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Investigation on cycle time reduction in Production and Implementation of an Inventory Model in an Apparel Industry

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Abstract - *Apparel industries are now a days facing intensive competition. The key to competing in the market place is to simultaneously improve both quality and productivity on continual basis. The major purposes of the use of lean are, to increase productivity, to improve product quality and manufacturing cycle time, to reduce inventory, reduce lead time and eliminate manufacturing waste. To achieve these, the lean production philosophy uses several concepts like Kaizen, Kanban, 5's, Just in Time (JIT) etc. This project addresses the approaches to implement lean practices in apparel industry.*

Key Words: Lean, Inventory models, Cycle time, Apparel industry.

1. INTRODUCTION

Lean Manufacturing is a systematic approach for achieving the shortest possible cycle time by eliminating the process waste through continuous improvement. Thus making the operation very efficient and only consisting of value adding steps from start to finish. In simple words lean is manufacturing without waste. The garment industry has opportunities to improve, but requires some changes. Under the highly competitive environment, the garment industry has numerous opportunities for improvement using lean principles. Lean practices can fulfil the customer demands with high quality and services at right time.

G. Vijayakumar, Y. Robinson published a journal which deals with studying the impact of lean tools on manufacturing performance [1]. They identified the eight types of wastes existing in the apparel industry. Based on their survey the rejection rate from clients to the apparel industry is as high as 34% due to the poor techniques that existed there. They used 5S concept to eliminate wastes in the performance. The main reason for customer dissatisfaction is inability to meet the order on the due dates [2]. The implementation of 5S has solved this problem. Proper layout resulted in lesser processing time hence increased productivity [3]. The main reason for high wastage in the apparel industry are that there is no systematic arrangement of raw materials, finished goods and work in process goods and underutilization of machines and workers. Also unwanted wastage of time or delay in several non-value added activities and lack of a system to monitor or supervise the activities of workers and movement of materials. Hence the objective of the project was to increase the productivity and reduce wastes in the apparel industry by using various lean tools and to improve the timeliness of the order delivery.

2. DATA COLLECTION

The apparel industry produced vast range of products that include promotional T shirts, customized logo T shirts, bulk and wholesale T shirts, team or group T shirts, plain T shirts, printed T shirts, corporate T shirts, hoodies, etc. Customers can choose their own T shirts from their store and after that, they can also order them to add embroideries or print their company's logo or tagline or any other texts in the T shirts according to their wish and need.

The following chart shows the activities in production and dispatch.

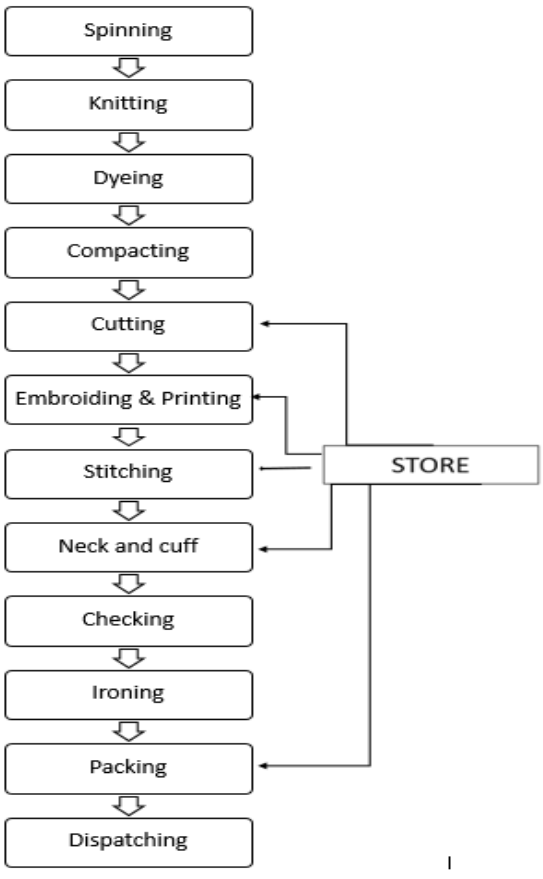

Fig -1: Activities in Production & Dispatch

To understand the problem better, a discussion was held with the employees to find the bottlenecks in the process delay. They were discussed below in the cause and effect diagram, an effective way to organize and display their various theories about what might cause the delay.

