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MEASURING THE IMPACT OF LEAN TOOLS IN A PRINTING MACHINERY MANUFACTURING COMPANY

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ABSTRACT: Lean manufacturing is an applied methodology of scientific, objective techniques that cause work tasks in a process to be performed with a minimum of non-value adding activities resulting in greatly reduced wait time, queue time, move time, administrative time, and other delays. This work addresses the implementation of lean principles in a printing equipment manufacturing company. The prime objective is to evolve and test several strategies to eliminate waste on the shop floor. This paper describes an application of value stream mapping (VSM). Consequently, the present and future states of value stream maps are constructed to improve the production process by identifying waste and its sources. A noticeable reduction in Work-in-progress inventory, cycle time and increase in efficiency is confirmed. The production flow was optimized thus minimizing several non-value added activities/times such as waiting time, material handling time, etc. This case study can be useful in developing a more generic approach to design lean environment.
KEYWORDS: Lean Manufacturing, Value Stream Mapping (VSM), Work-In-Progress (WIP), Enterprise Resource Planning (ERP), Cycle time

INTRODUCTION

Lean manufacturing is based on the Toyota Production System developed by Toyota which focuses on eliminating waste, reducing inventory, improving throughput, and encouraging employees to bring attention to problems and suggest improvements to fix them [1]. Lean manufacturing has increasingly been applied by leading manufacturing companies throughout the world. A core concept of lean manufacturing is pull production in which the flow on the factory floor is driven by demand from downstream pulling production upstream. Some of the changes required by lean manufacturing can be disruptive if not implemented correctly and some aspects of it are not appropriate for all companies [2]. A lean manufacturing facility is capable of producing product in only the sum of its value added work content time. Features of a typical lean manufacturing model include: one unit at a time production, non-value added time eliminated, production in the work content time only, and relocation of required resources to the point of usage.

In the present day of manufacturing, assembly line can be formed easily for any industry whether it is a small-scale or a medium-scale industry. When the takt times are calculated for every part manufactured in the industry through different part movements, then the problem of locating machines on the shop floor occurs when it is a job type production unit; this problem is the main reason for reconfiguration of machines and layout design for every demand. To eliminate these problems, a proper method is required to achieve a rhythm in manufacturing lean line by identifying value adding, non-value adding, and necessary non-value adding activities through an optimum feasible takt time.

This paper presents a case study of a medium-scale printing equipment manufacturing industry facing the problems such as waiting and excessive WIP. This work addresses the implementation of lean on the printing equipment manufacturing, with a focus on the ERP activities which should have a proper rhythm of production line, minimizing wastages like bottleneck time, waiting time, material handling time, etc. The prime objective is to develop different strategies to eliminate waste. The lean tool value stream mapping (VSM) applied as a method to lead the activities. A GEMBA walk is made and it is found that several superfluous transactions are taking place in ERP system.

A new inventory organization which will reduce 50% of the number of transactions and save a sum of rupees eighteen lakhs per annum is suggested. VSM is used for the analysis of inventory holding time, lead time, value added time and non-value added time. The cost-benefit analysis is made for both the current state and future state. The change that has been proposed has decreased the inventory level, follow-up required by buyers and better utilization of machines.

BRIEF LITERATURE REVIEW

Currently, production lines are still fundamental to get the smoothing of production system [3], and they are studied under several operative perspectives seeking its flexibility [4, 5]. Both concepts are subjects of pull systems. In production lines, pull and lean systems are concepts frequently connected, although they pursue different objectives; pull system toward the reduction of work-in-process (WIP) and lean system toward minimizing the buffer variability [6]. Moreover, with respect to the election of production control system in a pull system, the alternatives considered are focused on kanban [7] and constant work in process (CONWIP) [8], both of them focused toward the reduction of WIP.

Although many tools exist, from its origin, VSM has demonstrated its efficacy [9-13]. Following the benchmarking perspective, as well the use of a contrasted tool, facilitates the interchange of improvements. It is a tool that provides communication solutions for practitioners to obtain maximum efficiency and definitions of theoretical development points to become a reference among redesign techniques [12]. A detailed description of VSM can be seen in Rother and Shook [14]. Thus, as improvement tool simplifies the measurement of times without added value, so the calculation of indexes of lean metrics is easier and it is possible to enhance the operative actions with strategic results.

