A Case Study - Lean Manufacturing Effect in a Material Handling System by using Value Stream Mapping

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Abstract— Lean manufacturing is "A systematic approach to identifying and eliminating waste through continuous improvement". The concept of lean thinking originated from Toyota production system. Lean manufacturing focuses on efficiency and services at lowest cost as fast as possible. In industry material handling is the most important part of the production department. And in many industries like milk dairies, sugar factories, fertilizer companies where decrease in time and elimination of labor cost in a material handling system is very important. Focus area of this research is elimination of unnecessary cycle time in material handling system by using most effective tool of lean manufacturing which is known as "Value Stream Mapping".

Key words: Value Stream Mapping, Lean Manufacturing Effect

I. INTRODUCTION

Lean manufacturing is the philosophy to reduce the wastes in manufacturing Manufacturers are now a days facing intensive global competition. The key to competing in the international market place is to simultaneously improve both quality and productivity on continual bases. The major purposes of the lean production are to increase productivity, improve product quality and manufacturing cycle time, reduce inventory, reduce lead time and eliminate manufacturing waste.

A. Value Stream Mapping (VSM)

Value Stream Mapping is defining that it is the process of mapping the material and information flows required to co-ordinate the activities perform by the manufacturers, suppliers and distributers to deliver products to customers. Value Stream Mapping is used to illustrate the flow and relationship between work processes. A key component of VSM is differentiating value adding activities from non-value adding activities. Reducing or eliminating no-value adding activities is of paramount importance and a principal goal of lean manufacturing. VSM is a paper and pencil tool that helps you to see and understand the flow of material and information as a product or service makes its way through the value stream. A current state map (CSM) is drawn by cross functional, multi-disciplined team to document how thinks actually operate. Then a Future State Map (FSM) is developed to design a lean process flow through the elimination of the root causes of wastes & non-value added activities and through process improvement all leading to and implementation plan that details the actions steps needed to support the objectives. During the 1990's the driving force behind the use of value stream mapping emerged as lean manufacturing which was pioneered by Dr. James Womack, author of The Machine that changed the world (1990) and lean thinking (1996). Just as function analysis part of value management, value stream mapping is part of lean manufacturing.

B. Steps of Value Stream Mapping (VSM)

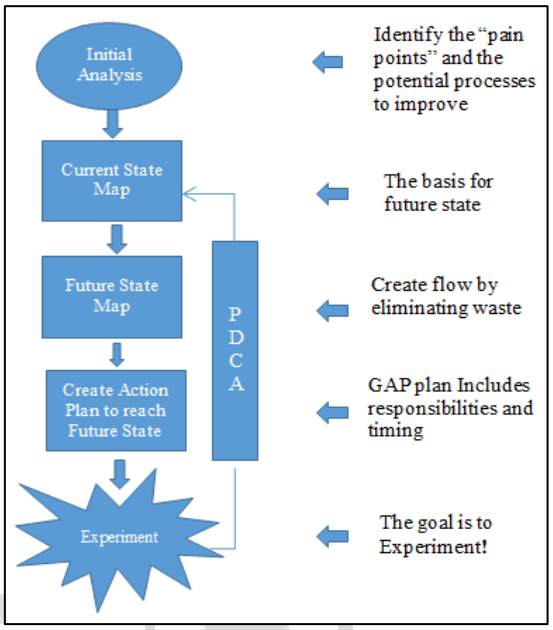

Fig. 1: Initial value stream mapping step [8]

R. Sundar, A.N. balaji and R.M. Satheeshkumar were reviewed on "lean manufacturing implementation techniques. "They were suggest that organization had to focuses on all the aspects such as value stream mapping (VSM), cellular manufacturing (CM), U-line system, line balancing, inventory control, single minute exchange of dies(SMED), pull system, kanban, production levelling, etc. This survey reveals that the successful lean manufacturing system implementation leads integration & simultaneous implementation of lean elements along with proper sequence. [5]

Satish Tyagi and Kai Yang were interested in study of "Value Stream Mapping" to reduce the lean time of a product development process". They were states that the objective and associated problems with product development process for a case study unit of a gas turbine manufacturer. Specifically, Value Stream Mapping based method is used to develop the current state map in order to find the wastes in the process and action plan to eliminate all the wastes to reach the future state. [8]

Danijela Gracanin, Borut Buchmeister, Bojan Lalic was describes that Value stream optimizing is very important for lean manufacturing effort. Value stream mapping represents very efficient tool for visualization of activities within production flow focus on activity duration with the purpose to eliminate non-value added activities. The increasing intensity of in the global market. [9]

