IMPLEMENTATION OF LEAN TOOLS TO IMPROVE PRODUCTIVITY IN RUBBER PARTS MANUFACTURING PROCESS AT UNIQUE INDUSTRIES, MADURAI

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ABSTRACT

Lean manufacturing practices are generally aimed at improving the product quality and increasing profitability for manufacturing in the international market. They also provide the application for variety of tools and strategies which can help in identification of waste, reduction or elimination of waste, lowering the production cost, reducing human effort and minimizing product manufacturing time. The research project is mainly focused on implementing Kaizen and 5S to improve the productivity. The present work proposes a methodology by implementing lean production techniques for productivity in the rubber part manufacturing process. In this project a lot of business implications are suggested to improve the overall productivity of the company. But due to the present Covid-19 outbreak situation the study was only limited to providing suggestions to the company. By following those suggestions in the future the company can able to cut down the cost, increase productivity and improve safety of the workers. The study was done in Unique Industries, Madurai and the responses were collected manually by approaching each and every employee to find out the difficulty that they face in the company. Fishbone diagram was used to find out the root cause of the problem and come up with innovative solutions and ideas that would be suitable for the company to implement in the future so that their productivity level would get improved.

Keyword : - *Lean Manufacturing, Kaizen, 5S*

1. INTRODUCTION

The rubber industry is one of the key sectors of the Indian economy. India is the fourth largest producer of natural rubber and the third largest consumer of the polymer. As far as consumption of natural and synthetic rubber together is concerned, the country occupies the fourth position. Although, rubber product manufacture started in India, in the year 1920, the industry has been mostly inward oriented, catering to the needs of the vast domestic market. Unique industries established in the year 1993 by a group of technocrats, in Madurai, the rubber city of India, to manufacture Special Purpose Machinery for Rubber industries, more specifically for the Belting and Sealing Industry. Unique industries is a pioneer in India with 15 years of exposure to rubber engineering is located in Madurai. The rubber city in India .Unique commenced its operations in 1993 as a SPM builder for rubber industries and expanded its wings in 2000 to manufacture molded rubber products and in 2009 to produce rubber /Plastic molds and Specialty Industrial / Auto components.

1.1 Need for study

Most of the process is done manually and there is a wide scope for semi-automation and full automation of process. There was a lack of mistake proofing system (Poka-Yoke) in the molding machine which may cause serious

accidents to the workers and there was an improper arrangement of work table causes lot of time to finish the product

2. OBJECTIVES OF THE STUDY

2.1 Primary Objective:-

To implement lean tools to improve productivity in the rubber parts manufacturing process at Unique Industries, Madurai.

2.2 Secondary Objectives:-

To study the current manufacturing process of rubber products. To implement a continuous improvement process (Kaizen) to simplify the process. To study the quality issues and the defects that occurs during the manufacturing process.

2.3 Research Methodology

The type of research method used here is descriptive research. Descriptive research is defined as a research method that describes the characteristics of the population or phenomenon that is being studied. In other words, descriptive research primarily focuses on describing the nature of a demographic segment, without focusing on "why" a certain phenomenon occurs. In general there are 3 main reasons to conduct descriptive research they are:-

- To identify the areas for further research.
- To help in planning resource allocation.
- To provide information about the condition.

Data was collected by continuous observation of the manufacturing process with the help of the supervisor who guided me for the entire process. The data was also collected by interacting with the workers to identify the areas in which they faced difficulties. The problems and queries where hand written and later used for analysis.

2.4 Primary Data

Primary data was collected from the company by face to face interviews with the employees and the insights given by the supervisor who is in charge of the entire operations and the plant.

3. ANALYSIS AND INTERPRETATAION

3.1 Time Study

First step in the analysis process was to do a time study to determine the time taken to complete each process, here time study was done for both compression and injection molding machine. The actual set curing time is 150 sec.

