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A Case Study Analysis of a Plastic Packaging Company Using Value Stream Mapping Technique

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Abstract: Value Stream Mapping (VSM) is a lean manufacturing tool that has been used by organizations to visualize and minimize wastes in manufacturing and service operations as well as to identify the bottleneck processes and many other process improvement outcomes. Yet, there are organizations that are not taking advantage of this very important lean tool in their lean journey. This paper deals with a real case study in which the application of VSM for implementing lean principles is demonstrated in a plastic packaging company, by focusing on both processes and their lead times.By analysing some lean principles and techniques, after drawing the current state map, the resulting future state map shows very significant reduction in key performance indicators. Specifically, the target plastic packaging company is expected to derive the following benefits of reducing the total production lead time from 5.8 days to 3.1 days, the cycle time from 290 seconds to 125 seconds; and significant reduction in WIP at different workstations, if the suggested recommendations are implemented.

Keywords: VSM tool, lean manufacturing, WIP, lead time, cycle time

1. INTRODUCTION

Lean manufacturing has increasingly been applied by leading manufacturing companies throughout the world. A core concept of lean manufacturing is pull production in which the flow on the factory floor is driven by demand from downstream pulling production upstream. The story of lean manufacturing or lean production for a layman understanding is well documented in the book "The machine that changed the world" [8] that discussed Toyota's secret weapon in the global car wars that revolutionized the world industrial complex.

One of the core concepts of lean manufacturing is Value Stream Mapping. VSM includes all the steps, both value added and non-value added, required to take a product or service from raw material to the waiting arms of the customer. This enables to see at a glance where the delays are in process, any restraints and excessive inventory. Current state map is the first step in working towards ideal state for organization. VSM is primarily concerned with mapping the movement of information and materials through the value stream. In the literature [2] the two dominant objectives of VSM application are (i) reducing manufacturing lead time and wastes of a manufacturing company, and (ii) increasing capacity of that manufacturing company.

Value Stream Mapping (VSM) is used to define and analyse the current state for a product value stream and design a future state focused on reducing waste, improving lead-time, and improving workflow. One of the unique characteristics of VSM in comparison with other process analysis techniques is that one map depicts both material and information flow that controls the material flow. The focus of VSM is on a product "value stream" (all actions required to transform raw materials into a finished product) for a given "product family" -- products that follow the same overall production steps [1].

2. OVERVIEW OF VALUE STREAM MAPPING

Value Stream Mapping is a Lean technique used to analyse the current material and information flow necessary to bring out the products or provide services for the customer. This technique includes all the activities that follow the product from the customer order, going through the entire production process and the finally delivery to the customer. Value Stream Mapping is the perfect argument for Lean practitioners to show where data comes into play, how it is collected quickly and efficiently, and how Lean project action plans are created from this data. Because anywhere there is a process there are bound to be wastes. Therefore, it is desirable to find the best solutions and techniques to reduce wastes or even eliminate them completely. The advantage of using this method allows anybody to "see" both process flow and communications flow within the process or value stream. Because of this ability to gather, analyse and present information in short period of time, this method has rapidly gained popularity in the process of continuous improvement.

Because VSM is an analytical method, and depending on the level of details, the VSM can address only to a process step, to one or the production lines, or to the entire factory [3]. VSM is one of the most important and powerful Lean tool for an organization to implement and improve on its lean journey. The car manufacturer Toyota Company in Japan was the first company to use VSM techniques in its lean concepts implementation.

VSM has been thoroughly analysed and a team created to improve the productive system of a manufacture application. It is a graphical tool created to use a predefined set of standardized icons that help the organization to see and understand the flow of material and information as the product goes through different stages.

After drawing the value stream, it helps the organization to differentiate value-adding activities from non-value adding activities from current condition and identify kaizen opportunities. The real benefit is, it gets the company away from isolated point kaizen and builds towards a true system based on the flow of materials and information across the entire value stream, modification of inner wheel housing process line by considering case study of an packaging industry with effective cycle time reduction is made clearly, assembly lines are still fundamental to get the smoothing of production system in any medium organization [4].

