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Reduction Manufacturing Cost by Lean Manufacturing Tool

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Abstract - In today's competitive world, while large-scale companies have taken the first steps to implement lean in their organizations, small and medium establishments (SME's) also need to follow the lean thinking and implement the same to achieve their set goals. Small and medium-scale enterprises contribute about 90% of total industries in India and in all countries. Firstly we carried out the plant survey and discussed with the engineers of the plant and took the first step towards identifying the wastes in the plant. We identified two areas viz. Packaging and Machining cycle time reduction for cam follower lever part no 205069. In packaging we studied current packaging method, identified wastages in current packaging method and suggested plastic crates as an alternative for the current method i.e. corrugated boxes. Though the motive behind switching over to plastic pallets from current packaging method is cost effectiveness and ease in packaging due to exceptional properties of plastic pallets, the main aim behind going lean in packaging is to reduce the environmental hazards caused in current packaging method. For reducing the machining cycle time of lever 205069 we studied the current machining program on the VMC. Initially programs used for machining were manual. We prepared the new program with the help of DELCAM software. The new program eliminated the unnecessary tool travel and reduced machining cycle time. Thus, with the help of proper Lean tools, we tried to implement Lean principles in Small-Medium Scale enterprises like General Machine Tools. Also, we involved Cummins India Limited while working for packaging with plastic crates. Thus an attempt was made of implementing Lean principles within the supply chain and established the concept of involvement of customers in implementing Lean Manufacturing.

Keyword: Lean Manufaturing ,Manufacturing cost,management Tool.

I. Introduction to Lean Manufacturing

Lean Manufacturing is derived from the methods of the successful Japanese automobile manufacturer, Toyota. Lean Manufacturing became internationally recognized as a result of the 1990 book, The Machine That Changed The World, by James Womack and Dan Jones and Daniel Roos. The focus at Toyota, according to Taiichi Ohno, was "the absolute elimination of waste," where waste is anything that prevents the value-added flow of material from raw material to finished goods. Lean Thinking is a highly evolved method of managing an organization to improve the productivity, efficiency and quality of its products or services. In today's competitive market, lean is turning out to be "the solution" to manufacturing industries across the spectrum for survival and success. Lean manufacturing helps organizations to achieve targeted productivity and more by introduction of easy-to-apply and maintainable techniques and tools. Its focus on waste reduction and elimination enables it to be engrained into organization culture and turns every process into a profit centre.

Lean manufacturing is all about driving toward achieving profitability and productivity through continuous improvement and resource waste elimination. It is an organizational culture as well as specific practices with clear goals. The goal of Lean is to eliminate the non-value added wastes that incur in any process. There is a need for shift in thinking to "a zero tolerance for waste". Persistence for improvement, learning by doing, attitudinal changes and teamwork, along with emphasis to bring value quickly and remove waste continuously, form the essence of lean. Lean emphasizes the learning by doing approach, where the members of a process improvement team are those most closely associated with adding value to the product. The whole process is based on defining customer value, focusing on the value stream, making value flow, and letting customers determine the product or service they want, with a relentless pursuit of perfection in a timely manner at an appropriate price.

II. LITERATURE REVIEW

Krisztina Demeter, ZsoltMatyusz[1]; This paper concentrates on how companies can improve their inventory

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turnover performance through the use of Lean practices. The paper emphasizes on inventory turnover and the aim is to eliminate excess inventories as a form of waste. For eliminating these inventory wastes a bundle of practices and tools is made that consists of JIT, TQM, TPM and HRM which lead to the elimination of waste and force continuous improvement. The paper also explains about how type of production system and ordering policy impacts on inventory turnover.

A. Pool,J.Wijngaard, D. Jouke van der Zee[2]; This paper explains the study consideration about the principles of 'flow' and 'pull' production system – suggesting a regular, demand-driven product flow by introducing cyclic schedules. It also explains how cyclical scheduling helps to realize regularity in the continuous part of production which further helps in a closer coordination of the planning and control processes.

S. Sharma, R. Gupta, A. Kumar, B. Singh[3]; This paper explains the importance of suppliers involvement in lean manufacturing. It explains how supply chain of any organization is directly associated with the leanness in terms of suppliers and the organization. Indian SMEs are still resisting accepting the role of their suppliers to make them leaner.

