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Improving Productivity Using Lean Tools in Manufacturing Industry

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Abstract: **Lean Approach is the most coherent and the most prominent concept in minimizing the waste which can be in any form, this could be a process, function, product, or service; anything that requires an investment of time, money, and talent that does not create customer value is a waste. Lean manufacturing, which was originated by Toyota in the Japanese automobile industries, seeks to minimize or eliminating waste in order to further enhance the production process. Lean manufacturing offers a disciplined solution to lower waste while keeping compliance with regulatory standards for things like production and quality. Kaizen (continuous improvement), single minute exchange of die (SMED), and Gemba approach are appropriate tools for this project. Kaizen is the terminology for debating and bringing into execution ideas that will help to upgrade a process. By streamlining and standardizing the operations for the exchange of tools using basic principles and simplest applications, SMED is engaged with decreasing waste and boosting flexibility in manufacturing processes. Gemba approach, which requires an engineer to be physically present on the production floor, is relevant to manufacturing organizations.**

Keywords — Productivity, Lean Manufacturing, Kaizen, Single Minute Exchange of Die, Gemba technique.

I. INTRODUCTION

Productivity is simply the proportion of goods / services produced per unit of all the materials which used create that result. It's important that production should match with the productivity which does not happen in always. Productivity is nothing but the rate of output and input and production is about increased productivity in given period of time. Collectively, productivity improvement is related to how people successfully combine distinct resources to make the particular output which can be any part and service that others dream or have a thought of buying it. Manufacturing industries must optimize their capacity production and be competent in order to compete with their rivals considering the production demand's steep increase. Alternatively, the manufacturing process should be efficient and capable of minimizing the costs with having the high technologies. Hence we need find an answer to how to simplify the obstacles on the way of improving productivity [1]. Lean manufacturing can be one of the answers to the above question. A manufacturing philosophy that seeks to limit product processing times, increase throughput, and strengthen the individual characteristics can be derived as the basic concept of lean manufacturing. The basic thought of lean manufacturing is to manage customer value while minimizing the waste, as a result achieving better productivity by creating a larger value in less or no investment at all [1]. The belief of lean manufacturing is no one will pay for the mistakes that made instead will pay for the service that received through the product. The main motive of a lean manufacturing system is to develop a high quality products in very low cost and in a short time by simply removing the wastes which results in efficient use of layout, optimize cycle time, minimize costs and maximize overall productivity. This waste can be in any form like waiting time, work in progress, overproduction, rejected parts and so on. There are plenty of tools available in market like Kanban, Bottleneck analysis, Kaizen, SMED,5S techniques, Value stream map etc. can help in minimizing the wastes present in any manufacturing organization. The study is carried out in File (Rasp) manufacturing industry. The organization lack to meet the expected target to some extent as there is rapid change in customer demand. The focus is particularly on the cutting stream of rasp as it faces the problems like machine setting time, defective product, waiting of material, chisel break, chisel grinding, unskilled operator, etc. Kaizen and SMED along with gemba technique helped to minimize this waste.

II. LITERATURE

Kulkarni et al. [1] implemented the new integrated approach for effective productivity development with the help of the Work study methods associated with Lean production principles and Tools. Bottleneck Analysis was the best way to identify and eliminate the problem area from the system so as to utilize that time in production time which can allow increase in the production time. Sundar et al. [2] made an effort to create a lean route map so that the organization can

