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Analysis and Reduction of Production Waste in the Process of Production of Fruit Beverages in Beverage Industries using Value Stream Mapping and Pareto Principle

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Abstract - *The project entitled as "analysis of wastes and reduction of the same in the process of production of fruit beverages using value stream mapping and Pareto principle was carried out at KTR beverage Industry, Bengaluru. Leading manufacturers of Fruit Beverages.*

The organization aims to achieve excellence in manufacturing by continuous maintenance of their best quality and to be cost competitive in the market but unable to meet these objectives due to the presence of some wastes in their production unit. Hence, one of the lean quality tool Value Stream Mapping (VSM) and Pareto principle is introduced in order to identify and analyze in detail about wastes produced and reduction techniques are suggested.

The overall objective of the project was to study the waste produced in the production unit that to in processing and distribution units. In order to improve and increase the production and for betterment for the industry.

***Key Words*: Waste reduction, Beverages, Quality, Value Stream Mapping (VSM), Pareto Principle, Production Wastes**

INTRODUCTION

Production control has been extensively distributed using Values Stream Mapping (VSM) and statistical analysis in several manufacturing outfits in recent time. These helped to gauge and improve the procedures required to effectively deliver products or services with minimal itches and wastes. The VSM may be a potent method for exposing the section where waste is predominant in any process, not just production. The step-by-step analysis of production stages using the Value Stream Mapping provides an outcome of whether any stage is value added or not. Value Stream Mapping is preferred to other methods because it shows the flows from the position of demands to the top of all activities after products and services must be made available.

The Pareto principle, states that 80% of waste comes from 20 % of the causes or reasons. In other words, most of the activities have no or little effect. It also means that 80 % of the industrial output is produced by 20 % of the labors. The Pareto analysis is that technique, where a plenty of possible courses of events are competing for action. It helps to spot the highest portion of causes that has to be addressed to proper solution to majority of the problems.

Value Stream Mapping (VSM)

A value stream map (VSM) is a flowchart that illustrates and analyzes the steps involved in producing a product or delivering a service. Once someone maps this current state of the process from start to end, he or she should find areas that don't add value to the process methods and reduce those areas. Value stream mapping started with Lean methodology because it is a strong way to visualize the key objectives of Lean methodology: to control and monitor and to manage all waste, including overproduction, defective parts, and transportation of individual or group of people and products.

Value Stream mapping steps

Step 1: Creating the present state map

Setting up an objective and implementing a thought to visualize using value stream symbols. There are many symbols for each and every process flow, material flow, transportation, inventory etc…..,

Step 2: Draw the flow of information and products, materials, people in the second step, we add information about how materials, people and product information flow through the value stream. Visualizing where the materials are stored. Information about shipment is additional to the process.

Step 3: Add process data

When adding process data, it's important to acknowledge what's useful for the given situation and purpose. In some cases, the aim might not be entirely clear before the analysis is completed, which results in addition of all the known data about the process or method. The list below gives an overview of process data and abbreviations will be of use for a VSM.

Step 4: Add timeline and calculations

In this final step, we want to calculate the takt time, the process times and waiting times (inventory lead times) and add these to VSM. These are going to be useful for estimating the total lead or interval time, process time and process efficiency.

The wastes identified within the industry include:

a) Transit leakages: The waste produced during transportation or carrying the product or raw materials from one place to different places.

b) In-house leakages: Disposable non-hazardous domestic wastes including raw materials, defective tetra packs, bottles etc.…,

c) Production or assembly line wastes: The bottles which are overfilled, under filled, missing crown and breakages

I. Objectives :

To Analyze the Wastes and Reduce them by considering the production or assembly line and distribution unit of fruit beverages in KTR Beverages Industry Using Value Stream Mapping and Pareto Principle.

II. Methodology Block Diagram

The project methodology is as follows:

Step 1: The input requirements are identified in production and distribution unit in KTR beverages. Problem is defined for easy and clear understanding.

Step 2: The outsight process is analyzed for defined problem.

Step 3: Objectives and sub objectives are set in this stage.