II. PROCESS OF FERTILIZER INDUSTRY

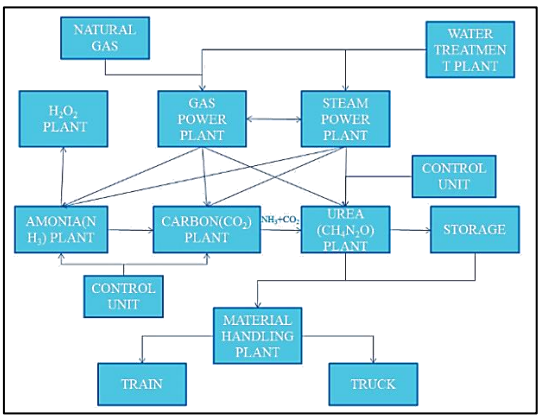

Fig. 2: Fertilizer Industry Layout

III. DEVELOPMENT OF CURRENT STATE MAP

There are various types of value stream mapping software, these include those that can be used to simply design and construct the maps to software that can carry out calculations and perform detailed analysis like talk time, lead time, cycle time, and also do time study analysis. Typically, the software is available as either enhancements to already available programs or standalone products specifically designed for Value Stream Mapping. The eVSM software is the easiest way to visualize the value stream and is used today by lean practitioners across the globe. It explicitly supports mapping at facility and enterprise levels for discrete parts manufacturing, food processing, chemical processing, administration and healthcare.

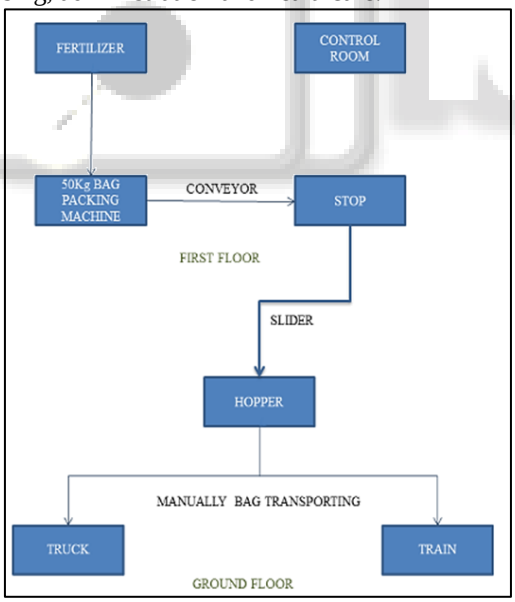

Fig. 3: Layout of Material handling department

First of all, fertilizer is produced by different chemical processes like mixture of ammonia(NH3) and carbon dioxide (CO2) gases. Amount of fertilizer coming out from the fertilizer producing plant and going to the material handling plant or storage through the conveyor belt. Then fertilizer is pouring in the bags of 50kg through the bag packaging machine. And then fertilizer bags are sealed with the help of machine. Packed fertilizer bags are going to the hopper. From the hopper, this fertilizer bags are manually lifted and transported by the workers till the train and trucks.

A. Procedure followed to Develop Current State Map

1) Data Collection Methodology and Process

The current and future state map is only as good as the data on which they are based collecting good, useful data can be a challenge. It can be a very time consuming step, if everything needs to be measure for the first time. In addition, where no measures are consistently collected. It will be necessary to obtain information about the operation from those directly involve with the operation, and this kind of data is often unreliable.

The following tips may help you get a better picture of what happens

- Follow the manufacturing process from start to finish to get the actual routine.
- Ask, if this is the normal routine, or if it is an alternative step.
- Observe some setups to get times and batch sizes.
- Use a stop watch or other method of getting a value and do it several times.
- Collect data on cycle times. Note that manual processes and manual/load/unload of machines can have large variations.
- Count shifts and number of operators.
- Observe or calculate the time required to transfer the fertilizers bags manually till the trucks & train.

2) Actual Data of Case Industry

Process	CYCLE Time	People
Manufacturing of fertilizer	60 min	10
Packing of fertilizer bags	20 secs	1
Manually bag transporting	1 min (per bag)	20

Table 1: Actual Data of case industry

The above data collected by the stop watch on the shop floor and this all processes is continuous process so inventory are not calculated during the observation

3) Calculations for manually transfers the bag

- If, 1 minute is required to transfer 1 fertilizer bag. Then in the 60 minute, there are maximum 60 bags are transferred in a shipment vehicle.
- If, 1 hour is required to transfer 60 fertilizer bags. Then in 12 hours, there are maximum 720 bags are transferred in a shipment vehicle. 12*60=720 bags.

