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Increasing Productivity by Reducing Manufacturing Lead Time through Value Stream Mapping

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Abstract: To survive in today's competitive business world, companies require small lead times, low costs and high customer service levels. As such, companies pay more effort to reduce their manufacturing lead times. Value stream mapping (VSM) technique has been used on a broad scale in big companies such as Toyota and Boeing. This paper considers the implementation of value stream mapping technique in manufacturing helical springs by railway spring manufacturing company. It focuses on product family, current state map improvements and the future state map. The aim is to identify waste in the form of non value added activities & processes and then removing them to improve the performance of the company. Current state map is prepared to describe the existing position and various problem areas.. Future state map is prepared to show the proposed improvement action plans. The achievements of value stream implementation are reduction in lead time, cycle time and inventory level. It was found that even a small company can make significant improvements by adopting VSM technology. It was concluded that if we adopt the VSM technique the company could reduce the manufacturing lead time from 36.86 days to 34.06 days.

Keyword- VSM, Current state map, future state map

Introduction:

Rail Spring Karkhana is the largest and only dedicated coil spring manufacturing unit of Indian railways. It was set up in 1989 on a turnkey basis by M/S Ernst Komrowski & Co, Germany, a leading spring manufacturing of Germany.

Having a turn over of 49 crore , the plant has state of art manufacturing facilities springs from hot rolled spring steel bars. The plant is capable of manufacturing spring with wire diameter up to 60 mm. The plant manufactures 90000-100000 springs per annum.

This paper will show how the waste reduction can be made throughout the process by using value stream mapping. It analyse the processes involved in manufacturing and identifies the key areas of wastage and possible solution to overcome them. Value stream mapping was chosen as a tool to gather information on the spring manufacturing because it has been used successfully by much organization to plan and identify internal improvement. Furthermore when used appropriately it can help the process industry eliminate waste, maintain better inventory control, improve product quality, and better overall financial and operational control .

Value Stream Mapping can be defined as the simple process of directly observing the flow of information and material as they now occur summarizing them visually and then envisioning a future state with much better performance.

The ultimate goal of VSM is to identify all types of waste in the value Stream and to take step to try and eliminate these. Waste can be part of a process that takes time and resources but adds no value to the product.

Value stream mapping aids in the development of a "current state map "which shows a currently operating situation. It records process information and information which can be used to identify key wastes, problems. Once the current state map has been analyzed the future state map can be drawn more effectively. Taylor stated" Value stream maps are very effective methods for summarizing, presenting and

communicating the key features of a process within an organization."

This research is based on a case study of a railway spring manufacturing karkhana, India

This is a part of a larger research in which the object is to identify, develop and stimulate the development and more efficient production process for use throughout the manufacturing company.

The aim of this research was to:

- Understand the `current state' of the manufacturing karkhana .
- Identify the key area of waste, problem and opportunities across the karkhana
- Develop of 'future state vision' of each of the supply chain.
- Increase the productivity
- Develop an action plan to achieve the higher production and lead time reduction

Data collection and Analysis:

This section will describe the processes which take place throughout the factory and will identify problems and issues

The processes which take place throughout the factory have been summarized as follows

- Then sample check for quench hardness. Coiled and tempered spring are end grinding to provide flat end for proper seating of spring are end grinded to provided flat end for proper for developing residual compressive stress on surface and improving fatigue strength
- Shot penned coiled springs are then tested for crack testing by magna flux testing.
- Then primer coating, scragging pre load testing and black painting are done.
- Rejected part are repitched and hot scragged.
- Finally black painted spring is checked for ultimate tensile test and dimensional test.
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Table 1 Summary of the data in the current state map for RSK

Process stages Attributes	End tepering (min)	Coiling+ quenching (min)	temperng (min)	End grinding (min)	Shot peening (min)	Primer paint (min)	inspection (min)
Cycle time	3	30+12	90	30	10	8	8
Value added time	2	12	90	20	5	2	5
Non value added	1	5	00	7	00	00	00
Necessary non value added	1	30	00	5	5	6	3
Change overtime	30	30	00	60	00	00	50
Available time	420	420	420	420	420	420	420
Uptime %	92.85	92.85	100	85.71	100	100	88.09
No. of operator	6	7	2	8	3	6	18
Observe inventory of days	5.89	00	4.81	3	4.8	4.8	5.89
Wip no. of spring	2212	00	1806	1156	1800	1800	2096

- Take a peeled bar (metal bar). This bar is made up of different composition of metal like Cr, V, Mo, steel etc.
- Then end tapered bar supplied to bar heating furnace (prepare for coiling), coiler, oil quenching tank, and tempering furnace.

