Research Article

Improvement in Line feeding System in Assembly Plant using Lean Manufacturing Techniques

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Abstract

Today in automobile manufacturing firms the variety of customer demands influence the material flow in the plant. This material flow affects the ability to achieve the production targets. This requires logistics systems that can support production in small lot sizes as discussed in the case study here. Since continuous material feeding systems resulted in increased operator walk and search time an attempt to increase production throughput is made. In this paper best line feeding systems are implemented to support assembly line production systems to reduce the downtime at assembly line due to material shortage. The data is collected for downtime due to material shortage from each assembly line and analyzed for effects on production time. Time study is carried out to determine value added and non-value added activities and reduced them. Model station analysis has been performed on Booster assembly line to find out the suitable material feeding system using lean manufacturing through value stream mapping. Hence continuous supply system has been replaced by lean supply kitting system which resulted in reduced assembly line downtime, reduction in material flow lead time by 28.55% and reducing non value added activities by 11.91% in existing assembly line without any additional investments.

Keywords: Continuous Supply, Kitting, Value stream mapping.

1. Introduction and Literature Review

The Situation of assembly plant in which this study was conducted there is a single warehouse near plant from where vendors supply and store parts. The material is dispatched from the warehouse as per the next day assembly schedule, received and stored at the stores of In-plant. The assembly lines in the plant are mixed-model assembly line on which continuous parts are feed. There are many feeders whose job is to feed parts from store to workstations. There are many feeders whose job is to feed parts from store to workstations. Each feeder uses a transporter which is having a limited capacity to carry material. Each feeder is associated with a set of parts which he should feed. Each feeder is associated with a set of parts which he should feed. The Feeder or labors are not sustained in the plant. End Quality is of wrongly assembled parts due to wrong material feed by line feeder. As the materials picking and feeding is highly repetitive, the feeder experiencing the work as repetitive and as containing some physically stressful work situation.

The three different aspects of assembly line feeding are studied for design of optimum feeding policy. These are pallet to workstation, Trolley to workstation, Kit to assembly line. The analysis is done for this and best is selected for assembly line feeding. The best feeding system is the Kit to Assembly Line, while for high lot dimensions the best policy seemed to be the Pallet to Work Station is studied by Daria Battini, Maurizio Faccio (2009). Within the processes of the JIT system, the upstream manufacturer is required to deliver products using smaller delivery lot sizes, at a higher delivery frequency. A quantitative cost model which is executed using a JIT system by I-Chiang Wang (2010). A New approach for JIT Scheduling of part supply from central storage center is carried out. A complexity proof as well as different exact and heuristic solution procedures is provided. The direct comparisons are performed with the simple two bin Kanban system is provided by Raghavendra Ramappa, K. M. Sharath Kumar (2013). The efficiency of in-plant materials supply deliveries is not proportional to the size of the unit loads. There are fundamental differences between how large pallets, compared to smaller unit loads. Robin Hanson and Christian Finnsgard (2013) in this paper mentioned that it was possible to maintain number of operators maintaining the number of operators performing the in-plant deliveries by expanding the use of in-plant milk-run deliveries. The unit load size can have both a direct effect on the in-plant materials supply efficiency, and an indirect effect, by influencing the in-plant materials supply configuration recommended by Robin Hanson, Christian Finnsgard (2014).

Simon Emde ,Nils Boysen in their paper(2012) academic research has primarily focused on the technical
factors of material handling systems, with little or no discussion of human factors. In order to improve the performance of distribution operations, in this paper the implementation of technical and human factors both contributing improvement in material handling system. The technical and human elements both contributed in the material handling system implementation. A dynamic part feeding system for an automotive assembly plant which estimates the parts consumption amount dynamically considering the actual production progress and directs the feeding orders dynamically to the feeders.

