one of the key factors influencing the progress of any construction project. Improving productivity is the number one priority for any profit-oriented organization. The ratio of input to output can be used to define labour productivity
- Labor is an essential component of any construction company, and efficient labour management can result in increased production.
- The labour's work is critical to the success of any building project. Because labour productivity has a direct impact on construction productivity, it is critical to understand the elements influencing labourproductivity.[2]

2.METHODOLOGY



3. ANALYTICAL PROGRAM

Lean construction techniques :-

- ***Concurrent Engineering*:**Concurrent engineering can be described as parallel execution of various tasks by multidisciplinary teams with the goal of obtaining most favorable products concerning functionality, quality, and productivity
- ***Last planner*:**The last planner is the person or group of people responsible for production unit control, which means completion of individual tasks at the operational level. Last planner necessitates work flow control, ascertaining the stream of supply, design, and installation throughout production units.

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- ***Daily huddle meetings*:** Daily huddle meetings provides a platform for the team members to share their views and to share what has been achieved, at the same time, discus problems they are facing during the production process
- ***Plan Conditions and Work Environment in the Construction Industry (PCMAT)*:**The purpose is to introduce a plan of health and safety into the project execution, called "Plan of Condition and Work Environment." These safety activities can generate limitations for scheduled tasks and that is why it should be embraced as a part of assignments. All safety practices are therefore amalgamated in short-term planning, which can be analyzed through daily feedback from crew and subcontractors respectively
- ***Quality Management Tools*:**The fusion of quality management tools in the lean construction is based on the change from conformance based quality to the quality at the source. A point system is normally employed to evaluate the execution of planned controls, which will help workers to follow planned controls instead of quality corrections
- ***Visual Inspection*:**Visual inspection shows the uneven nature of the construction and leads to the implementation of visual tools for material, work and information flow, etc. Identification of materials can accelerate repetitive processes and diminishes the risk of selecting wrong product. Progress charts and schedules can implement the dedication to the completion of tasks.[3]

4.DATA COLLECTION

Data related to productivity was collected from a company named Purthi spaces which uses lean principles

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Sl no	Activity	Total Qty	Unit	Time	Workdone		No of Men	blocks /man hour
					Qty	Unit		
	GANG 1							
	Mason		2					
	Helper		2					
	Day 1 (22.04.2022)			TOTAL QTY	230	SFT		
1				9.00 - 10.00	34	SFT		30
				10.00 - 11.00	32	SFT		28
				11.00 - 12.00	32	SFT		28
	Blockwork	260		12.00 - 1:00	30	SFT		26
				2.00 - 3.000	32	SFT		28
				3.00 - 4.00	32	SFT		28
				4.00 - 5.00	35	SFT		31
				5.00 - 6.00	33	SFT		29
	DAY SUB TOTAL			8	260	SFT	2	228.228
	Day 2 (23.04.2022)							
2				9.00 - 10.00	33	SFT		29
				10.00 - 11.00	35	SFT		31
				11.00 - 12.00	38	SFT		33
	Blockwork			12.00 - 1:00	35	SFT		31
				2.00 - 3.000	34	SFT		30
				3.00 - 4.00	32	SFT		28
				4.00 - 5.00	28	SFT		25
		262		5.00 - 6.00	27	SFT		24
	SUB TOTAL			8	262	SFT	2	229.984
	Day 3 (24.04.2022)							
2				9.00 - 10.00	24	SFT		21
				10.00 - 11.00	27	SFT		24
				11.00 - 12.00	29	SFT		25
	Blockwork			12.00 - 1:00	35	SFT		31
				2.00 - 3.000	39	SFT		34
				3.00 - 4.00	32	SFT		28
				4.00 - 5.00	35	SFT		31
		255		5.00 - 6.00	34	SFT		30
	SUB TOTAL			8	255	SFT	2	223.839
	Day 4 (25.04.2022)							
2				9.00 - 10.00	22	SFT		19
				10.00 - 11.00	18	SFT		16
				11.00 - 12.00	24	SFT		21
	Blockwork			12.00 - 1:00	22	SFT		19
				2.00 - 3.000	18	SFT		16
				3.00 - 4.00	31	SFT		27
				4.00 - 5.00	28	SFT		25
		186		5.00 - 6.00	23	SFT		20
	SUB TOTAL			8	186	SFT	2	163.271
	Day 5 (26.04.2022)							
2				9.00 - 10.00	25	SFT		22
				10.00 - 11.00	20	SFT		18
				11.00 - 12.00	21	SFT		18
	Blockwork			12.00 - 1:00	25	SFT		22
				2.00 - 3.000	22	SFT		19
				3.00 - 4.00	26	SFT		23
				4.00 - 5.00	28	SFT		25
		190		5.00 - 6.00	23	SFT		20
	SUB TOTAL			8	190	SFT	2	166.782
	Day 6 (27.04.2022)							
				9.00 - 10.00	22	SFT		19
				10.00 - 11.00	25	SFT		22
				11.00 - 12.00	21	SFT		18
	Blockwork			12.00 - 1:00	21	SFT		18
				2.00 - 3.000	22	SFT		19
				3.00 - 4.00	22	SFT		19
				4.00 - 5.00	27	SFT		24
		185		5.00 - 6.00	25	SFT		22
	SUB TOTAL			8	185	SFT	2	162.393
	Day 7 (28.04.2022)							
				9.00 - 10.00	23	SFT		20
				10.00 - 11.00	27	SFT		24
				11.00 - 12.00	25	SFT		22
	Blockwork			12.00 - 1:00	22	SFT		19
				2.00 - 3.000	21	SFT		18
				3.00 - 4.00	20	SFT		18
				4.00 - 5.00	26	SFT		23
		190		5.00 - 6.00	26	SFT		23
	SUB TOTAL			8	190	SFT	2	166.782
	Day 8 (29.04.2022)							
				9.00 - 10.00	22	SFT		19
				10.00 - 11.00	19	SFT		17
				11.00 - 12.00	19	SFT		17
	Blockwork			12.00 - 1:00	22	SFT		19
				2.00 - 3.000	25	SFT		22
				3.00 - 4.00	24	SFT		21
				4.00 - 5.00	28	SFT		25
		183		5.00 - 6.00	24	SFT		21
	SUB TOTAL			8	183	SFT	2	160.637
	Day 9 (30.04.2022)							
				9.00 - 10.00	22	SFT		19
				10.00 - 11.00	21	SFT		18
				11.00 - 12.00	22	SFT		19
	Blockwork			12.00 - 1:00	24	SFT		21
				2.00 - 3.000	22	SFT		19
				3.00 - 4.00	25	SFT		22
				4.00 - 5.00	26	SFT		23
		189		5.00 - 6.00	27	SFT		24
	SUB TOTAL	1900		8	189	SFT	2	165.904

