Application of Lean Principles to Reduce the Non-Value Adding Transportation Activities in a Rubber Components Manufacturing Industry

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Abstract

The Automobile rubber components manufacturing is a mass production process with high operational and inventory costs. In the competitive manufacturing sector, industries are forced to produce products with a high variety of components at reduced cost and with improved quality products. The excessive operational and inventory costs, and wastes result in high product cost and losses in the profit. So, the small and medium scale rubber component’s industries are trying to implement the Lean concept in their operations, in order to survive in the competitive global market. The ultimate aim of this research is to evaluate the possibility of reducing the operational and inventory wastes, using lean manufacturing practices. This paper orients towards an identification and elimination of wastes in rubber component’s manufacturing industries, using lean principles. This approach is also focused on the reduction of non-value adding transportation activity by properly modifying the warehouse layout, using the spaghetti diagram, and provide the proper ergonomics to the workers.

Keywords: Rubber components manufacturing industry, non-value adding activity, lean principles

1 Introduction

SMEs (Small and medium sized enterprises) play a vital role in a nation’s economy in recent years. They are major suppliers of products to the large scale industries and must function to their fullest extent. The utilization of resources in these industries is not up to the level. The scenario will lead to various wastes in the industries. The industry was unaware of these wastes. The lean principle mainly aims to reduce the wastages and non-value added activity. The lean concept was derived by Toyato’s Taiichi Ohno, a pioneer in lean manufacturing. The seven types of ‘deadly’ wastages are identified by Taiichi Ohno, Womack and Jones (2007). The seven wastages include: Over production, waiting, transportation, over processing, inventory, motion, and defects. Lean is concerned with eliminating all types of waste, which is much more than eliminating waste by reducing the non-value adding activities. For the past twenty years the lean principles were applied most in the large scale industries especially in the automobile sector. In the case of medium and small enterprises, the implementation of lean principles seems to be less, compared to the large scale industries. These industries were ignored for a long time due to various reasons, like lack of awareness of lean methods, lack of knowledge, managerial constraints in implementation of lean and lack of qualified staff etc. Matt and Rauch (2013). These organisations also lack in quality control, inventory management, warehouse management and production planning and control. This results in quality problems, high rejection and rework rate, traceability problems and improper delivery activity Nitin Upadhye et.al. (2010). The other problems in the small scale industries were space constraints, labour problems and poor scheduling. The waste identification process was carried out in an automobile rubber component’s manufacturing industry, and possible remedies were suggested to mitigate the wastes Balaji et.al (2014). Andreachairing (2012) had analysed a case study in which spaghetti chart and activity worksheet has been used to reduce unwanted transportation movement and cost associated with it. This research work mainly focuses on reducing the non-value added activity in the warehouse of an automobile rubber component’s manufacturing industry, aims to reduce the transportation wastages and provide more accessibility and proper ergonomics to the workers. The present warehouse layout is mentioned and
unnecessary movements were analysed and try to eliminate those wastages by properly modifying layout using spaghetti diagram.

1.1 Industry profile and problem definition

The waste identification process is carried out in the automobile rubber components manufacturing industry, which is located in Chennai. The industry falls under the medium scale category, having 80-90 workers. It manufactures more than 96 rubber components that are supplied to major automobile manufacturers. Today, the company has grown as one of the leading suppliers to major automobile, home appliances and other engineering component manufacturers in India.

The company manufactures rubber components for specific requirements of the customer. The industry is the hub for manufacturing a variety of rubber components, according to the need of the customer. Some of the varieties are cover, grommet, boot, protector, damper, seal, insulator, packing, holder, cap, sealing rubber, and seal-O-ring.

Table 1 Application of rubber components in automobiles

<table>
<thead>
<tr>
<th>Product</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover</td>
<td>Electrical wire insulation , junctions, spark plug casing</td>
</tr>
<tr>
<td>Grommet</td>
<td>Sharp edge shields</td>
</tr>
<tr>
<td>Boot</td>
<td>Steering knuckle protector</td>
</tr>
<tr>
<td>Protector</td>
<td>Sharp edge shields, bolt casing , oil cap</td>
</tr>
<tr>
<td>Damper</td>
<td>Engine mounting base, Steering mount and chassis beam vibration damper</td>
</tr>
<tr>
<td>Seal</td>
<td>Oil leakage, coolant leakage preventer</td>
</tr>
<tr>
<td>Insulator</td>
<td>Battery electrical cable insulation</td>
</tr>
<tr>
<td>Holder</td>
<td>Head lamps, Engine Control Module holding, Horns, Warning lamps</td>
</tr>
<tr>
<td>Cap</td>
<td>Sharp edge shields</td>
</tr>
<tr>
<td>Sealing Rubber</td>
<td>Battery coolant seal</td>
</tr>
</tbody>
</table>

Table 1 represents the application of rubber components in the automobiles. The abovementioned components are used in automobiles, like two wheelers, three wheelers and four wheelers. Along with the automobile field the rubber components are also used in home appliances like refrigerators, mixer-grinders, washing machines, Air coolers etc.