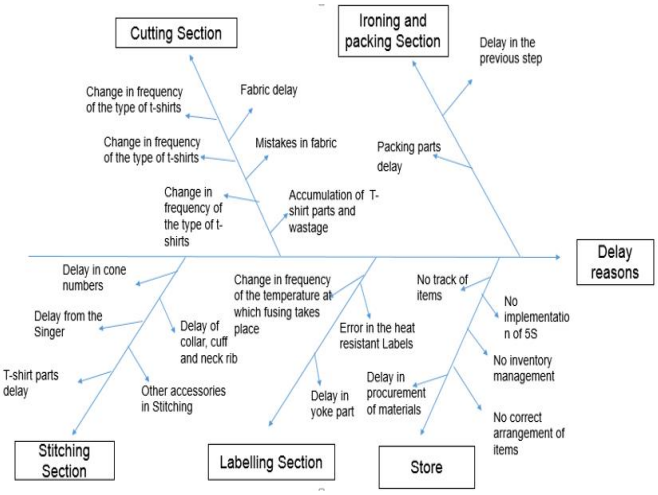

Fig -2: Cause and Effect diagram

The analysis was based on a particular order in which a order of 5000 T shirts should be delivered. The time taken in each section is shown below.

Table -1 Time taken in each step of production

S.No	Section	Days
1	Materials delivered to Store	19
2	Cutting Section	1
3	Labelling Section	1
4	Stitching Section	3
5	Ironing and Packing	2
6	Delivery	1
	Total	27

It has been found that materials arrival in the store takes more days that causes the delay in the production. It was also found that production sections have to wait until all the materials arrive at the store. The subsequent sections would start their work only when its previous sections work has been completed. As a result the production process was not continuous. Hence the sections had idle time which is to be removed

The fabric, collar and cuff arrival time is the highest. As they were bought from an outsource company so the decrease in the time of delivery of those components cannot be done. But we could improve the timeliness by adopting an inventory model so that the different sections could start their process as the materials were already available in the store which causes a decrease in the idle time.

2. INVENTORY MANAGEMENT

Inventory models in which the demand rate depends on the inventory level are based on the common real-life observation that greater product availability tends to stimulate more sales [4]. The scope of inventory management concerns the balance between replenishment lead time, carrying costs of inventory, asset management, inventory forecasting, inventory valuation, inventory visibility, future inventory price forecasting, physical inventory, available physical space, quality management, replenishment, returns and defective goods, and demand forecasting.

Inventory management involves a retailer seeking to acquire and maintain a proper merchandise assortment while ordering, shipping, handling and related costs are kept in check. It also involves systems and processes that identify inventory requirements, set targets, provide replenishment techniques, report actual and projected inventory status and handle all functions related to the tracking and management of material. This would include the monitoring of material moved into and out of stockroom locations and the reconciling of the inventory balances.

2.1 Pareto/ABC Analysis

The ABC classification process is an analysis of a range of objects, such as finished products, items lying in inventory or customers into three categories. It's a system of categorization, with similarities to Pareto analysis, and the method usually categorizes inventory into three classes with each class having a different management control associated: A - outstandingly important; B - of average importance; C - Relatively unimportant as a basis for a control scheme. By combining all possible possibilities like size, grams per square inch (GSM), gender and colour, etc. a total of 910 final products were produced in the industry. The unit cost and the demand per item were multiplied and the whole data were sorted in descending order. The percentage of each items' value of the total value was found. Then the aggregate percentage of each component was found. The items with aggregate percentage of up to 80% were classified under A category, items with aggregate percentage from 80% to 95% were classified under B category and the items with aggregate percentage of 95% or above were under C category.

2.2 Data Collection

The primary data needed for inventory management are demand for the item which were acquired from the previous year sales invoices, the holding cost per unit time per unit product and the order making cost. The holding cost in this apparel industry involves the fraction of the cost of the land that the item occupies and fraction of the salary of employee used to maintain the inventory. Since

the items in inventory are low risk, conveniently stored items requiring less personnel to take care of the items a moderately low percentage of 5% of the unit cost of the item was taken as the value. The order making cost involves the summation of purchase order and the inbound logistics cost. If safety stock is needed the level of service that is required to be established should also be specified. Here we used a service level of 85%. The demand distribution is assumed to be a normal distribution and the lead times were also assumed to be a constant for a given product.

