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Value Stream Mapping in Construction for Improving Productivity

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ABSTRACT

Remarkable productivity improvements are observed in manufacturing industry which encouraged the emergence of lean thinking into construction industry. Poor management, output variability, labour intense work, interior work conditions and insufficient quality are the potential problems in construction industry which prevent implementing lean techniques. In this report productivity measurements for different activities like rebar installation, formwork installation and concrete pouring for column and slab processes are evaluated accordingly using output/input ratio. Value stream mapping (VSM) is used to analyse the lead times, work in progress levels (WIPs) and non-value added time. From the current state VSMs of bar-cutting/bending and column processes we have significant lead times, idle times Improvements are done by identifying the wastes and eliminating them and reducing the non-adding value.

Keywords : Lean thinking, Productivity in Construction, Value Stream Mapping (VSM), Waste, Variability.

I. INTRODUCTION

1.1 GENERAL

Construction management is very vital for any construction project to complete in scheduled time and without any cost overruns. Lean construction practice is growing tremendously in modern construction and in most of the projects lean construction techniques are applied. There is an analogy between construction and manufacturing industry, obviously with some similarities and differences. Lean construction techniques are first developed in the manufacturing industry, later it became subject of interest in the construction industry. Unfortunately, translating lean concepts from manufacturing to construction is not automatic because of the unique characteristics of the construction industry, in addition to the geographical diversity among projects. Now, due to the lot of research happening in construction industry lean construction techniques are effectively used in the construction to tackle some of the issues in the construction management.

1.2 LEAN CONSTRUCTION MANAGEMENT

Lean tool VSM is used to identify waste in current state and then making some improvements in the current system to improve productivity. VSM is used to identify value adding and non-value adding activities and eliminates waste ensuring smooth flow of materials and information. The purpose of studying this tool is to understand how VSM is helpful in lean implementation to develop a road map to tackle improvement and bridge the gap between the current and future state of different construction activities. In order to use VSM tool, one underlying prerequisite is

the production process should be repetitive. In manufacture industry all the products pass through the similar steps which are favourable for lean ideology and implement a lean model for continuous improvement. VSM uses the data related to the process in order to depict the current state quantitatively and to improve continuously to attain the future state. Due to long durations and high variability in construction site investigation is very much needed to understand the various activities on-going at site and collect statically valid data in short time.

II. OBJECTIVE

The objective of the project is limited to the activities performed during the concreting process of column and slab.

III. DATA COLLECTION

The general methodology of this study Productivity calculation was done according to quantity of work done to TMH that was operated. For different activities the productivity measurements are different such as reinforcement placing productivity is sqm/ TMH and column is kg/TMH,formwork(shuttering) installation is in sqm/TMH, bar bending and bar cutting productivity is in kg/TMH and for concrete pouring activity productivity is in cum/TMH. In order to depict the current state of the selected value streams we have to walk through all the steps involved in bar-cutting/banding and column concreting process and collect statistically valid data for all the activities in the process.

3.1 DATA ANALYSED

Productivity data are analysed as shown

Table 3.1 Bar-cutting data

Total workers working in one crew for bar cutting = 11
Average rebar cut per cycle = 74.1 kg
Average time taken per cycle for cutting = 14 minutes
Average TMH per cycle = 2.56
Average productivity for bar cutting = 29.46 kg/TMH

Table 3.2 Bar-bending data

Total workers working in one crew for bar-bending = 2
Average rebar bent per cycle = 1.21 kg
Average time taken per cycle for Bending = 2.27 minutes
Average TMH per cycle = 0.08
Average productivity for bar-bending = 16.3 kg/TMH

Table 3.3 Rebar installation of column

Total workers working in one crew = 6
Average rebar installed per cycle = 90 kg
Average time taken per cycle = 108 minutes
Average TMH per cycle = 3.62
Average productivity for bar cutting = 25 kg/TMH

Table 3.4 Formwork installation column

Total workers working in one crew = 11
Average amount formwork installed per cycle =
Average time taken per cycle = 70 minutes
Average TMH per cycle = 4.05
Average productivity = 1.79 TSA/TMH

Table 3.5 Column concreting data

Total workers working in one crew = 8
Average amount concrete poured per cycle =
Average time taken per cycle = 38.03
Average TMH per cycle = 5.07
Average productivity = 0.17 CUM/TMH

Table 3.6 Formwork shuttering installation data for slab construction

Workers	Total time taken (hours)	Productivity (SQM/TMH)
15	144	0.27
25	48	0.49

IV. APPLICATION OF VSM

4.1 Diagnosis and Analysis for current state and future state VSM of bar bending and cutting:

Non-value added and value added percentages are 70 and 30 % respectively. Since there is lot of machine cutting and bending we have a significant uptime of 56.3%. The total distance travelled is 80 feet and time taken is 150 seconds. The most time taking activities are making U bars of 12 meters length into straight 12 meter ones which take 11.4 minutes. This can be made zero by ordering 12 meter straight ones using a trailer vehicle. The total process cycle efficiency is only 16% which can be significantly improved with doing above improvement. The main problem is planning and control issues. On the site for bar bending and bar cutting there is not proper or timeline planning. Deficient midterm and long-term planning caused materials and workforce waste and also production delays. One cause of low productivity was waste that was generated in the process. The waste was not transported to any landfill or anywhere but rather it was lying on the site itself which added congestion to the site. There was neither reuse nor recycling of materials. Work balancing graph is shown in figure 4.1 with productivity times per worker for each activity on x-axis.

