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IMPLEMENTATION OF LEAN MANUFACTURING TO ENHANCE THE PRODUCTIVITY AND REDUCE THE HUMAN EFFORT IN PAINT PRODUCTION INDUSTRY: A CASE STUDY

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ABSTRACT

Effective manufacturing process and equipment planning and design aids in reaching maximum productivity by making the best use of available resources, resulting in the least amount of industrial waste and, as a result, lower production costs. The goal of this study is to examine how industrial engineering tools are used in the paint industry. This study started with a review of standard operating procedures and a comprehension of the present process flow. Simultaneously, observations were performed on the manufacturing line to identify flaws and areas for improvement. Time study, method study, and layout research methodologies were integrated to find and correct time spent in unnecessary labour and tool motions that resulted in long machine idle time.The packaging technique was time-consuming and archaic, but it was simplified. It was suggested that redesigning the process flow and efficient material handling could reduce machine idle time, that replacing the old packaging method with zip ties would require less manpower and help mitigate non-value added activities, and that this could lead to increased industry productivity.

Keywords:Production, lean manufacturing, Industry, layout.

1. Introduction:

As a result of the country's recent resilience, the world has come to accept India's and Indians' dominance in all spheres of life. India's economic strength, human resources, and political will are being recognized by world leaders. They are comparing the economies of China and India, and many believe that India will become an economic superpower within the next two decades.

India has demonstrated to the rest of the world how a country that experienced a major economic crisis in 1991 was able to use the crisis to effect significant change in public perceptions of economic growth and stability. The new economic policy of 1991 resulted in a paradigm shift in the planning and development process. The government made a sincere effort to link the Indian economy with the global economy as part of the liberalization and globalization process. With the globalization of markets and finance, the economy began to flourish. In a short amount of time, the Indian industrial sector became more sensitive and responded positively, demonstrating extraordinary growth.

The housing industry is one that has seen substantial growth in India in recent years. Increased disposable income, easier access to house loans from commercial banks and housing finance institutions, and government support in the form of tax breaks have all contributed to the industry's expansion. In addition to this business, the automobile industry has experienced rapid expansion in recent years. Both of these businesses have a significant multiplier effect on the Indian economy. The requirement for the use of paints is a common aspect in these two sectors. Paint is required in large quantities by both the housing and vehicle industries, and as a result, the paint industry has grown significantly.

Although paint looks to be a luxury item, it is actually one of the most important items in a man's life. Every person want to construct his or her own home. The majority of houses, whether modest or large, require painting. Paint plays a crucial function in the entire construction process. It both protects and enhances the appearance of buildings.

The Indian paint sector has also benefited from the economic reforms. Paint was one of the most expensive products in the construction sector. The excise duty on paints used to be as high as 40% in the 1980s. Following changes, the excise charge gradually decreased from forty percent to a lower amount. The excise tax is currently as low as sixteen percent. The sector has also benefited from the movant and convert facilities. The relaxation of the MRTP Act and FERA has aided the expansion of the Indian paint industry to some extent.

2. LiteratureReview

Several studies over the last four decades have sought to quantify line efficiency and the influence of interstate buffer capacity on various performance evaluations, and there is a substantial body of literature on the analysis of asynchronous serial lines with trustworthy devices. The majority of research is devoted to determining line efficiency as measured by throughput, either analytically or through approximation methods such as prediction equations or simulation models. To calculate throughput for lines of constrained length and/or specific processing time distribution functions, exact formulas and numerical approaches are established. Several approximate formulas and simulation methods are presented for the throughput of longer lines with varying distribution characteristics.Another set of studies looks for the best way to allocate buffer capacity to maximize throughput. Finally, a few researchers look into higher throughput situations. Only these studies will be discussed in this section.

2.1 Organization of the Workplace (5S): To promote easy operation within the workstation, appropriate workplace organisation is essential [6]. In an organization that wishes to eliminate unnecessary production costs and boost productivity, the workplace place organisation (5S) method is extremely useful. This strategy ensures that all activities in the workplace are completed in the proper sequence. Other strategies such as Just in Time (JIT) and Total Quality Management are aided by this technique (TQM). The 5S notation is derived from the sequential

implementation of five procedures in the workplace: Sort, Set in order, Shine, Standardize, and Sustain [7]. A clean environment guarantees that the entire production process runs smoothly and that the product shines.

2.2 SMED (Single Minute Exchange of Dies) is one of the many procedures utilised in the industrial manufacturing process. It usually aims to shorten the time it takes to complete an equipment swap. Waste is frequently hidden in the form of mobility, transportation, waiting, faults, and overproduction during changeover time. When the teams involved in changeovers are individually responsible for a given machine, SMED works best [10]. It is a powerful strategy for reducing waste in processing activities and improving them as quickly as possible [5]. External activities are separated from each other and the details of the changeover procedure are highlighted.