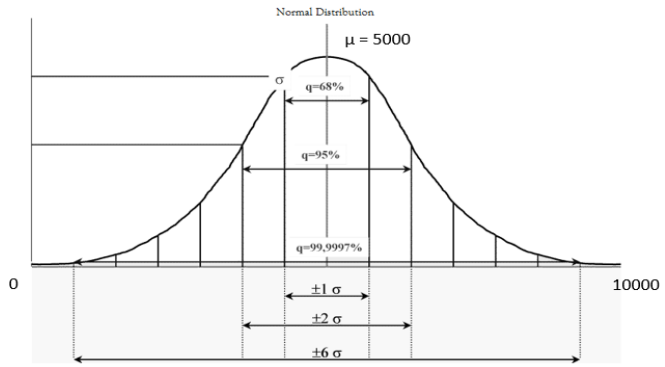

Fig -3: Demand distribution

2.3 Inventory model

The quantity to be reordered is based on the inventory management model adopted. The different inventory models are

a) Continuous review policy with fixed order
b) Periodic review policy with fixed order
c) Order up to level continuous review policy
d) Order up to level periodic review policy

In the continuous review process, the inventory levels are continuously reviewed, and as soon as the stocks fall below a pre-determined level (usually called, reorder point, or reorder level), replenishment order is placed. Under periodic review, the inventory levels are reviewed at a set frequency. At the time of review, if the stock levels are below the pre-determined level, then an order for replenishment is placed, otherwise it is ignored till the next cycle. Independent demand items are managed using periodic review system and dependent demand items are managed with continuous review system. Since the demand for each item in the apparel industry is dependent on the demand for T shirts, continuous review model is adopted.

Continuous review policy with fixed order

The orders are placed when the quantity in inventory falls below the reorder point. The ordering quantity is constant irrespective of the quantity consumed during lead time. When implemented to our case, it is found that the economic order quantity is not sufficient to meet the demand during the lead time. The quantity on hand falls below the reorder point in certain cases hence fixed order policy is not feasible. This rule of ordering is applicable only if the lead time is shorter than the stock cycle.

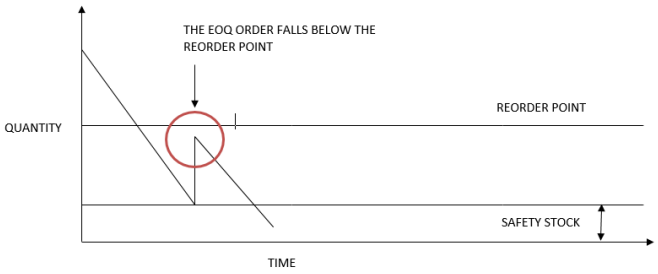

Fig -4: Continuous review policy with fixed order

Order up to level continuous review policy

To overcome the drawbacks of the above ordering system, the order quantity was such that it replenishes the inventory to the maximum level once the order was placed. The quantity consumed during the lead time was also taken into consideration. This method uses predetermined order up to level for inventory to determine the order size. The inventory is reviewed continuously and the order is made as soon as the inventory level falls below the reorder point. The order size is based on the on-hand inventory

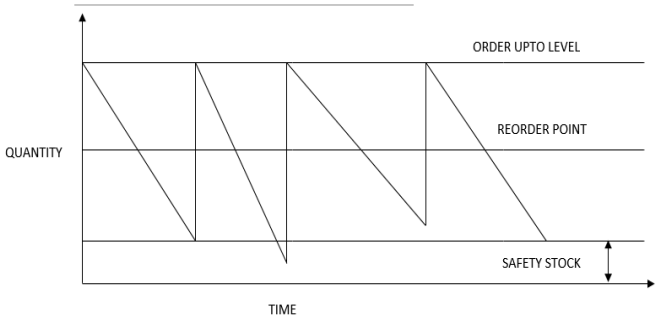

Fig -5 Order up to level continuous review policy

Table -2 Time taken after implementing inventory

S.no	Section	Days
1	Materials delivered to Store	3
2	Cutting Section	1
3	Labelling Section	1
4	Stitching Section	3
5	Ironing and Packing	2
6	Delivery	1
	Total	11

3. CONCLUSIONS

1. After implementing the inventory policy, the materials delivered to store has been reduced to 3 days.

2. Total cost of production of T-shirts has been reduced. This is because the inventory policy prevented the excess orders which were used before. The percentage of decrease in cost is **6.66%.**
3. To control the process and inventory 5S was implemented in the industry, along with 11 kaizens as a startup of the process.

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