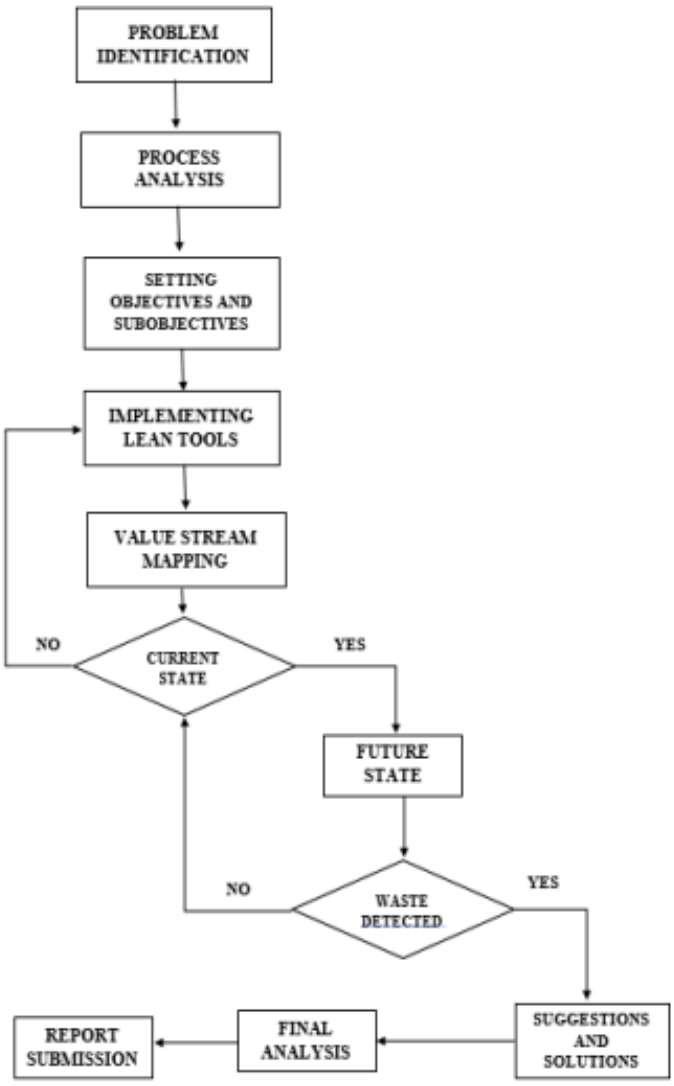
Step 4: Analyzing and selecting best fit lean manufacturing tools are done in this step. Value stream mapping was best fitting tool.

Step 5: Current state mapping is done where sorting of value added (VA), non-value added (NVA), various types of time data are mapped.

Step 6: Future state mapping is drawn, all wastes are identified, check for improvements from current state.

Step 7: If wastes are identified implement Pareto principle to analyze the Causes of the Wastes produced.

Step 8: Suggestions and solutions are implemented, a final analysis is carried out, and study report is prepared.



III. Data collection and Data Analysis

a. The Current State Value Stream Map

• The VSM was used to evaluate the value added (VA) and non-value added (NVA) time of beverage industry.

• The lead time is the time interval between the initiation and the completion of a production process.

• From the present VSM, total Value Adding & Non Value Adding time were observed respectively 5429 sec and 35716 sec from the bottom line of figure 1

• The uptime of filtering, mixing, filling, labeling, and packaging was observed 72%, 65%, 76%, 62%, and 68%respectively. The daily demand is 6000 bottles.

• The in-process inventory was observed between each two processing stages, which could be reduced using lean manufacturing tools

Fig 1. Shows present State VSM.

Present Process Cycle Efficiency

• **Value Added time**= 5429 sec = 87.65 min

• **Non-Value-Added time** = 35716 sec = 597.1 min

• **Lead time= Value Added time (VA) + Non-Value-Added time (NVA)**

At present, VSM, in the reduced NVA time and VA time, were observed; therefore, Process Cycle efficiency was calculated.

Lead time = 5439sec + 35826sec= 41265 sec = 687.75 min = 11 hours 46 min 25 sec

Process cycle efficiency = Value added time/lead time *100 = 12.1806%

Takt Time Calculation- Present State VSM

Takt time is the average time allowed to produce unit production of product to meet customer demand, and the processing time should be less than or equal to the take time.