3. METHOD0LOGY OF VALUE STREAM MAPPING

By practicing VSM, elimination of waste and streamlining the business is very effective by implementing fallowing stages of VSM techniques like Identify what product or family of products to be mapped, draw the current state map, identify where the improvements can be done to eliminate waste finally draw the future state map [4]. The following steps provide detail description of Figure 1(b):

Whenever there is a product for a customer, there is a value stream. The challenge is in seeing it. Value stream mapping can be a communication tool, a business planning tool and a tool to manage change processes. Value stream mapping initially follows the steps shown in Figure 1(a). Notice that "Future State Drawing" is highlighted, because the goal is to design and introduce a lean value stream. A current state without a future state is not much use. The future state map is most important. The purpose of value stream mapping is to highlight sources of waste and eliminate them by implementation of a future state value stream that can become a reality within a short period of time. The goal is to build a chain of production where the individual processes are linked to their customers either by continuous flow or pull, and each process gets as close as possible to producing only what its customers need when they need it. The final step is to prepare an implementation plan that describes how the future state value stream would be achieved. The exercise of drawing a value stream map as per Figure 1(a) can be summarized by the following steps:

1. Selecting a product family.
2. Having one person personally lead the mapping effort.
3. Beginning at the "door to door" level.
4. Considering both the material and information phase.

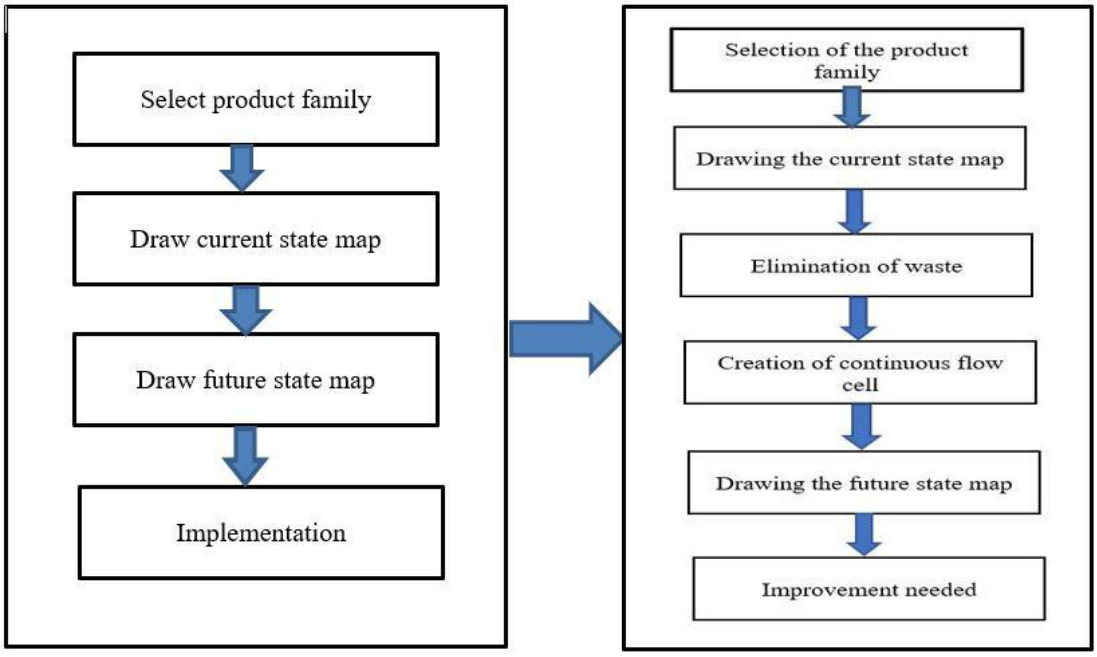

Figure 1: steps of VSM methodology [5].

