

Lean Manufacturing Techniques for Effective Utilization of Man Power in Engine Accessory Production Line

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ABSTRACT: Lean principle is a technique used in all industries to improve performance, productivity, reducing the production cost, eliminate wastages and reduce non-value added, non-cyclic activities. This paper describes the effective utilization of man power in engine accessory production line carried out at XYZ organization located in South India. The various activities of the workers have been categorized into cyclic and non-cyclic activities. After observing the production line, there are 10 workers whose utilization ranges from 29.42% to 71.28%. A standardized work combination table is drawn for all 10 workers to identify their utilization. Using ECRS tool, some activities were eliminated, few processes were combined and machines were rearranged and simplified. Value Stream Map (VSM) is drawn to find out the current cyclic and non-cyclic activities. Future Value Stream Map is developed to design a lean process flow through the elimination of the root causes for the wastes and through process improvements. This paper uses some lean techniques thereby helps the management to improve the utilization of man power in engine accessory production line.

KEYWORDS: Lean Principle, ECRS, Standardized Work Combination Table, Value Stream Mapping, Engine Accessory.

I. INTRODUCTION

The objective of Lean Manufacturing is to reduce waste and highly responsive to customer demand while producing quality products in the most efficient and economical manner. The core idea behind lean manufacturing is maximizing customer value while minimizing waste, thereby achieving manufacturing excellence through the creation of more value with fewer resources. 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. Eliminating waste along entire value streams, instead of at isolated points, creates processes that need less human effort, less space, less capital and less time to make products and services at far less costs and with much fewer defects, compared with traditional business systems Lean can be applicable to any process not only to the manufacturing. Value is defined as a product or service for which customer desires. There are various tools which is used widely for implementation of Lean in industry. SWCT is a kaizen tool, which means standardized work combination table. ECRS is a tool which is used to eliminate, combine, rearrange and simplify the process, so that the productivity can be improved. With the help of this tool, we can able to identify the activities of the worker in the graph form. Value-stream mapping is a pencil and paper tool that helps you to see and understand the flow of material and information as a product makes its way through the value stream. Value Stream Mapping can also be applied to the process industry as well as to the service sector. In this paper, VSM technique is applied to the flow line manufacturing process in the context of production improvement. The main objectives of this paper are to find out the cyclic and non-cyclic activities, identify the unused man power and to effectively utilize the man power.

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II. LITERATURE REVIEW

Sindhuja. D (2012) presented the procedure of ECRS and also explained where to apply it. By applying ECRS, many non value added activities can be reduced. The main aim of using ECRS tool in horn assembly is to eliminate the goal to combine or reset the place, time and person and to simplify the method provides better effect and process flow method. D. O. Fakorede (2014) presented briefly how to compare the utilization of men and machines on Nigeria mills. By using this paper, the productivity also improved in that particular organization. The analysis also shows that increase in manpower can also give rise to increase in productivity, although it has been observed that increase in production may or may not affect increase in productivity ratio. Rohana Abdullah (2014) explained the improvements on man to machine ratio suggested through work study which leads to an improved number of workers in a production line. By reducing workers and optimizing sources, the operation cost can be improved and helps the semiconductor manufacturing company towards achieving competitive advantage over other competitors. N. Sathiya Narayanan (2015) explained the basic concepts of Value stream mapping and how to implement them in production line. He also explained the advantages of using VSM very clearly. In this paper, the implementation of VSM leads to increase in productivity and reduce in lead time by reducing non value added activities.

III. PROCESS FLOW

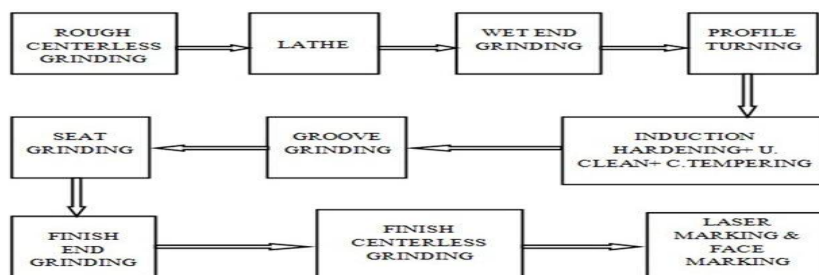


Figure 1: Process flow in production line

This study concentrates on the utilization of worker in a manufacturing industry. Initially, raw material from cut bar section is moved to forge shop. After the process in forge shop, the unfinished product will be shifted to machining line. In machining line, the production sequence is from Rough Centre less grinding to Laser marking and Face marking. In between there are many operations such as Lathe (facing, chamfering, turning), Wet end grinding, Profile turning, Induction hardening, ultrasonic cleaning, continuous tempering, Groove grinding, Seat grinding, Finish end grinding, Finish Centre less grinding. Totally there are 10 workers in the machining line.

