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Implementation of Value Stream Mapping Methodology in Pulley Industry

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Abstract: Nowadays in a competitive market, various industries are facing various problems because of changing scenario in terms of high-quality demand, reduced the cost of production and increased productivity. This thesis attempts to provide a successful solution for these problems through lean manufacturing techniques. Lean manufacturing is the best technique for the elimination of waste from the organization. Value Stream Mapping (VSM) is the one of the lean manufacturing tools. In VSM processes in an organization are strictly divided into the two groups: Value Adding Processes (VA) and Non Value Adding Processes (NVA). The goal of VSM is to identify waste in terms of non-value added processes. Current State Map (CSM) is drawn to give details about the current position and find various problem areas. Future State Map (FSM) is drawn to show the implementation action plan. In this thesis, a study has been carried out from Maheshwari Power Drive, G.I.D.C., Naroda, and Ahmedabad. Three product line of different pulley like 36 8M 45 timing pulley, 22 8M 25 timing pulley, 32 8M 50 timing pulley are analysed. In this study, first of all, collecting the details from each product line and create a three current state map and then choose any one as per requirement of the improvement. Then create a future state map for the plan of improvement and then apply the proposal within the industry.

Keyword: Lean Manufacturing, Value Stream Mapping, Value Added And Non-Value Added.

1. INTRODUCTION

Lean manufacturing is one of the initiatives that many major businesses in the world have been trying to adopt in order to remain competitive in an increasingly global market. Lean manufacturing has been the buzzword in the area of manufacturing for past few years in the world. To understand what lean is it is helpful to understand why it developed Lean (and the Toyota Production System) have two main purposes; Provide customer satisfaction and do so profitably. Principles of lean manufacturing are widely used by industries to eliminate waste. A lean organization understands customer value and focuses its key processes to continuously increase it. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste.

After Second World War Japanese manufacturers were faced with a big shortage of material, money, and human resources. These conditions resulted in the birth of the lean manufacturing concept (Womack et al., 1990). Early Japanese industrial leaders such as Toyoda, Shigeo Shingo, and Taiichi ohno devising a new, disciplined, process-oriented system, which is known today as the "Toyota Production System" or "Lean manufacturing".

Value stream mapping (VSM): The use of Value Stream Mapping (VSM) has been attributed to the cause of much of the success that Toyota of Japan has had since the 1980's1. Developed during the work conducted by Taiichi Ohno at Toyota in the 1960's and 70's, at its basic level VSM is a systematic methodology to identify wasted time and actions in a manufacturing process. In more recent times VSM it has been used to re-engineer businesses because it identifies unnecessary effort and resources to permit simplification and streamlining of operations processes.

In Taiichi Ohno's words - "All we are doing is looking at the time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value-added wastes." (Ohno, 1988)

