Lead time reduction using Value Stream Mapping in Powder Metallurgy based industry

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Abstract *- Due to high uncertainty in supply and demand in automobile industry there is a long waiting time for the product and hence due to this many manufacturers lose their customers. Thus in order to meet the market demand, the industries are required to reduce their lead time by utilising the concept of Lean manufacturing (LM). Value stream mapping (VSM) is one of the Lean Manufacturing tools which is used to explore the wastes, inefficiencies, non-valued added activities in a single, definable process out of complete process line. This single step is highly complex and occurs once while the process lasts for many years. A case study of a powder metallurgy plant is used to illustrate a detail procedure of how non-value added activities can be reduced using the Value Stream Mapping Technique.*

Keywords - Lean Manufacturing, Value Stream Mapping, lead time.

I. INTRODUCTION

With the increasing demand of consumers in private automobile sector, which has motivated the automotive companies to flourish their business with the application of modern techniques. Lean Manufacturing is one of the modern and broad concept which meets the customers' expectations in terms of cost, quality and demand. Various tools of Lean Manufacturing includes: Kanban, kaizen, Single minute exchange of dies (SMED), 7 wastes, Just in Time (JIT), Poka-Yoke, Andon, Jidoka etc. and importantly Value Stream Mapping (VSM). In this paper we are going to discuss one of the LM tools i.e. VSM. The objective of this paper is to use a case-based approach to demonstrate how lean manufacturing tools when used appropriately, can help the process industry eliminate waste, maintain better inventory control, improve product quality, and obtain better overall financial and operational control [3].

II. PRODUCT PROCESS FLOW

Traditionally for gear manufacturing forging technique was used which took a lot of time, manpower and investment. With the advancement in technology a new concept came into being i.e. powder metallurgy, with the use of this technology with a single compaction the gear is manufactured and requires less time as compared to forging technique.

A powder metallurgy based gear manufacturing industry involves various steps for manufacturing of a gear. This steps include powder mixing, compaction, sintering and secondary operations which can be further sub divided into sizing, magnetic particle inspection, hard machining, heat treatment, cleaning of parts, final inspection, packaging and finally dispatch.

III. CASE STUDY (PROBLEM STATEMENT)

The ultimate goal is to identify all value added and non-value added activities using Value Stream Mapping in the manufacturing process of the gear and to take steps to try and reduce/eliminate these wastes.

The parameters involved in VSM are Inventory, cycle time, changeover time, uptime, no. of operators, no. of shifts, scrap rate, pack size/pallet size, batch size and distance travelled.

A. Methodologyfor Value Stream Mapping

The following methodology is used for the VSM of Gear manufacturing.

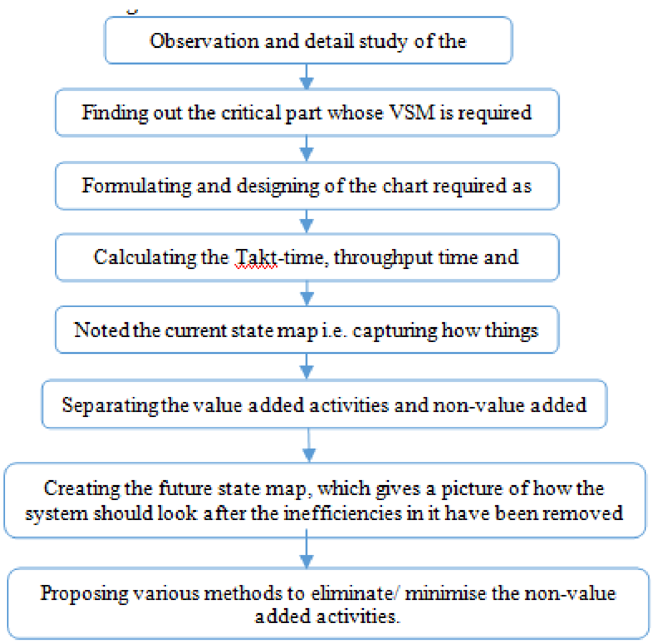

Fig.1 Methodology for VSM

B. Value Stream Mapping

A value stream is defined as all the value-added and non-value-added actions required to bring a specific product, service, or combination of products and services, to a customer, including those in the overall supply chain as well as those in internal operations[4]. VSM is an enterprise improvement technique visualize an entire production process, representing information and material flow, to improve the production process by identifying waste and its sources [4]. VSM creates a common language about a production pro2cess, enabling more purposefuldecisions to improve the value stream. A value stream map provides a blueprint for implementing lean manufacturing concepts by illustrating how the flow of information and materials should operate [4]. VSM is divided into two components: big picture mapping and detailed mapping [5]. Before starting detailed mapping of any core process, it is useful to develop an overview of the key features of that entire process. The overview will help accomplish the following [5]:

- Visualize the flows.
- Identify where waste occurs.
- Integrate the lean manufacturing principles.
- Decide who should be on implementation teams.
- Show relationships between information and physical flows.

Visualizing the flow creates the ability to see where, when, and how both the information and product flows through the organization.

IV DATA COLLECTED

The data collected here is in step by step by noting down the cycle time, change-over time and various other parameters.