4) Cost of the workers

- Cost of the worker per person of one day is 150/Rs.
- There are around 20 workers are busy with transporting the bag through the delivery vehicle.
- So the cost of the worker of 1 day is 20*150=3000.
- This is the scenario of the one day, now if we see the monthly cost of 20 workers then monthly cost of transporting is calculated as 3000*30=90,000.
- Now the total cost of 20 workers for 1 year is calculated as 3000*365=10, 95, 000.

B. Symbols used in VSM

Symbols used in value stream map	Meaning of symbol
	Customer/Supplier Icon: represents the Supplier when in the upper Left, customer when in the upper right, the usual end point for Material.

	Go See Icon: gathering of information through visual means.
	External Shipment Icon: shipments from suppliers or to customers using external transport.
	Push Arrow Icon: represents the "pushing" of material from one process to the next process.
	Production Flow
	Shipment Arrow
C/T	Cycle Time

Table 2: Symbol used in VSM

C. Diagram of Current State Map

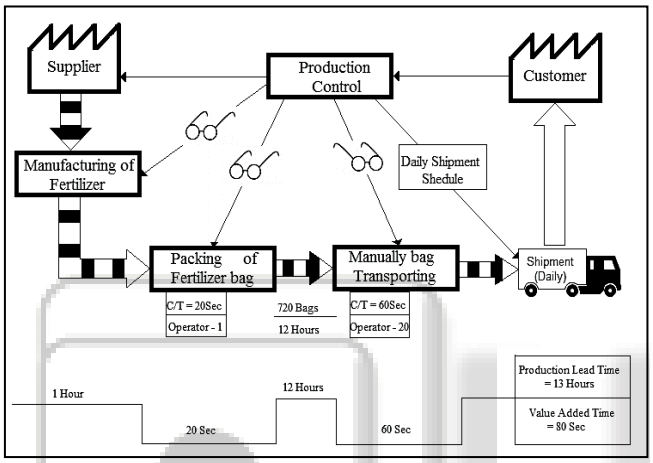

Fig. 4: Current State Map

1) Current State Map

The current state map shows how things really work, This is the "as-is" condition with all of the problems, inefficiencies, and flaws displayed for the entire team to see. The current state map should be an honest depiction of what really happening. There must be through documentation of all non-value added activities. The mapping team should identify the wastes in the system and the root causes of those wastes. The identification of root causes of wastes leads to the elimination of problems and prevention of similar problems from reoccurring.

This section is applicable to both maps and simulation models, in that validation is required to move forward with confidence. However, static maps are more difficult to validate, since all results are calculated manually, and lake the element of time. Typically, static map only provide lead time and cycle time data, whereas computer simulations can provide data on inventory fluctuations, process waiting time, and other time base values.

These charts have three components:

a) Along the bottom

Each chart shows for the single product all the steps taken to transform it from a raw material state to a final product. Deciding on what constitutes a value adding activity is critical. The test we adopted for this was to put yourself in the position of the consumer and ask if you would pay less for the product or be less satisfied with it if a given step and its necessary time were left out.

b) Information Flow

The top of the chart shows the information flow. This starts where an order enters the system and flows mainly in the opposite direction to the product.

c) Timeline

The charts also shows the time-line, that is how long the product takes in the value chain and the proportion of that time that is value adding.

- In the current state map the activities are shown in rectangle boxes.
- First the customer gives the order about requirement of fertilizer bags to the production control department.
- Then production control department gives the order to supplier.
- Then manufacturing of the fertilizer is starts.
- After manufacturing the fertilizer packing of the fertilizer bag is done. The packing time of the one bag is 20 second. Which is packed by automatic machine and only one operator is required for packing the bag.
- As we discussed and calculated there are 720 bags are transported in a delivery vehicle in 12 hours with manually transporting.
- Hence the production lead time is 13 hours and value added time is 80 sec.

D. Waste Check List

Factor Inspection	Waste Identify
Handling and movement	Yes
Balance product supply with end user demand	No
Physical Fault	No
Wasting and damages	Yes
Layout	No

Table 3: Waste check list

E. Area of Improvement

The area of improvement of case industries mention below

Area of Improvement	Suggestion
Handling and movement	Stacker machine
Wasting and damage	Proper inspection and procedure

Table 4: Area of improvement

From the current state map identify the waste in the some task which is mention to above table and suggestion also given there. In the material handling waste suggestion is the stacker machine instead of manually transporting.

1) Reduce Handling and Movement

Each time the product is handled or moved it adds cost but does not always add value. It can also impair quality. One of the most difficult challenges of supply chain management in any industry is to minimize handling and movement and this is particularly true for fertilizer in which production is so widely depressed.