S.N.	Process	Cause	Corrective action plan
1	End tapering	Extra movement due to longer distance	Change the place between two end taper machine and inventory
2	Bar heating and coiling	Large distance	Reduce the distance between two machine
3	Coiling , quenching, tempering	Delay in process	Parallel inspection process
4	Grinding process	Extra time on handling spring	Change material handling technique.
5	Primer paint	Process layout	Change process layout

Table 2 Root cause analysis & remedial action

Design/methodology/approach

VSM process symbols are used to discuss lean implementation process in the production industry. The existing status of the selected manufacturing industry is prepared with the help of VSM symbols and improvement areas are identified. Some modifications in current state map are suggested and with these modifications a future state map is prepared.

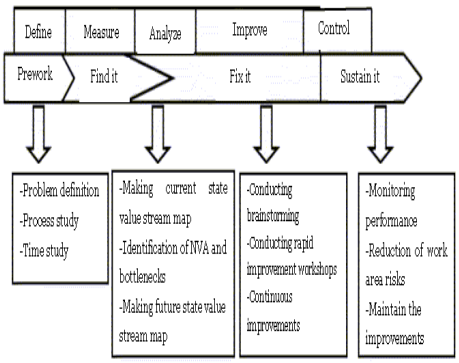
In order to implement lean principles, a task group was formed with people from different parts of the organization, all having rich knowledge and information

Pertaining to process, production, and equipment and planning. The objectives of the operation were:

(i) To reduce the level of non value activities present in any form by

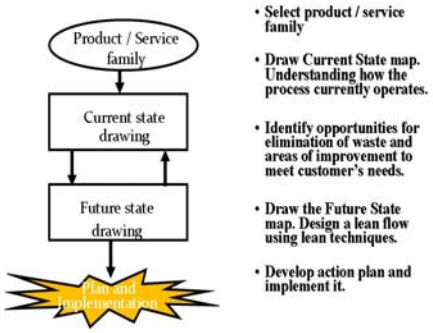
Implementing the various lean tools (ii) to reduce the overall process time of the Assembly line in shop floor through improvements in the layout, processing step Change, and by parallel inspection/ testing for quality. The methodology adapted to achieve the objectives is given in Figure

Methodology for Lean Implementation



Methodology of implementation of vsm

The Complete Value Stream Mapping Step

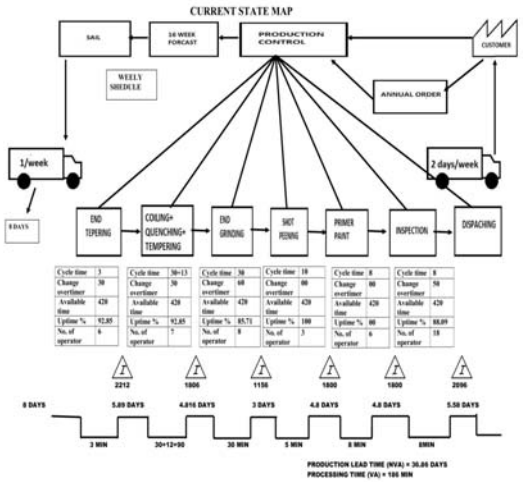


Selection of critical product family

A particular product or product family should be defined as the target for future improvement. In our study we choose a helical spring having a diameter of 33mm because this dimension diameter spring is most demandable

Current state value stream mapping

To construct the current state value stream map, relevant information was collected by interviewing people on the shop floor. As Data relevant to the customer, 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.



Takt time

Takt time can be defined as the time required producing one unit of daily salable quantity. To calculate takt time in the context of present problem, the average demand per three shifts was found to be 375 spring under study. The company runs for three shifts, 60 min per shift excluding break time. This results in a takt time of nearly 3.36 min. Therefore, it is concluded that one spring must come out during every 3.36 min interval.

To increase the productivity the site require some changes it could be used in optimize the floor layout and inappropriate maintenance practice cause machinery to fail their for regular and routine maintenance schedules need be in place to reduce machine error ,down time and minimize energy consumption. By changing the processing sequence minimize the time, rejection, and unnecessary movement on shop floor.

Data Analysis

Here we analyze the data collected by us

Basically improvement/modification is done by us in this section. Here we calculate the value addition percentage in the different process . Also we analyzed the root causes of different problems and suggested their remedial actions.

