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Lean Technology in Construction

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Abstract: Since the 1940's, lean production principles have evolved and were successfully implemented by Toyota Motor Company. Lean construction is a production and management-based approach to a project. An increasing number of construction academics and professionals are storming the ramparts of conventional construction management in an attempt to deliver better value to owners while making real profits. As a result, lean-based tools have emerged and are successfully applied to simple and sophisticated construction projects. Generally, lean construction projects are easier to manage, safer, completed sooner, cost less and are of higher quality. Thanks to the success of the lean production system in manufacturing the construction industry has adapted lean techniques to eliminate waste and increase profit. It is a way to design production system to minimize the wastage of material, time, and effort in order to generate the maximum possible amount of value. The main objective of this study is to analyze and implement the lean construction practices.
Keywords: lean construction, economic, safe, construction management

I. INTRODUCTION

Lean may be a systematic, continuous improvement approach that focuses activities on reducing waste aligning them to an overall growth strategy. Leaders of a lean organization are dedicated to developing Lean thinkers and endless improvement culture. A lean enterprise essentially eliminates waste throughout the business process. Waste costs us resources but adds no value to the purchasers we serve. These non-value-added activities typically equals to 95% of all manufacturing effort; a mere 5 percent of your manufacturing activities add value for your clients. Lean will assist you increase profits while: Reducing cycle time Reducing inventory and work-in-process Reducing costs Increasing capacity Increasing productivity while improving quality Lean Enterprise may be a business system for organizing and managing development, operations, suppliers, and customer relations. Business and other organizations use lean principles, practices, and tools to make precise customer value- goods and services with higher quality and fewer defects-with less human effort, less space, less capital and fewer time than the normal system of production. Many of the key principles were pioneered by Ford, who was the primary person to integrate a whole production system, under what he termed “flow production”. Following war II, the Toyota Motor Company adapted Ford’s principles as a way of compensating for is challenge of limited human, financial, and material resources. The Toyota Production System (TPS), which evolved throughout the enterprise to supply a good sort of products a lower volume and lots of fewer defects than competitors.

A. Constrution Management

Construction management may be a vast field with innumerable variables and external factors affecting it. the general management of the processes required to bring the location operations of a project to a satisfactory conclusion, typically administered either by a personal consultant or an employee of the project client. it's a management sort of contract synonymous with management contracting except that works contractors are appointed as direct contractors to the client, instead of as subcontractors to the contract manager. Construction Management refers to the study and practice of the managerial and technological aspects of the development industry. Comprehensive management of each stage of the project, beginning with the first concept and project definition, yields the best possible benefit to owners from construction management.

B. Lean Production Theory

Taiici Ohno, an engineer working for Toyota, developed lean production theory as a way of eliminating waste. Ohno shifted the eye of researches faraway from the effect of worker productivity on craft production alone towards a consideration of the assembly system as an entire. Ohno followed the work of Ford in continuing the event of flow-based production management.

The underlying goal of lean production theory is that the avoidance, elimination, or reduction of waste. Howell (1999) defines waste by the performance criterion by defining waste as time, space, or material utilized in the performance of an activity that doesn't directly contribute value to the finished product. Using these broad definitions for waste, lean production theory attempts to maneuver a production system towards perfection, or zero waste. Koskela (1992) describes the traditional production philosophy as a “Conversion Model”, which is comprised of the subsequent items: A production process may be a conversion of an input to an output. The conversion process is often divided into sub-processes, which also are conversion processes. Minimizing the value of every sub-process can minimize the value of the entire process. the worth of the output of a processes related to the prices of inputs thereto process. Lean production theory interprets the assembly system as a series of conversions and flows. Conversion activities that add value to the ultimate product. Flow activities are those activities that transfers the merchandise to and from conversion activities. A primary goal of lean production theory is to scale back or eliminate the share of flow activities during a project while increasing the efficiency of conversion activities. the subsequent list outlines key principles of lean production theory (Koskela 1992): Reduce the share of non-value-adding activities. Increase output value through a scientific consideration of customer requirements. Benchmarks Reduce variability. Reduce cycle times. Increase output flexibility. Increase process transparency. Focus control on the general process. Build continuous improvement into the method. Balance flow improvement with conversion improvement. Simplify by minimizing the number of steps, parts, or linkages. Though lean production theory was developed for manufacturing, the similarities between craft manufacturing process make lean production theory very applicable to construction.

