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APPLICATION OF VALUE STREAM MAPPING (VSM) IN REDUCING PRODUCTION LEAD TIME

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Abstract- *Value Stream Mapping is a lean tool used for reducing lead time, uncovering waste in production and supply process by identifying non-value-adding steps first and then removing them. A flow diagram of the process and material is drawn which reflects the current state of the operation. The non-value added actions are identified in each step. The waste of time and resources between the steps are also come to light. The process is then analyzed to reduce lead time and simplify the process by taking some necessary actions or applying some lean tools. By reducing waste the proportion of value adding time in the whole process increases and the process throughput production lead time decreases. After that a new, improved, well planned diagram is made. This is called future state map which makes the redesigned process more effective and more efficient.*

Keywords: VSM, Value Stream Mapping, Lean tool, Productivity, Production Lead Time

1. INTRODUCTION

With manufacturing becoming a more and more competitive market, companies globally strive to increase their effectiveness. Increasing labor costs in many industrialized countries, as well as reducing and controlling operating costs, are just a few reasons companies choose to move or outsource their operations. Typically a majority of companies outsource to countries where wages are low and production costs are lower. To reduce cost and remain competitive with manufacturers abroad, companies use a variety of different methods. One of the main methods is called "lean manufacturing." The main principle of lean manufacturing is to reduce waste in an operation, such as long lead times, defects and material waste. In order to visually display where waste occurs in the process, a value stream map (VSM) is drawn.

1.1 Value Stream Mapping

This is a step by step guide to creating a current state value stream map, the first step in working towards ideal state value stream and a truly lean system. Current state value stream map is a team effort that is conducted by those people who are involved in the process, at the actual process, not by an expert locked in a room with a pile of procedures.

2. LITERATURE REVIEW

Lean manufacturing has received sample attention in academic literature and practical performance, from how the lean production concept was formulated and disseminated (Browning and Heath, 2008) until recent comprehensive literature review (Shah and Ward, 2003, Soderquist and Motwani, 1999 and McDonald et al 2002). This research addresses the confusion and inconsistency associated with "lean production". They attempted to clarify the semantic confusion surrounding lean production by conducting an extensive literature review using a historical evolutionary perspective in tracing its main components. They identified a key set of measurement items by charting the linkages between measurement instruments that have been used to measure its various components from past literature, and using a rigorous, two-stage empirical method and data from a large set of manufacturing firms, they narrow the list of items selected to represent lean production to 48 items, empirically identifying 10 underlying components. In doing so, they made map the operational space corresponding to conceptual space surrounding lean production. Configuring theory provides the theatrical underpinnings and helps to explain the synergistic relationship among its.

In them, a common topic appears, that is, the need to explore the implementation and performance relation-ship with a practical focus and with a definition of the context because the results depend on the manufacturing environment. We affirm that it is not possible to define the context without including the product and the manufacturing process, at least from an operational and technological perspective.

In this sense, a real and detailed case study provides the sufficient items to evaluate the implementation and under what conditions, allowing the benchmarking between practical of companies. It is possible to find analysis of case studies about steel production (Liker

and Mier 2006), forging processes (Pavnaskary et al 2003), aircraft manufacturing (Browning and Heath, 2008), or assembly lines of vehicles (Shah and Ward, 2003); although the last one has been studied deeply, some criticisms can be found in the literature due to lack of resulting data (Browning and Heath, 2008).

Their methodology is similar, using lean tools, and they are adapted to the study variables, but the improvement point and the results achieved are different. Furthermore, in line with Milterburg (Miltenburg, 2001) (Bamber and Dale, 2000), how an implementation can be done is a subject that benefits from research. In addition, "a line of interesting researches is one that follows real one-piece flow production systems over time to learn what problems are most difficult at different points in time, how these problems are solved" (Bamber and Dale, 2000). An assembly line comprises a sequence of workstations through which a predefined set of tasks are performed repeatedly on product units while they are moving along the line. [2]

It was originally developed to support mass production of single homogeneous standardized com-modify to gain a competitive unit cost. As a consequence of just-in-time (JIT) implementation, manufacturers aim to achieve continuously improved productivity, cost, and product quality by eliminating all wastes in their production systems. However, the straight line cannot fully support the adoption of JIT principles to manufacturing especially in the utilization of multi-skilled operators. [3]

3. VSM METHODOLOGY

There are several important steps to getting started with value stream mapping process.