2. LITERATURE REVIEW

Tomas rohac, Martin Janushka drawn current state map for a manufacturer producing plastic products dedicated to the pharmacy and health care industry. They told that implementation of VSM technique uncovers a number of problems and bottlenecks in company logistic processes. They suggested 5 improvements after the application of this 5 improvement they noted that total lead time was reduced from 29,636 days to 9,600 days.[1] Nor Azian et al. explain the kanban system and how kanban implement in the Malaysian small and medium enterprise. They also found the factors that hinder SME companies from implementing the kanban system are identified as ineffective inventory management, lack of supplier participation, lack of quality improvement, lack of employee participation. After implementing kanban they reduce operational costs, wastes, scraps, and losses[2] Jafri Mohd Rahani et al. have a goal to apply value stream mapping to improve the production line of a color industry. In this study, they found that the big mixer and deplak mixer stations have the most cycle time so they applied continuous flow in the production line. They draw a future state map with providing 5s principles and kanban method. After applying this tool the total lead time decreased from 8.5 days to 6 days and value added time decreased from 68 minutes to 37 minutes.[3] Juthamas Choomlucksana et al. presented a case study in manufacturing sheet metal stamping process. They showed that the deburring and polishing processes create the most non-value added activities and it should be addressed as quickly as possible. They used kaizen,5s, visual control,poka yoke tools and analysed that this tool help in reducing the processing time of a polishing stage from 6,582 seconds to 2,468 seconds or by 62.5% and also non-value added activities from 1,086 activities to 261 activities or by 66.53%.[4] Praveen Saraswat et al. gives the information about the value stream mapping. In this study, they found that annealing and CNC machining processing have higher cycle time and work in process. They apply the VSM and 5s as a lean tool and after successful implementation, they showed that total lead time was reduced from 7.3 days to 3.8 days and production lead time was reduced from 409 seconds to 344 seconds.[5] S. Santosh Kumar et al. use the experiencing VSM and line balancing to reduce the cycle time in an automobile assembly plant. With the successful implementation of lean tools and line balancing they reduce the cycle time of the total assembly and efficiency of the line[6], R.M.Belokar says that VSM has the reputation of uncovering waste in manufacturing and business processes by identifying and removing or streamlining non-value added steps. With the help of VSM, they use a new fixture, a new robot welding machine and also improve the layout of weld shop. They found that there is about 44% improvement in value-added activities.[7] A.Jayaganthan develops the VSM techniques in the pump industry. They also pointed that the company does not want to compromise with quality. They suggested the 7 proposals for future value stream map for the company to reduce material handling time [8] A Ramchandran et al. have discussed about the production improvement of the automotive industry by lean manufacturing technique of VSM. They improving the cycle time of welding process by introducing a new welding machine and by improving the layout of weld shop. At the end, they found that there is reduction in cycle time from 29 seconds to 15 seconds and 66% improvement in production by improvement in value adding activities.[9]

3. CASE STUDY

In this study to select the 36 8M 45 timing pulley product line from pulley industry at G.I.D.C., Naroda, Gujarat. The reason behind the selection of this product is that they are demanded more in number by the customer when compare to other products. Collecting data from door to door, this data are helpful for the drawing current state map.

DATA COLLECTION OF 36 8M 45 TIMING PULLEY

TABLE 3.1

Timing Pulley type	36-8M-45
No of teeth	36
Pitch	8 mm
Belt width	45mm
Material	Mild steel
Outer diameter	90.30mm
Internal diameter	45mm
Width	55mm

Into the 36-8M-45 timing pulley, there is various process needed for the manufacturing a pulley. It is shown in figure 3.1 and there have a different cycle time, and lead time and change over time of each process it is shown in table no 3.2