Table 1: Compression molding machine

Process	Machine-1	Machine-2	Machine-3
Setting time	25 sec	45 sec	36 sec
Curing time	193 sec	205 sec	175 sec
Removal time	45 sec	33 sec	115 sec
Total time taken	263 sec	283 sec	326 sec

Table 2 : Injection molding machine

Process	Machine-1	Machine-2
Setting time	30 sec	64 sec
Curing time	251 sec	305 sec
Removal time	52 sec	90 sec
Total time taken	333 sec	459 sec

Interpretation:- From the time study it is evident that there is a considerable amount of time loss in the setting and removal process (curing process is automated and it cannot be reduced further), due to this time delay there is loss of heat in the mold plates this in turn causes improper bonding of shells and rubber strips causing poor flow, which is a defective product. Theoretically the setting and removal time must be less than 30 seconds. Above which there are lots of chances to cause a poor flow in the next cycle.

In order to reduce the setting time and removal time a training session was conducted to minimize the time loss.

Table 3 : T-Test for analysis of Setting time in compression molding machine

	before training(time in seconds)	*after training(time in seconds)*
Mean	32.875	25.5
Variance	81.83928571	22
Observations	8	8
Pearson Correlation	-0.005050111	
Hypothesized Mean Difference	0	
df	7	
t Stat	2.042827963	
P(T<=t) one-tail	0.040188359	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.080376719	
t Critical two-tail	2.364624252	

Interpretation:- Training were given to 8 employees and study was done, from this we found out that There is a significant difference in setting time due to training of employees ($p<0.05$, where $p= 0.04$) and the average setting time was 33 seconds now it has become 25.5

Table 4 : T-Test for analysis of Setting time in injection molding machine

	before training	*after training*
Mean	49	33.75
Variance	200.6666667	37.58333333
Observations	4	4
Pearson Correlation	0.460600839	
Hypothesized Mean Difference	0	
df	3	
t Stat	2.424532332	
P(T<=t) one-tail	0.046893785	
t Critical one-tail	2.353363435	
P(T<=t) two-tail	0.093787571	
t Critical two-tail	3.182446305	

Interpretation:- Training were given to 4 employees and study was done, from this we found out that There is a significant difference in setting time due to training of employees ($p<0.05$, where $p= 0.04$) and the average setting time was 49 seconds now it has become 34 seconds after training.

Table 5 : T-Test for analysis of Removal time in compression molding machine

	before training	*after training*
Mean	81	59.375
Variance	580	286.8392857
Observations	8	8
Pearson Correlation	0.898721847	
Hypothesized Mean Difference	0	
df	7	
t Stat	5.289823804	
P(T<=t) one-tail	0.000567927	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.001135853	
t Critical two-tail	2.364624252	

Interpretation:- Training were given to 8 employees and study was done, from this we found out that There is a significant difference in setting time due to training of employees ($p<0.05$, where $p= 0.00$) and the average setting time was 81 seconds now it has become 59 seconds after training

Table 6 : T-Test for analysis of Removal time in injection molding machine

	before training	*after training*
Mean	60.5	41.25
Variance	191	48.91666667
Observations	4	4
Pearson Correlation	0.460378358	
Hypothesized Mean Difference	0	
df	3	
t Stat	3.133950462	
P(T<=t) one-tail	0.025953129	
t Critical one-tail	2.353363435	
P(T<=t) two-tail	0.051906258	
t Critical two-tail	3.182446305	

Interpretation:- Training were given to 4 employees and study was done, from this we found out that There is a significant difference in setting time due to training of employees ($p<0.05$, where $p= 0.02$) and the average setting time was 60.5 seconds now it has become 41 seconds after training.

3.2 Brain storming

There was a brain storming session conducted in the company that comprised of supervisor and a member from each department, the session was about the problems that they encounter during the production process and how to minimize those.