IV. DATA COLLECTION

Data are collected using stopwatch and recorded for the actual production on a shift basis. It helps to find out the major time consuming operations, cyclic and non-cyclic activities. It also helps to visualize the root causes and possible solutions for the problems.

A. Cyclic & Non-Cyclic activities

The activities which are repeatedly done at regular cycle of time is known as cyclic activities. The activities which are randomly done without regular cycle of time is known as non-cyclic activities. The cyclic activities include loading, unloading of job and getting job from previous machine. The non-cyclic activities include inspection, adjustments, packing, walking.

B. Takt time & Utilization

Takt time is defined as the time required for completely transforming the raw material to finished product based on the customer demand.

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$$\text{Takt time} = \frac{\text{Time available for a shift or a day}}{\text{Demand per shift or day}}$$

The customer demand for the line is 6200 jobs per day and the exact working hours per day is 21 hours. By calculating using the given data, the takt time is found to be 12.194 seconds.

Utilization is the ratio of the time consumed by the activities of worker to the takt time.

$$\text{Utilization} = \frac{\text{Time for worker activities}}{\text{Takt time}}$$

CURRENT LAYOUT OF MACHINING LINE

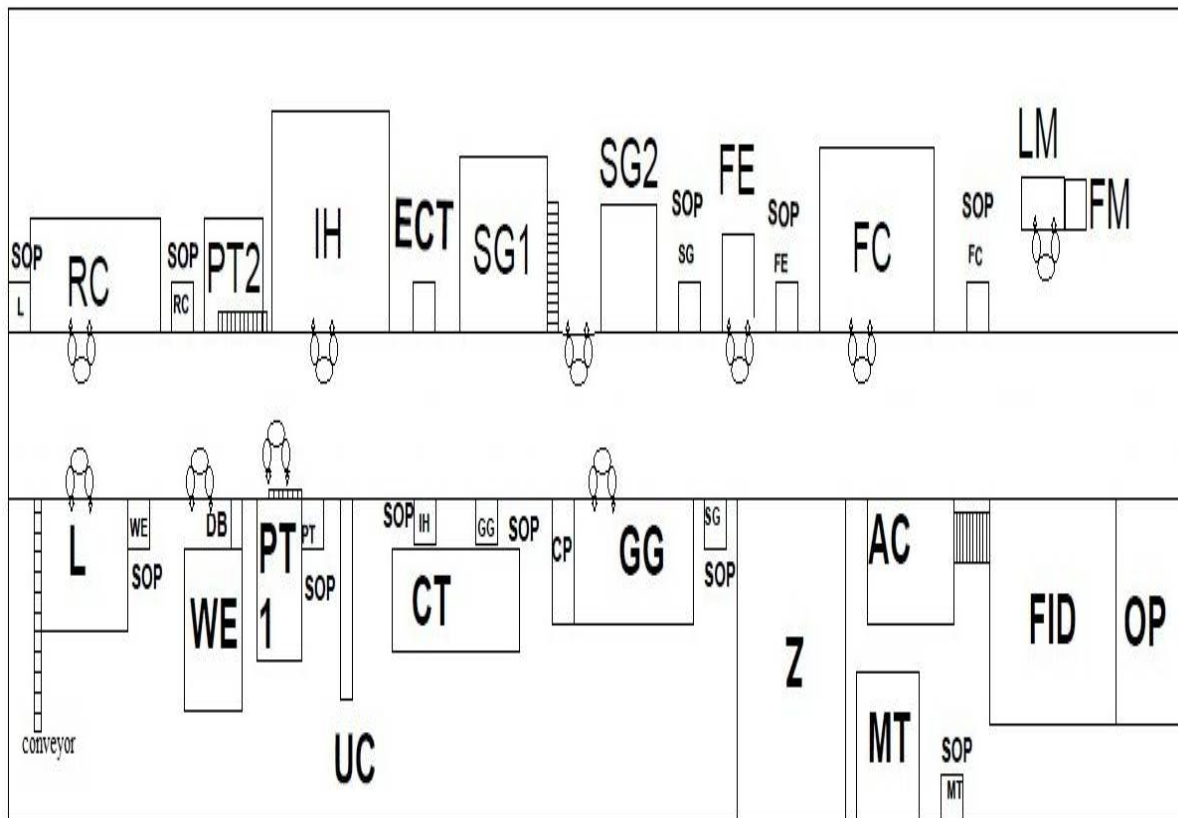


Figure 2: Layout of Machining line

From the layout, it is easy to understand the positions of the machineries, number of workers and the process flow. There are totally 10 number of workers working in the line. And the process starts from RC to Laser Marking & Face Marking.

V. CURRENT SCENARIO

The worker's utilizations are below 75% in the current scenario. Cyclic utilization of each worker has a percentage of less than 45. Similarly non cyclic utilization also has same percentage as that of cyclic utilization.