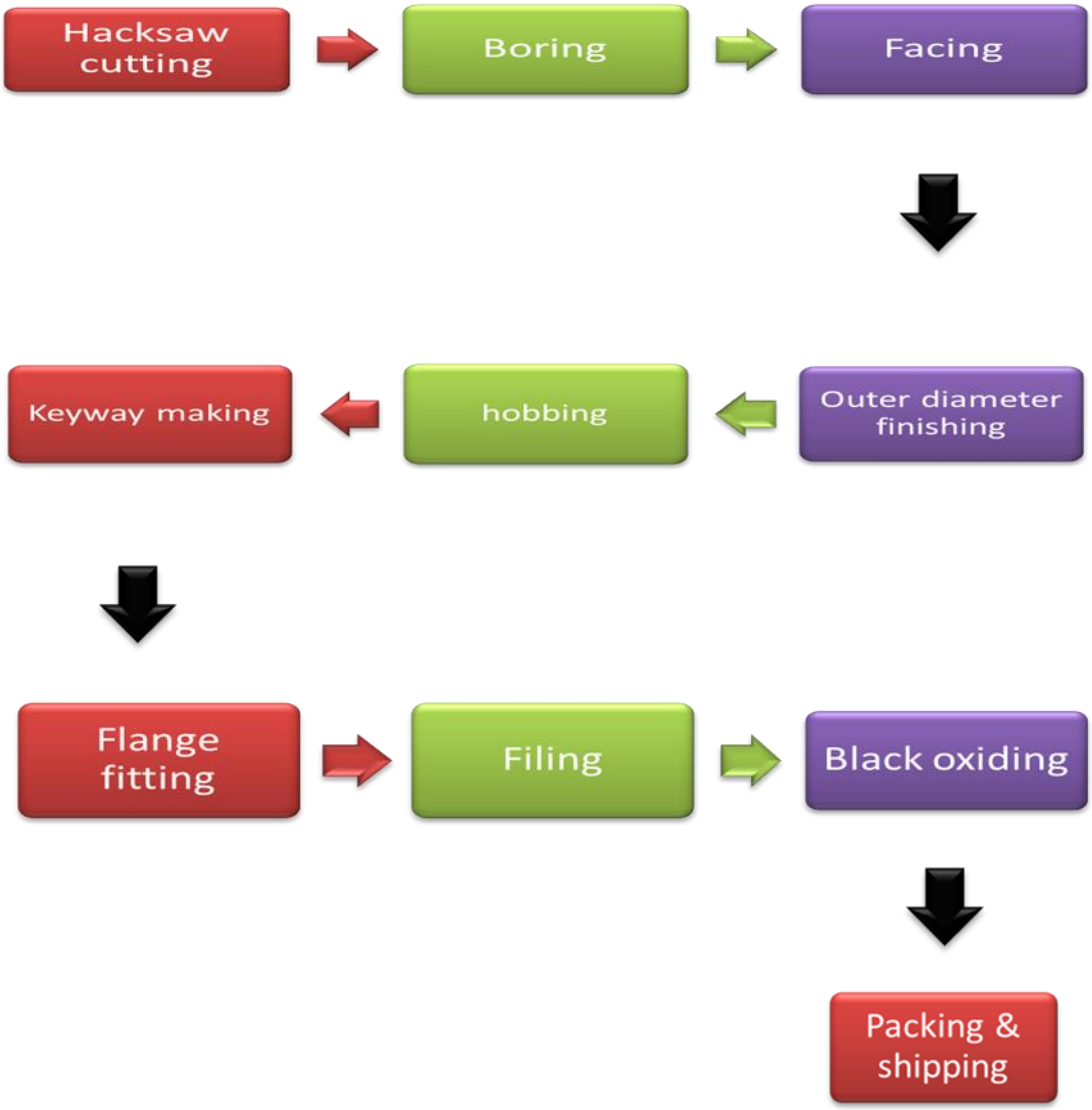


Figure 3.1 Process layout of 36 8M 45 timing pulley