II. LEAN METHODOLOGY BASICS

A. Introduction

This project work concentrates on applying techniques of Lean Production in making construction management simpler. Following section describes the fundamentals of Lean methodology and a few of the lean tools generally.

B. The Lean Manufacturing Model

The search by manufacturers for solutions to the rigid rules mandated by their MRP (Material Requirement Planning) systems has led many to the techniques of Lean manufacturing. Lean manufacturing methodologies aren't new techniques for the millennium, but are, in fact, a compilation of the many of the technique’s manufacturers have utilized in the past and are conversant in. The difference is that the consolidation of those techniques into one set of powerful methodologies and their application. Achieving Lean goals using one-piece Lean manufacturing methods is actually a line-balancing methodology utilized in conjunction with a series of Kanban material-handling technique. Mathematical models are created and iterated until the optimum utilization of producing resources is identified. Specifically, the Lean manufacturing methodologies are a series of techniques that allow product to be produced one unit at a time, at a formulated rate, while eliminating non value adding wait time, queue time, or other delays. Product is pulled through the road, in response to actual demand as against being pushed through by the launch of orders supported the output of a planning system. Thought of in terms of a pipeline, discrete product is often made to maneuver through the manufacturing process no end. If product can move without, it is often thought of very similar to liquid through a pipeline. This metaphor of moving product through a pipe is that the source for the term flow. The goal of lean manufacturing, is to determine and style a producing line capable of manufacturing multiple products, one at a time, using only the quantity of your time required to truly build the merchandise. The techniques of Lean manufacturing seek to scale back the nonvalue-adding wait, scheduling and queue times to zero. The resulting, often significant, reduction in manufacturing time interval is that the basis for all the associated benefits of Lean manufacturing

C. The Kanban Methodology

There are two primary resources needed to supply any product; labor and material. Lean manufactures balance and link their manufacturing processes together, staffing those resources to customer requirements to supply products. The component materials required to create those products are placed at the purpose of usage on the Lean line utilizing a way called Kanban. The Kanban system utilizes a series of signals to point when parts are needed to replenish production. The Kanban methodology may be a material presentation method designed to simplify material handling and inventory management. This method requires a fewer inventory transactions and reduce the quantity of system maintenance activities normally needed to stay up with the rea-time environment of the workplace. this technique establishes a relationship that identifies where materials are used, and where they're refill must be established.

III. BENEFITS OF UTILIZING LEAN TECHNIQUES FOR MANUFACTURING

A. Improved reaction time to customer demands.
B. Reduced Inventories
C. Reduced capital requirements
D. Simplicity and Visual control
E. Productivity Improvement
F. Operational benefit

IV. TOOLS REQUIRED GENERALLY

A. Master Schedule
B. Reverse Phase Scheduling (RPS)
C. Six-Week look ahead (SWLA)
D. Weekly Work plan (WWP)
E. Present Plan Complete (PPC)
F. Increased Visualization
G. Daily Huddle Meetings (Tool-Box Meeting)
H. First Run Studies
I. The 5s Process

V. APPLICATION OF LEAN METHOD IN CONSTRUCTION

A. Quality control
B. Ease in construction procedure
C. Material management and material saving
D. Project management
E. Economical
F. Easy for collaboration

VI. CASE STUDY

The objective of this case study is to qualify the potential benefits of applying effective material management practices on commercial construction projects. A case study approach is used to compare the work of B. B. Masonry and Plastering, constructed at two similar, medium sized commercial construction projects located in Walwadi area of Dhule city. The projects were executed under similar conditions.