2.3 Work standardisation: In lean management, they are procedures that must be followed during the manufacturing process [3]. The goal of work standardisation is to ensure that all employees/workers can correctly and to the appropriate quality perform a given activity or carry out a long process from (a) to (z). Standard work standardisation begins with the creation of a standard form of work and subsequently extends to all tasks. It's best if the form is as simple as possible.

2.4 Kanban System: Kanban is a lean manufacturing system that aims to enhance efficiency by controlling inventories and the supply chain. The Kanban implementation process is a little depressing. Kanban, on the other hand, is incremental and improves over time. When things happen, changes are created, and the first steps are the most significant. The second stage in Kanban implementation is usually to create a Kanban board [9]. The basic concepts to follow while implementing Kanban are visualisation of workflow, reducing the number of issues being worked on, and optimising cycle time.

3. SYSTEM MODELING AND PROBLEM FORMULATION

3.1 Serial production lines： A serial production line is made up of a series of manufacturing units that are positioned in a sequential order, as well as material handling equipment that carry parts (or jobs) from one unit to the next.

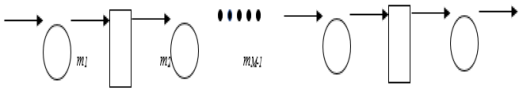

Figure 1:displays a block diagram of a serial manufacturing line, with circles representing producing units and rectangles representing material handling equipment

3.2 Assembly systems: Two or more serial lines, known as component lines, one or more merge operations, where the components are assembled, and maybe many additional processing operations conducted on an assembled part make up an assembly system. Figure 2.2 is an example of a typical assembly line in the automotive industry.

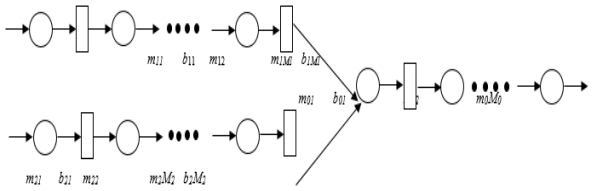

Figure 2: System for assembly using a single merge operation

4. Methodology

The researcher walked through the facility, identifying each operation process involved from raw materials to finished goods, as well as all of the places where inventory is stored between processes, and observing how the material flowed from one operation to the next in order to gain first-hand knowledge of the production flow and become familiar with the activities performed at the floor shop.

In Industrial Engineering, there are a variety of approaches that can be used to reduce waste. Work Study methodologies, such as Method Study and Work Measurement, were chosen by the researcher from among these options. The initial hurdle was to choose the product to be investigated, using the fundamental Method Study approach.

For the former procedure, a time study was conducted to determine how much time the operator would need to set up the machine, combine chemicals, powders, and other materials, and produce the product. Operation, transit, inspection, delay, and storage were the main components.

As a result of the time study, the total time needed to prepare the machine was discovered to be 25.5 minutes. Similarly, the second step involved conducting a time study for product packaging, which revealed that the total time required to package the product was 56.2 minutes. The machine used a 30-minute interval between each addition to blend the elements. A total of 150 items were captured in time. (Refer to Fig.3).

S.NO.	Elements	Distance (meters)	Time(Seconds)
1.	Walk to the rest platform	9.70	6.00
2.	Bring rest platform	3.00	3.00
3.	Walk to sitting stool	3.00	7.00
4.	Move away sitting stool	4.00	9.00
5.	Walk to power trolley	11.00	28.00
6.	Bring powder trolley near machine	10.25	4.00
7.	Walk to forklift	1.30	3.00
8.	Insert forklift into the trolley	---	4.0
9.	Walk to machine	2.00	6.00

Fig.3- Time Study Sheet

S.NO	Repeating Elements	Sequence	Elements	Distance (Meters)	Time (Seconds)	○	⇨	D	□
1.		1	Walk to rest platform	9.70	6.00				
2.		2	Bring rest platform	3.00	3.00				
3.		3	Walk to sitting stool	3.00	7.00				
4.		4	Move away sitting stool	4.00	9.00				
5.		5	Walk to powder trolley	11.00	28.00				
6.		6	Bring powder trolley near machine	10.25	4.00				
7.		7	Walk to forklift	1.30	3.00				
8.		i	Insert forklift into a trolley	---	4.00				
9.	v	8	Walk to machine	2.00	6.00				

Fig.4- Flow Process Chart

4.1 High level Problems identified in a nut shell.

• Improper Layout, resulting in extra motions

• Improper tool placement

• Non-productive tasks with no end value

• Improper Material Handling

• Traditional and time-consuming packaging methods

• Traditional production processes and equipment

• Poor ergonomics

4.2 Developing of Improved Layout: The layout of that area is determined by how materials and machinery are arranged. Before deciding on changes to the current layout, a thorough examination of the flow was conducted, as changing the layout is a costly procedure that entails the relocation of heavy-duty machinery and the halting of production.