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use a flexible production system. Lean principles define the value of a product / service as perceived by the customer and make the flow more consistent with the customer pulling and striving for perfection with continuous improvement to eliminate waste by filtering Value Added (VA) and Non-Value Added (NVA). Waste sources of work for NVA are transport, inventory, motion waiting, overproduction, over processing and defects. NVA job waste was an important obstacle to VA work. The eradication of this waste is achieved through the successful implementation of lean elements. A value stream map for an automobile company of anti-vibrations solutions ,which allowed the organization to focus on current lead times, stock levels and cycle times in order to determine the ratio of total value-added process time to total lead time of the product line which was under investigation was created by Mitta et al. [3]. After proper assessment the production increased due to a decrease in downtime and a decrease in cycle time. The reduction in waiting time after production operation was also achieved. Genett et al. [4] first understood the nature of production process in the company which was a fish processing company. Aim was to identify the waste using lean concept, which affects the quality and production of the products. The results of this study were allowed to present the current state of the process. Kumar et al. [5] used the Lean-Kaizen concept with the VSM tool in the spindle kick disco (SKDM) model in respective company. The Fuzzy TOPSIS was used to select the most suitable KE for lean benefits such as cost reduction, reduction in lead time, asset reduction, CT reduction, production improvement, and product quality improvement. Lean-Kaizen with VSM-fuzzy technique found to be an effective method that helped to eliminate waste in the organization and encourages people to achieve organizational goals. Gurway [6] implemented a kaizen tool along with the 5S technique in order to solve the problems faced by the company who was manufacturer of PVC and HDPE pipes which were increased lead time and stock out situation. The standard operating procedure of sales order processing was provided in this work. To reduce setup times, work-in-process (WIP) and distances travelled by operators at Elevator Company, the SMED methodology was used by Eric et al. [7]. Also, standardization of setup operation was done; as a result the process had become much faster and understandable to operators. These developments helped to reduce consumption of energy and building materials. Tilkar et al. [8] applied the SMED to improve the productivity of respected company. An optimal standard procedure was prepared for changeover operations at defined machine. As a result the cycle time was also reduced. Mahmood and Shevtshenko [9] provided a better understanding of lean production approach in order to enhance productivity, reduce cost and maximize customer value while minimizing waste during the production processes. The study was carried out in metal manufacturing company which produces copper strips for automotive and electrical applications. The tools – VSM, Kanban, Dedicated Flow improves safety and productivity. Lean implementation had showed improvement by reducing WIP inventory from 1026 tons to 800 tons while overall inventory level had fallen down from 1845 tons to 1600 tons. Manikandaprabu and Anbuudayasankar [10] performed the research work in the manufacturing industry, for improving production and processing performance with lean tools. This model study demonstrated a variety of waste in the manufacturing industry such as goods, reduction of lead time and recycling of waste to improve productivity. So lean tools like VSM, bottleneck analysis, Kaizen, making or purchasing a decision helped to identify the different types of waste produced in the organization and the opportunities to eliminate / reduce them.

III. PROBLEM IDENTIFICATION

The manufacturing of wood rasp undergoes many processes out of which cutting stream consumes more time as a result, the organization is facing the problems to meet the customer demand as there is the difference of 20% to 21% between expected target and actual production in rasp cutting stream which means cutting stream is having the scope of improvement which can help to improve the productivity

IV. METHODOLOGY

The steps followed during the study were as shown in fig-1.

A. Analysis of manufacturing process

The production of wood rasp undergoes many process which are raw material cropping, annealing, tang pressing and punching, round side grinding, pint polishing, edge cutting, flat side grinding, flat side cutting, round side cutting, point cropping and snapping, stamping, straightening, hardening, aciding, scouring, proving.

B. Selection of pilot area for study

Measurement of time require for each process of rasp manufacturing is done using stopwatch at each station. The analysis of time measurement shows the pilot area which is responsible for not fulfilling the customer demand is rasp cutting stream as it is time taking procedure and the operator operating the cutting stream faces more problems such as chisel break, tool grinding, cam adjustment etc. while machining as compare to other streams. The information of percentage difference between expected and actual output of rasp cutting stream for the month of November is collected from the production book. The figure-3 shows that the difference between the expected target and actual production for flat and round ide cutting is 20% and 21% for flat side cutting and round side cutting respectively. This increases the opportunity for the application of lean tools.

