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Implementation of Value Stream Mapping Methodology in Bearing Industry

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Abstract: ***Lean manufacturing is best way for the reduction of non value added cost, lean word defined by Crafcik in the book of "the machine change the world" in 1988. Lean means thinner and thinner as well as possible to reduce the cost. Lean manufacturing gives the benefit without investment with some modification. In this paper study of the bearing industry at Ahmadabad, Gujarat, for reduction of product lead- time and fulfill the customer demand. This industry is not fulfilling the customer demand and that cause increase the production lead time. In this study to selecting the medium size spherical roller bearing and apply the value stream mapping techniques for detecting the flow of non-value added cost with the help of current state map and after analyze it and then prepare a future state map for the proposed implementation. And after apply the entire proposed lean tool and derive the benefits and fulfill the customer demand with reducing lead time.***

Keyword: ***Lean manufacturing, Value stream mapping, value added and non-value added.***

I. INTRODUCTION

Lean manufacturing is a systematic method for reduction of waste within industry. Lean provides various lean tools for the reduction of waste, there are different lean tools available like, kaizen, kanban, setup time reduction, 5s, pokayoke, just in time (JIT), Total productive maintenance (TPM), etc… there are many types of tools available in lean techniques, it is apply as per requirement. Lean manufacturing most useful techniques for the all manufacturer, it is defining the entire situation from workshop and gives the way for solution with simple action. Lean provides flexibility in work and reduces the human effort and gives the systematic manner in work. It is also provide the safety in all working areas.

Lean gives the better result in any types of problem, lean helps to visualize the all action with the help of value stream mapping tool.

Value stream mapping (VSM): Value stream mapping is mapping method it is visualize the all action on the workshop with the help of current state map. It is define the all the activity in form of current state map and future state map. Current state map gives the snapshot of the work shop, it means that what things are actually running on the workshop. Current state map draw with the help of pencil and paper and also use the stopwatch for the time study data. Value stream mapping defined the all value added and non-value added flow. Also future state map is a similar to the current state map, in this map only defined the proposed changes and which tools are used for the action against non-value added flow. VSM is good methodology are useful for the reduction all non-value added flow. Primarily starting with first step to select the individual product, and then collecting data and analyze it, collecting data with the help of door to door visit and see all the action, and next step is to draw the current state map and then analyze it after prepare a future state map for the implementation of lean tools as per requirement. And then last step to apply to the all necessary changes apply on the selected product line.

II. LITERATURE REVIEW:

Pravin sarasvat et.al. (2015) says that value stream mapping study has been able to highlight a number of unnecessary activities, to apply the value stream mapping tool reduced the total lead time and production lead time with using kanban, pull system, super market and 5s. In this paper main aim of the reduce production lead time and work in process in order to increase the production rate. A.Arun senthil kumar et.al. (2015) apply the cellular manufacturing in garment industry and says that layout design and flow of materials have a significant impact on performance of manufacturing system. P.Arunagiri et.al. (2014), study on automotive industry and identified a high impact lean tool like 5s, OEE, 8-step problem solving method and most effective tool used in automotive industry. In order to find the most influential lean tools based on the ranking. It also focuses on the flexibility of tools and how these lean tools can be effectively utilized for the increase in the production rate of the manufacturing industries. P.Arunagiri et.al. (2014) survey has been conducted in 91 automobile company and pointed out three major waste are occurs in automotive industry, this process is identified by weighted average method and compare each other its own weight. Study identified the major waste in automotive industry, transportation waste, waiting time, and unnecessary motion are major waste occurs in automotive industry. Rehab M. ali et.al. (2014) implement the takt time and says that one of the main tool of lean manufacturing is takt time. Ahmed Naufal Bin Adnan et.al.(2013) implement the just in time production through kanban system and analyzed that kanban system resulted in reduction of inventory to minimum levels besides increasing flexibility of manufacturing. Nor Azian Abdul Rehman et.al. (2013) says that kanban system is one of the manufacturing strategies for lean production with minimal inventory and reduced cost. Apply the kanban system in whole product line and reduce the over stock by communicating a supplier by E-SIM software. S.palanisamy et.al. (2013) apply the change over time and improve productivity, also reduction of setup time with MES is proposed to overcome the drawbacks of the conventional SMED and to increase its efficiency. Anna Wronka et.al. (2013) implement the kaizen techniques for small improvements in to the industry, says that kaizen method is both opportunity and a threat for the modern organization especially enterprises. Md. Isanur Shaikh, et.al. (2013) design and implement the cellular manufacturing in sewing floor of readymade garment industry, says that apply the cellular manufacturing so that factory can reduce the cost, improve quality, and delivery performance. Adnan Hj. Bakri et.al. (2013) discussed about total productive maintenance (TPM) and gives the suggestion of lean and TPM have a broad scope of improvement of industry. Ratneshwar singh, et.al. (2013), has defined the TPM(Total productive maintenance) eight pillar, 5s, jishu hozen, planned maintenance, quality maintenance, Kaizen, office TPM, safety and environment, also discuss that quality and maintenance of manufacturing system are closely related function of any organization.

