IMPROVING VELOCITY RATIO USING VALUE STREAM MAPPING FOR AFTERMARKET PRODUCTS

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ABSTRACT

TQM uses many tools and techniques for continuously improving productivity, product quality and on-time delivery to customers along with reducing cost. Lean Manufacturing is one such modern technique for continuous improvement. Only few small and medium organizations in India are implementing Lean Manufacturing. Literature survey indicates that there is great demand for the Lean implementation initiatives by many manufacturing industries in India, particularly by the Small and Medium Enterprises. In this article, an attempt has been made to improve the velocity...
ratio for handling aftermarket products of a XYZ company using Value Stream Mapping, a Lean tool. A current value-stream map was created that reflected the current operation status of the warehouse. A future value-stream map was then proposed to serve as a guide for future lean activities.

**Key words:** Lean manufacturing; Value Stream Mapping and Design; Local Distribution Centre; Area Distribution Centre; Push and Pull system; Kanban; Leveling; Velocity ratio.

1. **INTRODUCTION**

Value Stream Mapping (VSM) is an extremely valuable tool in lean manufacturing and for continuous improvement effort. It identifies the waste in the system, paving the way for a successful lean implementation.

Generally, VSM is being implemented for production line. It is observed from the literature survey that the VSM implementations and solutions obtained are industry specific. Based on this gap identified by the research scholar, it was proposed to carry out the research study in a sector other than the production line. As a result, in the present study, an attempt has been made to use VSM as a technique to improve the velocity ratio of aftermarket products. A current value-stream map was drawn which indicated the various Value adding and Non-Value adding activities present in the system. Then a future value-stream map was proposed to reduce the Non-Value adding activities and to improve the velocity ratio.

2. **LITERATURE REVIEW**

Lean Manufacturing (LM) is gaining momentum in the advanced manufacturing areas. Many new and revolutionary ideas & processes have emerged in the field of LM. Toyota has popularized the concept of LM and introduced the concept- Toyota Production System (TPS).

Ohno [1] pointed out that Lean is a manufacturing phenomenon that seeks to "maximize the work effort of a company's number one resource, the People". Lean is
therefore "a way of thinking" to adapt to change, eliminate waste, and continuously improve.

Nightingale and Mize [2] are of the opinion that LM is a corporate activity of continuous improvement and requires effective strategies to successfully implement. Wilson and Pearson [3] and Kesser [4] discuss that a good strategy needs to be defined and redefined dynamically according to the current circumstances of manufacturing during the implementation of lean. Therefore, an effective assessment tool plays a critical role in evaluating each stage of manufacturing and further in determining the strategy and priorities of lean implementation.

Hay, E.J. [5] has proposed a holistic approach to LM, where he discusses the methods of removing waste from the system and consistent improvement in the efficiency. Womack and Jones [6] are of the opinion that the managers should identify the value of the customer and focus on their existing organizations to redefine the value and continuously strive for the elimination of wastes with the help of value addition tools.

2.1 VALUE STREAM MAPPING

Rother and Shook [7] stated that 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, from raw material to the arms of customers. VSM is a simple visual representation of every process in the material and information flow. Since in the present study, the focus is only on the supply chain system, the concentration is channelized towards mapping the processes and information flows that occur when a part leaves the manufacturing plant and finally reaches the end customer.

A future state map shows how things should work in order to gain the best competitive advantage. The opportunities for improvement at each step that would have a significant impact on the overall production system are highlighted on the future state map and then implemented, creating a leaner production process.

Rother & Shook [7] have identified that the VSM helps in visualizing entire operations, provides a common language when talking about the process, makes decisions about flow apparent, and used to implement various lean principles. VSM
forms the basis for the implementation plan by serving as a blueprint, shows linkage between material and the information flow.

Womack & Jones [8][9], Daniel. T.Jones [10], Peter Hines and Nick Rich [11] and Taiichi Ohno [1], have studied the implementation of VSM effectively. Taiichi Ohno [1], VSM helps to understand and streamline work processes using the tools and techniques of LM. The goal of VSM is to identify, demonstrate and decrease waste in the process. VSM can thus serve as a starting point to help management, engineers, production associates, schedulers, suppliers, and customers to recognize waste and identify its causes. As a result, VSM is primarily a communication tool, but is also used as a strategic planning tool, and a change management tool.