Satya S. Chakravorty (2009) use of Simulation is done to analyze the better results than the static feeding system. The small tow trains are enabled to carry out flexible small lot deliveries at low cost. In this paper the supermarkets are decentralized in-house logistics areas in the direct vicinity of the final assembly line, which serve as intermediary stores for parts. Small tow trains are loaded with material in a supermarket and deliver parts Just-in-Time to the stations lying on their fixed route. An exact dynamic programming is proposed and validated practically and analyzed through fixed installation cost and maintenance cost. Varsha Karandikar, S. M. Sane (2013), investigated the ergonomics aspect of machine design of work station to kill the root cause of the problem. And also explained the procedure for determining the workstation dimensions and layout has been explained. A Traditional approach picker –to- material approach is replaced by material-to-picker approach. The material pickers assessed work situations perceived as physically stressful. The feeding of material was rather light but having highly repetitiveness in arm movements. The material pickers experiencing the work as physically stressful. The works activities are divided into different hierarchical levels analyzed them and are focused to eliminated by M. Christmansson, L. Medbo (2002).

Varsha Narayan Karandikar, Shriram Madhukar Sane (2013) described the newly defined Posture–State Variation Report [P–SVR] method of postural analysis to highlight the areas for improvement in work posture for operator comfort and to find out quantitative value of severity of work based upon postural video analysis. Varsha Narayan Karandikar, Shriram Madhukar Sane (2014), discussed waste identification and elimination and de-bottlenecking to balance the line and optimize utilization of resources for improving the productivity. Fawaz A. Abdulkmaleka, Jayant Rajgopal (2007) analysed process sector Value stream mapping is applied to identify the opportunities for various lean techniques. Also the simulation model is derived for before and after scenarios in detail. Value stream mapping collaboration is primarily a communication tool, and a strategic planning tool. Mapping out the flow of material and information from the internal and external value chain, inside and outside the company focused to eliminate Non value added activities by Synthia Xin Shen, Chuan Feng Han (2006).

Figure 1: Current State Value Stream map

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2. Current Value Stream Mapping

All data of current state were collected for the raw material flow started from external raw material warehouse, dispatch details, receipt area at assembly plant, unloading, binning, picking and the line feeder. It also includes customer demand determination, value added and non value added time. The times are all based on the average of historical data.

A value stream is a collection of all actions (value added as well as non-value-added) that are required to bring a product (or a group of products that use the same resources) through the main flows, starting with raw material and ending with the customer. While researchers have developed a number of tools to optimize individual operations within a supply chain, most of these tools fall short in linking and visualizing the nature of the material and information flow throughout the company’s entire supply chain. Taking the value stream viewpoint means working on the big picture and not individual processes. It helps enterprises in understanding streamline work processes by using the strategy tool and techniques to decrease the wastes in the process. For every assembly line, the production scheduling determines how many components are required in every work station during a specific period of time. The main problem of such scheduling is how to carry the components from a Supermarket (central store) to every station of the Assembly line.

2.1 Current State Map

Material flow Lead Time=19.37 hour

Value Added Time=5992.27 sec.

2.1.1 Major wastes in the process

- Material mix-up Issue-Due to similarity in the parts the material mix-up takes place in the Assembly line.
- Searching Time-The searching time of material required for the assembly line is requiring the main reason for delay in material supply.
- Material Handling – The Cycle turns in the material feeding found to be very large and focused to eliminate.

3. Required Scenario for Line Feeding

Table 1 Current Required Scenario for Line Feeding

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameter</th>
<th>Quantification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Available time</td>
<td>28800 sec per shift ( 8 Hr./shift)</td>
</tr>
<tr>
<td>2</td>
<td>Demand/ production</td>
<td>560 Pieces/ shift</td>
</tr>
<tr>
<td>3</td>
<td>Qty. feed/hour</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>No of Workstations</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>No of operators for line</td>
<td>1+1 Supervisor</td>
</tr>
<tr>
<td>6</td>
<td>Assembly/hour</td>
<td>70</td>
</tr>
</tbody>
</table>

3.1 Total Bill of Material (BOM) Content Verses Child part

![Graphical Representation of total BOM quantity and Child Parts content per BOM](image)

3.2 Total Parts Handled and no. of Turns

![Total Cycle Turns per Bill of Material or for different variant](image)

3.3 Assembly line Downtime of Last four Months

![Downtime Analysis for the last four months May-June-July-August](image)
3.4 Categorized Cycle Time of Each activity

The time it takes to pick all parts depends on kit size and number or it majorly depends on the production plan.