III. CASE STUDY

In this study to select the spherical roller bearing product line from bearing industry at Ahmedabad, 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.

There are twelve processes require for the manufacture of Spherical roller bearing. Start with material inspection and after heat treatment and cleaning and then phosphating. This process is common for inner and outer ring product line, and after than Heat treated rings are fed into a completely automated machine where the ring undergoes face grinding, OD grinding and track grinding if it's an outer ring and face grinding, track grinding and bore grinding in case it's an inner ring. The ring is transferred from one machine to another by a robotic arm and conveyors. The ring then moves to the next machine for Honing. Honing is done to achieve a high surface finish of around 0.2 microns. After this process the bearing has to pass through stringent quality inspection and then it is demagnetized and the bearing number, manufacturer name and company logo are Laser marked. Then a worker manually assembles the rollers in the cage, puts guide rings, assembles the OR and IR and checks the clearance. The bearing is sent for washed, oiled and sealed.

Also data collection from each work station, to produce the medium size spherical roller bearing to require about twelve to thirty process.

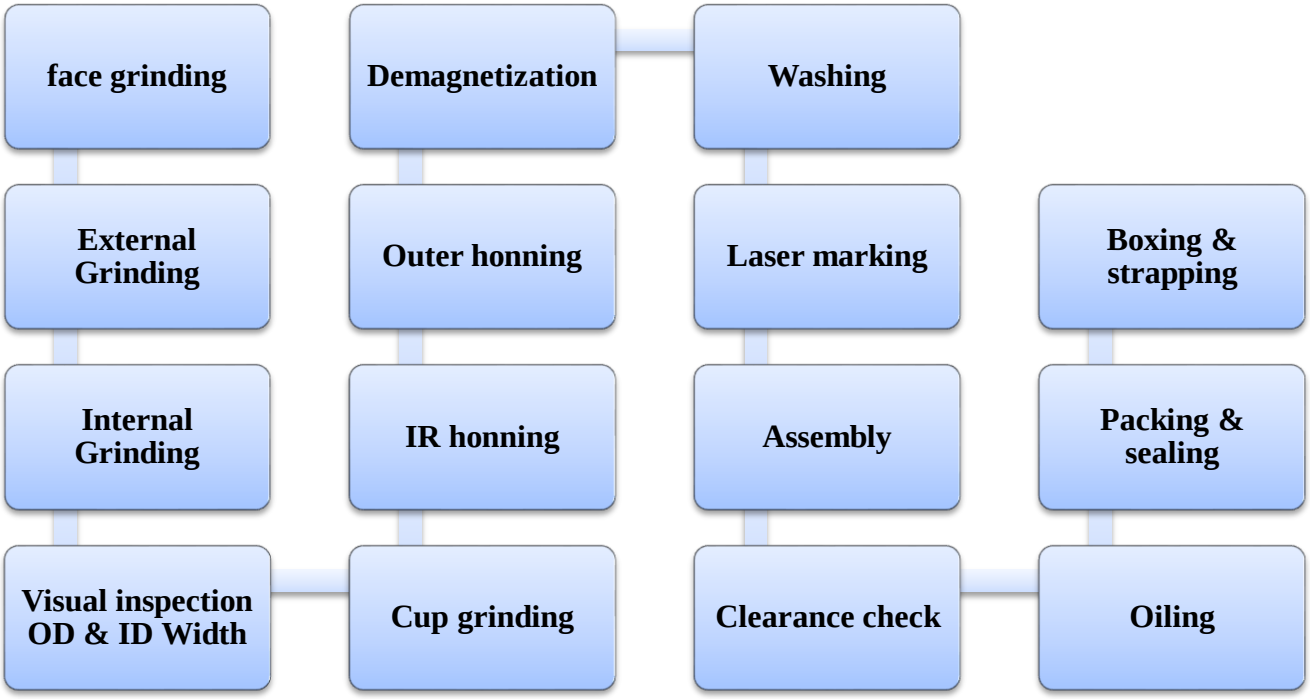


Fig 1 Process layout of spherical roller bearing

There are all the process is necessary for the production of spherical roller bearing, it is also shows that necessary process cycle time and also change over time, lead time.

