

USE OF THE VALUE STREAM MAPPING TOOL FOR WASTE REDUCTION IN MANUFACTURING. CASE STUDY FOR BREAD MANUFACTURING IN ZIMBABWE.

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Abstract

Value Stream Mapping (VSM) is a World Class Manufacturing tool that can be used to minimise waste in manufacturing. Companies are experiencing intense competitive pressure due to globalisation hence they cannot afford to operate with waste in their processes. This paper details the use of the VSM tool in reducing waste in bread manufacturing for a company in Zimbabwe. The case study shows how the VSM tool was used to identify and reduce defects by 20%, unnecessary inventory by 18% and motion by 37%. It incorporates waste relationship ranking and the importance of management commitment in waste reduction.

Keywords

Value Stream Mapping, Waste Reduction, Value Addition, World Class Manufacturing

1.0 Introduction

Manufacturing processes are the basis on which businesses create their wealth through value addition. Some processes in manufacturing are essential but do not add value while others are not essential and do not add value. Most organizations are not quite aware of the non-value-adding processes in their plants. Value Stream Mapping (VSM) is a set of methods to visually display the flow of materials and information through the production process [1]. The objective is to identify and improve value-addition as well as eliminating or minimizing non-value adding activities. VSM has been used as step in the implementation of Lean programs resulting in success [2]. This research is a case study of VSM implementation at a company that bakes bread and confectionery foods in Zimbabwe. The paper critically analyses the company's manufacturing processes to identify waste streams. An improved future state map is developed that has improved efficiency. Although this project has been limited to a fast-food manufacturing company, available literature shows that VSM can also be applied to all other sectors with necessary adjustments. It will yield results as organizations are seeking ways to increase the value of their products and services by eliminating waste [3].

1.1 Aim

To use the Value Stream Mapping tool in identifying, quantifying and minimizing major wastes in a bread manufacturing set-up.

1.2 Objectives

1. To quantify by rank the seven wastes of lean within the bread making process
2. To develop the Current State Map for use in developing the Future State Map.
3. To formulate practical means of reducing the identified major wastes.
4. To convert the improved work flow into a lean system with savings.

1.3 Scope

The study focused solely on a bread production line (Line 1 of Panavizion Bread) which contributes to 90% of sales. The VSM tool was used to analyse both the flow of information and the flow of materials. Line 1 produces bread with the standard white loaf being the predominant one. However, mapping the value streams of other products would give similar results since they go through similar manufacturing processes.

1.4 Methodology

This study was a case study of the bread-making process analysis using the Value Stream Mapping tool. This tool was used in addition to questionnaires and interviews. Data stored in the company's Enterprise Resources Planning (ERP) system was used (SAGE Pastel).

1.4.1 Major Assumptions

The methodology adopted here was subject to the following assumptions:

- 1 All pre-existing data is reliable and accurate but will be analyzed for consistency.
- 2 Top-level management will give support and backing for the project.
- 3 The model shall be created based on one product line.

1.4.2 The Value Stream Analysis tool (VALSAT)

The value streams to be reviewed were identified and through a series of interviews with managers, they were ranked. The managers were given written overviews of each waste and how these wastes affect efficiency and profitability. This led to the drawing up of the overall structure of the seven wastes and the appropriate tools to use for analysis [4-6] as shown in Table 1.

Table 1: The Seven Stream Mapping Tools [4]

Wastes / Structure	Mapping Tools						
	Process Activity Mapping	Supply Chain Response Matrix	Production Variety Funnel	Quality Filter Mapping	Demand Amplification Mapping	Decision Point Analysis	Physical Structure (a) Volume (b) Value
Overproduction	L	M		L	M	M	
Time Waiting	H	H	L		M	M	
Transport	H						L
Inappropriate Processing	H		M	L		L	
Unnecessary Inventory	M	H	M		H	M	L
Unnecessary Motion	H	L					
Product Defects	L			H			
Overall Structure	L	L	M	L	H	M	H
Origin of Tool	Industrial Engineering	Time compression/ Logistics	Operations Management	New Tool	Systems Dynamics	Efficient Consumer Response Logistics	New Tool
Notes: H = High correlation and usefulness M = Medium correlation and usefulness L = Low correlation and usefulness							

The researchers then used the identified tools for the major wastes (Shown in Fig. 3) to develop the Current State Map as well as the Future State Map. Waste reduction was obtained by using the “kaizen blitz” approach which was conducted through structured brainstorming sessions with shopfloor employees.