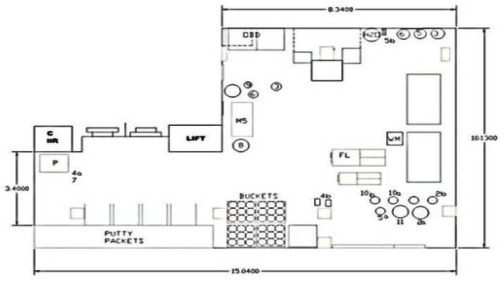

Fig.5- Original Layout

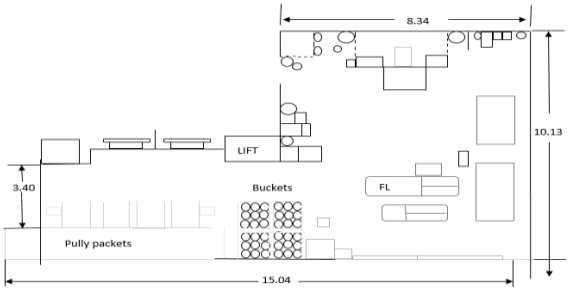

Figure 6 – Proposed Layout

The researcher discovered the following issues using a flow process chart (see Fig. 2) and a string diagram (see Fig. 12):

• All chemicals are kept a safe distance away from the equipment.

• Water-requiring chemicals are kept away from the faucet.

• There is no place for MCB maintenance because the weighing machine is kept away from all preparation centres.

The following suggestions were made to reduce worker fatigue, enhance material movement, improve material accessibility, increase free space, and improve worker and material safety in accordance with convenience.

(Refer to Fig. 3 & 4):

•Relocating the chemicals and bonds to make room for new ones.

• Water-required chemicals would be kept close to the faucet.

• Two more weighing machines have been added to improve feasibility.

• Setting aside free space for MCB maintenance.

• Providing free space near containers to make them more accessible.

• Reallocation of raw materials to avoid interfering with the other machine's setup.

• Relocating packaged goods closer to the lift area to improve accessibility

4.3. Improvement in Material handling

In the course of processing, moving and transporting goods from one location to another takes a lot of time and work. Although it is costly and adds no value to the end product, it cannot be totally eradicated, but it can be significantly minimised if suitable safety measures and equipment are applied at the lowest feasible cost. The researcher advised the following improvements to eliminate supererogatory worker motion and superfluous material transportation.

4.3.1 Overhead wiring of Manual forklift

The wiring of the manual forklift is currently strewn across the floor in a haphazard way (see Fig. 5). As a result, the risk of the operator's feet becoming entangled in the wire increases, limiting the manual forklift's movement. The researcher proposed overhead wiring (see Fig. 6) with an air tool stand that included a spiral hose to solve this problem.

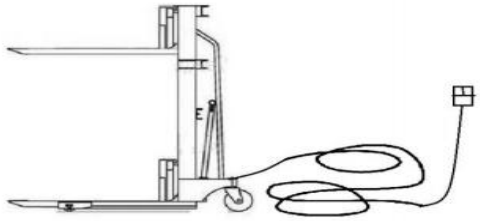

Fig.7- Present Arrangement

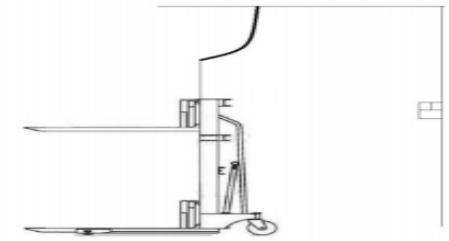

Fig.8- Proposed Arrangement

Benefits of the proposed idea area as follows:

•There are no obstacles in the way of the manual forklift's progress.
• There are fewer risks of wire damage, which means fewer chances of electrocution
• Powder trolley movement is unrestricted Better manual forklift handling techniques, such as straight motion rather than radial motion.