In this product of spherical roller bearing customer demand is1000 per month, and three working shift with one shift have a 8 hours, and 30 minute lunch break and 05 minute tea break per shift. In to the product line taking the sample and analyze each process and measure with stop watch and also discuss with supervisor and workers for the flow of data and information flow and prepare a list and take average of the cycle time, Lead time, change over time.

Table 1 Spherical Roller Bearing product line data for outer ring

Process	**Cycle time**	**Number of operator**
Face grinding	201sec	1
External grinding	206sec	1
Internal grinding	210sec	1
Cup grinding	295sec	1
Outer honing	197sec	1
Laser Marking	172sec	1
Inspection	14.4sec	1

Table 2 Spherical Roller Bearing product line data for inner ring

Process	**Cycle time**	**Number of operator**
Face grinding	185sec	1
External grinding	220sec	1
Internal grinding	199sec	1
Internal honing	180sec	1
Laser Marking	161.5sec	1
Inspection	11.8sec	1
Packing	218sec	3

Table 3 Spherical Roller Bearing product line data for Change over time

Process	**Change over time**	**Number of operator**
Face grinding	40min	1
External grinding	45min	1
Internal grinding	38min	1
Cup grinding	50min	1
Internal honing	35min	1
Outer honing	38min	1
Laser Marking	10min	1
Inspection	10min	1

Table 4 Data for manufacturing activity

		TIME DURATION (SECONDS)										
Sr. No.	**OPERATION**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Time**
1	Demagnetizing	35	35	30	35	35	35	40	35	35	35	40

2	Washing	30	35	35	35	30	35	35	30	35	35	35
3	OR Laser Marking	170	175	165	170	165	180	175	165	185	175	172.5
4	OR Width & OD Check	7	8	7	7	8	9	8	8	7	8	7.7
5	OR Track Check	6	7	6	7	7	6	6	7	7	8	6.7
6	IR Laser Marking	155	160	160	170	165	165	155	150	165	170	161.5
7	IR Bore & Width	5	6	5	5	6	6	6	7	7	6	5.9
8	IR Track Check	5	6	7	6	6	5	6	7	6	5	5.9
9	Cage & Roller Assembly	30	35	100	105	95	35	40	40	35	45	56
10	Cage & IR Assembly	25	20	15	15	20	15	20	15	15	25	18.5
11	Cage & OR Assembly	70	55	35	50	45	50	35	50	40	35	46.5
12	Radial Clearance Check	10	25	15	15	10	10	15	15	20	15	15
13	Waiting for Washing	50	45	45	50	55	60	65	65	45	50	53
14	Washing & Oiling	100	100	105	100	105	100	100	100	100	100	105
15	Dripping	25	30	30	30	25	30	30	25	30	30	30
16	Wrapping	90	95	95	85	90	100	90	90	85	100	92
17	Boxing	90	95	100	85	105	90	95	110	95	95	96

Create current state map of spherical roller bearing:

Table 5 Customer requirement data

Customer Demand:	1000/month
Customer Demand per Day	33pcs/day
Total Shift:	THREE(With 8 hour)And 35 minute lunch & tea break
Total Available Time:	80100sec/day