Furthermore, the expanded version of Figure 1(a) resulted in Figure 1(b). Most lean practitioners agree with this expanded view [5]:

i. Selection of the Product family: First, we have to select the product that to be manufactured. In this case the product is plastic.

ii. Drawing the Current State: This is an important step in Value Stream Mapping Process. The data is collected while walking along the shop floor and studying material and information flow. The data collection begins at the shipping end (Downstream end) and work towards the upstream.
iii. Elimination of Waste: After analysing the current state map we found that there is a huge difference between production lead time and the actual processing time. There are good opportunities to eliminate waste from the production line.
iv. Creation of Continuous flow cells: The continuous flow cells are created to introduce a continuous flow in the value stream.
v. Future State Maps: The purpose of value stream mapping is to identify and eliminate sources of waste by implementing a future-state value stream that can become a reality within a short time. The goal is to build a chain of production where the individual processes are linked to their customer(s) either by continuous flow or pull, and each process gets as close as possible to producing only what its customer(s) need when they need it.
vi. Improvements needed: Suggesting possible improvements in the future is part of continuous improvement process.

4. VSM SYMBOLS

Typical VSM symbols as shown in Figure 2. Software packages such as Microsoft Visio, eVSM, iGrafx and, Edraw Max have built-in VSM symbols and in some cases additional symbols more than what is shown in Fig.2.

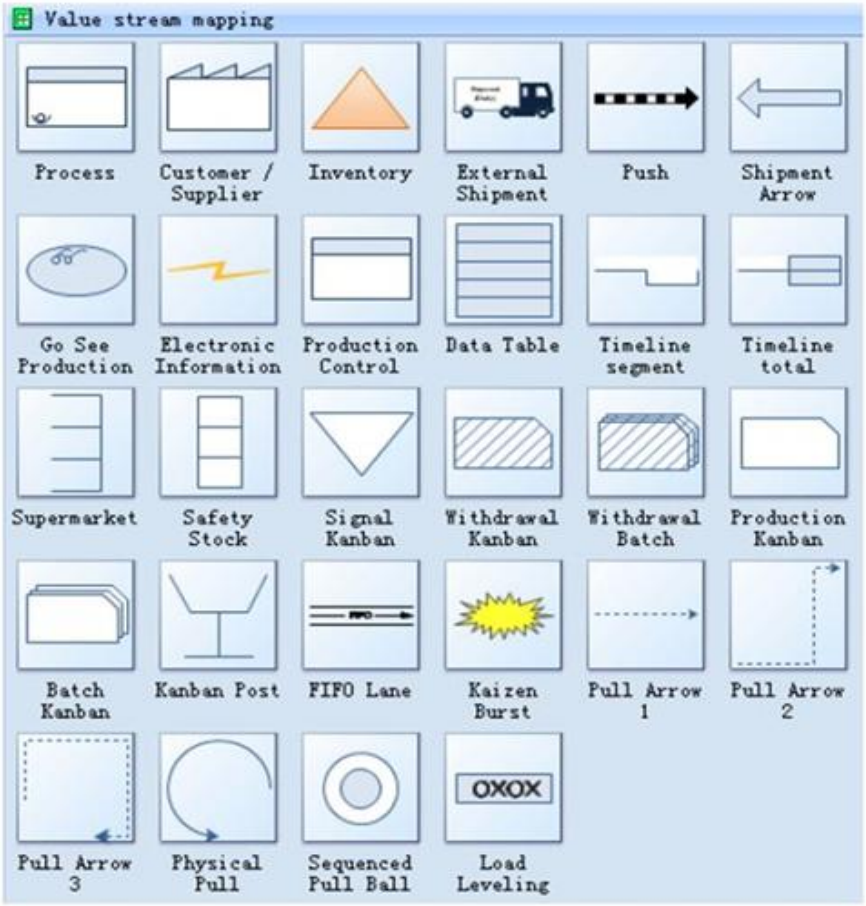

Figure 2: typical symbols used in VSM

5. SIGNIFICANCE OF VSM

The significance of VSM has widely been recognized throughout the literature [6]. In a nutshell, some of the well documented importance of VSM are:

1. It helps to visualize more than just the single-process level, i.e. assembly, welding, etc., in production. The flow can be seen.
2. It helps to see more than waste. Mapping helps to see the sources of waste in the value stream.