Womack [6] and James Moore [12] have stated that various types of organizations are implementing LM practices to respond to competitive challenges. Doolen [13] has extended the applications of lean production techniques in electronic manufacturing sectors. Further, Hyer [14] has implemented LM in the office-service and administrative processes. The use of VSM appears to be increasing, particularly since the publication of “learning to see” by Rother Shook [7]. One of the unique characteristics of VSM in comparison with other process analysis techniques is that one map depicts both material and information flow. Kevin [15] has discussed many strategies for improvement through future value stream mapping (FVSM).

Askin & Goldberg [16], Allen et al. [17] and Kotelnikov [18] have discussed that 5S, Pull system/Kanban, Cellular/Flow Manufacturing, Single Minute Exchange of Dies (SMED), Total Productive Maintenance (TPM), Value Stream Mapping (VSM) techniques can be effectively applied to the manufacturing industry in order to reap the benefits of lean production efforts. However, it has been demonstrated that, differential realization of benefits occurs when lean production techniques are implemented in industries other than the auto industry [6], because every industry has its own economic situation and system of operations. In order to facilitate consistent evaluation of lean production efforts, many lean assessment tools have been developed and introduced by various research or consulting groups. The ultimate objective of these lean assessment tools has been to investigate, evaluate, and measure the current manufacturing situation.
against the “standard” lean characteristics, as well as assess lean implementation and continuous improvement during the lean implementation.

Karlsson [19] have proposed the basic procedures to be followed in the Lean implementation and have discussed the role of pull system to push system, the need for multi functional teams, decentralized responsibilities and continuous improvement measures to be taken. McCallum [20] suggests that a holistic solution needs to be found, since the LM technique is unsustainable.

Simchi-Levi D [21] opined that the customers sometimes value their order status more than a reduced lead time. McDonald et.al [22] points out that the VSM creates a common language for production process, thus facilitating more thoughtful decisions to improve the value stream. While researchers and practitioners have developed a number of tools to investigate individual firms and supply chains, most of these tools fall short in linking and visualizing the nature of the material and information flow in an individual company. Hines [11] has opined that the value stream is “the specific activities within a supply chain required to design order and provide a specific product or value”.

Abbett and Payne [23] have discussed the application of VSM in an aircraft manufacturing unit. They have developed the current and future state maps with the objective of reducing lead-time according to customer’s requirements.

McDonald [22] has used simulation techniques for the high-performance motion control products manufacturing system to demonstrate that, simulation can be a very crucial tool in assessing different future state maps. They demonstrate that simulation can provide and examine different scenarios to complement those obtained from future state mapping.

2.2 VALUE STREAM DESIGN

VSD is a process of designing the current value stream in a better way to overcome the current problems and to eliminate the wastes. The purpose of VSM is to highlight sources of waste and eliminate them by implementation of FSVM, which can become a reality within a short period of time. The goal is to build a system where the individual processes are linked to their customers either by continuous flow or pull, and
each process gets as close as possible to adding maximum value to the final product reaching the customer.

2.3 AFTER MARKET PRODUCTS INVENTORY CONTROL

After market products (from company’s point of view) also referred to as Service Parts or Spare Parts (from customers point of view), is a term used to indicate additional parts available and in proximity to a mechanical item, such as a automobile, pumps, etc for which they might be used for repair. Without the spare part on hand, a company's customer satisfaction levels could drop if a customer has to wait too long for their item to be fixed. Therefore companies need to plan and align their service parts inventory and workforce resources to achieve optimal customer satisfaction levels with minimal costs. The main question under study is which parts to put on stock in which location and in which quantity.

3. AN OVERVIEW OF THE SUPPLY CHAIN NETWORK OF THE COMPANY

The study was carried out in the XYZ Company, which is a leading supplier of technology and services, and has a strong presence in the country at numerous locations in diverse industry segments - both automotive and non-automotive.

The supply chain begins with the customers (dealers) placing an order with the local sales office of the company, located at convenient places across the country. When a customer places an order, the Sales office in turn informs the plant to manufacture these required numbers of parts along with a buffer stock in case of unforeseen fluctuations in demand or other circumstances. The sales office also informs the supplier to replenish the plant with the required raw materials that have been consumed during this process. After the required numbers of products are manufactured by plant and have been inspected, the Sales office in turn issues a pick slip to Area Distribution Centre (ADC) that authorizes them to collect the products from the plant. The ADC that is located in the region of the end customer receives this stock of finished goods.