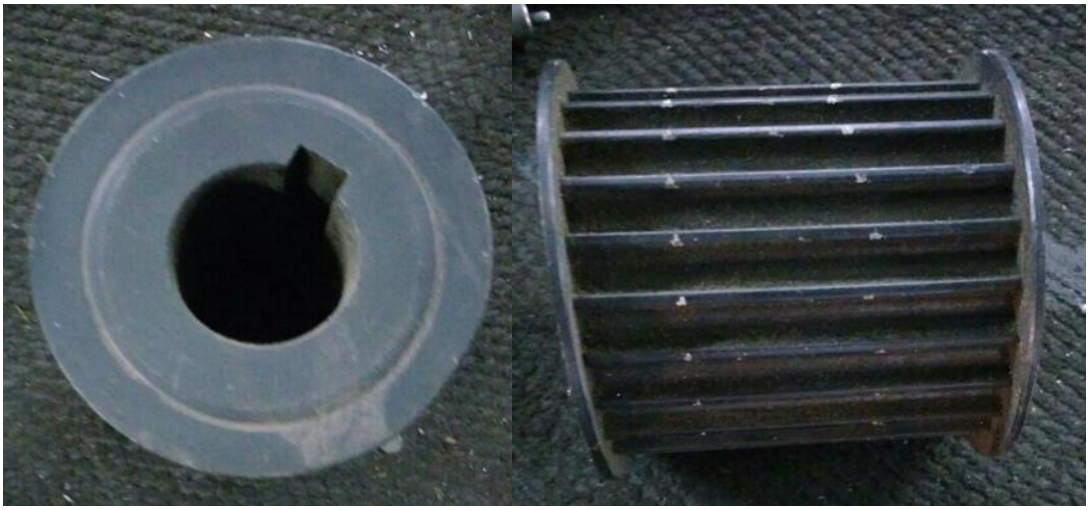
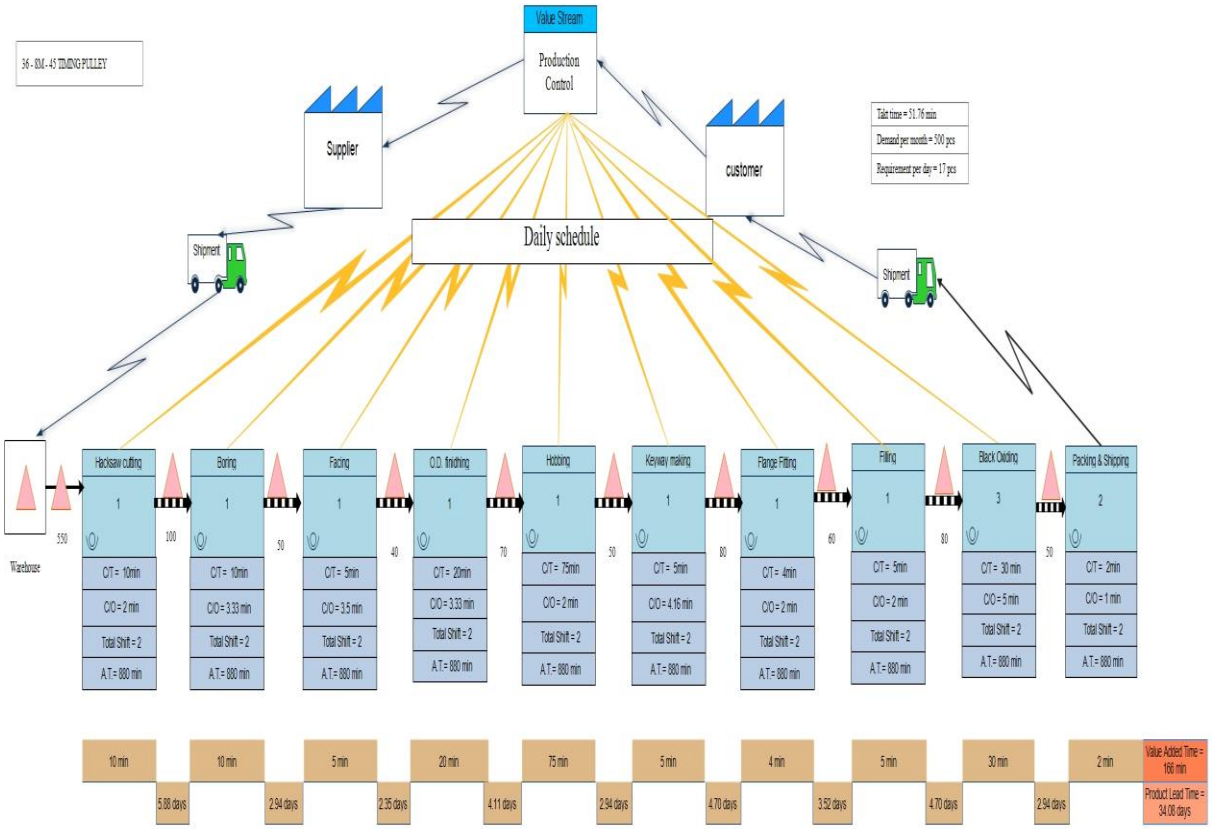