Table 1 Data for VSM

Operation description	Existing process		Proposed process	
	cycle time	delay time (min)	cycle time	delay time (min)
Material Inspection	1.85	36.28	1.85	36.28
Compaction	15.88	16.927	15.88	16.927
Sintering	17	33.854	17	33.854
Oil Dipping + Sizing	17.45	33.854	17.45	33.854
MPI*	8.6	150	8.6	150
Outside Heat Treatment	66.46	150	66.46	60
Receiving Inspection	3.7	150	0	0
Outside Machining	66.5	150	70.2	150
Cleaning	17.538	33.854	17.538	33.854
MPI	8.6	33.854	8.6	33.854
Final Inspection (Oil Dipping+ Packing)	29.54	33.854	29.54	33.854
Dispatch	6.5	1560	6.5	1560
Total	259.618	2382.477	259.618	2142.477

*MPI-Magnetic Particle Inspection

V. DATA ANALYSED

In order to improve the process flow throughout the production line we are required to calculate the base line for the process i.e. Takt-time.

Cycle time =machine time + man time.

Considering three shifts of 8 hours each per day and a productive time of 7 hours (1 hour for Breakfast, Lunch and tea time).

Monthly requirement = 40000 parts,

Therefore, Daily requirement = 40000/30 = 1300 parts approximately.

Takt-time = (no. of available hours / customer requirement)

Takt-time = ((7*3*60*60)/1300) = 58 sec

Therefore, with the productivity index of 87.5% we need to produce one job after every 58 sec.

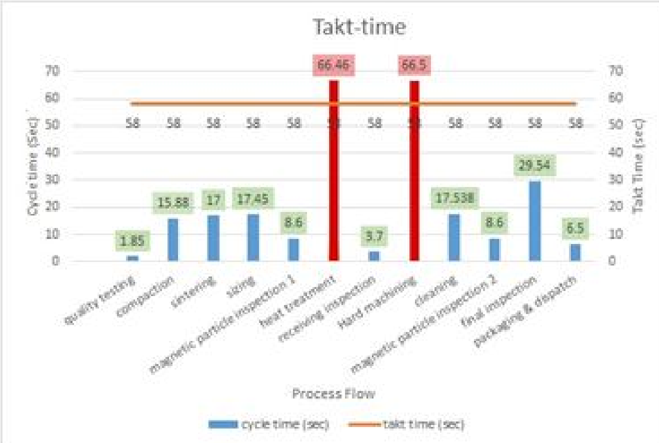

Fig.2 Existing Value Added Activities in the entire process.

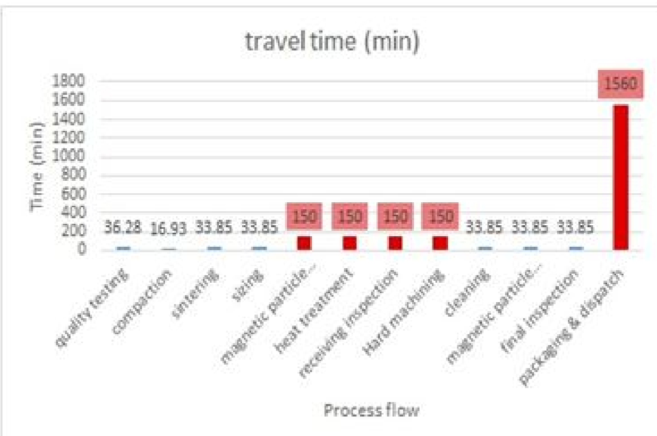

Fig.3 Existing Non Value Added Activities in the entire process.

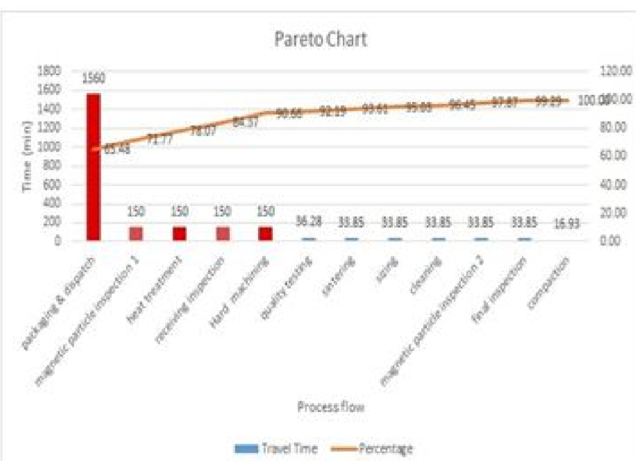

Fig. 4 Pareto Chart for existing process

After calculating cycle time for various steps in existing process (Fig. 1) we found that:

Value Added time (VA) : 259.62 sec(refer Fig. 1)
Non value added time (NVA):109.96 sec(refer Fig. 2)

Existing Throughput time VA+NVA= 259.62+109.96
=369.58 sec.