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Table 1: Current Cyclic and Non-Cyclic Utilization

S.No	Workers	Working Machine	Utilization (%)		
			Cyclic	Non cyclic	Total
1.	1	Rough centre-less grinding	21.62	16.57	38.19
2.	1	Lathe	19.97	25.28	45.25
3.	1	Wet end grinding	20.05	9.37	29.42
4.	1	Profile turning	26.64	28.42	55.06
5.	1	IH + Ut. Cleaning + C. Tempering	30.26	1.02	31.28
6.	1	Groove grinding	21.43	49.85	71.28
7.	1	Seat grinding	21.22	35.26	56.48
8.	1	Finish end grinding	33.03	10.39	43.42
9.	1	Finish centre less grinding	26.12	5.12	31.24
10.	1	Laser marking & Face marking	43.467	15.39	58.86

The utilizations of each worker have been tabulated in Table 1. This utilization was calculated based on the Takt time (12.194 sec). The minimum utilization in the line is 29.42% for the worker in the machine Wet end grinding. Thus the utilization has been calculated for all workers.

VI. DATA ANALYSIS

The collected data are analyzed using lean tools such as SWCT, ECRS and VSM. By using SWCT tool the utilization of workers has been plotted based on the Takt time. By identifying the non cyclic activities, suitable suggestions are discussed below. ECRS tool is used for combining the workers, eliminating the unnecessary activities, rearranging the position and simplifying the process. Here ECRS is used for all workers and identified the problems. VSM is developed for all the workers in the machining line based on their cyclic and non cyclic activities. A future state VSM is planned based on the given proposals and its machining shop manpower utilization is analyzed.

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SWCT for RC Worker

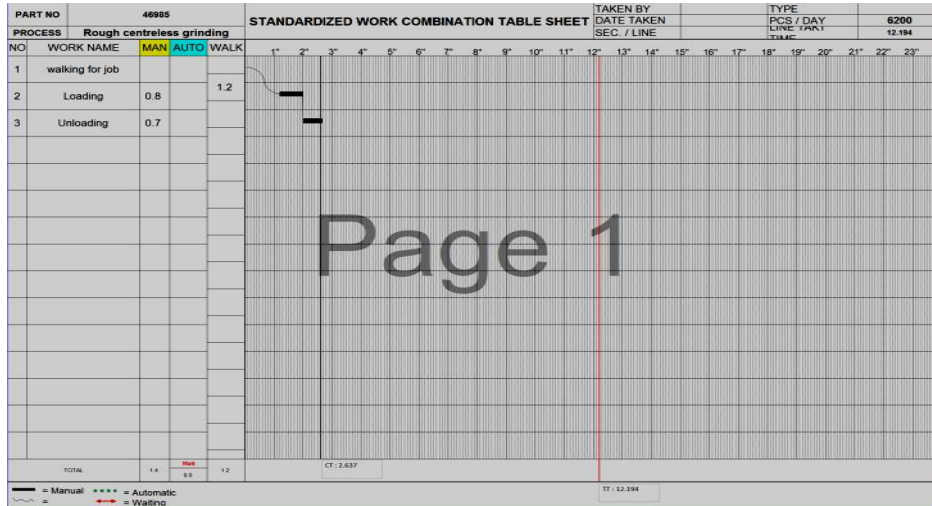


Figure 3: SWCT for RC

From the above graph, the red line shows the Takt time. The straight line indicates the loading and unloading of job and the curved line indicates movement of the worker. Here, we can see only 20% of the time was utilized as the cyclic time. Similarly the SWCT was plotted for another nine workers and the utilization have analyzed.