Figure 3.2 36 8M 45 TIMING PULLEY

TABLE 3.2 36-8M-45 TIMING PULLEY PROCESSES

Process	Cycle time	Change over time	WIP	No of operator
Hacksaw cutting	10 min	2 min	0	1
Boring	10 min	3.33 min	100	1
Facing	5 min	3.5 min	50	1
Outer diameter finishing	20 min	3.33 min	40	1
Hobbing	75 min	2 min	70	1
Keyway making	5 min	4.16 min	50	1
Flange fitting	4 min	2 min	80	1
Filing	5 min	2 min	60	1
Black oxiding	30 min	5 min	80	3
Packing and shipping	2 min	1 min	50	2

CURRENT STATE MAP OF 36 8M 45 TIMING PULLEY



Average demand per month for 36 8M 45 timing pulley is =500pcs.

Average production per month=430pcs

This means that the production line has a scope of improvement in terms of productivity.

This improvement can be in terms of reduction the wastage of time in certain production related activities.

The sole purpose of this research work is to analyze and enhance the productivity such that the manufacturer of the timing pulley can meet the demand requirement.

AVAILABLE TIME
The total available production time is 8 hours per shift. There is 30-minute lunch break and 10-minute tea break.

Total available time = No of shift x(Total time per shift in minutes – Planned downtime (time of breaks, meeting,etc.))

Total available time =2 x (8 hours x (60 min/ 1 hour) – 40 min)

Total available time = 2 x 440 minutes

Therefore the available production time is 880 minutes.

UP TIME
It is calculated by dividing actual operating time by available time. The actual operating time is the total available time minus the time that the changeover takes.

Up time =(Actual operating time)/(Available time)

=(Available time-Changeover time)/(Available time)×100

=(880-28.32)/880×100

=0.9678

= 96.78 %

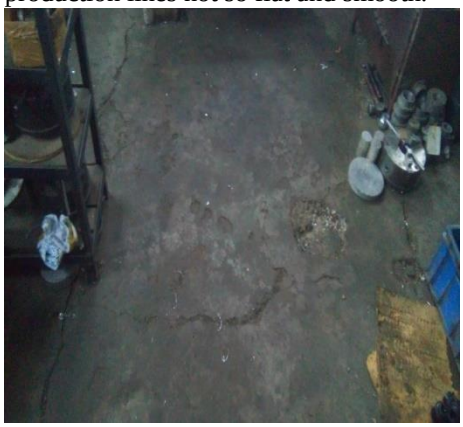
TAKT TIME
It is calculated by dividing available time per day by customer demand per day.
Takt time =(Available time per day)/(Customer demand per day)