- Identify Product Group
- Identify the Current State Map
- Observe and Confirm Process
- Creating Future State Map
- Creating the Implementation Plan

3.1 Identify Product Group

Within a warehouse, the first important step to carry out when developing a value stream map is to identify the product or product family (group of products that pass through similar processes and use common equipment and resources) would like to improve.

3.2 Identify the current State Map

Once defined the scope, the next step is to create a "current state map," or a visual representation of how the process (or processes) in the warehouse are operating at the present moment.

3.3 Observe and Confirm Processes

The mapping then begins by going to the warehouse floor to observe processes firsthand. In fact, going to the gemba (or the place where the work happens) is critical to having an accurate current state map. To do this, the value stream mapping team typically starts the value stream walk at the end of the process, with the last process closest to the customer. [1]

3.4 Future State Map

This stage is the critical part to improve the operations and to achieve the lean system. The TAKT time is based on the bottleneck capacity. Also, some tools of lean manufacturing are identified to help implement the lean system. On the other hand, rework and inventories as these infrequently give value to the customer (Womack, 2006). [1]

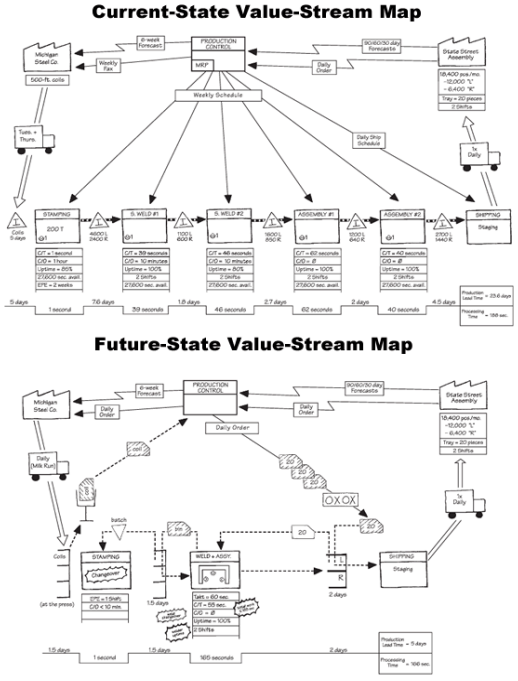

Fig 1: An Ideal Value Stream Map

In this figure there is an example of value stream mapping of a battery plant. Here current state map is shown in the upper section and future state map is shown downward.

3.5 Creating the Implementation Plan

The most important and final step of the value stream mapping process is the creation of the implementation plan to achieve the future state. Typically, the implementation plan is split into three phases: 30-60 day improvements, 90-180 days 'developments, and 360-daysdevelopments. The team should prioritize the plan to get the majority of the improvements implemented within one year. [1]

4. DATA ANALYSIS

4.1 Information Collection

To generate a VSM of any product, at first we have to collect the information about the product and the manufacturing processes related to it. There are different ways to collect information and relevant data from the manufacturer company. We acquired some

basic information about Bata shoe company ltd. and its product from the ENT (Engineer and Technician) department. Then we were permitted to visit the different job floors.

We visited to the different floor and talked with the floor managers, operation managers and workers. They gave us different types of information like number of machines, number of operators, uptime, production rate, scrap rate etc. We also obtained information when we visited to floor ourselves. The floor manager described the manufacturing processes to us and answered our question when we walked through the floor. After the observation of operations, we again met with the floor managers and asked the questions to them which is needed for our goal. When we observed the floors, we did a little conversation with the workers and tried to find out their problems. The workers and operators also provided some important information and data.