This paper unifies several gaps and it shows how value stream transformation actions can achieve high levels of performance in a short time and in a real industry, inside a context of an production line with a small space and that it requires flexibility.

PROBLEM DEFINITION

This work deals with the end to end perspective of reducing waste at production line of a printing equipment manufacturing company which has three assembly units (namely A, B and C) located at three different places. Each of the three units does the assembly for different types of printing machines. Some parts are common to units A and B and for the machining processes, all the units use the CNC machining facility located at Unit-C. Since mismatch of batch order timing to the CNC department, every month the timing of common parts did not coincide. Also, the size of the batch order was different for units A and B. This led to two separate set-ups of the CNC for machining of the same part.

After intense brain storming and a thorough GEMBA study of the industry, it is observed that the activities contain various forms of non-value-adding activities as follows: (i) Superfluous transactions (ii) Unnecessary transportations (iii) WIP. Certainly, all of these factors lead to high production lead time and cost. In the existing conditions, the average production lead time is found to be around 75.2 days.

LEAN IMPLEMENTATION

In order to implement lean principles, a task group was formed with people from different parts of the organization, all having rich knowledge and information pertaining to process, production, equipment and planning. The objectives of the operation were (i) to reduce the level of non value activities present in any form by implementing the various lean tools (ii) to reduce the overall process time through improvements (iii) to introduce pull production and (iii) to reduce the WIP. The methodology adopted to achieve the objectives is given in Figure 1.

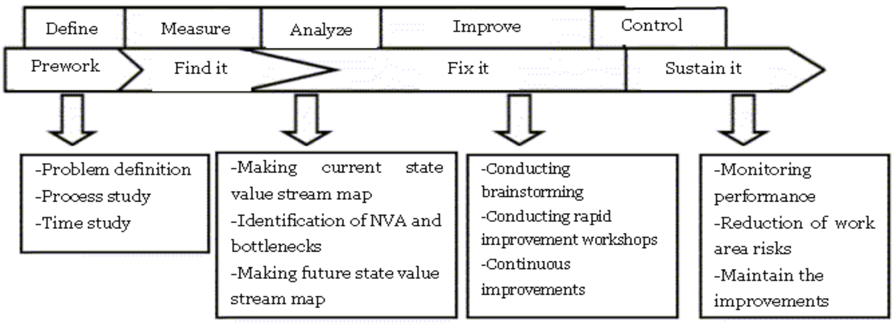

Figure 1. Methodology for lean implementation

Current state value stream mapping

To construct the current state value stream map for the selected product impression cylinder, relevant information was collected by interviewing people on all the three units. The sequence of activities is as follows:

- *Unit-A gives a purchase order (PO) for 75 impression cylinders to an external castings supplier who delivers it after turning*
- *Secondly, a job order is given to Unit-C for machining in vertical machining centre. After the operation is completed the material is delivered back to Unit-A.*
- *As a third step in the sequence, a PO is given for horizontal machining operation to an outside vendor. Thus the material is transported to outside and transported back after the operation.*

- *For plating, another PO is given to an outside vendor. Again the material needs to be transported and then back to Unit-A.*
- *The same procedure is carried out for 75 and 25 impression cylinders by Unit-A and Unit-B respectively.*

A sample form obtained from an ERP system developed for this purpose is shown in Figure 2. Figure 3 shows the job order transaction for hard chrome plating obtained from ERP. Data relevant to the vendor, such as quantity to be delivered, delivery time were observed and information related to the assembly line, such as processing time, inventory storage, inspections, rework loops, number of workers and operational hours per day were collected and documented properly. To complete the value map, a timeline is added at the bottom of the map recording the lead-time and the value-added time. Eventually, the value stream map for the current state is constructed as shown in Figure 4.

As observed from the value map, various value-added activities present in the flow line, bottlenecks are identified and quantified in time, as shown in Table 1. It is found that about 55% were value added activities, compared to 45% of non value added activities. It is concluded that the mismatch of batch order timing and size of the batch order is the major issue which is not within the current levels of demand.