Table 2: ECRS Table for All Workers

S.No	Workers	Working Machine	E	C	R	S
1	1	Rough centre less grinding	*	*	*	*
2	1	Lathe	*	*	*	-
3	1	Wet end grinding	*	*	-	-
4	1	Profile turning	-	*	-	*
5	1	IH + Ut. Cleaning +Con. Tempering	*	*	-	-
6	1	Groove grinding	-	-	-	-
7	1	Seat grinding	*	*	-	*
8	1	Finish end grinding	*	*	-	-
9	1	Finish centre less grinding	*	*	-	-
10	1	Laser marking & Face marking	-	-	-	-

From the table, the ECRS which applied for various process was tabulated. *symbol indicates that the corresponding tool used for that corresponding process. Example: In Lathe three tools are used (E, C, R).

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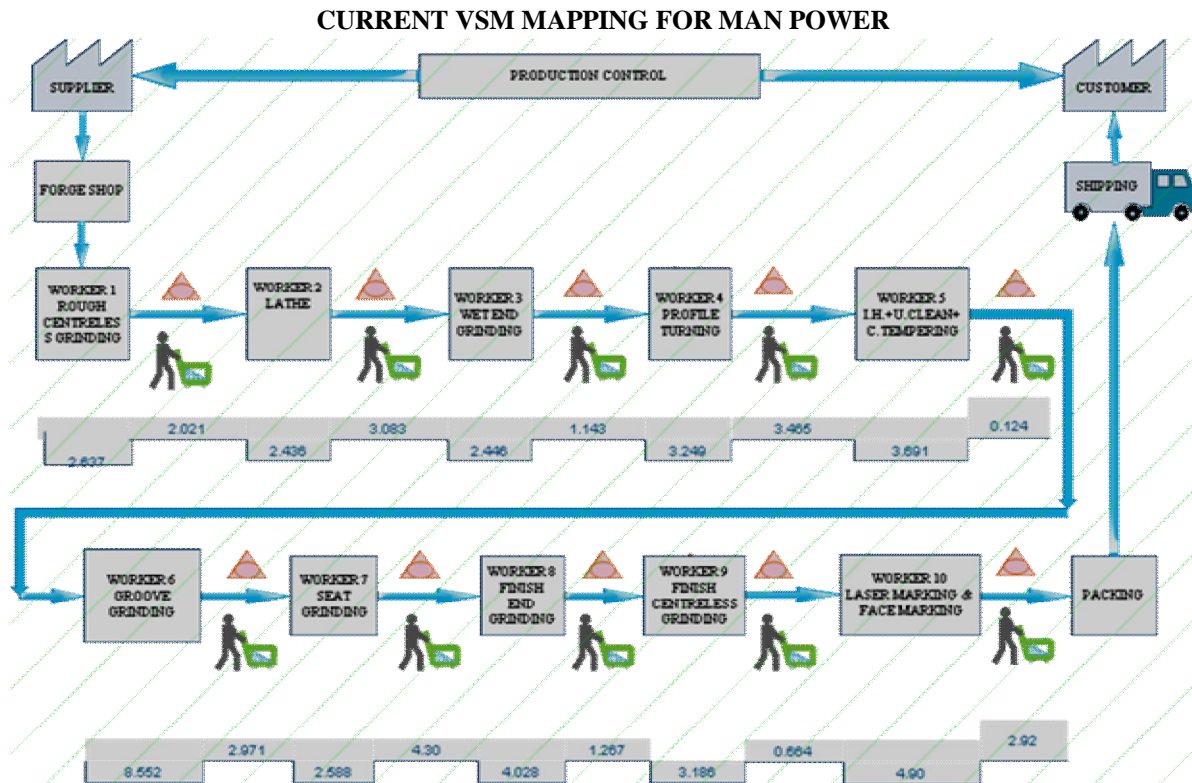


Figure 4: Current State VSM

From the figure 4, the cyclic and non cyclic activities have calculated as 32.15 sec and 25.03 sec respectively. The line below indicates the cyclic activities and above indicates non cyclic activities. The triangle with circle indicates inspection with delay.