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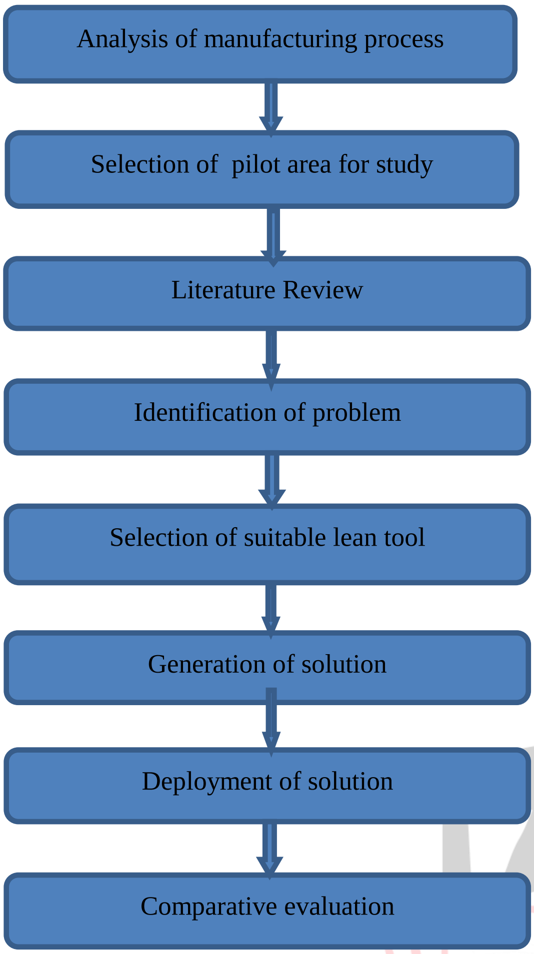

Fig -1: Methodology

Fig -2: Varieties of Rasps Manufactured

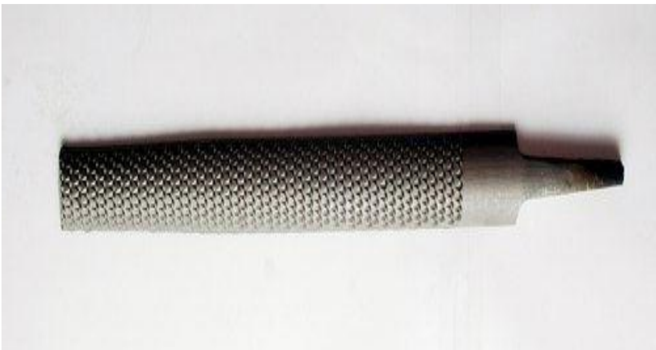

Fig- 3: Half-Round wood rasp

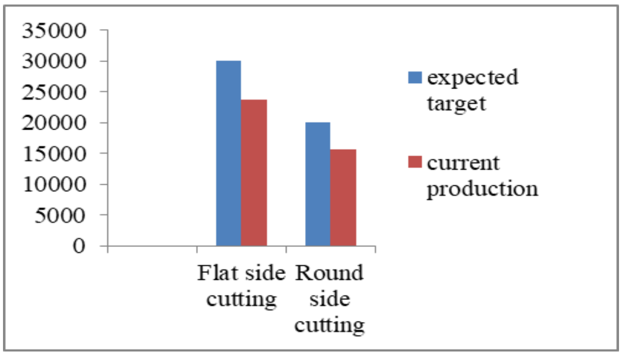

Fig- 4: Comparison between expected target and actual production

C. Identification of problem:

After studying the manufacturing process, the following are the problems which need to be focused.

1. The company is manufacturing varieties of wood rasps ranging from 6 to 14 inch rasps .There is much time involve in cutting stream
2. There is percentage difference between actual production and target value as the operator is facing many problems while machining.