Table 1. Current state va/vva time analysis

Description	Days
Lead time	75.2
VA time	40.6
NVA time	4.53
Inventory holding time	30

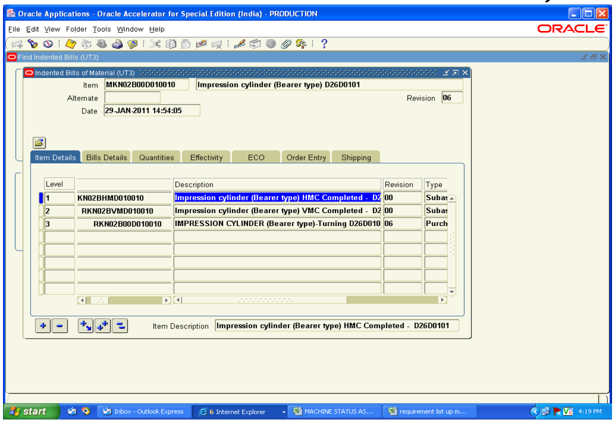

Figure 2. Bills of materials obtained from ERP system

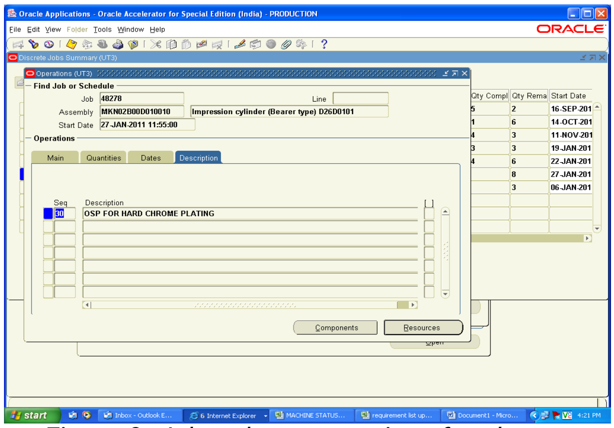

Figure 3. Job order transactions for chrome plating

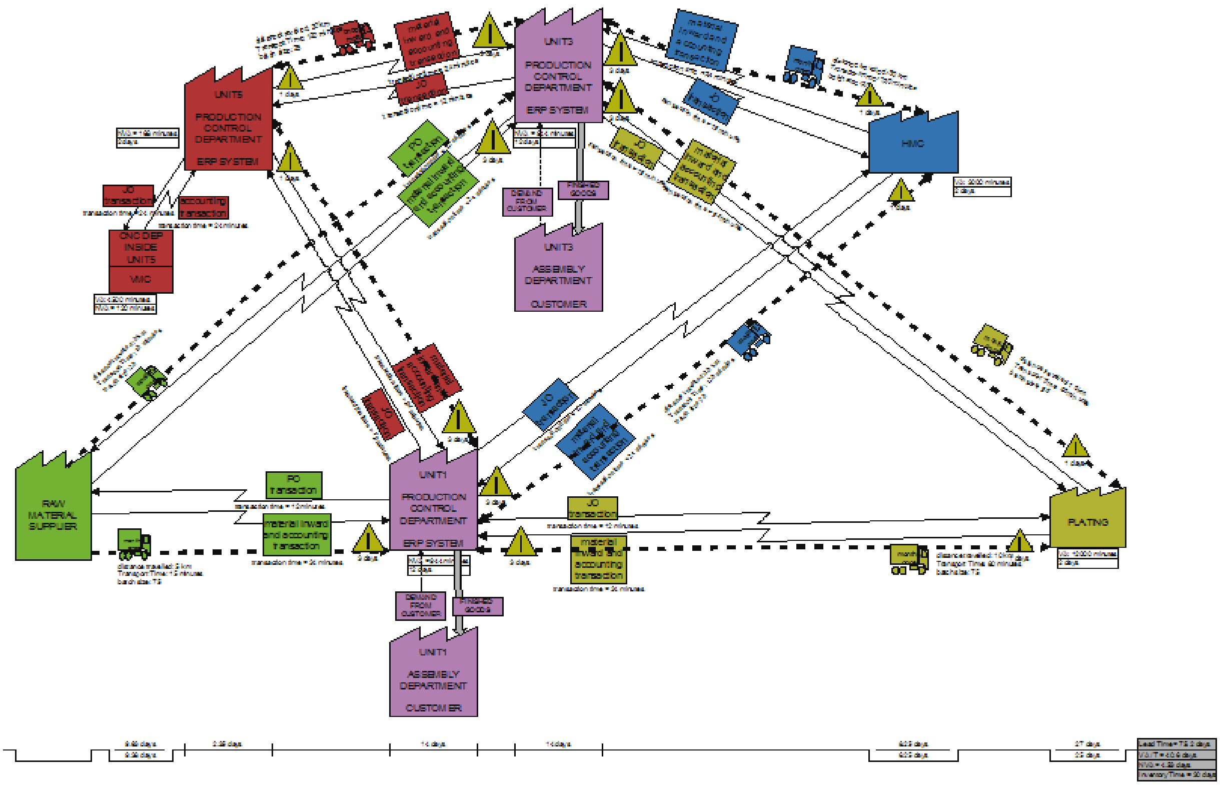

Figure 4. The present state value stream MAP

Cost benefit analysis

A detailed cost-benefits analysis is done considering the labor cost and various expenses including the cost associated with the ERP system. The procedure is as follows:

- *Wages for ERP related labours*

Salary of one worker = Rs. 15, 000/month
Total number of workers = 10
*Total number of working hours/month = 25 days * 8 hours/month*
*Wages/hour = (15000*10)/ (25*8) = Rs. 750/hr.*

- *Cost of investment of ERP*

Capital investment cost, C= Rs. 1, 50, 00, 000/-
Rate of interest, i = 9%
Number of years, n = 10
*Cost of investment of ERP = (C + (i*n*C))/n = Rs. 625/-*

- *Cost of maintenance of ERP*

Cost of maintenance = Rs. 1000/hr

- *Total cost of one transaction through ERP*

Number of transactions a person can do in one hour = 5
Total Number of transactions/hr = 50/hr
Total cost of transactions = Rs. 2375/hr
Cost of one transaction = Rs. 47.5/-

- *Overhead costs*

Cost of printing purchase order = Rs. 202/-
Cost for transaction (inside and outside delivery) = Rs. 1750/-

- *Transportation cost*

Total transportation cost = Rs. 280/-

- *Set-up time costs*

Total cost for 70 common parts = Rs. 2, 12, 100/month.
Similarly for 190 separate parts = Rs. 2, 70,560/month.

Improvements

A GO-SEE approach is made for the current state process and some changes are made to reduce the time and cost. Initiatives taken to reduce the NVA activities are:

- *Standard work sheet is prepared*