PROPOSALS

Based on the above analysis the following suggestions have given to improve the manpower utilization.

- Combine the following process and reduce the workers, 1.a. Rough centre less grinding-Lathe-Wet end grinding. 1.b. Induction hardening, Ultrasonic cleaning, continuous tempering-seat grinding. 1.c. Finish end grinding-Finish centre less grinding.
- Use open end type of conveyor, so that the job will collect in the tray directly.
- Put worker who operating profile turning machine for taking job from run out checking point.
- Change the position of run out checking point in forge shop and put weighing machine nearby it. Change the orientation of lathe by rotating 90⁰ towards left and place the conveyor for unloading the job, so that job will reach the worker at wed end grinding.
- Change the direction of conveyor for profile turning machine 1, so that walking time of worker in induction hardening will reduce.
- Increase the length of conveyor and change the position of it in seat grinding machine 1, So that walking time for worker in finish end will reduce.

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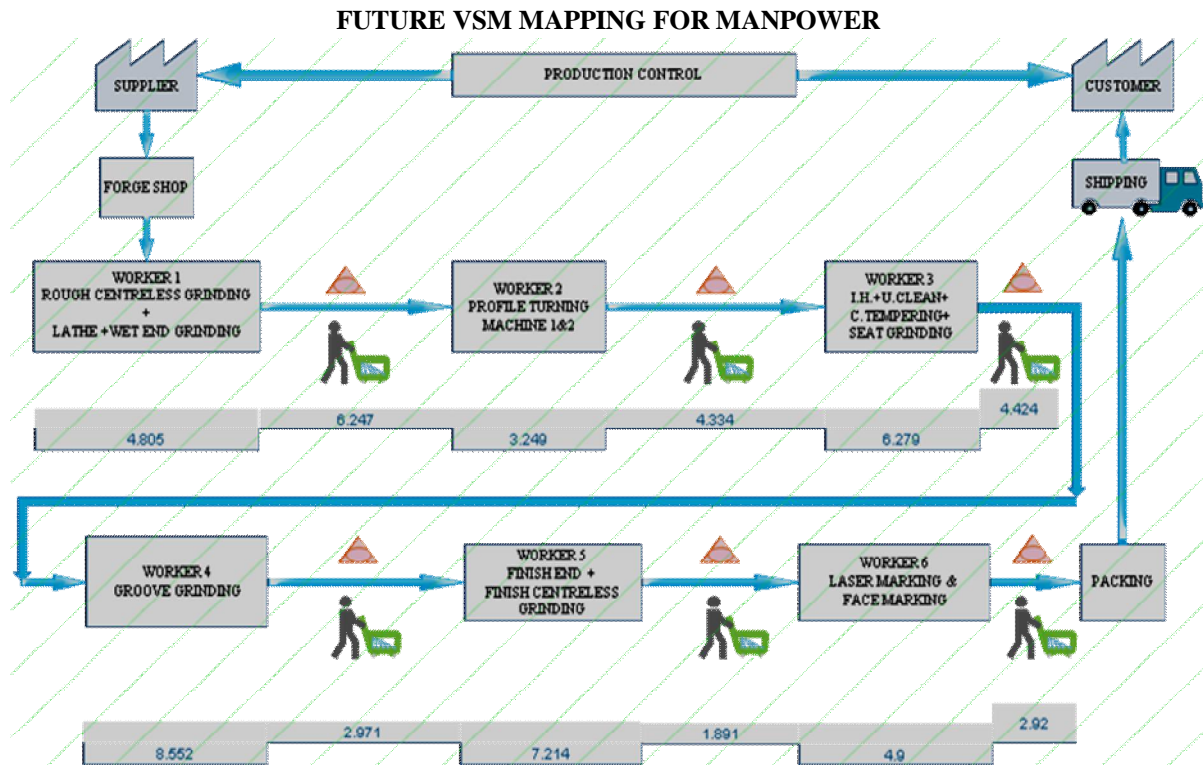


Figure 5: Future state VSM

From the figure 5, the cyclic and non cyclic activities have calculated as 34.99 sec and 22.79 sec respectively. After implementing the proposal the cyclic time of the workers has been increased whereas non cyclic time has been reduced. As cyclic time increases utilization of the workers also increases.