Reducing handling and movement can save costs both directly (through cheaper distribution) and in directly (by reducing quality problems). However, later in the process there are various ways in which flow can be disrupted including.

- Packing lines interrupted by equipment breakdowns, low running speed or defective sealing.
- Complex layout in retail packing and labelling areas that result in extra handling

– Manually transporting of the product.

2) Reduce Product Wastage and Damages

At a packing time of urea bag there are some amount of fertilizer is dropped on the floor. It is a one type of wastage. If proper inspection and accuracy will be maintained, then product wastages and damaging is reduced.

IV. DEVELOPMENT OF FUTURE STATE

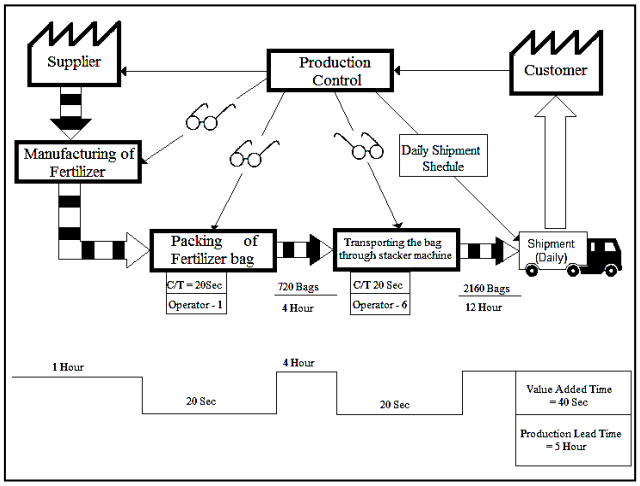

Fig. 5: Future State Map

A. *Future State Map*

Future State Map improves the flow and reduces waste in the value stream. This future state must meet the customer requirements and it includes necessary process improvements to achieve the value stream vision. The mapping team revisits the initial business objectives and reviews the current state map to capture their initial ideas for changes. Key to improving the flow of the value stream is the elimination of the root cause of the wastes identified in the current state.

In the current state map manually transporting of fertilizer bag is replaced by stacker machine. The reduction in time and less people requirement occurs. A future state map identifies improvement to be made to the value stream will shorten the overall cycle time.

– From the future map the procedure is same as current state map till the packing of fertilizer bag.
– There are 720 bags are manually transferred in a current state map within 12 hours. Here in a future state map. There are 720 bags are transferred in a delivery vehicle within 4 hours and 2160 bags are transfer within 12 hours.
– The cycle time of manually transferring the bag is 60 sec and operators or workers are busy with transferring the bag is about 20 in a current state map.
– Now in future state map the cycle time of transporting the bag thorough stacker machine is 20 sec and operators or workers are busy with stacker machine is only 5.
– Hence at the last the value-added time is 40 seconds and production lead time is decrease from 13 hours to 5 hours.

Activity	Bag packing	Bag transportation
Current State	20 sec	60 sec
Future State	20 sec	20 sec

Table 5: Cycle time of all process

– In the above table. The bag transporting time till the delivery vehicle is 60 sec per bag in a current state map.
– The capacity of the delivery truck to carry the load is approximately 50 bags, each bags has 50kg weight so total load is carried by truck is 2500kg.
– For fully load the 1 truck there is 40 min is required. This is counted by stop watch in a case industry.
– While in future state map, only 20 sec is required to transport the bag till the delivery vehicle.
– So, with the manually transporting the bag 1 min is required. For each bag while with the stacker machine there are three bags are transported in a 1 min.
– So, for the fully load the truck with stacker machine maximum 17 min is required.
– Hence, the saving in time = manually transporting time - transporting with stacker machine time.

= 40 min – 17 min = 23 min

– So, process of loading the truck is 23 min faster than manually transportation.
– If we see the whole day scenario for loading the trucks we get the benefit around 480 min means 8 hours process become faster with compare to manually transporting.

V. RESULT AND DISCUSSION

– After the analysis of current and future state map shown in above figures. Some important findings of the case study are interpreted.
– Manpower is reduced from 20 to 6 By replacing the manual transporting of fertilizer bag till delivery vehicle is replaced by stacker machine. It directly reducing the manpower which is associated with manually material handling by replacing the stacker ROI and transportation time is calculated and obtained beneficial for system.
– ROI with energy cost 20 person associated with transferring the bag till delivery vehicle whose wheezes are 150Rs. Per year total cost of workers per year 10,95,000Rs. The stacker machine cost is approximately 1,00,000Rs. The operating and energy cost including maintenance cost of the stacker machine of the year is 2,00,000Rs. And only 6 workers are required for handling stacker machine. And 6 workers cost per year is 3,28,500Rs. So the total cost of transferring the bags with machine is 6,28,500Rs. So the Return of Investment approximately 1 year which is clear by below graph.