The industry has a good manufacturing capacity but lacks the material transportation, storage and warehouse facilities. Due to the space constraint in the industry, the secondary process activities like trimming, cleaning and inspection have been carried out in the warehouse of the industry.

1.2 Processes involved in the manufacturing process

Figure 1 represents the processes involved in the manufacture of rubber components from raw material to finished goods. The processes involved in the manufacturing unit are indicated in blue, and the processes involved in the warehouse section are indicated in green. Semi-finished components have been formed during the high pressure forming process in the industry. High quantity of rubber components are separated from the batch, and placed in the various bins. Then the parts are moved to the trimming section for removing the unwanted portion from the component, followed by cleaning the burrs or unwanted portions in the component. After cleaning, the part will go for inspection and quality checking. The defect less products are weighed, counted and packed in the plastic bags. The bags are labelled before dispatch.

2 Methodology

The methodology adopted in this research work paper: Initially the paper will discuss the wastages, followed by analysing the various activities in the
present warehouse layout, then discuss the various wastages in the warehouse, followed by the modified warehouse layout, and finally, the reduction in the transportation wastages are discussed.

3 Introduction about the wastages

3.1 Over Production

Over production means manufacturing an item before it is actually required. Producing more, compared to the customer requirement.

3.2 Waiting

When resources like people and equipment are forced to wait unnecessarily because of delays in the arrival of resources. Man idle or waiting time and machine idle or waiting time.

3.3 Transportation

People, equipment, tools, documents or materials are moved or transported unnecessarily from one location to another, and transportation wastage is generated.

3.4 Over Processing

This term refers to extra operations, such as rework, reprocessing, handling or storage that occurs because of defects, over production or excess inventory.

3.5 Inventory

This refers to the inventory that is not directly required to fulfill current customer orders. Inventory includes raw materials, work-in-process and finished goods.

3.6 Motion

This term refers to the extra steps taken by employees and equipment to accommodate inefficient process layout, defects, reprocessing, over production or excess inventory. Motion takes time and adds no value to the product or service.

3.7 Defects

Having a direct impact on the bottom line, quality defects resulting in network or scrap are a tremendous cost to organizations. Associated costs include quarantining inventory, re-inspecting, rescheduling, and capacity loss.

4 Spaghetti diagram

A spaghetti chart/diagram is a graphical aid used in lean manufacturing activities. It is used to detail the actual physical flow and distances involved in a work process. Processes that have not been streamlined frequently are poorly laid out, with the work/product taking a path through the work area. A spaghetti chart often traces the walking patterns of workers in a process, ranging from manufacturing settings to healthcare. It mostly serves as an illustration of a system’s inefficiency. Spaghetti diagrams are visual representations of the work unit flowing through a process. They illustrate the flow sequence of the information or component and document the functional dependencies and responsibilities for each step in the process.

4.1 Benefits of the Spaghetti Chart

- Identifies the inefficiencies in the Area / Plant layout
- Identifies opportunities for less handling
- Identifies opportunities for better workforce communication
- Identifies Resource allocation opportunities
- Identifies opportunities for safety improvements

5 Present warehouse layout

Figure 3 Present warehouse layout.

In the rubber component’s manufacturing industry, more inventories were handled in warehouse area for ready despatch to the customers. At present, the company handles the semi-finished and finished goods are carried out in the unallocated floor space. This results in accessibility and traceability problems. The stations in the warehouse are not properly allocated for easy product flow. They have more unnecessary movement and also the movement path was criss cross and zigzag. Monitoring is difficult to the supervisors, because the hidden areas are more. So these are the reasons to change or modify the warehouse layout properly.
Figure 3 represents the present warehouse layout of the basic structure. This layout provides the details of the locations of the work stations in the warehouse. The details of the present warehouse with the process sequence will be explained in the spaghetti diagram.

In the present warehouse process involved from semi-finished goods to finished goods are discussed in detail. The process of semi-finished goods to finished goods processing station sequence are noted below,

1. Manufacturing unit to Trimming
2. Trimming to cleaning
3. Cleaning to Assembly
4. Assembly to Inspection
5. Inspection to Storage
6. Storage to Packaging
7. Packaging to labeling
8. labeling to dispatch
9. Dispatch to Delivery vehicle.

The listed warehouse process sequences are mentioned and analysed using the spaghetti diagram.