=880/17

=51.76 minute

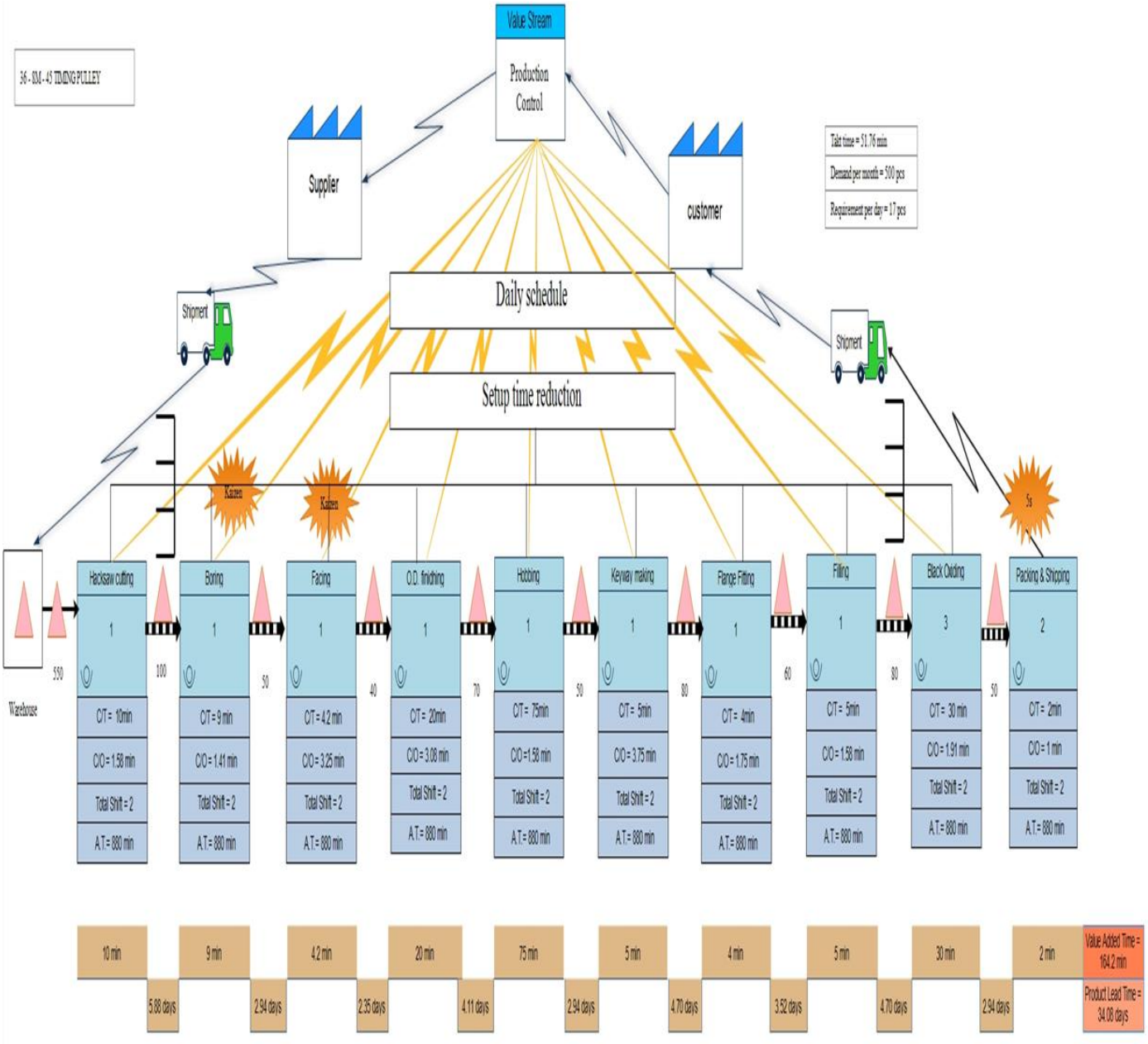
TABLE 3.3 PROPOSED CHANGES FOR IMPROVEMENT

SR.NO	OBSERVATION	PROPOSED CHANGES	PROPOSED BENEFITS
1	It has been observed that when setup is required for the machine, at that time worker first assemble necessary tools and consume 5 to 7 minutes.	If necessary tool pre-assemble before shutting down the machine.	Reduce internal setup time approximately 5 to 7 minutes.
2	It has been observed that when measuring the component with the help of simple vernier calipers instead of digital vernier calipers, occurs dimension defects.	Use digital vernier calipers instead of simple vernier calipers.	Reduced rejection rate.

3	It has been observed that all the equipment are not at proper place. So that confusion for select and pickup the equipment. 	Apply 5s in the current product line.	Reduction of waste, time, rejection.
4	It has been observed that the floor surface of the production lines not so flat and smooth. 	Apply 5s in current product line	Reduction of time in transportation, reduce accident case in the production line.
5	It has been observed that the after the production or in between the two processes pulleys are not so arranged in systematic order. 	Sorting of pulley	Reduce the time for worker in searching of proper size pulley in between the production processes or at the time of customer demand
6	It has been observed that at the time of boring and facing worker take 2 or 3-time measurement of the component in processing time.	Apply marking on the component so that the worker know how much boring and facing is done.	Reduce the cycle time of boring and facing.