- *Stringent monitoring is done and improvement opportunities are addressed in time*
- *Wherever possible, inefficient operations are eliminated;*
- *To handle higher capacity, equipment layout modification was done*

The improved sequence of activities is as follows:

- *The CNC department is made as a separate inventory organization.*
- *Once the purchase order is received from the Unit A and B, the CNC department in turn sends a purchase order for 100 units of cylinders to the raw material supplier*
- *The material is pulled through sequential pull.*
- *The vertical machining centre does the required operations and then sends the material for horizontal machining and from there it was directly delivered for plating operation.*
- *The 75 and 25 finished units are sent to Unit A and B respectively.*

Future state value stream mapping

Finally, the future state value stream map is constructed as shown in Figure 5, which reported a considerable depletion in non-value-added time. A drastic reduction in time for machining process is also observed.

Table 2 outlines the improvement after lean comparing the value stream analysis report for the present and future state. It is found that about 76% were value-added activities compared to 24% of non-value-added activities. Comparing the value maps, it can be concluded that a 28 days reduction in non-value-added activities is achieved. There is also savings in time for lead time of inventory, transportation time and processing time.

Table 2. Improvements after lean

Description	Present state	Future state
Lead time	75.2 days	47.4 days
VA time	40.6 days	40.6 days
NVA time	4.53 days	1.57 days
Inventory holding time	30 days	5 days

Table 3. Cost-benefit analysis

Description	Amount (Rs)
Cost saved for common parts	1, 15,675/month
Cost saved for individual parts	33,155 / month
Total savings	1, 48,830/month