3. It provides a common language for talking about manufacturing processes.
4. It makes decisions about the flow apparent, so the brainstorming is possible. Otherwise, many details and decision on the shop floor just happen by default.
5. It ties together lean concepts and techniques, which helps to avoid "cherry picking".
6. It forms the basis of an implementation plan. By helping to design how the whole door-to-door flow should operate. For missing piece in so many lean efforts value stream maps become a blueprint for lean implementation.
7. It shows the linkage between the information flow and the material flow. No other tool does this.
8. It is much more useful than quantitative tools and layout diagrams that produce a tally of non-value-added steps, lead time, and distance travelled, the amount of inventory, and so on.
9. Value stream mapping is a qualitative tool by which the detailed description of how the facility should operate to create a flow is perceived.
10. Numbers are good for creating a sense of urgency or as before/after measures. Value stream mapping is good for describing what one can going to do to affect those numbers.

6. CASE STUDY

The company selected for this empiric research is Constantia Parikh Packaging Pvt. Ltd, India. The company was established in 1999, Parikh Packaging is the flagship company of 70 years old Parikh Group which was incepted in 1940. The Ahmedabad-based packaging plant joined Constantia Flexibles in 2013 to support the group for further growth and expansion in Asia. Constantia Parikh is mainly producing: Snacks & chips packaging, stand up pouches, single-unit shampoo sachets and different rollstock laminate materials. 'Parikh Packaging' embraces the manufacture, supply and conversion of films, aluminium foils and papers that are used separately or in combination, for primary retail food packaging, and other applications such as pet food, pharmaceuticals and home and personal care. The focus of company's product development is on the manufacturing of packaging solutions with a minimal impact on the environment, low material usage and high recyclability, while also achieving ideal product characteristics.

The research objective is to reduce the production lead time and WIP to increase the production rate in Constantia Parikh Packaging Company, so that customer order demand can be fulfil. Batch processing in full capacity and bottlenecks in the production process are key contributors to long Production Lead Times. The results of the research would have direct impact on product Production Lead Time and WIP which would aid in reducing cost and meeting customer demand. The current information was collected directly from the company by talks and discussions with managers, owner, and production supervisors. Example of such information is customer demand, general process flow, supply of raw material etc. Information about cycle time, changeover time, and number of operators involved in each processing steps, amount of inventory and work-in progress between processes was determined. Current map was drawn which shows the material and information flow. Takt time was calculated and compared to average cycle time. The different areas were identified which needed improvement. Thereafter, future state map was developed followed by some suggestions. Lean tools and techniques were suggested for improvising the material and information.

6.1 Preparation of current state VSM

Current state VSM is used to map work processes, material flow, and information flow. For this project Edraw software is used to create current state and future state VSMs. E-Draw Max is a vector-based diagramming application with rich examples and templates. Easy to create flow charts, organizational charts, business process, UML diagrams, work flows, program structures, net-work diagrams, chart and graphics, mind map, directional maps and database diagrams [8]. The following data was observed in the current state map as shown in Table 2 and Table 3. Fig.3 shows the current Value Stream Map.

Table 2. Value Stream Input data

Customer Order	7000
Working Hours	Two shifts with 12 hours per day
Break	2 hours
Raw Material	Weekly
Working Day/Week	7

Table 3: Cycle time, Change over time and WIP of Different Processes

Processes	Cycle time	Change over time	WIP
Feeding	10	5	600
Forming or Erecting	90	15	1000
Filling	15	4	200
Closing	80	8	700
Inspecting and packaging	85	12	800
Labelling	10	6	300