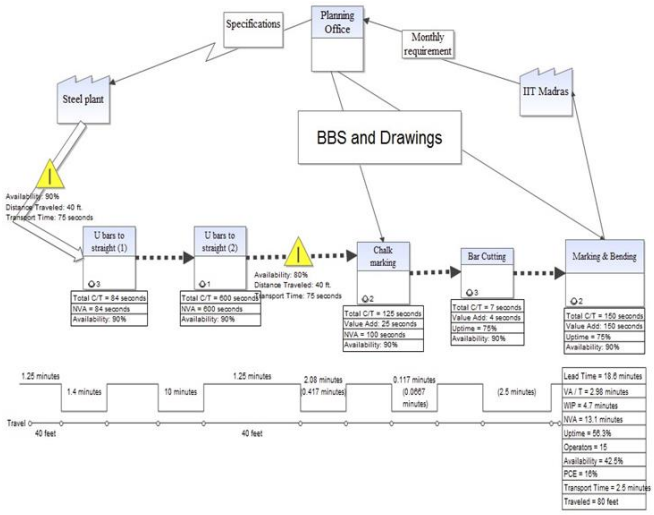

Figure 4.1 Current state VSM for BB process

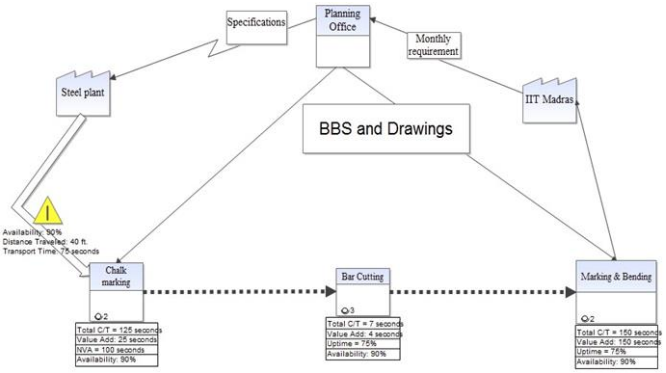

Figure 4.2 Future state VSM for BB process

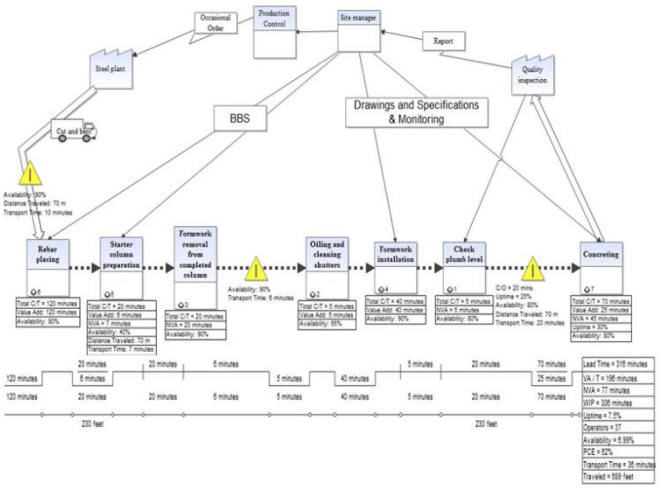

Figure 4.3 Current state VSM for column process

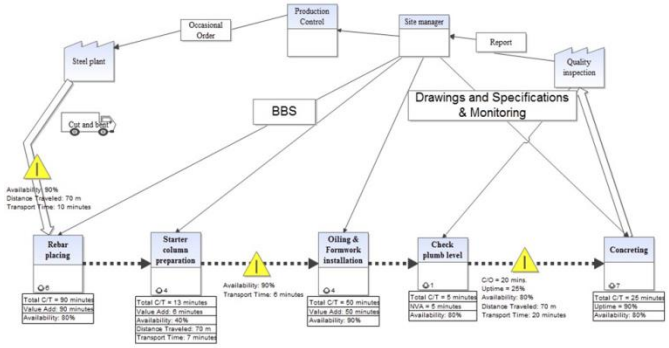

Figure 4.4 Future state VSM for column process

V. CONCLUSION

Activity productivity measurements were evaluated according to the output/input ratio for bar-cutting/bending, rebar installation, formwork installation and concreting activities for column and slab construction. After restructuring the current state process map by eliminating non-value added activities with appropriate action i.e. for future state non-value added percentage were decreased to 28 and 2.3 respectively. PCEs were improved by 34.1 % and 16.1 % respectively. Simulating the current and future state of bar-cutting process is increased by 22.64 % and column concreting process is improved by19.23 %. This research mainly focused on VSM implementation in office building construction. Current state is drawn understanding process in detail using data collected from site by which wastes are identified easily and eliminated.

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