			
7	It has been observed that the worker moves from one station to another station for collecting the pulley which is used for the black oxidising and collecting of raw material after hacksaw cutting for boring, during this moment there is loss of about 8 to 9 minutes per day to reduce this loss we have to purpose a systematic material flow system.	Apply supermarket It has been proposed to apply the supermarket between two workstation where the worker has more movement for collecting pulleys.	Reduce waiting time and also save 8 to 9 minutes per day, Reduce unnecessary motion of worker.
8	It has been observed that when one process is completely finished on the pulley then that pulley is idle on the way and after that when some pulleys are accumulated and then the worker takes pulleys for the next process.	Apply the belt conveying system, Apply the pull system, pull the pulley after finished the process for next process.	Reduced inventory between two workstations and control the production
9	It has been observed that when the pulley is sent to the black oxidising process then it is further returned to the main production workstation after the completion of black oxidising for packing and shipping.	If there is possible then arrange the packing and scheduling station near the black oxidising station.	Reduce the transportation time between black oxidising and packing.

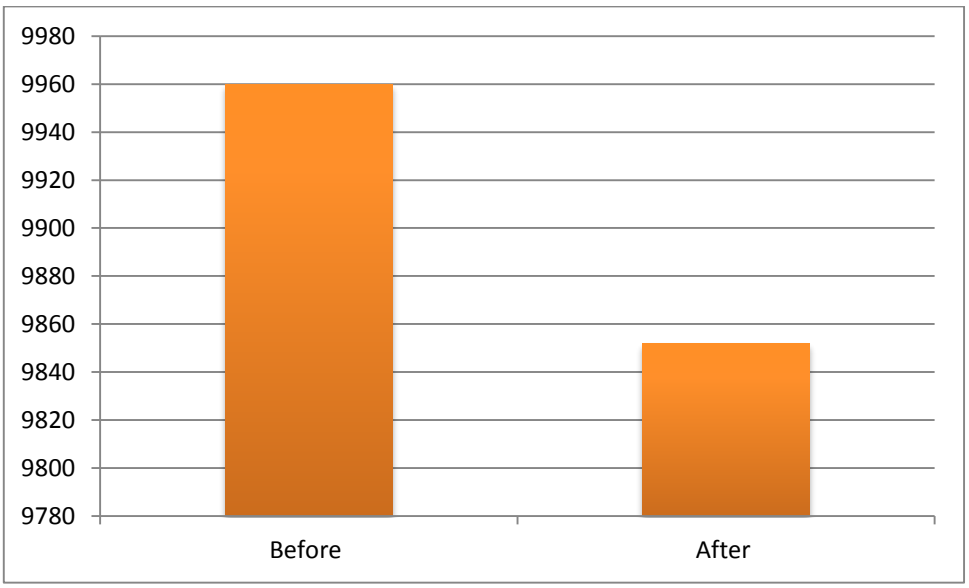
FUTURE STATE MAP OF 36 8M 45 TIMING PULLEY



RESULT AND DISCUSSION

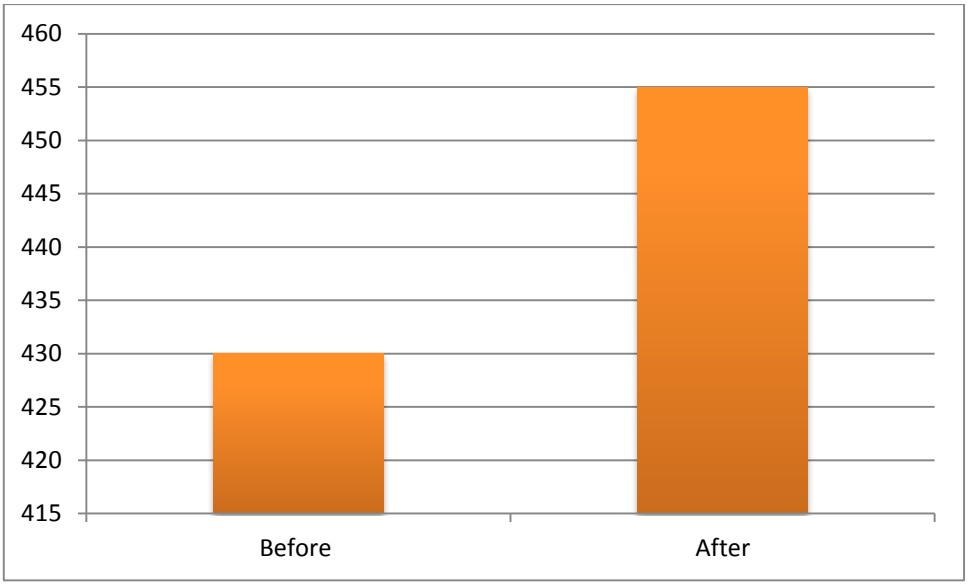
4.1 PER PIECE REDUCTION OF PRODUCT CYCLE TIME

36 8M 45 timing pulley is consumed 9960 sec/piece before implementing value stream mapping and after reduces the cycle time of pulley per piece is 108 sec.



4.2 PRODUCTION BENEFITS PER MONTH

It has been observed that before implementation of Vsm Company make 430 pulley per month and after implementation of Vsm Company make 454.93 so that company has benefits of 24.93 pulley per month.



4.3 COST BENEFIT ANALYSIS

Table 4.1 Types of cost of 36 8M 45 timing pulley

TYPE OF COST	Rs.
Shipping, handling, and transportation of one pulley.	120 Rs
Staffing cost	➢ 500 Rs /Day per worker ➢ No of worker 10 ➢ 15,000 Rs per person per month ➢ 1.50,000 total staffing cost per month.