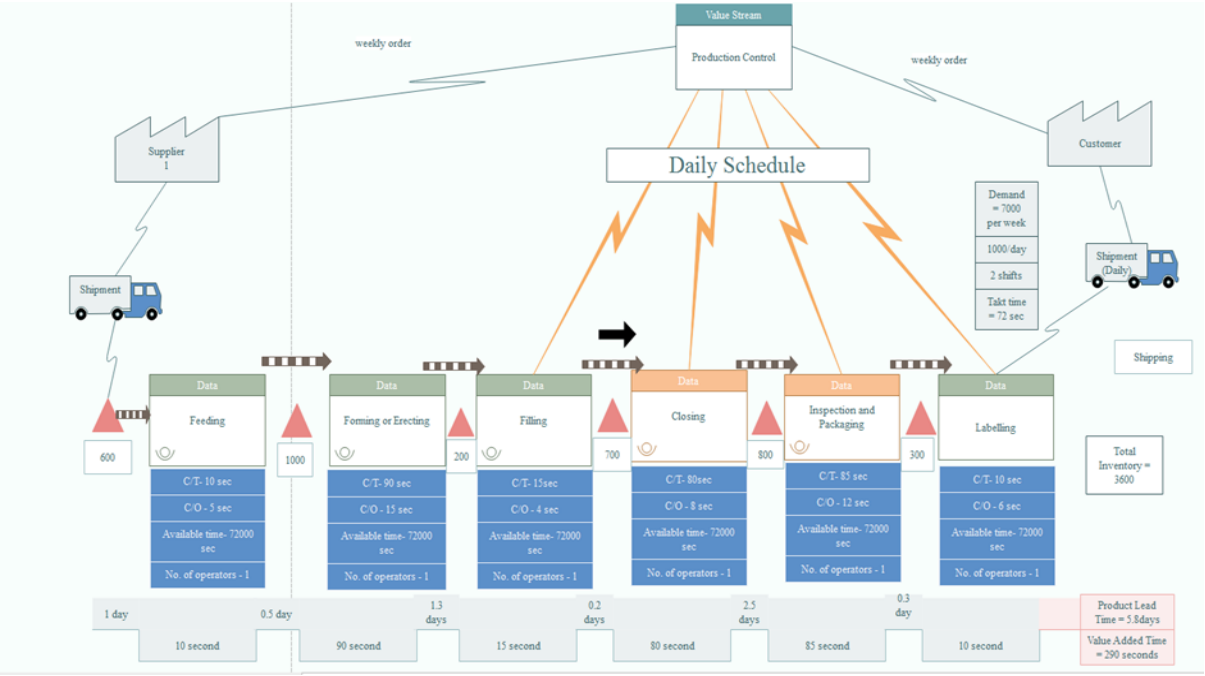

Figure 3: current state value stream map

6.2 Analysis of current state Value Stream map

The actual value-added time is 290 seconds and the lead time is 5.8 days so the ratio of value-added time to lead time is very less.

Available working day in a week = 7 day

Demand per day= 7000/7 = 1000 units

TAKT Time =Net available time per day/ Customer demand per day

= 20*60*60/1000

= 72000/1000 = 72 seconds

It is clear from the above the three processes (Forming, Closing, Inspecting and Packaging), generally takes higher time than Takt time. So, these three processes need more improvement. Fig.4 shows the comparison between cycle time and takt time for different processes. Current state map shows the work in process (WIP) in different processes. It can be seen that the processes Forming, Inspecting& Packaging and Closing have the maximum inventory. As shown in current state map reason for high WIP is longer cycle time. So, there is need of improvement at these processes.

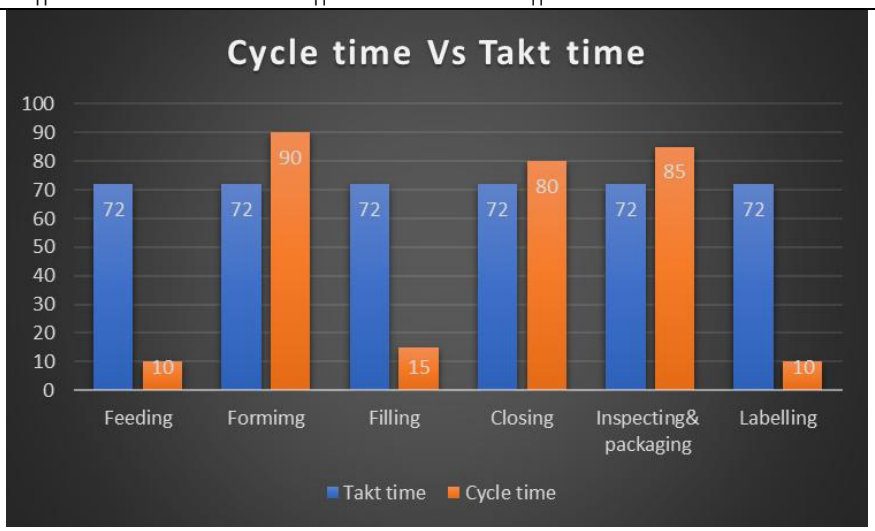

Figure 4: Comparison between cycle time and takt time

Number of workstation Required = sum of all cycle time/ takt time

= 290/72

= 4.02

So, there is a requirement of 4 workstation.