A. Project Description

1) *Project A:* The case study is a three-storey residential building with 12 flats constructed in Walwadi area of Dhule city. The Building consists of a R.C.C. frame and brick façade. The total Built up area is 478.418 sq.m. The area available for the storage of construction material was limited.
2) *Project B:* The project as also a three-storied residential building with 10 flats and 8 shops at ground floor constructed on corner plot of Walwadi area of Dhule city. Total built up area is 557.303sq.m. The area available for storage of construction material is more as compared to Project A. Both the structures were constructed by a local contractor by using a nonuniform work force available locally. The site staff consisted of a single project supervisor.

a) *Masonry and Plastering Work:* The case study involves the construction of the B. B. Masonry and plastering for both the structures. The operation involved are preparation of mortar, transportation of bricks, mortar, laying of bricks, checking horizontality and verticality, spreading mortar, filling, joints with mortar and finishing.

B. Data Collection

The data collected for this case study were collected as part of an ongoing study of construction labour productivity. The goal of the research is to test a productivity measurement technique that provides daily assessment of the problems affecting production without the need for continuous on site work measurement methods.

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C. Productivity Measurement

The ineffective material management leads to the inefficient use off craft labour. Construction labour productivity is the measure of the effect.

Construction labour productivity is defined as:

Labour productivity=work hour/units of output

This definition is often called the unit rare. The measurement scheme can be readily applied to task or crew level work.

D. Summary of Material Management Conditions

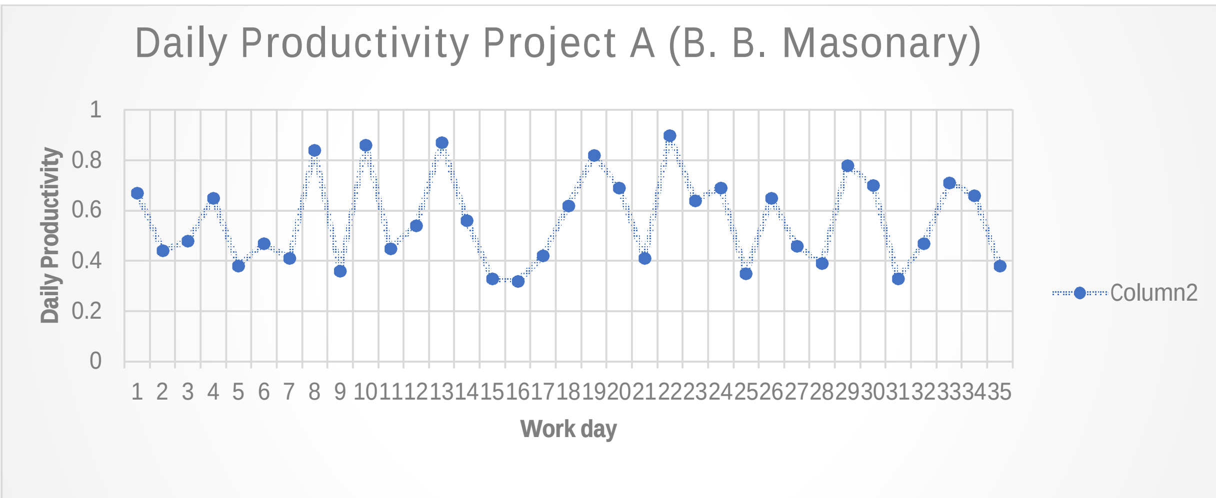
For Project A, the construction of B. B. Masonry activity lasted 35days and required 271.5 work hours. Also, for plastering activity data were recorded daily and yielded the daily and cumulative productivity. The same procedure has been carried out for the Project B.