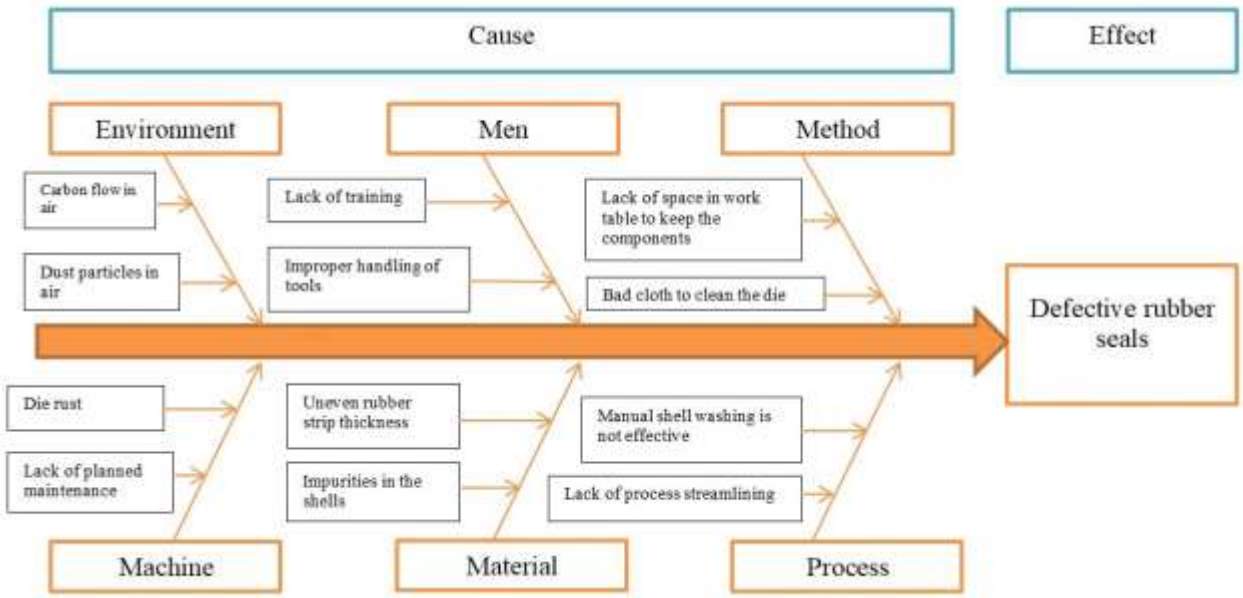
Interpretation:-
Through the session we gained more insights that threw light in this research. The points that came to light were:-

- lack of instructions at the start of the production
- Non-value added activities during production and trimming
- Improper shop floor layout
- Un-trained man power employment
- Under utilizations of machines

- Equipment breakdown
- Unbalanced work allotment
- Material shortage
- Non-maintenance of 5S in the production and cleaning area

3.3 Fishbone diagram

Fig 1 : Fishbone diagram



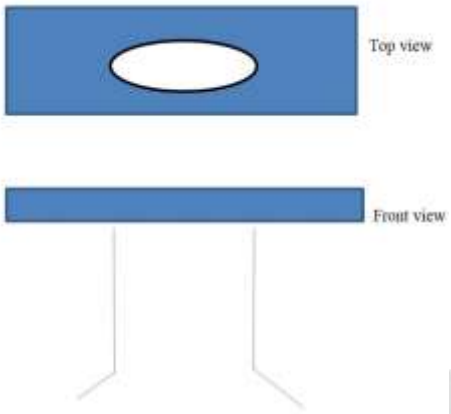
From the diagram one learns about the causes which really affect the production and the trimming process. In this diagram, the problem in Environment, Men, Method, Machine, Material and process were analyzed and these problems were corrected.

3.4 Kaizen

The process done here are mostly manual and hence there is a lot of scope for kaizen process. Kaizen can ultimately make the work done much easier and efficient and thereby it can save a lot of time and thus improve productivity which makes the company reach the daily goals. With the help of supervisor a lot of regions in the production area were observed were Kaizen can be implemented. Some of the areas where the Kaizen practices were implemented are:-

1. Lot of finished rubber seals falling outside the collecting bin, this can be minimized by keeping a slope in the front in the shape of a rectangle with the circular pipe at the center so that it does not disturb the worker and also it does not allow finished rubber seals to fall down

Fig 2 : slope to collect the falling rubber seals



An analysis was done to find out the number of seals falling out of the collection bin (for a batch of 100)