After the ADC has received stock of the finished products required by the end customer, they in turn intimate the Local Distribution Centre (LDC) that is located in
proximity to the customer’s facility to receive these finished products. Once the goods arrive at the respective LDC, the goods are thoroughly checked for any transit damages that might have occurred on the way. Correct Batch number is also inspected in order to ensure that all the parts belong to the same batch and are of the same make and model type. When all is found to be satisfactory, the finished products are stored according to the part number and batch identification. The customer is then intimated about the arrival of the finished products. The LDC then transports these requisite goods to the correct customer on time and with the right quantity. The customer then signs an approval form stating that he has received his goods on time, with the right quality and the right quantity.

3.1 PRESENT NETWORK OF THE COMPANY

The diagrammatic representation in Figure 1 shows the supply chain network of the company in detail. The four manufacturing plants are depicted as Ban P, Nh P, Na P, and Ja P. Four ADC’s and Twenty one LDC’s are depicted in the diagram. Five important warehouse-distribution centers are also indicated.
3.2 DISTRIBUTION CENTERS

- **Area Distribution Centre (ADC)**

  ADC is a warehouse cum distribution centre that caters to various subordinate warehouses known as Local Distribution Centers (LDC) at strategic market locations spread across regions. The ADC directly receives finished goods or other trade goods from the manufacturing plants.

- **Local Distribution Centre (LDC)**

  LDC is a warehouse cum distribution centre that caters to the customers in a locality or a specific region. Unlike ADC’s which cover regions spread across the country, LDC focuses on markets in the respective district, region or state where that particular LDC is located. There are twenty one LDC’s situated across the country in all the major states where company has a significant customer base. The different processes associated with LDC are Receiving, Storing, Picking, Sorting, Packing and Shipping.

4. PROBLEM DEFINITION

To understand the supply chain system of the company in depth and to identify day to day processes that occur in storage cum distribution center, a detailed study was carried out in a LDC. After the data collection, a brainstorming session was conducted, and the following major problems were identified.

1. System was plagued with plentiful non value-adding activities, which in turn increased the inefficiency in the system.

2. The goods being dispatched have no fixed time of delivery. The customer/dealers had an option to pick up the consignment any day in a month. This provision was exploited by the customers/dealers as they visited only at the end of the month or at any point of time convenient to them. This created lot of chaos in the supply chain due to unpredictability.

3. The information flow was misinterpreted in the entire supply chain. This deficiency generated a bullwhip effect, where problems were only magnified. The information flow was erratic, leading to plentiful problems.

4. The customer service level was low.
5. There were lot of unnecessary movements of men and material in the warehouse. There was no poka-yoke for FIFO (First in First Out) concept to work effectively.

- **TECHNIQUES USED TO SOLVE PROBLEMS**

  Based on the problems identified, it was decided to use the following Lean techniques after a brainstorming session with the management and employees.

  1. Value Stream Mapping
  2. Value Stream Design
  3. Leveling

5. **VALUE STREAM MAPPING AT LDC**

  As a first step, the current state of the LDC was studied. The whole information flow and material flow from the customer’s order to delivery was noted down. With the help of various value stream symbols, a VSM was drawn in which the current state was mapped. During the VSM, both value-adding and non value-adding activities in the whole customer order to delivery cycle were identified and recorded. The VSM prepared is shown in Figure 2.
It is seen from the Figure 2 the cycle begins from the customer/dealers when they place an order for a product to the sales office. The supply chain planner in the sales office will in turn send the information regarding the product and quantity which the customer has ordered to the supplier (the one who supplies raw materials for manufacturing that product), the manufacturing plant, ADC and LDC. Once the information is given to the supplier, one or two days will be taken to supply the raw materials required. Once the required raw materials are received, the actual production starts. Finished goods are then inspected and packed before they are sent to ADC. Periodically goods are transferred from ADC’s to LDC’s. Once a truck arrives at a LDC, again the goods were inspected before they were kept in racks. Later, based on the customer withdrawal pattern, the products were being sent to the customer/dealer. From this current state map, it can be seen that an inventory of 36 days was needed to fulfill the customers demand and also the customer satisfaction level was very low. It was also seen that some inventory was carried at each stage which was found to be unnecessary. The

**Figure 2 Value Stream Mapping of LDC**
flow of information to all stages is a non-value adding activity and also leads to confusion.