Responsible Factors:

After observing and studying the cutting operation of both flat and round side cutting properly responsible factors which consumes the production time are as follow:

a. Chisel/ tool break
b. Time consuming machine setting
c. Improper packing of metal strip placed between file and file bed
d. Improper placing of tools and component parts

D. Selection of Lean Tools:

To get the exact result of lean manufacturing is possible only after implementation of suitable lean tool. So it is very important to select the appropriate lean tool for minimizing the difference between expected target and actual production of rasp cutting.

i. Single minute exchange of die:

SMED tries to minimize the setup times to less than ten minutes, which does not mean exact 10 minutes but means the single digit. In reality not all installations can be practically cut down to this period of one to nine minutes, but the effort can be made by SMED. Average setup occurs per month are 15 to 20. As the company manufactures variety of rasps shown in figure-1 due to which it undergoes multiple setups as per the demand, which confirms the opportunity for reducing the setup time to increase the production time using SMED lean tool.There is need to minimize this waste of time in machine setting. The steps involved in single minute exchange of die are as follows:

1. Select the pilot area
2. Identify elements of machine setting
3. Separate elements as internal and external
4. Convert internal elements to external
5. Standardize and streamline remaining elements

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ii. Kaizen:

Kaizen is a concept which focuses on improving the workplace or organization through incremental measures by removing waste. In short Kaizen classify itself as the best way to improve performance among all lean manufacturing tools. As the tool becomes blunt due continuous cutting operation due to which operator has to grind the tip of tool as per the specification of the tool. This need to be investigated as it happens more often and also consumes the most of the available production time. Kaizen can help to tackle this problem as this area need improvement.

iii. Gemba Technique:

Gemba technique means engineer has to be present physically on the shop floor in case of manufacturing organization, as an operating room in case of hospital, the job site in case of construction project, and the kitchen in case of restaurant. This technique will help to implement other lean tools.

V. RESULT AND ANALYSIS

A. Kizen Deployment:

Chisel /tool break while cutting

As the tool becomes blunt due continuous cutting operation operator has to grind the tip of tool as per the specification of the tool. This activity consumes time which results into reduction of production time, so there is need to reduce this loss of production time. Total time required for this activity (on each machine two files get cut on round side) is as shown in table-1

Table-1: Time required for chisel grinding

Activity	Time (minute)
For one chisel break	3.12
For both chisel break	7.58
Total time loss per machine per shift is approximately	15.16

Total numbers of machines available for round side cutting are 7

Solution identified:

Minimize the walking distance of operator from cutting machine to grinding machine

Fig-5: Before relocation

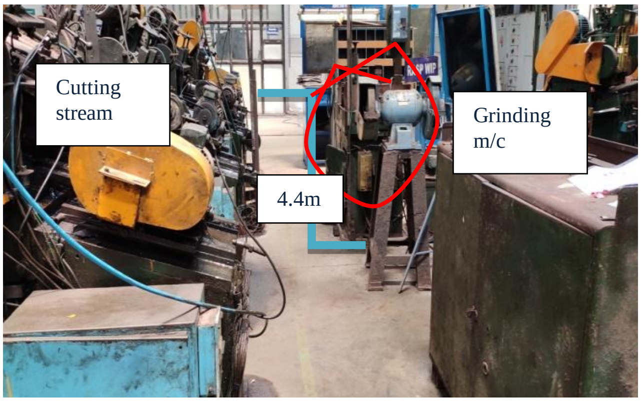

Fig-6: After relocation

After relocation of grinding machine the walking time is reduced by approximately 1 min which shown in the figure-6, as a result time required,

For one chisel break =2.12 min.

For both chisel break =6.58 min.

Total time required per machine per shift becomes 13.16 min.

Fig-7: Comparison between chisel grinding time required before and after relocation

B. SMED Deployment:

As discussed above cutting stream undergoes multiple setups, time require for this need to be minimize so as to improve the available production time. The steps followed for implementation of single minute exchange of die are as follows:

Step 1 – Selection pilot area

Flat side cutting stream is selected for the implementation of SMED program. The baseline measured changeover time using stopwatch.