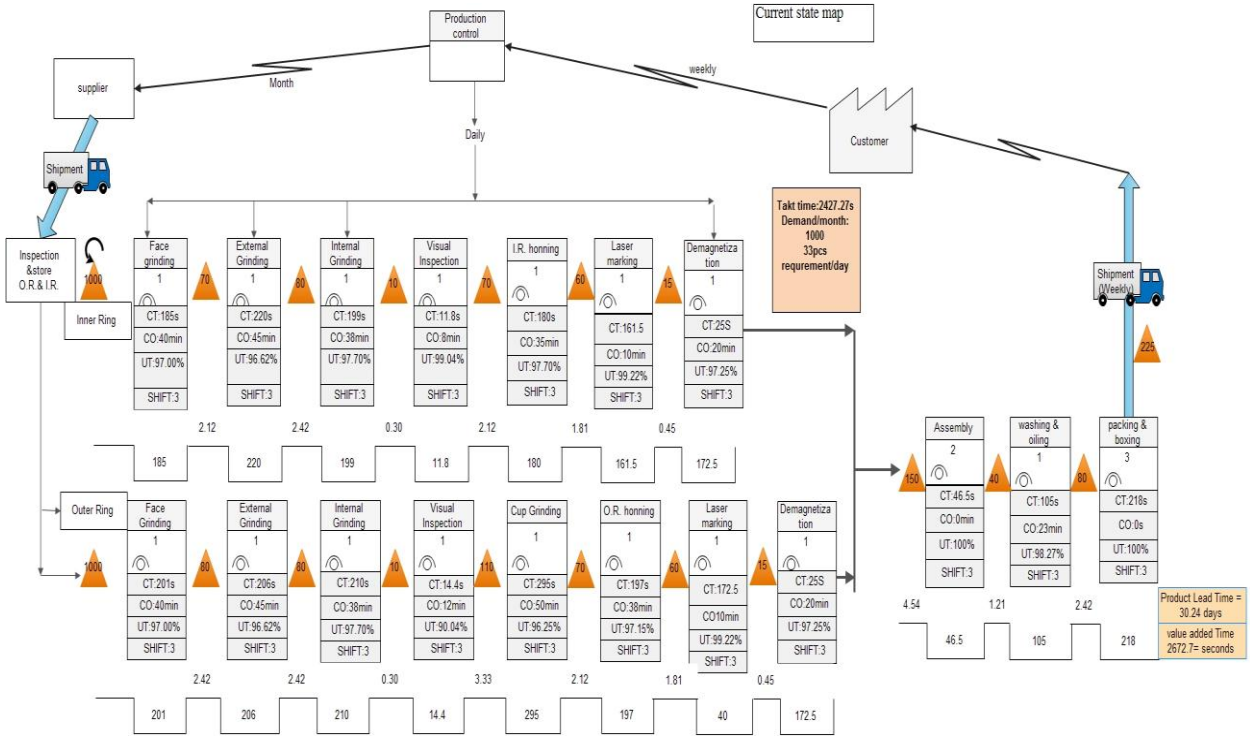


Figure 2 Current State Map of Spherical Roller Bearin

3.1 Analysis of current state map:

A) Problem Discussion:

- Industry: Bearing industry
- Location :Ahmedabad, Gujarat
- Problems: Company is suffering from the various wastes and demand dissatisfaction in the product line of spherical roller bearing.
- Proposed study: Study product line and generate CSM (Current State Map) Identify the NVA (Non Value Added) Activities.
- Apply Lean Tools as they continually focus on the reduction of waste, reduction of setup time, reduction of cycle time, etc.
- Various Lean Tools are available. However, Value Stream Mapping (VSM) provides better illustration of the whole of the problem. So VSM and other lean tool can give better result. Other tools like use of Jigs and Fixtures, 5S, Changes in Material Handling Systems, etc. shall also be applied as and when necessary and applicable.

B) Calculate Takt time:

We can see the current state map in to the figure 2 and calculate the takt time and after compare with actual lead time of one product. And see there what are actual requirement of the production time and how much loss occurs.

Customer Demand=1000/month or 33/days (approx.)

Total Available time = (Total time- industry down time)