4. Improvement in Assembly Line Feeding

It is initiated well in advance of the actual production start to be able to prepare and deliver the kit on time. Kitting involves the gathering of all the parts needed for a particular assembly from the Supermarket and issuing the Trolley to the manufacturing line at the right time and in the right quantity.

Line feeding is initiated by the Production Planning and control department based on the customer’s orders and then shop floor orders are generated by the plant’s SAP system and then it is physically checked by the line feeding supervisor. Line feeding supervisor will first verify that adequate quantity is available for each part number. If there are parts shortages, parts are ordered from the external Raw material warehouse which is located nearby the Assembly plant. In general, the kit/ trolley is not released from the supermarket until parts arrive, but in some special cases a shop order with a part shortage can be processed. Line feeding supervisor then releases the kit/ material trolley to the supermarket for picking. The trolley is typically sent to the off line setup area within 3-4 hours.

Figure 6 Kit Cart at assembly Station

Kitting is performed directly from supermarkets by line feeding operators. The advantage of this approach is reduced manpower workload. The disadvantages are operator training, lost inventories and complex replenishment logic that requires advanced inventory control Software. The issue of inaccurate on-hand inventory counts still remains because counts are still maintained by the SAP system. A variation of this
approach is where only the most frequently used parts are stored in supermarkets and kitting is a combination of central stockroom kitting and supermarket kitting.

5. Results and Discussion

Table No.2 shows graphical representation of the cycle time of line feeding along with kitting operations performed at different ways also the other operators requiring less operation time than before it was done. Thus it is matching and performing with the Suggested in SOP. The Result Shows how a percentage of reduction in the work content.

Table 2 Reduction in Total time and no. of turns

<table>
<thead>
<tr>
<th>Picking BOM</th>
<th>No. of Turns</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOM#1</td>
<td>No Kitting</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Kitting</td>
<td>2</td>
</tr>
<tr>
<td>BOM#2</td>
<td>No Kitting</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Kitting</td>
<td>1</td>
</tr>
<tr>
<td>BOM#3</td>
<td>No Kitting</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Kitting</td>
<td>1</td>
</tr>
<tr>
<td>BOM#4</td>
<td>No Kitting</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Kitting</td>
<td>2</td>
</tr>
<tr>
<td>BOM#5</td>
<td>No Kitting</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Kitting</td>
<td>2</td>
</tr>
<tr>
<td>Average</td>
<td>No Kitting</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Kitting</td>
<td>1 OR 2</td>
</tr>
</tbody>
</table>

Hence continuous supply system has been replaced by lean supply kitting results showed reduction in assembly line downtime, increase in material flow lead time by 28.55% and reducing non value added activities by 11.91% in existing assembly line without any additional investments.

Table 3 Value stream mapping (before and after)

<table>
<thead>
<tr>
<th>Results of VSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current State Map</td>
</tr>
<tr>
<td>Value Added Time</td>
</tr>
<tr>
<td>Future State Map</td>
</tr>
<tr>
<td>Value Added Time</td>
</tr>
</tbody>
</table>

5.1 Value Stream Map (Future State)

In assembly, the use of kitting to present parts can reduce man-hour consumption Compared to continuous supply. The different aspects of kitting have been stated to contribute to the reduced man-hour consumption:

1) Often, kitting is associated with parts being presented closer to the assembly object than is feasible with continuous supply, which can then reduce or eliminate the time needed for Walking
2) With Improved kitting, no time needs to be spent searching for parts. Both of these aspects are significant in relation to the man-hour consumption in assembly.

The elimination of time spent searching for parts had a significant impact on the overall time spent feeding parts, the use of kitting, compared to the use of continuous supply, reduced man-hour consumption in line feeding mainly by reducing searching time.

References

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