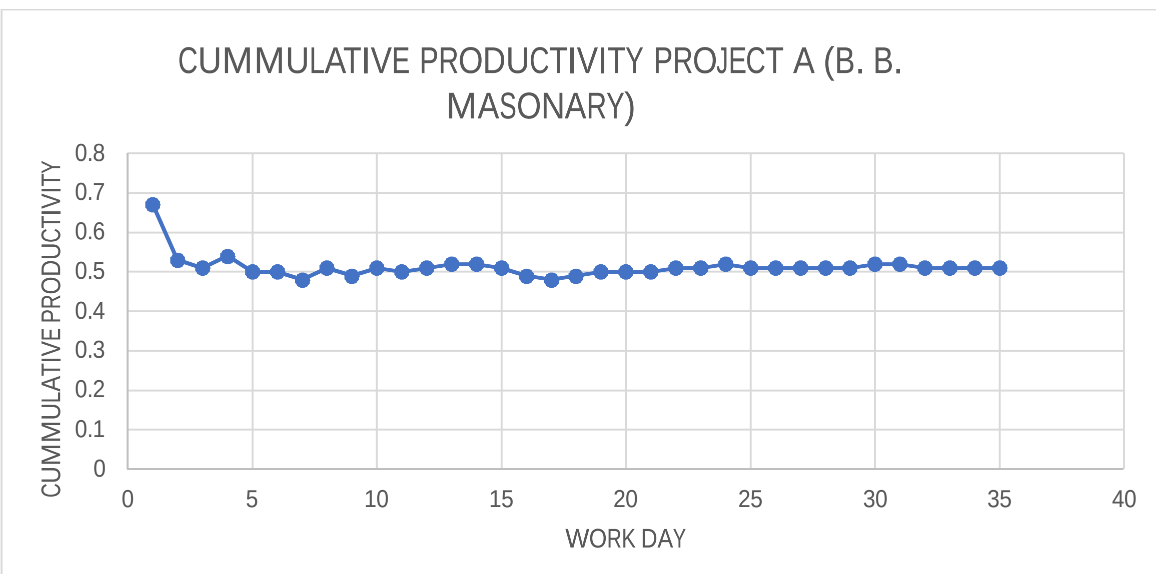
The data is presented in the form of graphs:

- Daily productivity vs. work day
- Cumulative productivity vs. work day.