= 86400-6300

=80100

Takt time =Total Available time/Customer Demand

=80100/33

=2427.27sec

3.3 Future state map of spherical roller bearing:

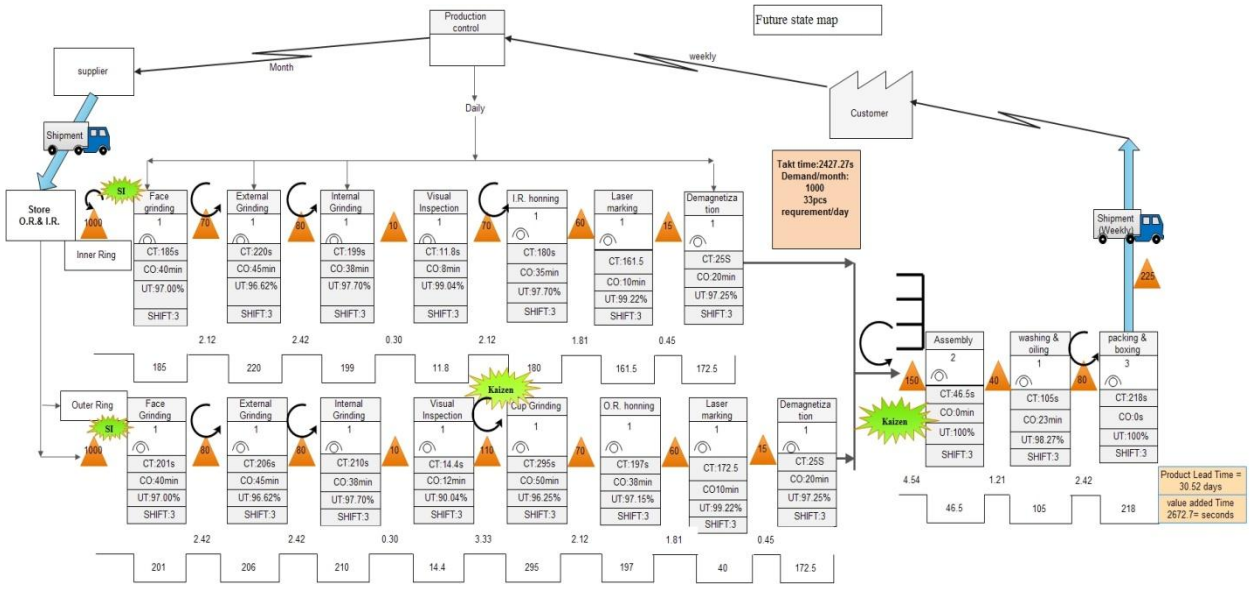


Figure 3 Future state map of spherical roller bearing

Table 6 Implementation

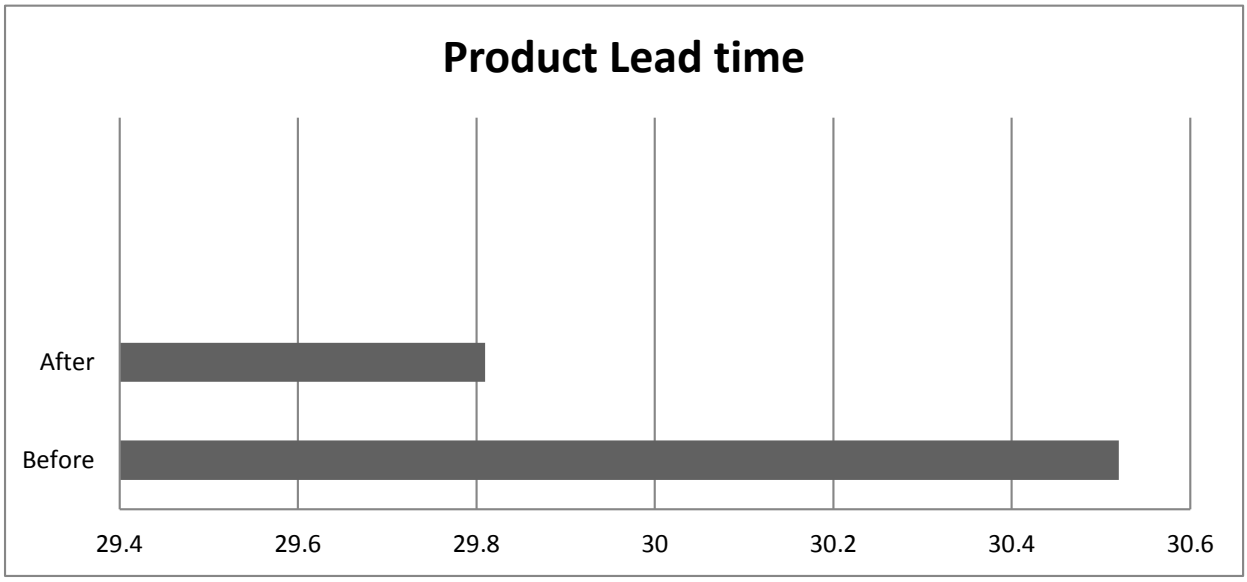
Before	After	Benefits
It has been observed that the worker moves from one station to another station for collecting the ring which is used for the assembly; during this moment there is loss of about 1592 sec per day to reduce this loss we have to purpose a systematic material flow system.	Kanban system implementation. It has been proposed to apply the super market between two workstation of magnetization and assembly. So that after consume the time 46.2 sec/day.	Derive the benefits 1388sec/day.
Two pieces per day has been rejected for metrological problem and Bearing cracks results in 1208sec consumption.	Implement the stage inspection before face grinding process and check the outer diameter, inner diameter, width, and cracks defects. And after consume 570sec.	Save the time 638sec/day
It has been observed that when setup is required for the machine, at that time worker first assemble necessary tool and consume 5 to 7minutes of each	Gives the instruction of all workers and apply the rules in the industry for necessary tool pre-assemble before shutting down the machine.	Save the 27min per machine setup.

work station and total time consume about 246min/day.	And after consume 219min.	