6.3 Preparation of future state Value Stream map

The future state map is draw to give propose suggestions and recommendations for improvement in the current position of the company. The future state map below shows all the areas that require improvement and the ways it can be improved. If all the suggestions are implemented gradually in an incremental way, then the Production Lead Time for the product will be 3.1 days which is 5.8 days earlier. The processing time is also reduced from 290 seconds to 125 seconds.

In future state map the total work station is 4. Supermarket is used for storage of WIP in future for storage of WIP, this reduces the excessive WIP at Inspection and Packaging. Production Kanban is also used which give the storage information to the work cell (Filling and Closing) for maintaining the production. A warehouse is introduced in the future map for storage of raw material. Whenever there is requirement, raw material is available, so inventory reduced at first work station. At second last station the no of operator increased to two which reduce the WIP at Inspection & Packing. Fig.5& 6 shows the future state VSM and comparison of cycle time and takt time of different processes in future state.

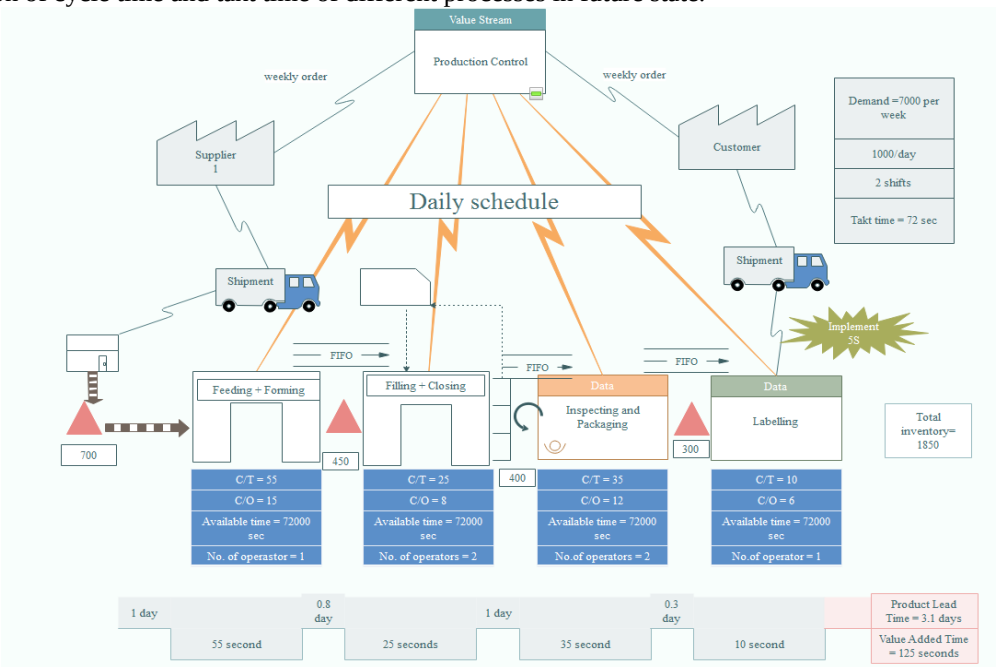

Figure 5: Future state of Value Stream Map

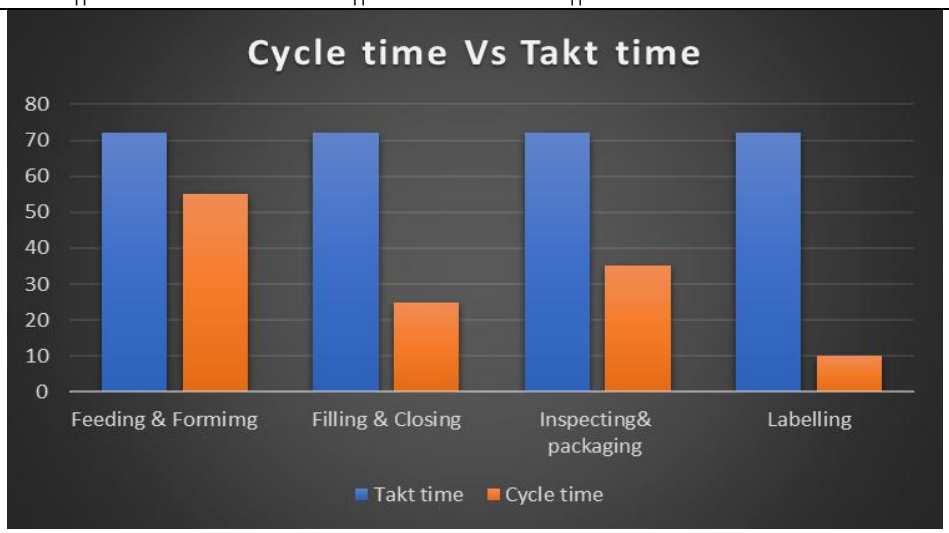

Figure 6: Comparison of cycle time and takt time in future state

FIFO was utilized to maintain controlled inventory. It is a lane which can hold fixed/decided number of inventory. Whenever the lane is full, the earlier operator stops producing parts preventing the overproduction of products/parts. So, lane between two decoupled processes maintains a flow between them. FIFO symbol is shown between two process boxes with maximum inventory it can hold. Implementing 5S following benefits can be achieved.

- Thoroughly eliminate waste due to surplus inventory.
- Reduce space requirements.
- Adopt better storage methods.

6.4 Results and Suggestion

Comparative study shows the significant reduction occurs in WIP and Production Lead Time& total cycle time as shown in Table 5& 6 respectively. Value stream mapping technique was used to draw maps and after applying some tools and giving some suggestions for the product.

Table 5: Reduction in WIP for different processes

Processes	WIP in Current State	WIP in Future State	% Reduction
Feeding & Forming	1600	700	56.25%
Filling & Closing	900	450	50%
Inspecting&Packaging	800	400	50%