Office rent	30,000/month
Electricity	20,000/month
Water	2000/month
One time cost	4,00,000 Rs
Machinery cost	35,00,000 Rs

1) With the implementation of super market, company saves 90 sec in boring workstation and 140 sec in black oxidant workstation. So that company saves 230 sec (3.83 min) per pulley. So that company saves 57.45 min per day.

2) With the help of marking system company save 1 min of boring cycle time and 0.8 min of facing cycle time per day. So that per pulley it save 1.8 min in a cycle time of 36 8M 45 timing pulley. So that company saves 27 min per day.

3) After reduce the setup time company save total 214.2 sec (or) 3.57 min/pulley. So that company saves 53.55 min per day.

So that company saves total (57.45+27+53.55=138) min per day. So we can say company saves 4140 min per month.

The total cycle time of 36 8M 45 timing pulley is 166 min. With the addition of this result, company makes (4140/166) =24.93 more pulley per month.

Before implementation of lean manufacturing customer demand per month is 500 pcs and company make 430 pcs per month.

After implementation of lean manufacturing company make more 24.93 pulleys per month, so that company makes 454.93 pcs per month after implementation of lean manufacturing.

The cost of one pulley of 36 8M 45 timing pulley is 800 Rs.

So company earn more (800x24.93=19,944) Rs per month or (19,944 x 12=2, 39,328) Rs per year.

CONCLUSION

In this study to implement the value stream mapping process for the reduction of non-value added flow, also into the literature review different research paper refer and apply the value stream mapping and conclude that it is most important techniques for the manufacturer, researcher, and practitioner. In this study to reduce the cycle time with the help marking system reduce the change over time with the help of supermarket and setup time reduction. And also satisfied the customer demand monthly as per require a schedule.

Value stream mapping techniques are applied in any type of organization for the reduction of the unnecessary activity or non-value added flow.

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