Application of Value Stream Mapping for Process Improvement in a Food Manufacturing Industry - A Case Study

N.S. Shobha and Dr.K.N. Subramanya

Abstract--- *This paper titled "Application of Value Stream Mapping for Process Improvement in a Food Manufacturing Industry - A Case Study" is the result of a work carried out to improve the Processes in a food manufacturing industry. The objective of the work was to reduce the Overall Lead time of the line and to reduce the scrap rate with the help of value stream mapping (VSM).The VSM for the current state is drawn to identify the non value added activities. Cause and Effect diagram and Pareto Analysis were used to analyse the problems, and to reduce the current scrap rate of 4%. A future State VSM was drawn which depicted the decrease in lead time by 11.7% and reduction in scrap rate by 0.6%.*

Keywords--- *Value Stream Mapping (VSM), Economic Order Quantity (EOQ), First In First Out (FIFO)*

I. INTRODUCTION

THE lean manufacturing methodology is described as a series of techniques that allows product producing one unit at a time, at a formulated rate and eliminating non-value-adding time, queue time or other delays. The benefits of lean manufacturing are: reduced inventory levels, decreased material usage, optimized equipment, reduced need for factory facilities, increased production velocity, enhanced overall production flexibility and reduced complexity. Value stream Mapping (VSM) is a lean manufacturing technical methodology applied to interpret the Flow of materials and information currently needed to transit goods or services to the end Consumer. The goal of VSM is to identify all types of waste in the value stream, decrease and eliminate these wastes. This mapping method identifies the three critical management task which includes: production flow, design flow, material & information flow and the integration of design & production flow.

A Cause-and-Effect Diagram is a tool that helps to identify, sort, and display possible causes of a specific problem or quality characteristic. It illustrates the relationship between a given outcome and all the factors that influence the outcome. Constructing a Cause-and-Effect Diagram helps to identify the possible root causes, the basic reasons, for a specific effect, problem, or condition. A Pareto chart is a type of chart that contains both bars and a line graph, where individual values are represented in descending order by bars, and the cumulative total is represented by the line. The purpose of the Pareto chart is to highlight the most important among a set of factors.

II. LITERATURE REVIEW

Several authors have contributed to the literature on value stream mapping and optimizing the resources. Some of the relevant works used in our works are as follows:

A Paper by William M. Goriwondo, Samson Mhlanga and Alphonce Marecha on use of the value stream mapping tool for waste reduction bread manufacturing company in Zimbabwe and this paper details the use of the VSM tool in reducing waste in bread manufacturing.The author used VSM tools identify and reduce the defects by 20%, unnecessary inventory by 18% and motion by 37%. [1]

A paper by Nitin Upadhye, S.G. Deshmukh and Suresh Garg titled Lean manufacturing in biscuit manufacturing

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plant have taken up a case study in a medium sized biscuit manufacturing plant which is studied under the framework of lean manufacturing system and observed that 5S, kaizen, quick changeover, TPM and TEI are some of the tools, which can be effectively used to improve equipment availability, reduce wastage of material and improve quality. Barriers to achieve lean processes were Workers have a low literacy, knowledge, skills, and confidence level, low motivation, High breakdowns: The total time available per month is 1125 hours (375 hours per plant). Operational inefficiency, High level of inventory, Wastage of raw materials, High set-up time, and Poor quality due to in-process rejection, High breakage and expiry date items from market. Around 20% products are returned from market on account of damage and attainment of expiry date. These returned goods are sold at negligible price as an animal feed, Redesign of Marketing strategy was suggested. [2]

A paper by S. L. Adeyemi and O. Salami on Inventory management: As a tool of optimizing resources in a manufacturing industry have taken a case study of coca-cola bottling company, Ilorin and the main objective of this study is to determine whether or not inventories in the Nigeria Bottling Company, The study methods employed included the variance analysis, Economic Order Quantity (EOQ) Model and the Chi-square method. The Author collected data through Interview with some key personnel in the stores, purchasing, production and inventory departments of the company, Observation of the production process was done to see the flow of goods in the conversion process. Materials handling and storage were also observed and so was the patrol / inspection procedures. Record analysis of relevant data was obtained from the company's annual report and journals. [3]

III. MOTIVATION AND OBJECTIVES OF THE STUDY

Food industry faces growing challenges-Increasing operational complexity. Thus, improving productivity and measuring its level of increase is vital for achieving the planned results. This work aims at studying, analyzing and reducing the Lead time. It was found from the study that the product under study had a high demand of 291tonnes/week on average. The Lead time was 34days, which had higher raw material inventory levels and excess labour. In light of the above issues, the objectives set are: to reduce the Overall Lead time of the line considered for study, to reduce raw material Inventory level and to reduce waste and to optimize the manpower utilization.