After that we explored into the floors individually and tried out find out different problems which was very effective. By visiting the factory, we have acquired some great experience and also gather our required information and relevant data for our work.

4.2 Time Studies

We create the time line to give us information about total process times and lead times for inventory through our processes; we use the inventory at each stage and the daily demand to calculate the amount of stock in days and add this to the top of the time line, this will allow us to calculate a total lead time. The cycle time for one product is then placed in the lower portion and this will be added to give a total processing time.

It is usual to at this point to have lead times that are several days to several weeks and processing times that are only a few minutes which highlights just how much waste there is in our system. This gives us our completed current state value stream map; now the real work can start. When we collected all the relevant data and understood about the operations, then we had to conduct our own time studies to get exact cycle time of the processes. We were going through the different production line to record the cycle time. Time study is procedure to measure the time of any process practically. We use a stop watch to measure and a sheet to record. We conducted time study to calculate the cycle time. Cycle time clock starts when work begins on the request and ends when the item is ready for delivery. It means that cycle time is the total production time to produce a single product. The average cycle time told us that how well the current operation is doing in relation to the TAKT time. The classic calculation for the TAKT time is:

TAKT time = Available time to production / required units of production

It is not very easy to calculate or record the exact time because we have to measure them differently and also some manual error can be caused.

4.3 Information of Plants

In Bata shoe factory ltd. current condition of the production system is very efficient than any other shoe companies in our country. There are mainly two job floors, where different types of manufacturing process are being held to produce. There are two different section or job floor for producing plastic and rubber sandals. We worked on Rubber Section in this research. Some important information collected to generate current state map of Bata shoe factory ltd. are given below:

Condition:
There are total 9 workers are working in this section.
Total lead time: 17.4
Total Value added time: 31
Total Cycle time: 48.4 sec/pair
Average production rate: 623 pair/shift

Table 1: Data for Job Floor

Current Condition			
Machine Name	**Lead Time (Second)**	**Uptime (%)**	**Scrap (%)**
Mixing	2	82.22	0
2 Roller	2	97	0
9 Gram	2	97	0
Hydraulic Press	5	98	0.1
Cutting, Assembly & Finishing	15	94	0.24

5. SOFTWARE USED TO DRAW VSM

E-Draw Max, Version 7 was used to draw all the maps. E-DrawMax is vector-based diagramming software with rich examples. E-Draw Max software is easy to create flow charts, network-diagrams, chart and graphics, value stream mapping,SWOT diagram etc. E-Draw Max includes all the libraries andexamples of E-draw product line.

6. DISCUSSION ON DATA ANALYSIS

6.1 Current Situation

In Bata Shoe Company (Bangladesh) Ltd. current condition of the production system is very efficient than any other shoe companies in our country. The main raw materials for their production are Plastic (powder) & Rubber. All the raw material is ordered and stored in two different warehouses for different materials. There are mainly three job floors, where plastic powder is transformed into granular, other to turn granules into plastic sandals and the last one make Rubber sandals.
By investigation, these data are collected-
No. of Shifts = 3
Work hour per shift = 8 hours
Break time = 30 minutes
Average working days per month = 26
Monthly production hour = 26 × [(8×3) – (0.5×3)]
= 26× 22.5 hours = 2106000 seconds

Maximum Demand/month = 50000 Pairs
Takt time= 2106000/50000 = 42.12 sec
Current Lead time = 48.4 sec
Current Capacity = 2106000/48.4 = 43512 Pairs
Production shortage = 6488 Pcs (13%)