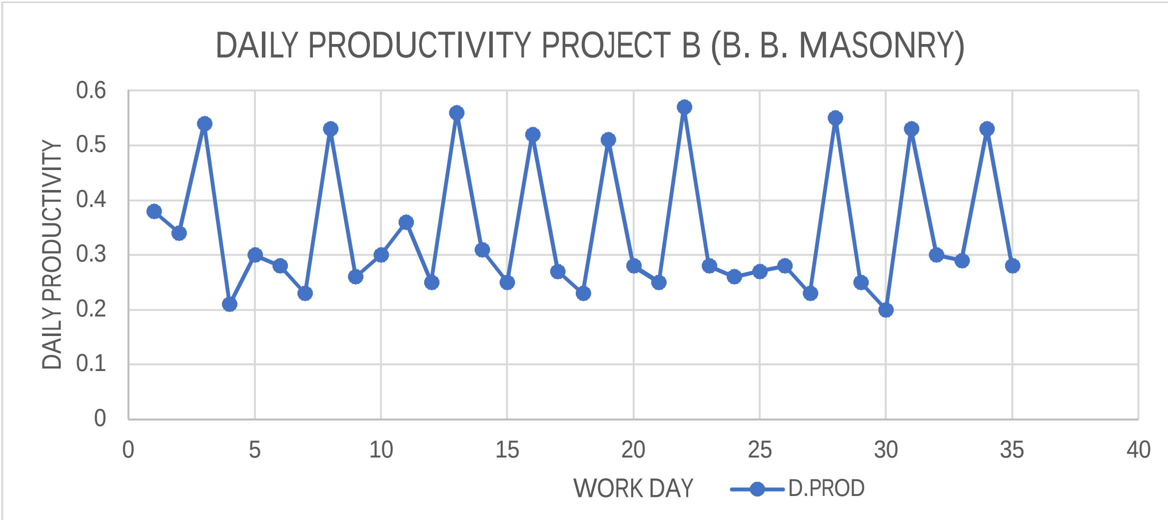
1) B. B Masonry

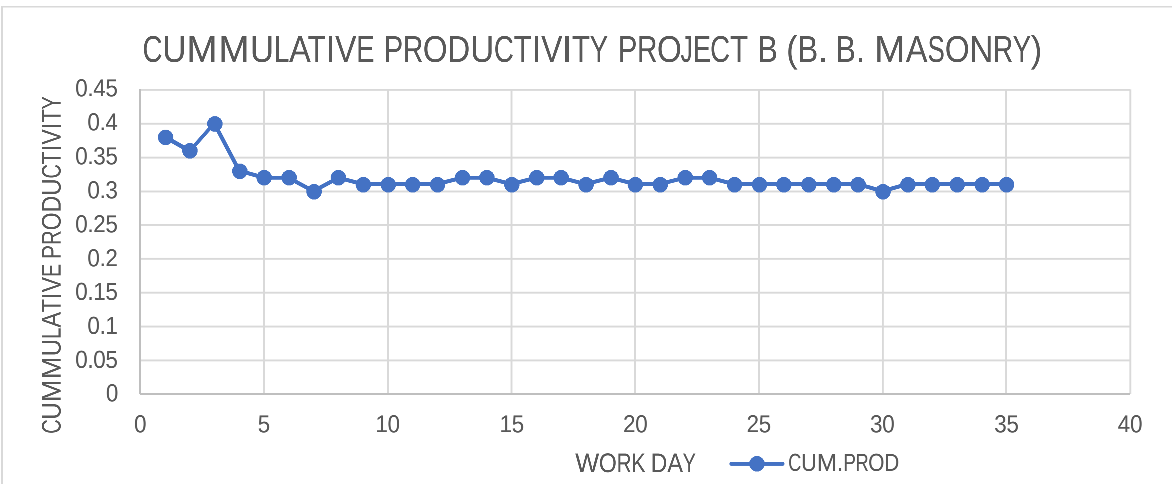
a) For Project A





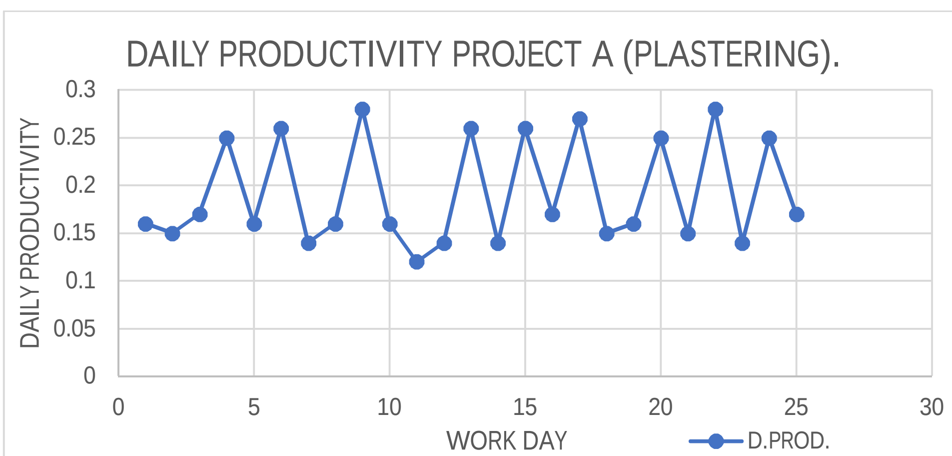
b) For Project B





2) Plastering