F. A. Abdulmalek, J. Rajgopal[4]; This paper explains about Value Stream Mapping as an important test in lean implementation. The concept of value stream mapping and model simulation is introduced. Value stream mapping is collection of all information from basic entry of raw material to the final finished product exist, to evaluate total time required at each operation or process or department in order to find the wastes in total production cycle.

B. W. Braiden, K. R. Morrison[5]; This paper highlights about the bottleneck operations and focuses on how bottle neck operations affect the productivity and throughput optimization. To increase the efficiency of process the bottleneck operations are necessary to be monitored. To tackle the bottle neck operations efforts are taken to increase the output by increasing resource uptime.

N. Upadhye, S. G. Deshmukh, S. Garg[6];This paper explains importance of lean manufacturing system for **small** and medium scale manufacturing enterprises. Competitive market is forcing big organizations to utilize the untapped potential of Medium Size Manufacturing Enterprises. In the era of outsourcing, SME's are the important links in the supply chain, making it more effective and efficient.

Sandra Rotenberg, Frank Cost [7]; This paper investigates on how small and large printing industry differ in adoption of lean manufacturing practices. It explains the importance of implementation of lean concepts to reconcile two important needs that are equally important. One is to offer continuously improving and innovative services to the customer,and simultaneously improving efficiencies of underlying operations.

G. Anand, Rambabu Kodali[8];This paper deals with conceptual performance measuring framework for lean manufacturing with a distinctive feature that can be customized for small scale as well as medium scale enterprise. It has been observed that many SME owners attempt to implement lean in their organization but feel that they have not achieved desired benefits.

III. SYSTEM ARCHITECTURE

a) Principles of Lean Thinking

1. Define value precisely from the perspective of the end customer, in terms of a specific product, with specific capabilities, offered at a specific price and time. As Taiichi Ohno, one of the creators of the Toyota Production system put it, all industrial thinking must begin by differentiating value for the customer, from muda – the Japanese term for waste.

2. Identify the entire value stream for each service, product or product family and eliminate waste. The value stream is all the specific actions required to bring a specific service or product through three critical activities in any business: Product/Service definition – from concept through detailed planning through launch Information management – from order taking through detailed scheduling to delivery Physical transformation – initial concept, to the receipt of the service/product by the customer Identifying the value stream almost always exposes enormous amounts of waste in the form of unnecessary steps, backtracking, and scrap, as the throughput travels from department to department and from company to company.

3. Make the remaining value-creating steps flow. Making steps flow means working on each design, order, and product continuously from beginning to end so that there is no waiting, downtime, or waste, within or between the steps. This usually requires introducing new types of organizations or technologies and getting rid of "monuments" – obstructions whose large scale or complex technology necessitates operating in a batch mode.

4. Design and provide what the customer wants only when the customer wants it. Letting the customer pull the product/service from the value stream eliminates the following types of waste: designs that are obsolete before the product is completed, finished goods, inventories, elaborate inventory/information tracking systems, and "left over's" no one wants.

b) NECESSITY OF LEAN IMPLEMENTATION

Like all small and medium scale manufacturing enterprises in India that follow the traditional practices in manufacturing, General Machine Tools have always tried to be execptional in its way. For all the products mentioned above, GMT has strive hard to meet the customer demand by providing the quality product in time and every time. With the increase in customers demands, GMT has succesfully meet them because of its excellence in labour

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and manufactuing technology. Although GMT can successfully repond to demands of market, it is necessary to optimise all the production parameters viz. Men, Machine, Material and Method. Optimum use of these parameters can help to reduce cost of product and gain more profit through quality and customer satisfaction. Lean manufacturing principles stress on profit through customer satisfaction and quality product. Lean tools like value stream mapping help to identify the non value added activities in system and help them to eliminate them easily.