Step 2 – Identify elements of machine setting

To identify all the elements of the machine setting the most effective way that is videotape the entire machine setting is done. And the list of all elements is prepared involved in machine setting.

Step 3 – Separate the external and internal elements

In this step, elements of the machine setting process are separated as external and internal.

a. Internal Elements: elements that completed while the equipment is stopped.
b. External Elements: elements that completed while the equipment is running.

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Step 4- Convert internal elements to external

In this step, the current machine setting process is carefully observed and converted internal elements to external as possible.

Step 5 – Standardizing and streamline remaining elements

In this step, the remaining elements are reviewed with an eye towards streamlining, simplifying and standardizing so can be completed in minimum time

Following table includes the steps stated as above which includes identification of each and every element of machine setting, separation of the element as internal and external, conversion of internal element to external element and standardizing and streamlining the possible remaining elements as per the need of machine setting.

Table-2: Elements of machine setting

Sr.No	Elements of machine setting	External/ Internal Element	Solution
1	Remove the point holder using Allen key	Internal	
2	Remove the file bed	Internal	
3	Clean the station and file bed	Internal	
4	Take the file bed from shadow board	Internal	
5	Place the bed on fixture/ work bed using hammer, packing strips	Internal	
6	Clean the point holder	Internal	
7	Take the file(scrap) for trial	Internal	
8	Search the suitable point holder from the container of point holder	Internal	Standardization and separation
9	Check if the file fit properly into holder or not	Internal	
10	Place the point holder	Internal	
11	Tighten the point holder	Internal	
12	Search for the bolt from the container which fit into holder properly	Internal	Standardization and separation
13	Again tighten the point holder using Allen key	Internal	
14	As the one operator for two m/c, operator is make another machine OK	-	Operator is suggested to make another machine Ok before starting the setting
15	Take the chisel from the shadow board	Internal	
16	Place the chisel after removing previous chisel	Internal	
17	Set the cut per inch on file	External	
18	As the file bed packing is loose adjust the bed packing	Internal	Standardization
19	Take the cam from the shadow board	Internal	
20	Loosen the cam fitting using spanner and Allen key	Internal	
21	Remove previously used cam	Internal	
22	Place the suitable cam and tighten it	Internal	
23	Tighten the all parts of cam fitting using Allen key and spanner	Internal	
24	Take the another suitable chisel from the chisel grinding station(in case of chisel break during trials)	Internal to External	Operator is suggested to check the availability of spare chisel at the start of setting
25	Place the tool/chisel and tighten it	Internal	
26	Loosen the nut to set waviness in cuts by trials	External	Standardization
27	Check the cut per inch, point and tang uncut and acc. Make changes after each trial	Internal to External	
28	Check the file if OK or NOT OK	External	
29	Clean the station and cover the cam fitting with casing	External	

Standardized Data:

The chart has prepared which gives the information about the chisel number, cam number with respect to particular item at each machine station, from which the operator can directly insert the chisel, cam and adjust the rod length without wasting the time. This can help in reducing the time required for waviness pattern adjustment on rasps while machine setting which results in the reduction of machine setting time. This can help to improve the productivity of rasp cutting stream. These charts are as shown in table-4, 5, and 6.

Table-3: standardized chisel number with respect to the item

Item Name	Chisel Number			
	MOB		JK	
	TA304	TA358/59/60	TA304	TA358/59/60
6 HR 01	9	33	8	32
6 HR 02	8	32	10	31
6 HR 03	10	31	10	31
8 HR 01	9	33	9	33
8HR 02	8	32	9	33

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8HR 03	10	31	8	32
10HR01	5	34	5	34
10HR02	9	33	9	33
10HR03	8	32	8	32
12HR01	36	36	36	36
12HR02	34	34	34	34
12HR03	33	33	33	33