6. SPECIFIC AREAS FOR IMPROVEMENT

Some of the areas identified for improvement (Kaizen Bursts) after drawing the VSM are as follows.

- Push system was followed for parts from ADC to LDC.
- Multiple information flows from the supply chain planner to the Manufacturing plant, ADC and LDC were identified.
- High inventory pooling at ADC due to limitations on transporting goods across country periodically because of tax restrictions levied by the government was noted down.
- Multiple inspections of finished goods at LDC, even though inspection was carried out by the plant and the ADC, was observed.
- Due to heavy reliance on past data and high unpredictability in the system, inventory coverage for products on an average was as high as 36 days.
- Inventory was carried at multiple stages in the LDC as indicated by VSM.
- Improper dispatch schedules from LDC to customers as they were taking products whenever they needed without fixed time.
- More trucks and more trips as there was no fixed delivery schedule.
- FIFO methods need improvements as they were not followed properly.
- There was no properly defined storage space for various products.
- Five S system was not properly implemented.
- Training is the need of the hour for the employees to work in the present system.
- Damages during transportation were common due to fluctuations in demand and supply.

7. VALUE STREAM DESIGN AT LDC

After mapping the current state, the next step is to improve the present situation to achieve a future state which should prove most optimal and must fulfill all the lean
thinking concepts as much as possible. VSD is used as a primary tool to eliminate waste in the system.

**CRITICAL LOOPS**

1. Pacemaker loop – Between customer and pacemaker process
2. Additional loops – Upstream of the pacemaker loop, there are material flow and information flow loops between pulls. Each pull system supermarket corresponds with end of another loop.

The VSD drawn for the LDC is shown in Figure 3. While the VSD was drawn, it was decided to implement few concepts namely, establishment of Supermarkets, adoption of Kanban system and Milkruns.

![Figure 3 Value stream design of LDC](image-url)

The first step taken during the VSD was to find out a *Pacemaker* in the existing network of the LDC. A pacemaker is the only person in the network to receive the information from the supply chain planner. In this network, the person who does the packing work at LDC is designated as pacemaker. Hence, most of the information flows, which were non value-adding activities, have been eliminated resulting in a faster and better information flow. One supermarket was established at the pacemaker stage and the
other one at the ADC. A small inventory of one day was carried at the entrance and exit of LDC.

A Kanban loop was introduced between the two supermarkets to send a trigger saying that a certain amount of products have been drawn and are needed to be replenished. This Kanban loop takes care of the replenishment of the products which were drawn without any information flow between people.

If a customer places an order for a product at the sales office, the information is sent to the pacemaker. The pacemaker draws the required quantity of ordered products, packs them and sends it to the customer within two to three days. While the products are sent to customer, the Kanban cards for the dispatched product and quantity are kept in the Kanban post at the pacemaker stage. Once in every 4 hours, a person collects the cards from the Kanban post at pacemaker stage and put them in the Kanban post at the entry of LDC. From the entry of LDC, an E-Kanban will be sent to ADC supermarket and the ADC delivers the required quantity of products to LDC. This in turn triggers a signal in the ADC supermarket to replenish the products that are being taken and the ADC sends a trigger to the company to manufacture the required quantity of products.

7.1 BENEFITS FROM VSD

The following are the benefits that can be obtained through proper implementation of VSD.

- A well defined system is designed and information flow is given better clarity.
- Pacemaker is the only entity in the system that receives information from the planner, instead of multiple people as in earlier system.
- The new system avoids confusion and chaos because of elimination of multiple communication channels.
- Establishing supermarket at critical points led to a drastic reduction in inventory. Only one day's inventory is being carried between the entry and exit points of LDC.
- Reinspection at the LDC is now limited only to checking transit goods damage. This resulted in inspection time being reduced to half.
• Introduction of Kanban loop between two supermarkets to properly define a replenishment time and aid in the implementation of First In First Out concept.
• Demand forecasting is now possible through real time customer withdrawal pattern rather than relying on past data to judge the nature of withdrawal in the future.
• Push system is converted into pull system as kanban triggers the manufacturing process.
• The concept of leveling is introduced to smoothen the dispatch schedules from LDC to customers.
• Introduction of Supermarket reduced the damages of products during transportation and improved Five S system.