IV. METHODOLOGY

The following methodology has been adopted to meet the objectives:

Step 1: Process Study: A Process is a set of interrelated concurrent and consecutive activities that convert existing resource inputs into planned outputs. The speed and efficiency by which the output results are achieved in a large measure depends upon the structure of the process and sub-processes that convert the inputs into outputs. The entire process of Manufacturing can be classified into eight main stages, namely Sifting, Pre-Mixing, Mixing, Forming, Baking, Cooling, Creaming and Packing

Step 2: The Current Value Stream Map: The Current VSM was drawn right from receiving the raw materials to the point of shipping the finished goods. The data box Consists of data on inventories (Raw Materials, Finished Goods, Work-In-Process), the Amount of productive time (the number of shifts per day and the number of working days per week), the frequency of the production cycle (displaying how often every parts is made), and the change over time. The next step was to draw the transport links between each facility, which may be ship, train or airplane. The data line shows the total time for each workshop, each distance traveled and the value added time for each stage in manufacturing. The Raw materials are received from local suppliers and also North Indian suppliers, the raw material is unloaded to the stores which take about 3mins. Once the raw materials are received it is put to a Quality Check, it takes about 3hours on average, only after the clearance the truck can leave. The raw materials stay in the stores for an average of 9days, then, the raw materials are send to production area in a FIFO manner. The process cycle time, Change over time, with number of workers, and the average scrap rate was recorded in the Data box

After the physical flow of the product was mapped, the information flow was drawn. The information flow comprises the frequency of orders and the way it is transmitted by between each facilities, e.g. by phone, electronically or fax. The weekly order are received, the Production Manager then plan the daily schedule and sends electronic information to all the department heads, the departments then procure the required raw materials from RM stores. The Logistics manager receives the Shipping chart of required SKUs to various warehouses. The plan was made in an excel sheet daily and electronically sent to finished goods stores. It is then shipped in the particular trucks that come as scheduled. The work in process inventory was very less in matter of minutes; the only reason for higher Lead time is due to higher raw material inventory level. The Value Added time was observed to be 129minutes, and the Lead time is 34days.

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Step 3: Data Analysis: There are 61 raw materials that are procured and the inventory was ordered based on Continuous review by the stores personal, the stock statements were frequently updated. This system had some flaws and Raw material inventory levels for minor ingredients were on the higher side. It was a Push system; also the Lead time was high for the minor chemicals and flavors, thus, the company orders inventory for 2 months. An EOQ model was developed in excel in order to reduce the inventory levels. The Raw material inventory levels came down to 6 days on average after revising the EOQ model. The FIFO system of Shipping was suggested to be implemented; until the entire lot is shipped from production area. This ensured smooth flow of finished goods, and the waiting time was reduced to one day.

Pareto Chart was drawn to identify the reasons for waste of various main ingredients and percentage of scrap. The table below shows the category of ingredients.

Table 1: Category of Ingredients and % Wastage

Category	Frequency	Cumulative %
Dough	1081.91	32.11
Cream sugar	943.82	60.12
Cream	840.95	85.08
Oven scrap	371.71	96.12
Packing	130.88	100.00

Step 4: Flow Process Chart – Man type was created and by studying each element of work and its content, Utilization of men was determined. After Studying the idle time and Working time, which is further divided into operations, Transportation, and Delay the present and proposed number of workers were determined and was depicted in the table shown below:

Table 2: Comparison of Man Power Utilization

	Stores	Maida, sugar	Pre-mixing	Mixing	Forming	Baking	Cooling	Packing	Shipping
Present	14	4	15	3	4	4	3	76	2
Proposed	14	4	13	3	4	4	3	72	2
Savings	0	0	2	0	0	0	0	4	0

Step 5: Future Value Stream Map: The next step was to draw a future state map (FSM) which makes the lean improvement based on the result of the current state map analysis. The FSM gave the best way that the process could operate starting from the current state analysis. Through gap analysis between CSM and FSM, the work group could discover all the problems and counter measures and make improvements and after each improvement session, the FSM changed back to CSM. The Future State VSM resulted in the major saving which are: reduction in raw material Inventory Level by 3 days, in pre-mixing area 2 Labourers and in packing 4 Labourers were reduced, the dough scrap rate in mixing was reduced by 0.4%, and the packing are scrap was reduced by 0.2% and a FIFO system used for Shipping reduced lead time by 2days.

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V. RESULTS AND DISCUSSION

The following results were obtained after proposing future value stream map. The consolidated results are depicted in the table below:

Table 3: Comparison of Measures of Performance

Results	Present	Proposed	% Savings
Lead time	34 Days	29 Days	14.7
Raw material inventory levels	9 Days	6 Days	33.3
Finished goods waiting time	3 Days	1 Day	66.67
Scrap rate	4%	3.4%	0.6
Man power requirements(Nos.)	91	85	6.5

The following suggestions were made to the organisation for implementation.

- Collecting tub for mixer should have a bigger Opening from 12 – 15 sqft
- Dough hoist machine should have angled plates on the hopper
- Post oven angle plate on conveyor should be of soft material
- Stacker conveyor speed for cream line should be reduced to 55 feet per min from 65 feet per min
- Packing should have horizontal feeding chute (presently 45 degree feeder) / automatic feeder
- To use the EOQ model with the required buffer stock, to manage inventory and reduce the raw material inventory levels.
- To introduce a FIFO system in the finished goods stores, so that the complete lot of biscuits are shipped.

VI. FUTURE SCOPE OF WORK

The EOQ model must be changed according to the newer raw material requirements. The effective inventory management is very important to keep the inventory levels low. In order to reduce the scrap rate the industry must introduce a continuous review and monitoring policy. The manpower requirements are a major issue in the night shift and to be addressed. The Lead time can be still reduced, by converting the future state map to current state map and analysing for improvements and work on a Kanban system, to try and reduce the buffer and WIP inventories and make the process into a pull system.

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