6.2 Current State Map

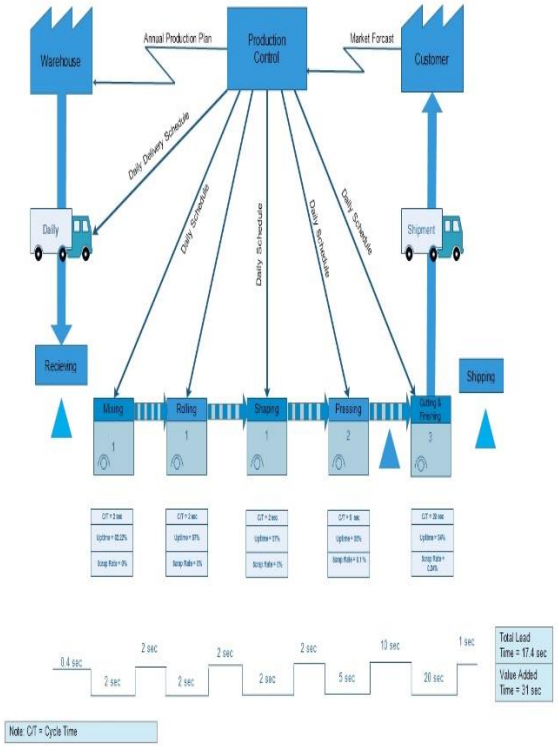

Fig 2: Current State Map of BATA Production System

7. RECOMMENDATION & CONCLUSION

7.1 Waste finding & Suggestion

- **Motion**: For our thesis purpose we observed and noted some unnecessary motion of workers and placement of some equipment in plastic section. Workers should be instructed about their movement. Workers move the plastic sandals by themselves which waste some times. If there is a conveyor used the time will be reduced and unnecessary movements.

  Workers have to bend down and turn their body and sandal on assembly desk. The suggestion for new designed tool can be made where sandals can be placed and its height will be parallel to the position of the assembly section. Thus, workers can work in good body movements.

- **Defects:** It was noticed that one m/c was not working. By regular maintenance the unexpected breakdown and defects in machines can be improved.

- **Inventory:** In both sections workers use different equipment for their work purpose. The equipment's are placed in a section. According to operation type the tools are placed in a side-section. The use of "5S" can ensure improved service and safety and efficiency. 5s is a part of kaizen. Sorting and set in order can ensure better discipline in the use of the equipment. Specific tool box for each equipment can make plastic molding section a decorated one.

  There are also some ergonomic error found in tools like chairs of the assemble section, cutting scissors. These should be change to reduce fatigue of the worker and improve productivity.

- Bata can introduce a training department for the workers. Workers can acquire knowledge about the working environment, individual performance, and safety precautions or hazards. It will increase lifetime of worker and most importantly the knowledge of the individual worker.

7.2 Future State Map

Future state map gives us the view how a manufacturing plant can operate in improved design comparing to the current situation. Improved stage of information flow, material flow and time flow are displayed in the future state map. Various lean tools to reduce waste throughout the manufacturing plant have been displayed.

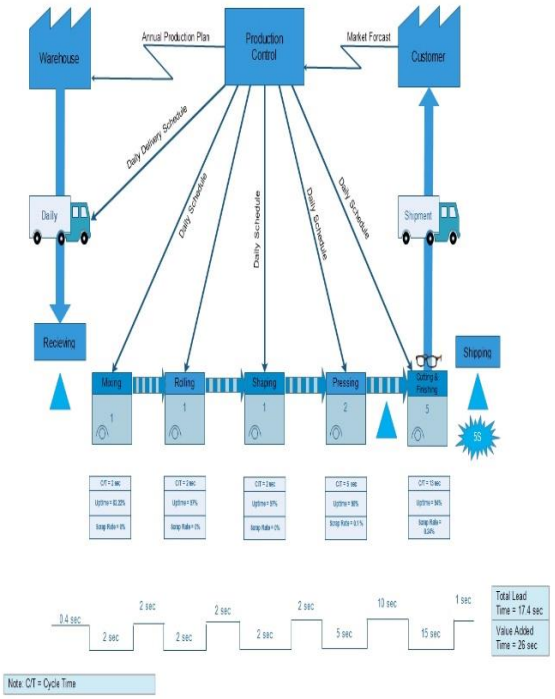

Fig 3: Future State Map of BATA Production System

In Future State Map we suggested-

- **5S:** In Rubber section the process are continuous. So, time is fixed and can't be reduced without increasing machine capacity. The only section can be improved is cutting and finishing section where 5S needed to be introduced which will reduce the wastes and time.