Table 1

S.N.	Manufacturing with:	Batching time	Mixing time	Packing time	Total time in (hours)	Total time (Minutes)	Time save
1	Present method	25.05 min	30 min	56.21 min	1 hr 51.26 min	111.26	
2	Proposed method	22.11 min	30min	41.50 min	1 hr 36.61 min	93.61	17.65 min

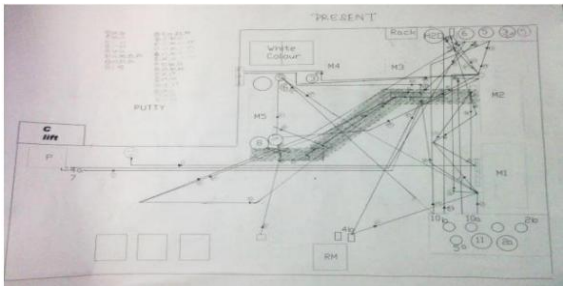

Fig.9- String Diagram of Original Layout

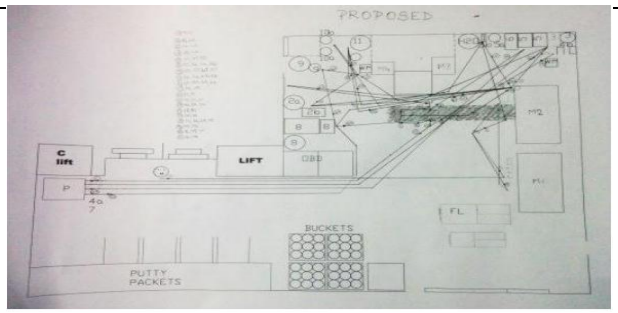

Fig.10- String Diagram of Proposed Layout

5. ResultsandDiscussion

5.1. Evaluation of developed methods

a) After the layout was improved, time was saved = 1.84 min.

b) Time is saved as a result of improved material handling= 1.1 min.

c) After packaging was improved, time was saved = 14.71 min.

Therefore, total time saved in 1 batch = 17.65 min.

- Shift Timings 10:00 am to 6:00 am including lunch break of 30 minutes.
- Total Available time = 450 minutes
- Number of paint bags produced and packed per batch = 52
- Number of working days in a month = 25

- **With Present Method**
- Number of batches that can be performed is

$$\frac{450}{111.26} = 4.04\ batches$$

- Number of paint bags that can be produced and packed in 4.04 batches is

4.04 x 52 = 210.28 paints bags

- Number of paint bags that can be produced per month is

210.28 x 25 = 5252 paint bags

- **With Proposed Method**
- Number of batches that can be performed

$$\frac{450}{93.61} = 4.8\ batches$$

- Number of paint bags that can be produced and packed in 4.8 batches

4.8 x 52 = 249.6 paint bags

- Number of paint bags that can be produced per month

249.6 x 25= 6,240 paint bags

- Increment in production of paint bags is

6240-5252 = 988 paint bags

- Therefore, increment in productivity is

$$\frac{988}{5252} * 100 = \mathbf{18.81\%}$$

Thus, we can say that with this calculation that if we will apply this phenomenal study in current inspected industry the productivity rate of overall industry is increased 18.81% approximately. This calculation is properly observed by calculating all the data's of time, men force and machinery. Now we can also see our result through graph chart,

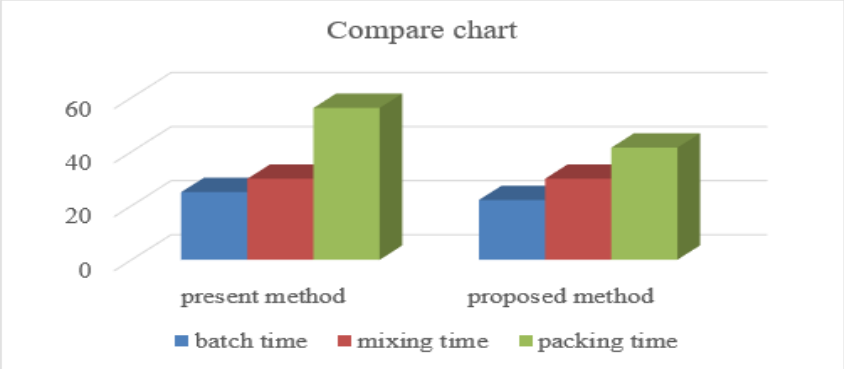

Fig11. Time Reduction Chart

Fig12. Increment of productivity

6. Conclusion

After reviewing their process map and value stream mapping initiatives, it is clear that lean manufacturing should be the foundation for all industrial processes. It is a way for running a successful business since it aids in reducing waste and improving productivity, which in turn aids in energy conservation.

The most important step toward a lean environment is for company personnel to be reminded of the value of lean implementation to the organisation and its employees on a regular basis. Quality and time can both be improved if lean is correctly implemented throughout the system. This will boost the company's profitability, which will lead to a pay hike. It has been discovered that avoiding congestion can save roughly 30 minutes of energy.

It was also discovered that non-value added activities cannot be eliminated entirely, as some non-value added activities are required for the processes to advance. The time it takes to accomplish these non-value added activities, however, might be reduced.

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