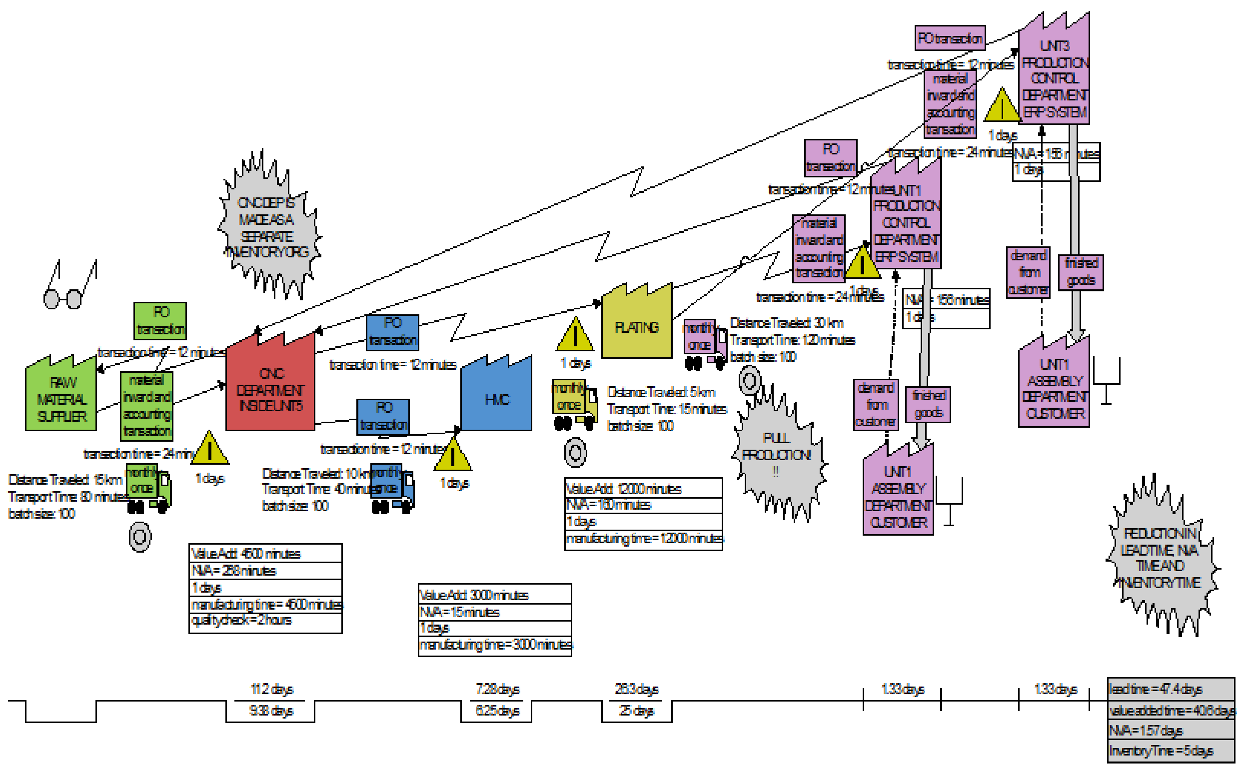

Figure 5. The future state value stream MAP

Future state - cost benefit analysis

Considering the future state and the common parts involved in unit A and B, the following is the outcome of cost-benefit analysis:

- *Unit A and B: Seventy common parts*

Total number of transactions = 15
Total number of PO printed = 5
Total number of DC and GRN printed = 2
Total transaction cost = Rs. 737.5/-
Total transportation cost = Rs. 140/-
Set-up time cost = Rs. 500/-
Total cost for 70 common parts = Rs. 96, 425/month

- *Unit A and B: one hundred and ninety individual parts*

Total number of transactions = 13
Total number of PO printed = 4
Total number of DC and GRN printed = 1
Total transaction cost = Rs. 629.5/-
Total transportation cost = Rs. 120/-
Set-up time cost = Rs. 500/-
Total cost for 70 common parts = Rs. 2,37, 475/month

Table 3 summarizes the outcome of cost benefit analysis and it can be noted that the cost of transactions, transportations and CNC set-up time costs drops drastically.

CONCLUSIONS

This present work provides a case study of the improvement of a printing equipment manufacturing company non value added activities by means of lean tools. It focuses the revamp of operations by eliminating non value-added time and improving line efficiency through VSM. It can be concluded that VSM is an effective tool for identifying the processing wastes.

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