8. LEVELLING

Leveling is a process of smoothening fluctuating demand from customers to result in a constant dispatch of products. Leveling establishes a well defined system free from fluctuations and forms a basis for pull principle. It is critical in deciding the success of pull and also establishes production program of small lots. It should be carried out before planning of pull principle.

8.1 BEFORE LEVELING

Figure 4 Customer withdrawal pattern before leveling
When the current situation in the LDC was studied, it was found that there was an erratic withdrawal of products from the LDC (Figure 4). Customers used to take products once in a month but they had no fixed time. Products were withdrawn whenever they needed. This resulted in carrying an excess inventory assuming that the customer would draw the products based on past data which led to unpredictability in the system. For example, if a customer has drawn products on 15th of the previous month, the planners will plan in such a way keeping the past withdrawal in mind. But in this month, the customer might withdraw at the beginning or at the end of the month. Because of this uncertainty, the company had to carry excess inventory in order to satisfy both the scenarios. This led to excess inventory being carried at multiple stages of the supply chain and hence resulted in valuable capital being blocked.

8.2 AFTER LEVELING

Figure 5 Customer withdrawal pattern after leveling

After establishing leveling in the LDC, it can be observed that a well defined system of withdrawal pattern is achieved (Figure 5). The monthly demand of a particular product family was monitored and broken down into weeks and then was further brought down into days. As a result of this, products are served to selected customers in a state on a weekly basis and later on daily basis which results in carrying a very less inventory in the system. Due to the leveled dispatch system established in the LDC, the company is
now well aware of the withdrawal pattern of the customers and is now capable of manufacturing the exact number of right products at the right time and right quantity.

9. APPLICATION OF VELOCITY RATIO IN LEVELLING

VSD highlighted the necessary steps to be taken in order to achieve an ideal situation. Non value-adding information flow, material flow and operating times were eliminated. VSD defined a pathway to achieve a leveled behavior system in a warehouse to optimize customer withdrawal patterns and simultaneously concentrate on value-adding activities gradually eliminating unnecessary processes. To obtain a leveled system, identification of the ratio between value-adding and non value-adding activities is crucial and this is where Velocity Ratio comes into the picture.

9.1 VELOCITY RATIO (VR)

It is defined as the ratio of value-adding activities to non-value adding activities in any process.

\[
\text{VELOCITY RATIO} = \frac{\text{Value added activities}}{\text{Non-value added activities}} \times 100
\]

From VSM, it can be seen that the total value-adding time is 40 minutes and the Non Value-adding time is 36 days. Hence, the present VR is

\[
\text{VR} = \frac{40 \text{ minutes}}{(36 \times 24 \times 60) \text{ minutes}} = 0.077\%
\]

This Ratio indicates the current performance level of the company simultaneously highlighting the scope for further improvement.

9.2 CURRENT SITUATION

When the current state in the LDC was studied, it was found that there were 4 processes which were value-adding, each taking 10 minutes. The 4 processes were INSPECTION of incoming products from ADC for correct consignment, REPACKING of received consignment into small required numbers, PACKING for delivering to customer and FINAL INSPECTION before delivering to the customer. There were also several non value-adding activities.
Information and material flow between the farthest ADC and LDC was considered for the study, since replenishment time between these centers was the longest and around 6 days compared to other ADC’s.

10. ROAD MAP TO ACHIEVE FUTURE STATE DESIGN

The final solution was achieved after stage by stage improvement and discussion with management for the feasibility of implementation. The various stages of improvements are shown below.

1. Weekly dispatch form ADC to LDC and monthly dispatch to customers.

<table>
<thead>
<tr>
<th>1 DAY</th>
<th>36 DAYS</th>
<th>1 DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 min</td>
<td>10 min</td>
<td>10 min</td>
</tr>
</tbody>
</table>

VELOcity RATIO = 0.0623

In this proposal, it takes 6 days for a truck to reach LDC from ADC and a truck is sent once every week. The customer withdraws products once in a month. Since the warehouse works only for 6 days a week, it is assumed that on average, the warehouse works for 24 days in a month. The summation of all these days results in carrying an inventory of 36 days.