- **Go-See:** Gathering of information through visual means. GenchiGenbutsu means "go and see" and it is a key principle of the Toyota Production System. It suggests that in order to truly understand a situation one needs to go to gemba or the 'real place' - where work is done. GenchiGenbutsu is therefore a key approach in problem solving. If the problem exists on the shop floor then it needs to be understood and solved at the shop floor.
  In Cutting & Finishing section more time is wasted. So, Go-see can be applied there to find the problem and seek for solution. [4]

7.3 Conclusion

By applying the improvements lead time will be reduced and the capacity will be increased so that the maximum demand can be produced by Bata Shoe Company. The improvements are shown in the Improvement Chart below-

Improvement Chart

Table 2: Improvement Chart

Parameters	Data
Demand	50000
Takt Time	42.12
Current Lead time	48.4
Current Capacity	43512
Improved Lead time	41.4 **(14.46%)**
Improved Capacity	50869 **(16.9%)**

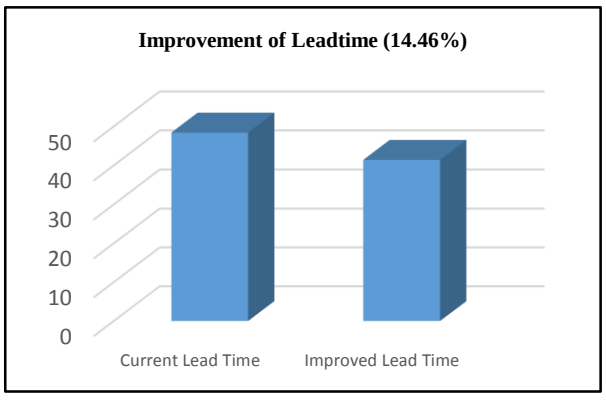

Fig 4: Improvement of Lead Time

In fig 4 contains two bars representing the current lead time and future lead time comparison. The current lead time is 48.4 seconds and the improved lead time reduced to 41.4 seconds. The future state map will improve the lead time by 14.46%.

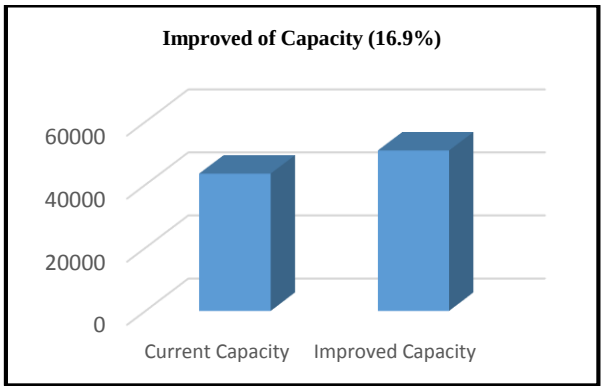

Fig 5: Improvement of Capacity

This graph contains two bars representing the current capacity and future capacity comparison of the rubber section. The current capacity is 43512 pairs and the improved capacity reduced to 50869 pairs. The future state map will improve the capacity by 16.9%.

Value stream mapping has been indicated as one of the best tool for Lean Production implementation in a facility. This method is not easy to use in the case of complex production processes characterized by multiple flows that merge. For our thesis work we selected Bata Shoes Company Plastic & Rubber sandal production plant. Value stream map has proven to be effective by analyzing Bata's current production state and recommendations are suggested.

It is feasible to use value stream map in the current situation. Applying lean tools such as Kaizen, Go-see & 5S- will be helpful for better material and information flow throughout the production system and can reduce overall value added time. Thus, production can be increased and customer demand can be fulfilled. We recommended Bata to apply the methods suggested during the project for better productivity.

8. REFERENCE

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