a) For Project A



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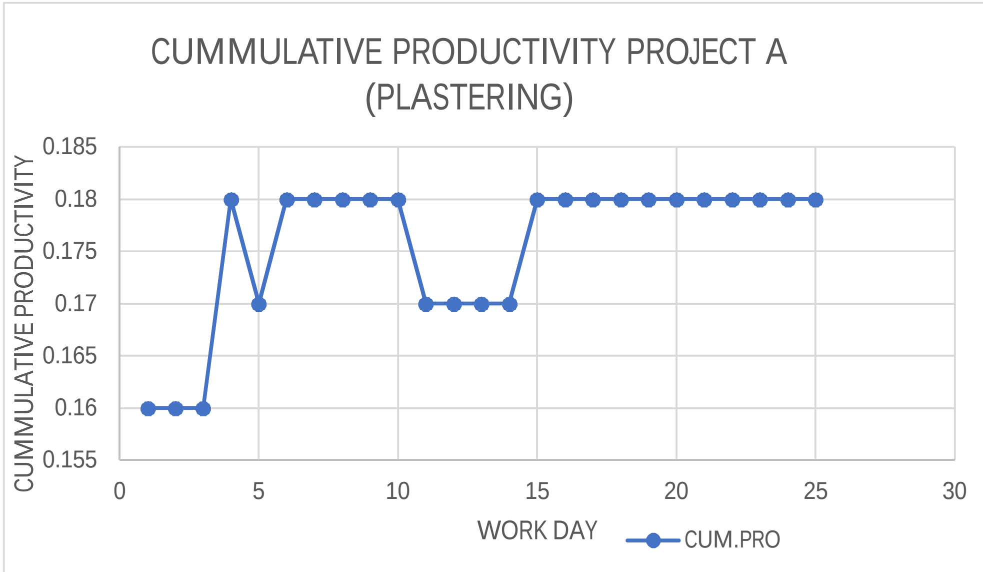
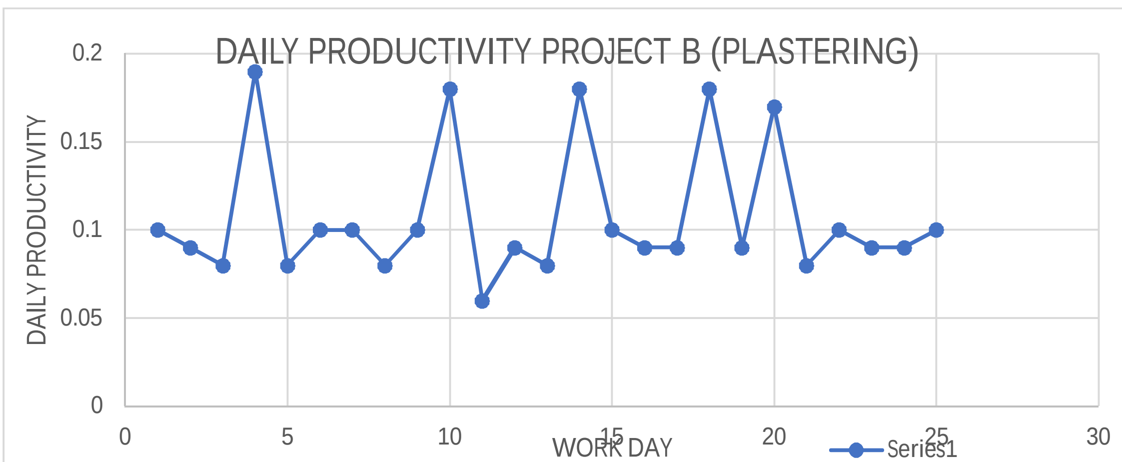
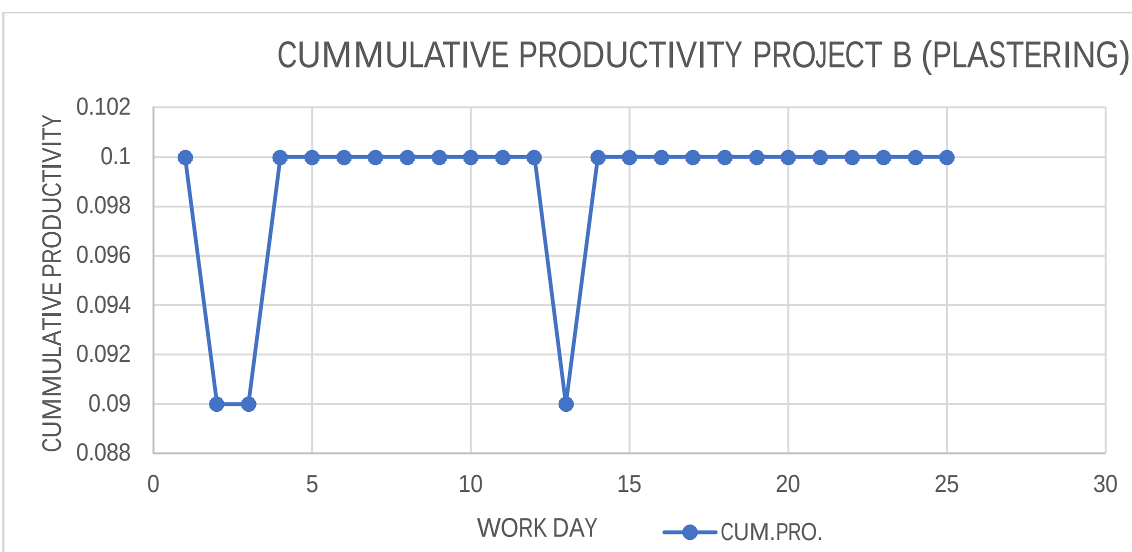