Table 7: T-Test for number of seals falling out of collection bin

	without tray	*with tray*
Mean	26.8	12
Variance	45.7	29.5
Observations	5	5
Pearson Correlation	-0.81025	
Hypothesized Mean Difference	0	
df	4	
t Stat	2.851431	
P(T<=t) one-tail	0.023164	
t Critical one-tail	2.131847	
P(T<=t) two-tail	0.046329	
t Critical two-tail	2.776445	

Interpretation:- 5 machines were fitted with a tray to minimize the seals falling out of collection bin. The test shows that there is a significant difference in falling of seals from the collecting bin ($p<0.05$, where $p=0.02$) and average number of seals falling when there was no tray was 27, with tray it is 12.

2. The inspection table uses an ordinary tube light which consumes more electricity, So CFL bulbs can be used to minimize the cost of electricity.

Analysis was done between the tube light and CFL bulbs on the basis of power consumption

Table 8: T-Test for power consumption between tube light and CFL bulbs

	Tubelight(power consumption in watts)	*cfl bulbs(power consumption in watts)*
Mean	55.16666667	14.33333333
Variance	5.366666667	1.466666667
Observations	6	6
Hypothesized Mean Difference	0	
df	8	

t Stat	38.26257166	
P(T<=t) one-tail	1.19529E-10	
t Critical one-tail	1.859548038	
P(T<=t) two-tail	2.39059E-10	
t Critical two-tail	2.306004135	

Interpretation:- Power consumption test was done for 6 tube lights and 6 CFL bulbs, from analysis it is found that there is a significant difference in power consumption between tube light and CFL bulbs (p<alpha, where p= 2.39E-10). The average power consumption for tube light is 55 watts whereas for CFL it is only 14 watts.

3. Conventional table makes the worker difficult to manage things like pallets, rubber strips and shells. To avoid this a table with racks can be provided

- Top rack:- shell box that is being used, pallets and a sheet of rubber strips
- Middle rack:- rubber strips that is arranged in the order
- Lower rack:- shell boxes

4. To avoid loss of temperature in the compression molding machine during a power cut, A UPS with auto start generator can be placed just like what that has already in injection molding machine.

5. Weighing scale is subjected to air breeze and vibration, to minimize this the weighing scale should be kept in a clean flat surface and a cardboard box should be placed on covering three sides to prevent air breeze, following this will improve accurate reading.

3.5 5S

The analysis of 5S was done by analyzing the employees and the supervisor about their roles and responsibilities towards organizing and the cleanliness of the workplace. Here the supervisor has a thorough knowledge in 5S principles and he leads the employees.

- First a team is formed after giving the brief about 5S and its benefits
- The team consists of members from various production departments.
- The team leader is changed every week so that everyone gets a chance to experience the leadership role.
- The supervisor after discussing with the team leader makes necessary changes to further improve the 5S process.
- Further training will be given from outside like coindia to improve the present 5S process.

Interpretation:- By implementing the 5S principles and practices the company was able to dispose waste safely, the workplace was kept clean, the machines were periodically cleaned and the workers were able to practice self-hygiene.

3.6 Poka-Yoke

There was a lack of hand sensor in the compression molding machine, this may lead to serious accidents when not handled carefully and also there was a lack of lubricant sprayer to lubricate the mold in order to prevent sticking of rubber strips due to heat.

Fig 3 : Hand sensor

Fig 4 : Lubricant Sprayer

Interpretation:- By implementing these two the safety of workers are improved and the productivity of the batch increases.

4. CONCLUSION

The company can improve the productivity by implementing automation to the process, like pick and place robots and poka yoke systems, the labors operating the molding machines are semi-skilled which increases the set up time of the shell and rubber strips and the removal time of the finished rubber seals. The shell washing process is done manually by just rinsing the shells in the toluene solution this does not prove to be an effective method. The company can also consider periodic training of labors in the field of equipment safety and material handling, as there is no mistake proofing system is involved one wrong step could be fatal. By implementing a cellular layout can minimize the movement of components from one place to another. The company has a wide scope in implementing various kaizen practices which would simplify the process and cut down the number of labors, which would be a cost cutting for the company.

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