2. Weekly dispatch form ADC to LDC and weekly dispatch to customers.

<table>
<thead>
<tr>
<th>1 DAY</th>
<th>19 DAYS</th>
<th>1 DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 min</td>
<td>10 min</td>
<td>10 min</td>
</tr>
</tbody>
</table>

VELOcity RATIO = 0.115

Since it is weekly dispatch from ADC to LDC, it takes total of 13 days for transportation. The customer takes products once every week, thus resulting in carrying an inventory of 19 days.

3. Weekly dispatch form ADC to LDC and daily dispatch to customers.

<table>
<thead>
<tr>
<th>1 DAY</th>
<th>14 DAYS</th>
<th>1 DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 min</td>
<td>10 min</td>
<td>10 min</td>
</tr>
</tbody>
</table>

VELOcity RATIO = 0.152
Again, the weekly dispatch from ADC to LDC takes a total of 13 days for transportation. The customer takes products once every day and this result in carrying an inventory of 14 days.

4. Daily dispatch form ADC to LDC and weekly dispatch to customers.

<table>
<thead>
<tr>
<th>1 DAY</th>
<th>13 DAYS</th>
<th>1 DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 min</td>
<td>10 min</td>
<td>10 min</td>
</tr>
</tbody>
</table>

VELOCITY RATIO = 0.162

In this case, goods are dispatched daily from ADC to LDC and the customers take products once every week resulting in carrying an inventory necessary for 13 days.

5. Daily dispatch form ADC to LDC and daily dispatch to customers.

<table>
<thead>
<tr>
<th>1 DAY</th>
<th>8 DAYS</th>
<th>1 DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 min</td>
<td>10 min</td>
<td>10 min</td>
</tr>
</tbody>
</table>

VELOCITY RATIO = 0.243

In this final state, the dispatch from ADC to LDC takes place daily and the customer also takes products daily. This results in carrying a minimum inventory of 8 days.

The summary of the stage by stage improvement is shown in Table 1

<table>
<thead>
<tr>
<th>Dispatch from ADC to LDC</th>
<th>Dispatch from LDC to Customers</th>
<th>Required Inventory Coverage(days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly</td>
<td>Monthly</td>
<td>36</td>
</tr>
<tr>
<td>Weekly</td>
<td>Weekly</td>
<td>19</td>
</tr>
<tr>
<td>Weekly</td>
<td>Daily</td>
<td>14</td>
</tr>
<tr>
<td>Daily</td>
<td>Weekly</td>
<td>13</td>
</tr>
<tr>
<td>Daily</td>
<td>Daily</td>
<td>8</td>
</tr>
</tbody>
</table>

**Table 1 Summary of stage by stage improvements**

Once this final stage of solution is achieved, there will be 99.757 % scope for improvement. The above steps indicate a gradual improvement in velocity ratio from 0.077% to a level of 0.243%. The net improvement in the VR from the current state to the final state will be 3.15 times.
11. RESULTS AND CONCLUSIONS

The successful implementation of Lean warehouse concepts resulted in the following improvements and benefits.

- Velocity ratio of value-adding to non value-adding activities is increased from the current 0.077% to 0.243%. This is an improvement of performance by 3.15 times over the existing system.
- A system of daily dispatch of products from LDC is established in order to improve customer service and performance levels of the LDC. This resulted in inventory coverage being reduced from 36 days to just 8 days.
- Conversion of push system to pull system with a leveled behavioral pattern improved customer satisfaction levels from the present level of 82%.
- Introduction of pacemaker in the LDC processes helped in reducing non value-adding information flow between various entities. Now information flows only between the pacemaker and the planner to coordinate the activities of the entire supply chain.
- Implementation of Kanban loop and supermarkets in the LDC resulted in a system, where replenishment of products in a LDC is now possible on a real time basis rather than depending on past demand forecasting data.
- A small inventory of only one day is enough between the entry and exit points of LDC rather than carrying an unknown amount of large inventory to satisfy customer demand.
- Reinspection of incoming goods to the LDC from ADC is now only limited to checking for transit goods damage, which results in reducing reinspection time from 10 mins to 5 mins.

REFERENCES