b) For Project B





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E. Comparison

1) For B. B. Masonry

Column1	PROJECT A	PROJECT B
Activity Duration	35 days	35 days
Total Qty. Work	533.26 sq.m.	897.91 sq.m.
Total work- hours	271.5	277.5
Total lost work hour	52.84	37.26
Total labour	169	192
Total mason	115	150
Work-hour overrun =(total lost work hr)/(total work hours)*100	(52.84/271.5)x100 = 19.46%	(37.26/277.5)x100 =13.42%
Time overrun	52.84 hours is equivalent to approx. 7 days.(7/35)x100 =42.86%	37.26 hour is equivalent to approx. 5 days.(5/35)x100 = 14.29%
Percentage of ineffective days	Out of 35 days, 15 days are ineffectively used. (15/35)x100 = 42.86%	Out of 35 days, 9 days are ineffectively are ineffectively used.(9/35)x100 = 25.71%

2) Plastering

Column1	**PROJECT A**	**PROJECT B**
Activity Duration	25 days	25 days
Total Qty. Work	1099.5 sqm.	2004.1 sq. m.
Total work- hours	197.5	198.5
Total lost work hour	29.73	18.77
Total labour	121	140
Total mason	80	111
Work-hour overrun =(total lost work hr)/(total work hours)*100	(29.73/197.5)x100 = 15.1%	(18.77/198.5)x100 = 9.46 %
Time overrun	29.73 hours is equivalent to approx. 4 days.(4/25)x100 = 16%	18.77 hour is equivalent to approx. 2.3 days.(2.3/25)x100 = 9.2%
Percentage of ineffective days	Out of 25 days,9 days are ineffectively used.(9/25)x100 = 36%	Out of 25 days, 5 days are ineffectively are ineffectively used.(5/25)x100 = 20 %

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F. Project Summary

Column1	PROJECT A	PROJECT B
	FOR B. B. MASONRY	
TOTAL QTY. WORK	533.26 Sq.m.	897.91 Sq.m.
TOTAL LOST WORK HOURS	52.84	37.26
WORK-HOUR OVERRUN	19.46%	13.42%
TIME OVERRUN	20%	14.29%
% OF INEFFECTIVE DAYS	42.86%	25.71%
	FOR PLASTERING	
TOTAL QTY. WORK	1099.5 Sq.m.	2004.1 Sq.m.
TOTAL LOST WORK HOURS	29.73	18.77
WORK-HOUR OVERRUN	15.10%	9.46%
TIME OVERRUN	16%	9.20%
% OF INEFFECTIVE DAYS	36%	20%

This shows the ineffective material management of Project A, it is due to the following reasons:

1) Lesser storage area as, Project B is constructed on a corner plot and has material sequencing and more storage area available were effectively managed.
2) Additional labour force was used to expedite the transportation of materials.
3) Supervisors, masons, and most of the labors were working with the builder for many projects.
4) No use of proper methodology like Lean.
5) No proper discipline for the activities.

G. Conclusion

The case study has presented a quantitative estimate of the work-hour losses resulting from ineffective material management practices. A contractor needs to consider the trade offs between investing in material management and incurring material related disruptions. The actions composing the informal material management program are quite simple. They involve organizing storage area, expediting and sequencing material deliveries.

We can conclude that the performance and system efficiency can improve if we follow Lean methodology in smaller processes and activities of construction and civil engineering.