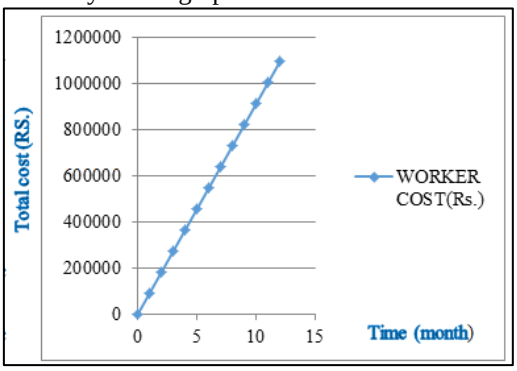

Fig. 6: Time-Cost Graph for manual bag transferring process

This is the time versus cost graph in which the manual material handling data are included. In this graph, x-axis is designated by the month and y-axis is designated by workers cost of one year. In manually material handling the yearly cost for transporting fertilizer bags 10,95,000Rs. As shown in above graph.

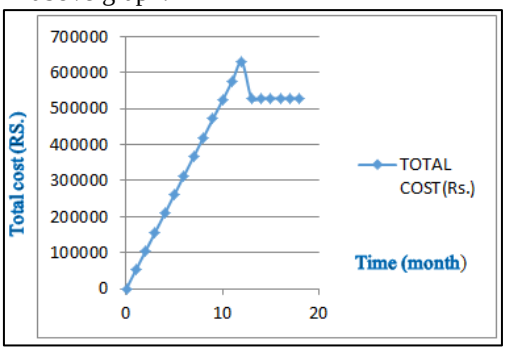

Fig. 7: Time-Cost Graph with using stacker machine

This is the Time versus Cost graph in which bag transferring with stacker machine data are included. In the graph shown that if we use the stacker machine instead of manual transporting then the initial investment cost, 6 workers cost and energy and operating cost including maintenance of machine is 6,28,500Rs. for 1 year. Then after 1 year initial investment cost of machine which is 1,00,000Rs. is neglected and only other costs are included. So the cost of the machine after one year is only 5,28,500Rs. So we can understand that if bags are transferred through manually then total cost is 10,95,000 Rs. and if we use stacker machine then the total cost after 1 year is 5,28,500Rs. So the clear benefit of using stacker machine is = 10,95,000Rs-5,28,500Rs.= 5,66,500Rs.

VI. Conclusion

This research has discussed the process which takes place in material handling and has highlighted problems which exists in a fertilizer industry. The report has highlighted in appropriate material handling which affected to the product quality and also transportation facilities of final product. In material handling the fertilizer bags are transport by manually, so it is time consuming and labor cost is also more. But we suggest a stacker machine and that result the product damage ratio decrease and man power also reduce.

References

[1] Tyson R. Browning, Ralph D. Heath., 2008. "Reconceptualizing the effects of lean on production costs with evidence from the F-22 program".
[2] J.A. Jimensez-Garicia, S. Tellez-Vazquez, J.M. Medina-Flores., 2011. "Materials Supply System Analysis Under Simulation Scenarios in a Lean Manufacturing Environment".
[3] A.C Yamagar, P.M. Ravanan., ISSN 1792-4693. "MATERIAL MANAGEMENT BY USING LEAN MANUFACTURING PRINCIPLES A CASE STUDY".
[4] Amelia Natasya Abdul Wahab, Muriati Mukhtar, Riza Sulaiman., 2013. "A Conceptual Model of Lean Manufacturing Dimensions".
[5] R.Sundar, A.N. Balaji, R.M. Satheeshkumar., 2014. "A Review on Lean Manufacturing Implementation Techniques".
[6] Dr. Bijay Nayak (Vice President, Manufacturingof SAVE International, USA.) "Lean Manufacturing and Value Management Convergence of Divergent Tools".
[7] Fawaz A. Abdulmalek, Jayant Rajgopal., 2006. "Analizing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study".
[8] Satish Tyagi, Alok Choudhary, Xianming Cai, Kai Yang., 2014. "Value stream mapping to reduce the lead-time of a product development process".
[9] www.kribhco.net
[10] Danijela Gracanin, Borut Buchmeister, Bojan Lalic., 2013. "Using Cost-Time Profile for Value Stream Optimization".
[11] Christ of Oberhausen, Peter Plapper., 2015. "Value Stream Management in the Lean Manufacturing Management".