MODIFIED LAYOUT OF MACHINING LINE

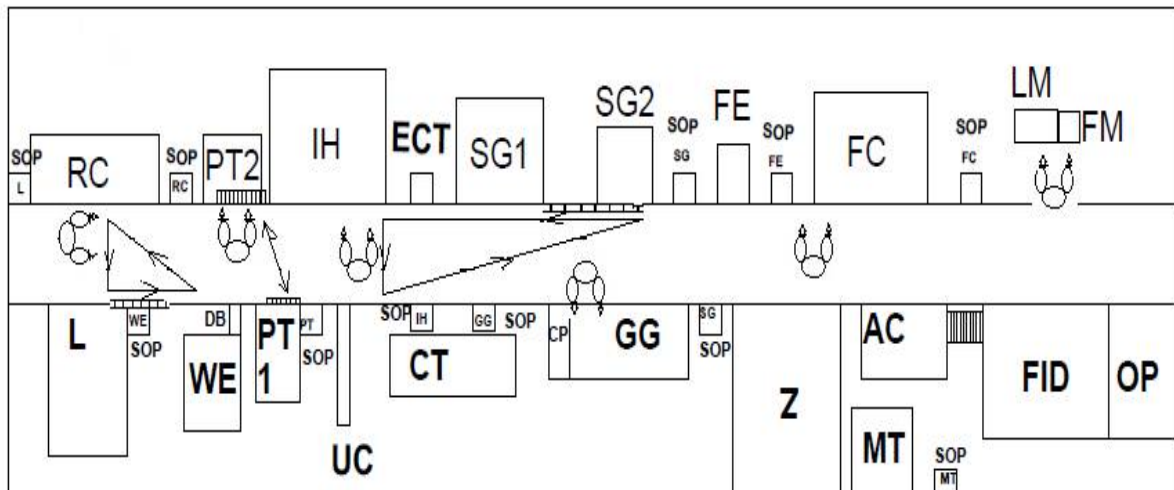


Figure 6: Modified Layout

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After the implementations of proposals the layout of the line was modified as above the Fig. 6. Here total numbers of workers are 6. And the movement of the workers is indicated in the layout.

Table 3: Comparison of Manpower

Before Improvement				After Improvement			
S No	Worker	Working M/C	Utilization %	S No	Worker	Working M/C	Utilization %
1	1	RC	38.19	1	1	RC + Lathe + Wet end	90.61
2	1	Lathe	45.25				
3	1	Wet end	29.42				
4	1	P. Turning	55.06	2	1	P. Turning	62.19
5	1	IH + U. Clean + Tempering	31.28	3	1	IH + U.C + Tempering + Seat grinding	87.76
6	1	Groove grinding	71.28	4	1	Groove grinding	71.28
7	1	Seat grinding	56.48	5	1	Finish end + Finish centre less	74.66
8	1	Finish end	43.42	6	1	Laser & Face marking	58.86
9	1	FC	31.24	Total no. of workers = 6			
10	1	Laser & Face marking	58.86				
Total no. of workers = 10							

From Table 3, the utilization before the implementation and after the implementation was compared. And the utilization for each worker was improved. And the number of workers reduced from 10 to 6.

VII. CONCLUSION

The utilization of worker in the line has been improved by implementing lean principle and its tools. The activities of individual workers includes cyclic and non-cyclic have been studied by using stop watch technique method and the utilization of the each workers were determined. The Plant layout of the line was analyzed and improved by lean tools such as SWCT (Standardized Work Combination Table) to find inactivity of workers, and ECRS (Eliminate, Combine, Rearrange, Simplify) to improve the utilization. By using these tools, the process have combined together, eliminated extra workers, rearranged the positions of machineries and simplified the process. So that, the number of workers is reduced from 10 to 6.

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