VII. CONCLUSION

In the present study the areas of low productivity have been examined and suggested some tools to improve the productivity. The work hour lost in respect of B. B. Masonry and plastering has also been estimated. The general observations are also recorded.

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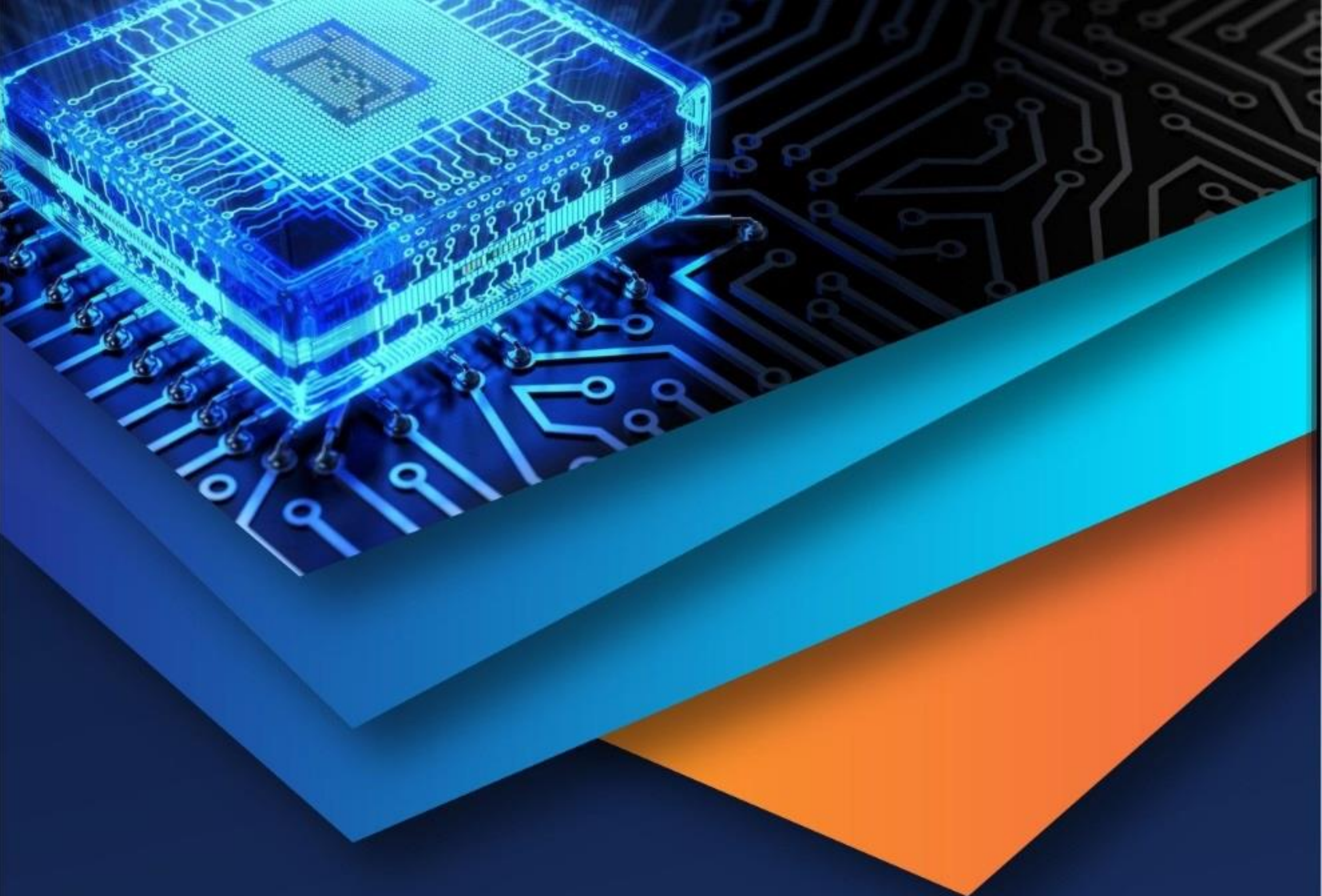

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