✓ Working shift per day = 2 shifts

✓ One shift time = 9 hours and 7 minutes = 597.1 min = 35826 sec

✓ Two shift time = 19 hours and 5 minutes = 1194.2 min = 71652 sec

✓ Total change over time = 1 hour = 60 min = 3600 sec

✓ Lunch time = 30 minutes = 1800 sec

✓ Net available time per day = Two shift time – (Total change over time + Lunch time) = 71652 sec – 5400 sec = 66252 sec = 1104.2 min

✓ Daily saleable demand = 6000 bottles

Takt time = machine available time/the required number of units = 66252/6000

= 15.817 sec/Bottle = **0.3843 min/Bottle**

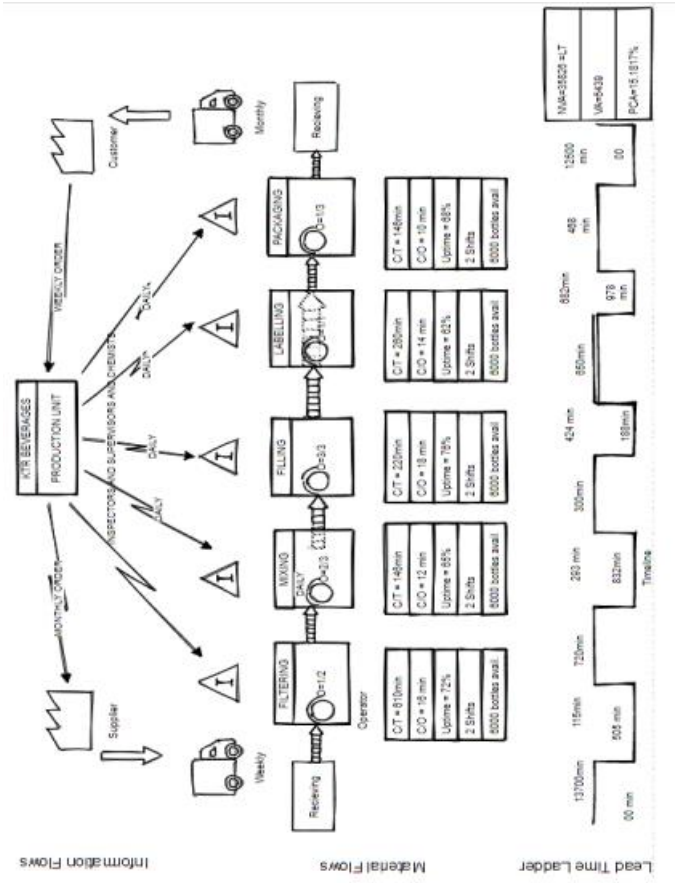


Figure 1: Present value Stream mapping

b. Future State Value Stream Map

✓ In future VSM, as shown in Fig 2 Future State VSM, it is observed that NVA time and the total number of labors are reduced, VA and uptime is increased, and an in-process inventory delay time is also reduced.

✓ The VA & NVA time were observed respectively 6123 sec and 13651 sec from the bottom line of figure 2.

✓ the lead time was observed as 19774 sec

✓ the uptime of filtering, mixing, filling, labeling, and packaging was observed 82%, 88%, 95%, 93%, and 91%respectively.

Future Process Cycle Efficiency

• **Value Added time**= 6123 sec = 102.05 min

• **Non-Value-Added time** = 13651 sec = 227.516 min

• **Lead time**= Value Added time (VA) + Non-Value-Added time (NVA)

At present, VSM, in the reduced NVA time and VA time, were observed; therefore,

Process Cycle efficiency was calculated.

Lead time = 6123sec + 13651sec= 19774 sec = 329.567 min = 5 hours 49 min 27 sec

Process cycle efficiency = Value added time/lead time *100 = 102.05/329.567

Process cycle efficiency = **25.16%**

Takt Time Calculation- Future State VSM

✓ Working shift per day = 2 shifts

✓ One shift time = 5 hours and 4 minutes = 329.56 min = 19774 sec

✓ Two shift time = 10 hours and 8 minutes = 659.13 min = 39548 sec

✓ Total change over time = 1 hour = 60 min = 3600 sec ✓ Lunch time = 30 minutes = 1800 sec

✓ Net available time per day = Two shift time – (Total change over time + Lunch time) = 39548 sec – 5400 sec = 3418 sec = 56.96 min

✓ Daily saleable demand = 6000 bottles

Takt time = machine available time/the required number of units = 3418/6000 = 6.82 sec/Bottle = **0.213 min/Bottle**