Table-4: standardized cam number with respect to the chisel number

CHISEL NUMBER	CAM NUMBER
31	2
32	2.5
33	3
34	3.5
36	4,4.5

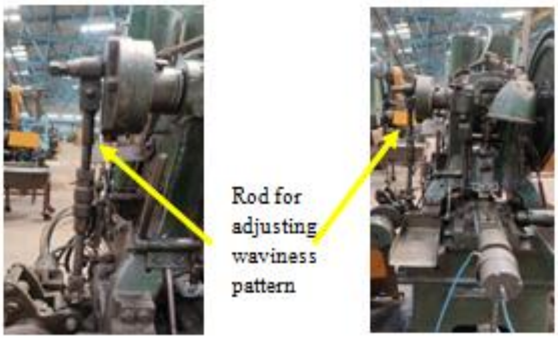

Fig-8: Rod for waviness adjustment

Table-5: Length of rod with respect to each item, machine number, cam number, chisel number

Item name	Machine NO.	Cam no	Chisel no	Length of rod (mm)
6 HR II	TA358	2.5	32	447
8 HR I	TA358	4.5	33	441
	TA359	3	33	438
	TA360	3.5	33	434
8HR I MOB	TA360	3	33	435
10 HR I	TA358	4.5	34	423
	TA359	4	34	449
10HRIMOB	TA358	4	34	445
	TA359	4	34	450
10 HR II	TA359	3	33	455
12 HR I	TA358	4.5	36	441

After successfully implementation of lean tools the difference between the expected target and actual production is calculated with help of production book, as mention in figure-7, this graph shows that the difference between expected target and actual production is minimized to 15% and 17% for flat side cutting and round side cutting respectively.

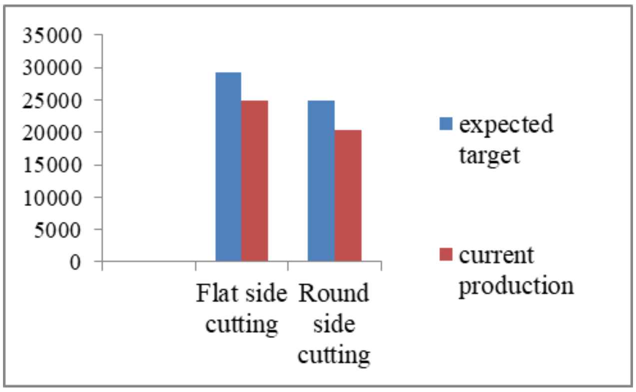

Fig-9: March production

VI. CONCLUSION

1. Lean manufacturing can be the one option for the manufacturing industries to deal with the rapid change in customer demand. Lean manufacturing is the best suitable technique to improve the productivity of rasp cutting stream.
2. Lean manufacturing tools helped to minimize the chisel grinding time by approximately 1 minute and machine setting time by approximately 6 to 8 minutes.
3. As a result the percentage difference between expected target and actual production is minimized by 4% to 5% as shown in the figure-9.
4. To improve productivity of rasp cutting stream selected suitable lean manufacturing tools are Kaizen, SMED along with the Gemba technique.

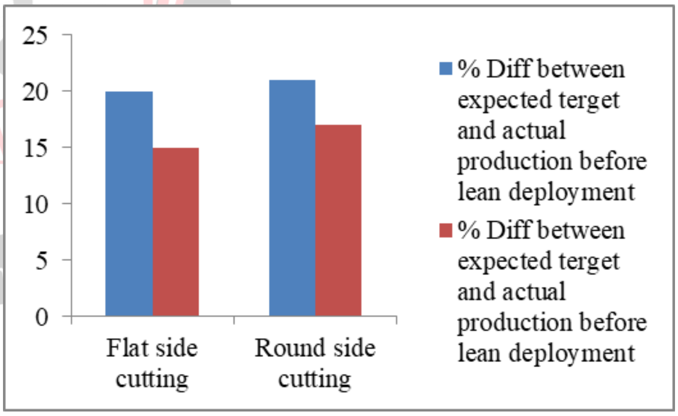

Fig-10: comparison of productivity between before and after implementation of lean tools

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