Process ratio: VA/(NVA+VA) = 259.62/369.58
= 70.24 %

As seen from Fig.(1), Fig.(2) and Fig.(3) we also found that maximum VA & NVA time required was for heat treatment and hard machining. Both the processes are done outside i.e. by a third party, hence travelling time is large. Travel time for dispatch cannot be reduced as it's not economical for the company to deliver parts via air courier service.

Seeing the existing process it is proposed that VA time of 3.7 sec at receiving inspection can be shifted i.e. by directly sending the batch of 1300 parts from heat treatment to hard machining thus skipping receiving inspection step and instead of that getting an inspection done at hard machining workshop and collecting the inspected data (after designing the norms and training the person for inspection) directly from the third party and passing the batch for next process after comparing it with pre-defined quality standards.

VI. RESULTS

On the basis of proposed/ future state of the map we could reduce NVA time by 240 min per 1300 batch (i.e. 11.077 sec per part).

Non value added time (NVA): 98.88 sec(refer Fig. 5)
Thus, optimizing the process by: 109.957-98.88 = 11.077 sec/part
Proposed throughput time: 259.62 + 98.88 = 358.5 sec
Process ratio : 259.62/358.5 = 72.42 %

Therefore, for 1300 parts total time saving will be = 1300*11.077 = 14,400 sec = 4 hours per 1300 parts in a total process time of 133.458 hours (existing).

Process improvement = (133.46-129.46)/133.46 = 2.997 %

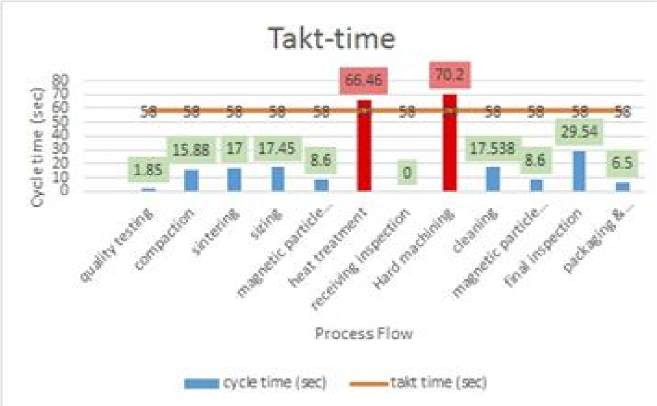

Fig. 5 Proposed Value Added Activities in the entire process.

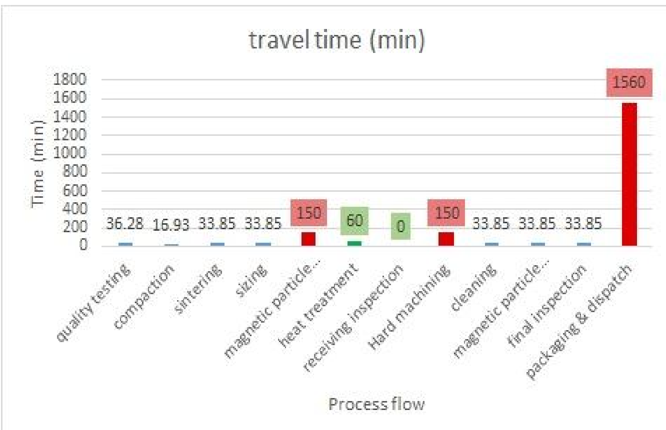

Fig. 6 Proposed Non Value Added Activities in the entire process.

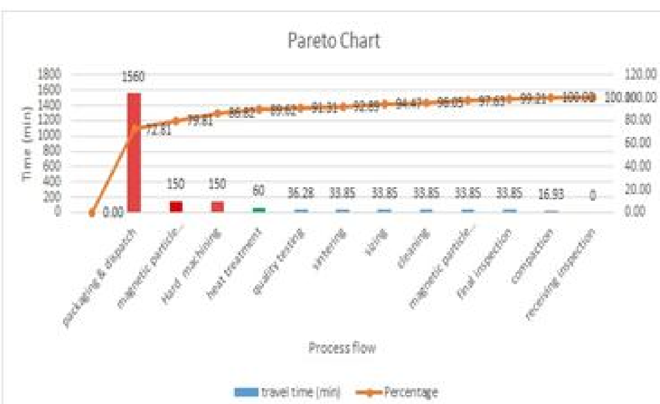

Fig. 7 Pareto Chart for proposed process.

Now, with the improvement in the production rate the company has the capacity to produce 1340 parts increasing its capacity by 40parts per day.

As, proposed throughput time = 358.5 sec
Time saving = 4 hours per 1300 parts
Increase in production rate = 4*60*60/385.5
= 40.16 ~ 40 parts per day.

Hence the capacity has increased from 40000 parts per month to 41200 parts per month.

VII. CONCLUSION

From the above case study we can infer that VSM plays an important role in the improvement of the process flow. Using it we could find the hidden waste and thus optimize the process by 3% approximately without involving an extra cost. Considering per part costs say □ 300/part then industry makes a profit of □12000 per day (as per calculation). Which goes around □ 36 lakhs per annum (consider 300 days of working in a year). Thus, this shows that small incremental steps in process improvement will allow sales of the organisation to beat any competitor were delivery, price and quality is expected by the customer.

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