5.2 Calculation:

Total length of the thread = 103.7 m
(Manufacturing unit to dispatch section)
Door to door length = 85.7 m
(Warehouse door to door)
Total number of pins = 14 pins
(Warehouse door to door)
Diameter of the pin (d) = 1 mm
Radius of the pin (r) = 1/2 = 0.5 mm

\[
\text{Radius of the pin } (r) = \frac{1}{2} = 0.5 \text{ mm}
\]

\[
= 2 \times \pi \times 0.5 = 3.14 \text{ mm}
\]

\[
= 0.0314 \text{ m}
\]

Total number of pins = 14 pins
(Warehouse door to door)

\[
= 14 \times 0.0314 = 0.4396 \text{ m}
\]

For perfect holding the thread is wounded over the push pin. The measurement of the thread total length process, the pushpin wound distance is also included. This may lose the accuracy. To retrieve these errors subtract the wounded thread distance over push pin from the total length.

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= 85.7 - 0.4396 = 85.26 \text{ meters}
\]

6. Modified warehouse layout

Figure 4 represents the Spaghetti diagram of the present warehouse layout. The layout is drawn from the dimensions of 1 centimeter = 1 Meter scaling down. So the scaling ratio is 1:1000. The starting point of is from the manufacturing unit and the ending point is the warehouse door step. The thread travels with each workstation of the product flow. It starts from the manufacturing unit to the dispatch section. In this spaghetti diagram two colour push pins are used. The blue colour push pin indicates the guideline / support for the rooting. The red colour push pin indicates the actual work station. The dimensions and other calculations are done as follows;
The rubber component’s manufacturing industry provides a space in the manufacturing unit itself. The trimming and cleaning sections are moved to the manufacturing unit. So while modifying the warehouse layout consider only the remaining stations like assembly station, Quality checking / inspection, storage, packing, labelling and dispatch sections.

Also the modified warehouse will consider the issues of unnecessary movements between the work stations, monitoring/ supervising troubles and the proper ergonomics to the workers.

Figure 5 represents the basic diagram of the modified warehouse layout. In this layout provides the details of locations of the modified work stations in the warehouse. The detailed diagram of modified warehouse layout with the process sequence will be explained in the spaghetti diagram .The modified warehouse layout spaghetti diagram is plotted as follows

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6.2 Calculations:

Total length of the thread = 71.6 m
(Manufacturing unit to dispatch section)
Door to door length = 53.6 m
(Warehouse door to door)
Total number of pins = 9 pins
(Warehouse door to door)
Diameter of the pin (d) = 1 mm
Radius of the pin (r) = 1/2 = 0.5mm

Using equation (1)
Circumstance of pin (C) = 2 ×3.14 ×0.5
= 3.14mm
= 0.0314m
Total number of pins = 9 pins
(Warehouse door to door)

Using equation (2)
Total circumstances = 9 × 0.0314m
= 0.2826m

Similarly, Using equation (3)
Actual total length of the thread = 53.6-0.2826
= 53.31 meters

6.3 Comparison of both present and modified warehouse layout

An analysis of both the present and modified layout diagram shows that, the present warehouse layout is more complicated, and the work stations are not based on the product flow. So the product moves from one station to another station in a zig zag path. It results in unnecessary movements between the workstations and also backtracking. The supervisors have trouble in monitoring the process and the workers, because of the hidden places in the layout.

The modified layout remedies all the above mentioned difficulties. The modified layout is developed based on the product flow. So, the product moves from one station to another station in a continuous flow. There is no backtracking. There is additional place given to the supervisors, so that they can easily monitor the process sequence and the worker’s movements. The modified layout is more accessible compared to the present warehouse layout. It will be proved by the calculations given below.

Present warehouse travel distance = 85.26 meters
Modified warehouse travel distance = 53.31 meters
Difference in length = (4)−(5)
= 85.26 − 53.31
= 31.95 m. ~ 32m.

Percentage reduction in travel distance= 37.53 %

7 Conclusion

From the research work, it is concluded that,
1. The improper warehouse layout is one of the reasons for generating non-value adding activities.
Using the spaghetti diagram the warehouse product movement distance was calculated; its value is 85.26 meters. Applying the lean technique concept of wastage’s reduction using the spaghetti diagram, the warehouse layout was modified and the product movement distance was calculated, and its value is 53.31 meters.

2. The modified warehouse layout results in a reduction of 32 meters in the transportation movement distance.

3. The modified warehouse layout provides the proper ergonomics to the workers from 1.4 meters to 2.0 meters working area cabin.

4. The modified warehouse layout is more accessible and economically feasible compared to the present warehouse layout. The transportation wastage is reduced by 37.53%.

5. Further, the reduction of lead time and other wastages will be carried out using value stream mapping.

References

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