Labelling	300	300	0%

Table 6: Reduction in Total Production Lead time and Total Cycle time

Time	Current state map	Future state map	% Reduction
Production Leadtime	5.8 days	3.1 days	46.55%
Total Cycle time	290 seconds	125 seconds	56.89%

Value stream mapping analysis at Parikh Packaging company gives the areas which have different types of wastes and require a lot of improvement. So, following suggestions are advised to Parikh packaging company regarding the shop floor activities improvement:

1. For easy flow of work in process inventory supermarket can be used in between the processes. It results in pull system in the production line, which results in almost 50% reduced WIP inventory.
2. There was no free space for finished product or shipping product at the end. Management suggested that 5S lean technique can be used to improve the working environment.
3. It is necessary that cycle time should be near about takt time. It can be achieved by balancing the production line which results in almost 57% reduced in total cycle time.
4. A warehouse is required to store the raw material. As discussed earlier in current state map there is no provision for storage of raw material. This results in better storage and handling of raw material.

7. CONCLUSION AND FUTURE WORK

This case study describes how the value stream mapping can be used to visualize graphically the flow of material and flow of information from customer order to finish product. With this approach (VSM) wastes in the company can be reduced. Before drawing the current state map, value must be defined according to the customer level, the delivery team level and the product level. This is done in order to determine which activities add value to the product and which do not. After drawing the current state map different areas of improvement were founded. There is improvement in the WIP and Production Lead Time and total Cycle time. Many other suggestions proposed to the industry for improvement. VSM deals with overall, integrated optimization of enterprise processes at every level. VSM can be utilized in the following manner:

i. VSM is utilized to identify and then eliminate sources of waste applying variety of lean tools.
ii. VSM is to establish continuous flow of material/product through entire supply chain process.
iii. VSM goals are to achieve shortest lead time, zero inventories with lowest cost and highest quality of product.

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