STANDARD PRODUCTIVITY RATES OF CONCRETE MASONRY:

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Table 1—Typical Concrete Masonry Productivity Rates[a]

Unit nominal size and description:	Productivity, number of units per mason per day[b]
4 x 2 x 8 concrete brick units	550 to 650
8 x 8 x 16 standard concrete masonry units	135 to 190
8 x 8 x 16 split face concrete masonry units	80 to 160

Notes:
[a] Values assume: walls are constructed in running bond with standard ⅜ inch (10 mm) thick mortar joints and are of convenient height; adequate masonry labor is available; and walls incorporate modular layout to minimize cutting.
[b] To obtain square feet of wall per day, multiply the values in the table by 0.89 (multiply by 0.083 to obtain m^2/day).

Table 1–Typical Concrete Masonry Productivity Rates (a)

5.CALCULATION

TYPICAL STANDARD CONCRETE MASONRY PRODUCTIVITY RATES:

SIZE DESCRIPTION	**PRODUCTIVITY,NO OF MASONS/DAY**
4x2x8 concrete brick units	550 to 650
8x8x16 standard concrete masonry units	135 to 190
8x8x16 split face concrete masonry units	80 to 160

SIZE :8x8x16

PRODUCTIVITY, NO OF MASONS/DAY: 135 to 190

Dimensions of block used on the site: 200mm x 200mm x 400mm

No of blocks to sq.ft conversion: The standard block size is 16″ wide x 8″ high. Multiply 16×8, and then divide by 144 to get the answer.

block sqft = (16 × 8)/144 = 0.89 sq. ft.

Productivity for sq.ft/day: 135x0.89 & 190x0.89 = **120.15** and 169.1

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According to data collected:day 1 total qty = 260

day 2 total qty = 262

day 3 total qty = 255, and no of masons to complete is2

Average = 260+262+255 = 259

2

According to calculation with 2 masons average productivity= 259

So productivity of 1 mason = 259/2 = 129.5

THEORITICAL STANDARD PRODUCTIVITY = 120.15

PRODUCTIVITY AFTER APPLYING LEAN = 129.5

Productivity for day 4 = 186

Productivity for day 5 = 190

Productivity for day 6= 185 and no of masons =2

Average= 186+190+185 = 280.5

2

According to calculation with 2 masons average productivity **=** 280.5

So productivity of 1 mason = 280 ÷ 2 = 140.25

THEORITICAL STANDARD PRODUCTIVITY = 120.15

PRODUCTIVITY AFTER APPLYING LEAN = 140.25

Productivity for day 7= 190

Productivity for day 8= 183

Productivity for day 9= 189,, and no of masons =2

Average = 199+183+189 = 285.5

2

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According to calculation with 2 masons average productivity = 285.5

So productivity of 1 mason = 285.5 ÷ 2 = 142.75

THEORITICAL STANDARD PRODUCTIVITY = 120.15

PRODUCTIVITY AFTER APPLYING LEAN = 142.75

Hence it is proved that applying lean principles help in improving productivity rate

CONCLUSION

In most countries, performance and productivity improvement are two focus areas in the construction industry. To ensure project productivity is optimised, construction firms increase their profit and market competitiveness by controlling project costs such as labor, material, equipment and overhead cost.The findings of the study concluded that construction productivity is one of the remarkable aspects that need to be measured, evaluated, and discussed in different studies around the world.

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. Optimization of labor source should be done in order to minimize no work condition and increase.

And the factors affecting construction productivity in the majority of the studies are tools and consumables, coordination, drawing management, material availability, labour skills, training, and reworkThus it can be concluded that by applying lean principles the productivity can be improvised and production cost can be minimized

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