c) VALUE STREAM MAPPING

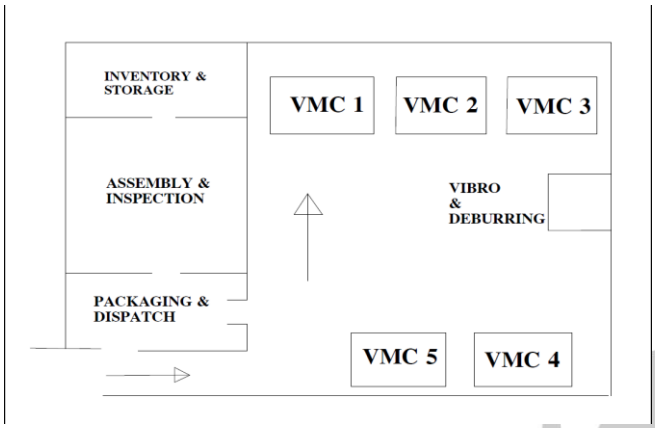

Fig. 1 layout of Lever line showing material flow

When we did value stream mapping of lever line a flow of material is been observed as follows. GMT works for lever line 205069 on the principles of PULL system i.e. products are manufactured according to customer requirements. Thus there are fewer inventories in this lever line. So after receiving of ordered casting material it is inspected for machining feasibility then ok components are send to the temporary storage then it is moved to VMC 4 which is for machining operation like shaft bore, pin bore, socket bore, wire slot milling and duplex milling. So it is bottleneck operation in total supply chain which is to be taken under consideration. At the dispatch of these levers they use corrugated boxes which are environment hazardous and also having some non-value added activities which are called as waste in lean manufacturing terminologies. Wastes identified in this are time waste, financial waste, ergonomic waste. In above mentioned two areas there are chances of improvement and possible implementation of lean principles.

d) Value Stream Mapping For Cycle Time Reduction

ABOUT LEVER:

Fig. 2 Lever No. 205069 considered for case study

The lever consists of Material Grade - SG Iron GGG70. 2500 levers are produced per week and dispatch is done twice a week. The current packaging method involves the use of corrugated box for packaging of levers.

e) CURRENT PACKAGING METHOD

Fig. 3 During and after packing of levers

In current packaging process, the levers are packed as assembly of lever, brass pin and wire to lock brass pin in pin bore. Before these levers are brought for packing, they are tested at the oil flow testing machine to verify that oil flows through all desired oil holes and the flow is blocked where ever necessary. Thus the whole assembly becomes oily. While packing the levers, this oil is likely to spill on the corrugated box. This makes the box weak and reduces its sturdiness.

To avoid this, the levers are packed in a plastic bag as shown in fig above. A box for lever 205069 occupies 20 levers/ box as shown in fig. above. The Box used for packaging of 205069 levers has dimensions: 37*23*7.5 cm. The levers are arranged in two rows where each row contains 10 levers. To avoid the risk of damage to levers due to impact or due to collision over each other, suitable cushioning is provided by using paper scrap. The box is then closed by sticking the open ends by Tesco tape.

While the worker wraps the open ends of box by Tesco tape, hand gloves are used to ensure that the oily or wet hands of operator don't damage the box.

Packaging using corrugated box

Fig. 4 Corrugated box used for packaging of levers

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Corrugated box is generally made from corrugated fiber board. It consists of a paper-based material consisting of a fluted corrugated sheet and one or two flat linerboards. **Packaging engineers design corrugated boxes** to meet the particular needs of the product being shipped, the hazards of the shipping environment, (shock, vibration, compression, moisture, etc.), and the needs of retailers and consumers.

The most common box style is the Regular Slotted Container (RSC) in which all flaps are of same length. Typically, the major flaps meet in the middle and the minor flaps do not.

The manufacturer's joint is most often joined with adhesive but may also be taped or stitched. The box is shipped flat (knocked down) to the packager who sets up the box, fills it, and closes it for shipment. Box closure may be by tape, adhesive, staples, strapping, etc. When sides (section) are examined attentively, rows of air columns in the walls of board are visible. The air works as a cushion, and these columns provide strength and sturdiness to the boxes.

Fig. 5 shows the cross section of corrugated box. The air columns provide cushion and corrugations provide strength.

The size of a box can be measured for either internal (for product fit) or external (for handling machinery or palletizing) dimensions. Boxes are usually specified and ordered by the internal dimensions.

These boxes are measured by using inner dimensions. These boxes are prepared using dimensions as, Length (L) x Width (W) x Depth (D) or Length (L) x Breadth (B) x Height (H). Commonly shorter side of the box is considered as 'width' while longer is 'length' and side perpendicular to length and width is known as 'depth' of the box.

f) PACKAGING USING PLASTIC PALLETS

Fig. 6 a. Plastic crates

Fig. 6 Plastic crates

Benefits of plastic pallets over corrugated boxes are:

1. More durable - longer service life, often lasting a hundred or more trips.
2. Plastic crates are waterproof
3. Lighter weight - saving on shipping cost, easier to handle and less chance of injury.
4. More uniform in size, shape and weight.
5. Rackable – Some of the strongest plastic pallets available are able to withstand their weight capacities on an open rack system that does not have decking.
6. Stackable – Many of these pallets are designed with a bottom deck that allows you to stack pallets on top of other loaded pallets without damaging the load.
7. **Plastic crates** are easier to handle than corrugated crates.
8. **Plastic crates** appearance is smoother, cleaner than cardboard. This offers the ability to sell out of the crate without the need to transfer onto shelves.
9. Plastic crates are safer to handle comparatively to corrugated boxes. Lower weight of Plastic crates decreases worker compensation and insurance costs associated with back injuries from lifting crates.
10. Plastic crates offer easier handling with loading by hand. Plastic crates are safer for use because of smooth design with no nails or splinters. Plastic crates usage supports a good delivery of product and is cost-effective in insurance to product delivered.

As plastic pallets satisfy our need to eliminate the environmental waste and the secondary aims of reducing the financial and space utilization waste, we look for plastic pallets as best alternative for corrugated box.

To check the cost effectiveness of the plastic pallets, comparison of costing using current method using corrugated boxes and using plastic pallets was thoroughly analyzed.

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IV. RESULT ANALYSIS

A. Cost Sheet For Packaging Using Plastic Pallets

Dispatch Quantity/ week		2500
No. of dispatch / week		2
Quantity/ Dispatch		1250
No. of lever/Pallet		24
No. of pallets required / dispatch		52
No. of Pallets required / week		104
Total No. of Pallets Required		260
Cost of Pallets		127920/-
Labour Charges/week		74.53/-
Packing Accessories' Cost/week		135.91/-
Total cost for one time		127920/-
cost/week		210.44/-
Cost/ piece		Rs. 0.61/- (For 2 yrs.)

B. Calculations For Per Piece Packaging Cost

a) TOTAL COST OF PLASTIC PALLETS

Cost of one Plastic pallet - Rs. 492/-
Dispatch Quantity- 2500 levers/week
Capacity of one box- 24 levers

Total no. of pallets required / week= $\frac{2500}{24}$

= 105

Dispatch / week – 2

∴ Pallets required / dispatch= $\frac{105}{2}$

= 52 pallets /dispatch

As the pallets are returnable, we purchase only required quantity of pallets which will be a single time investment.

We purchase a quantity equal to five dispatch batches.

i.e. No. Of pallets to be purchased = 52 × 5

= 260 pallets.

Hence, total investment in pallets = 260 × 492

= Rs. 1, 27,920 /-

b) LABOUR COST INVOLVED

Time required for packing 1 box (24 levers) = 129 sec / box

$= \frac{129}{24}$

= 5.3 sec / lever

= 2.15 min / box

In a week, 2500 levers are dispatched.

∴ Time required for packing of 2500 levers = 2500 × 5.3

= 13250 sec/ 2500 levers

i.e. 220.83 min / week

Monthly salary of the operator = Rs. 3840 /-(i.e. for 24 days = 11520 min)

Labour charges / week = = $\frac{220.83 \times 3840}{11520}$

∴ Labour charges / week = Rs. 74.53 /-

Fig 7. Current Packaging Method

As pallets are returnable, they can be reused again for a minimum period two years. Hence, the cost of pallets will be Rs. 1, 27,920 /- will be a onetime investment. This investment will be distributed over the levers that will be dispatched in two years using returnable pallets.

Fig. 8 Proposed Packaging Method

Later, after two years, per piece cost for packaging using Returnable plastic pallets will further reduce to Rs. 0.08 /lever. This cost includes only the packing accessories cost because the investment in plastic pallets is recovered in two years.

Fig. 9 Stacking of Pallets

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Hence apart from the initial investment, the per piece cost for packaging using Returnable plastic pallets is Rs. 0.61 /lever for first two years as this amount also includes the initial cost of pallets equally distributed over two years.

V. CONCLUSION

The task of this project was to investigate the reasons SME's to avoid the concepts of Lean manufacturing from the analysis of general SME's towards the development through techno management concept like Lean manufacturing , six sigma, 5s etc. concluded that there is least awareness about such concept in SME's. They assume that it requires more economical investments. Implementing Lean principles is not very complicated concept that is supposed to be digested by researchers, managers etc. rather implementing Lean requires co-ordinated efforts from managers to operators and also all other people who are part of supply chain. Lean deals with simply eliminating waste by using various tools like VSM, KANBAN, JIT, PAKA-YOKE and also computer software's like Pro-E, DELCAM, etc. helps in eliminating non value added process

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