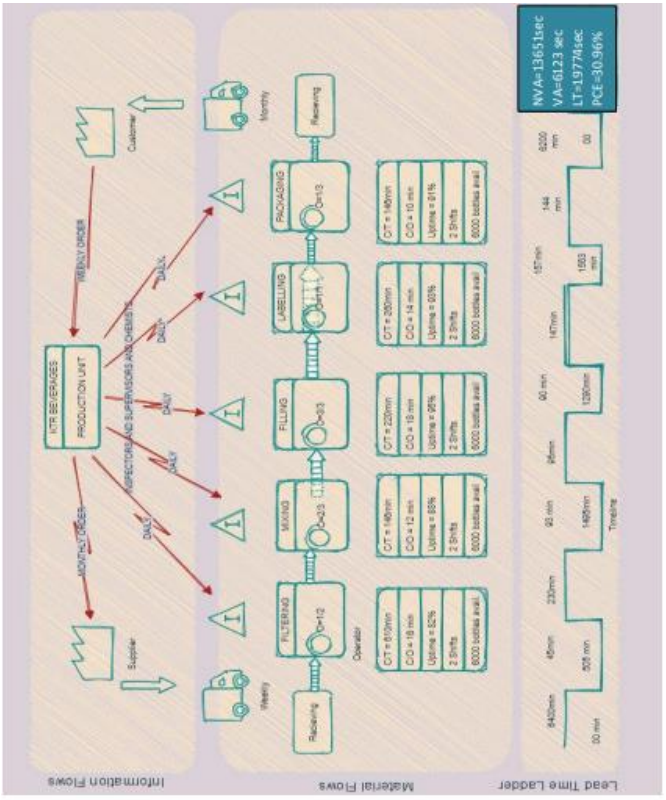


Figure 2 Future state Mapping

c. Pareto Analysis on Production Unit Where production wastes are produced.

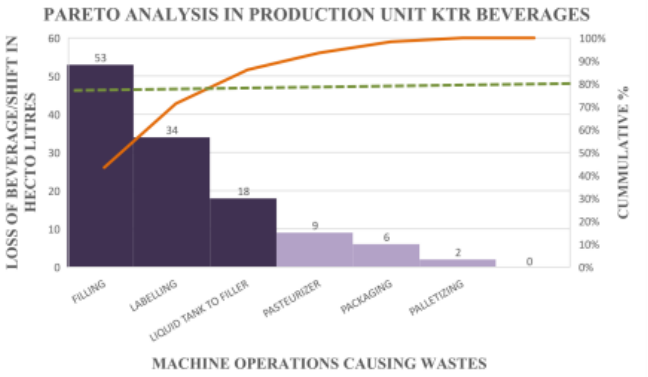


Figure 3: Pareto Analysis in Production unit

Table -1: Inputs To Pareto chart

Pareto Data			
Sl No.	Causes	Defects	Cum%
1	Filling	53	43.44%
2	Labelling	34	71.31%
3	To Filler	18	86.06%
4	Pasteurizer	09	93.44%
5	Packaging	06	98.36%
6	Palletizing	02	100%

✓with the use of Pareto, scarce resources are efficiently allocated.

✓the principle dictates that 80% of the failures are coming from 20% of the causes. It is important to note that this tool wholly bases recommended actions on present data. It does not consider probable increase or decrease and projected movements of anyone contributing factor.

✓To further illustrate, the Pareto chart has been designed to represent the vital few (one which are in dark color in figure 3) against the trivial many (light color graphs in figure 3). With the chart's help, it is easy to identify the causes of most of the problems.

✓ Here Fig 3 Pareto chart displays machine parameters like filler/ crowner, liquid tank pasteurizer, packer, and palletizer against machine operations.

✓The result is filler/crowner contributes a cumulative percentage cutoff of 53 defects. Labelling contributes 34 defects, and Liquid tank to filler contributes 18 defects. The first three factors cause 86.06% of total defects.

✓ Pasteurizer, packer, and palletizer contribute 9, 6 and 2 defects, these 3 factors contribute 13.94% of total cumulative defects.

IV. Results:

After implementation of quality tools and techniques it seen from current state lead time was 693.75min to 329.567 in future state map. It is noticed that 0.17min reduction from present and future mapping. The efficiency is increased from 12.1806% to 25.16%.

V. Conclusions:

1. VSM and Pareto principal practices of lean manufacturing applications are utilized for removing the waste from the beverage industry.

2. Pareto analysis can be used to identify key areas in the process that could benefit from a focus improvement initiative, thereby benefiting the overall industry.

3. Recommended solutions were identified and implemented to reduce the wastes of these critical process inputs. It is crucial to ensure that the workers comply with the standard operating procedures for waste to be reduced.

VI. Key Learnings

1. Value Stream mapping plotting current and future state maps.

2. Analyzing various parameters considered for value stream.

3. Document numbering for easy Access.

4. Pareto chart analysis, understanding 80:20 rule and applying the same.

5. Understanding various symbols used in value stream mapping

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