IV. RESULT AND DISCUSSION:

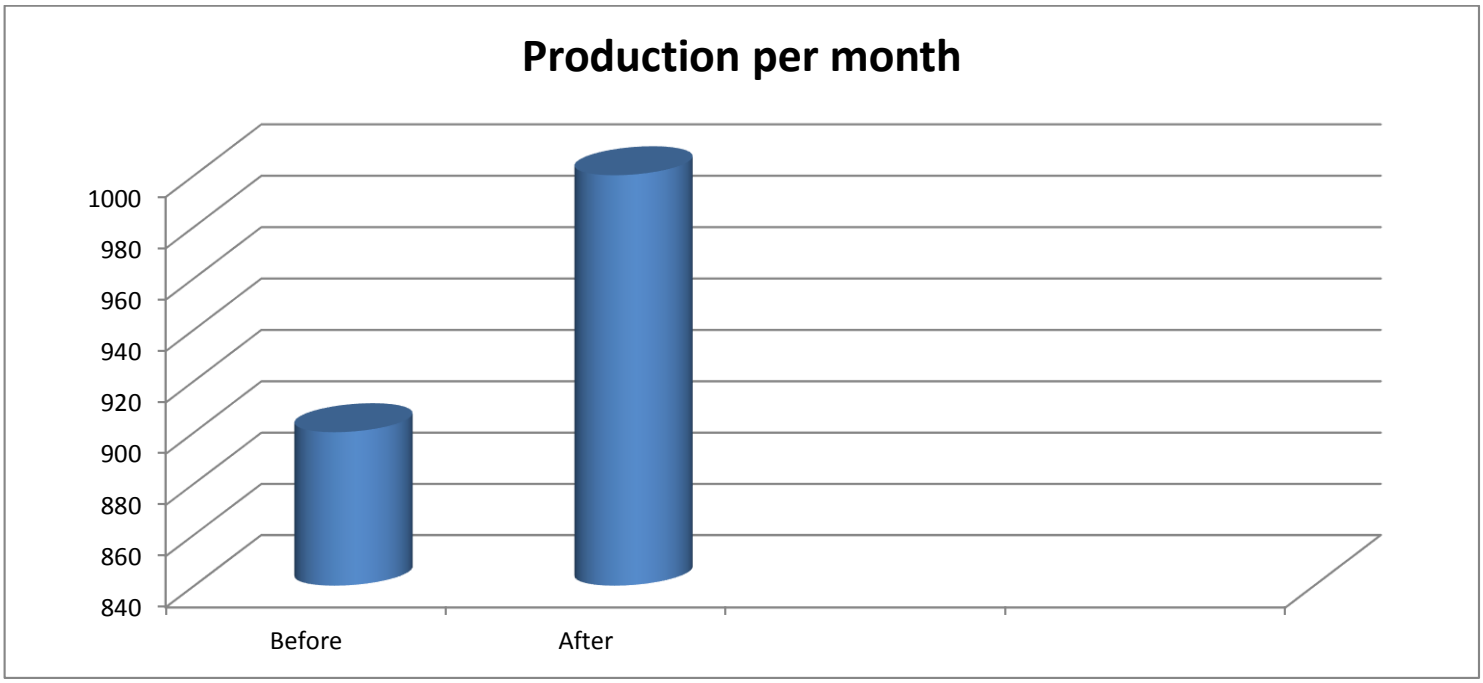
In this study to apply the lean tools of kanban pull system and also apply the super market and setup time reduction as per requirement and derive the benefits of various areas, reduced the product lead time and fulfill the customer demand.

4.1 Reduced product lead time: It has been observed that there is spherical roller bearings are reduced 900 pieces in 30.52 days before implementation value stream mapping, and not fulfill the customer demand. After implementing the value stream mapping produced 1000 bearings in 29.81 days, and reduced the product lead time 30.52days to 29.81days.



4.2 Fulfilling the customer demand:

By reducing the product lead time to fulfill the customer demand, before the implementing of value stream mapping company produce 900 bearing/month and after the implement the value stream mapping technique company produce a 1000 bearing/month, and fulfill the customer demand.



V. CONCLUSION

In this study to implement the value stream mapping process for the reduction of non-value added flow, also in to 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 lead time with the help of super market and setup time reduction, and implementing the stage inspection. And also satisfied the customer demand monthly as per require schedule.

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

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