Reducing lead time by improving production

1. End tapering process

As I discussed earlier in this process the cycle time is 3 min and daily average output is 360bar/day, and setup time is 30 min. As I noticed that most of the time spent in handling of material between inventory and machine and machine to machine. I have suggested some implementation area which will improve production as well as reduce inventory.

2. Coiling process

It is found that that in coiling of bar there is scale formation due to oxidation of hot metal surface in air, which causes rejection

in coiling in the sense of reducing diameter of coiled bar. There is no further any process to rework it to use again, we suggest that if the distance between bar heating furnace and coiling machine which is 7 mtr. reduced to 4 mtr, and some improvement in roller conveyor there is some option to change it into variable speed roller conveyor.

Because of it they can manage maximum and minimum speed of conveyor according to their need, another things is if they covered conveyor, there is another chances to reduced heat loss and scaling od bar surface.

- In current process the bar which is affected by scale formation and reduced bar diameter, goes further next process, leads to increase waste in time and money
- I suggest if we use Go – No Go gauge after coiling of bar we can reduced cost which we are spending on waste product in further operation.

If we reduced distance from 7 mtr to 4 mtr we can reduc15 sec

3. Grinding process

In grinding process most of the time spend on handling of coil from conveyor to machine, in grinding machine in one time four springs is placed. Each spring is placed one by one on machine and unloading one by one by single hook. If we used another handling system which can load 3 or 4 spring at a time. I suggest another handling system which can load four spring simultaneously.

Reduction in lead time by reduction in inventory

End tapering:- In current state map inventory before end tapering is for 8 days. We have increase in production per day is 30 bar/day so these inventory will consume in 7.52 days.

Coiling process:- In current state map inventory of week is 2212 and improvement in coiling production per day is 48. So these inventories will consume in 5.13 days

Grinding process:- In current state map inventory of week is 1806 and improvement in grinding production is 90 coil per day. So these inventories will consume in 3.376 days.

Inspection process:- In current state map inventory of week is 1800 and reduction in rejection of after primer paint which consume time an rejected after testing, so improvement in primer paint process by sequence change can reduced this time waste on testing on rejected.

Percentage of final rejection is 3.05 which is 55 springs, we save time spent on these rejected springs, new lead time of this process is 4.65 days.

Table 3 Comparison of production in process (no. of springs per shift)

Process	Before	After
End tapering	330	360
Coiling	432	477
Grinding	432	522

8.2 Improvement in Reduction in lead time

Lead time before improvement = 36.86 days

Lead time after improvement = 34.056 days

Saving in lead time = 2.804

% saving = 8%

Lead time	Before	After
	36.86	34.06

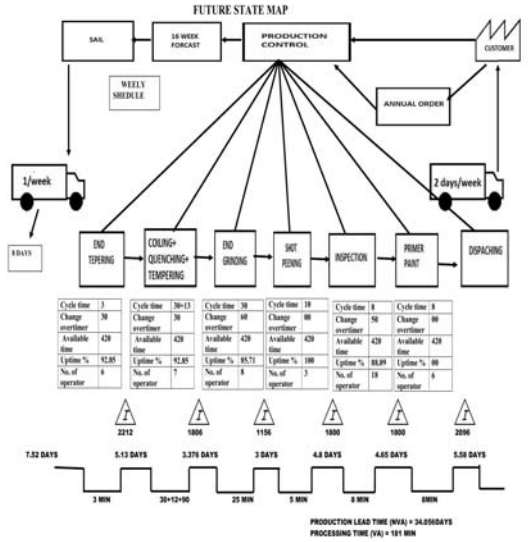
Table 4 Comparison of lead time in days

9.1 Conclusion

After analyzing the root cause, process activity charts and results this can be concluded that the main reason for non-value added activities are long distance, wrong handling, and not proper sequence. Thus it can be concluded that in the plant the wastes is mostly in the form of these activity. The VSM is an effective tool to eliminating the wastes and it also suggests ways to reduce non value added times in a manufacturing process.. The layout of the plant currently shows a lot of back tracking and it is proposed to modify the layout of the organization. This would result in reduction of transportation within company and unnecessary motions

The root cause analysis sheet shows the reasons of the wastages and also provides their solution. Large reductions in times can be achieved just by reducing time that the product waits in queue. Most important point is that In the improvement process, no new machines were purchased nor were operators expected to work faster or harder; only procedures and layouts were changed to allow the product to flow more smoothly through the manufacturing process. and this reduced the manufacturing lead time **8%**

Future state map



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