2.0 Lean Thinking and Value Stream Mapping

Lean thinking is the backbone of implementing lean systems in organisations. Value Stream Mapping is a tool that is ideal as the start of a change process towards creating lean enterprises [7]. The tool helps organisations to reduce lead times, inventory, improve quality and achieve better on-time deliveries and utilisation of resources [3]. It

detects bottlenecks and inter-dependencies in the processes and involves employees in the change process. VSM greatly contribute towards operation cost reduction, flexibility and ability to meet customer demands. Reduction of non-productive activities (waste) eventually save resources and allows reallocation of resources to improve throughput and profitability. Its application in various sectors has yielded positive results in all key performance areas of business. It is a lean tool that was developed by the lean production movement for redesigning productive systems [8]. In a bid to become lean, there are basically five main steps namely: (i) Define the value; (ii) Identify the value stream; (iii) Flow the product; (iv) Pull and (v) Strive for perfection [7]. Among these steps is imbedded the concept of Value Stream Mapping is also identified as the forth step in a model for implementing lean programs [2]. It helps to identify flaws in the system that requires redesigning and to prioritize improvements.

2.1 Defining the Value

The first step in lean thinking is to determine what value is, as described by the customer. Value is the information or product that the customer is willing to pay for and can only be defined by the ultimate customer [7]. When the customer no longer accepts what they are given, producers tend to use techniques such as lowering pricing or offering a variation of the same in order to entice buyers to purchase their product.

2.2 Identifying the Value Stream

A value stream needs to be indentified and it comprises all actions that are Value-Adding as well as Non-Value-Adding. Identifying value streams helps to demonstrate exactly how the process operates with detailed timing of step-by-step activities. It is a systematic approach that empowers people to plan improvements that make it easier to meet customer demands [9 and 10].

2.2.1 The Current State Map

The Current State Map (CSM) charts the present flow of information and material as a product goes through the manufacturing process. This is vital both to understand the need for change and to understand where opportunities lie.

2.2.2 The Future State Map

The Future State Map (FSM) is a chart that suggests how to create a lean flow. It proposes closing the gap between the CSM and the envisaged [11]. It uses lean manufacturing techniques to reduce or eliminate wastes and minimize non-value added activities. The FSM is used to help make decisions that create future process improvements.

2.3 Flow the Product

Flow is the progressive achievement of tasks along the value stream so that once started, the product proceeds from raw material into the hands of the customer with no stoppages, scrap, or backflows [7]. Value addition to the product needs to be maximized while non-value addition is minimized if not eliminated. All impediments to continuous flow must be removed as product should continuously undergo processing until finished.

2.4 Pull

Pull is the concept of letting the customer pull the product rather than pushing products onto the customer [7]. It means making what the customer wants and only when the customer wants it. The idea is that nothing is made until it is needed, and then made as quickly as possible. Pull is created by having the ability to design, schedule, and make exactly what the customer desires when the customer wants it. This is critical in fast moving consumer goods.

2.5 Strive for Perfection

There is no end to the ability to reduce costs, scrap, mistakes, space, etc. Perfection is an unachievable goal where you aspire to continuously improve. Lean is always working towards improvement.

3.0 Company Audit and Results

The results of this study consist of the Manufacturing Flow; the waste identified and ranked the Current State Map and the recommended Future State Map.

3.1 Manufacturing Process Flow

Panavizion Bread's production process is shown in Figure 1 below. The line is a dedicated flow line which is semi-automated. The various operations needed to produce a loaf of bread are also shown on the Current State Map (CSM) shown in Figure 2.

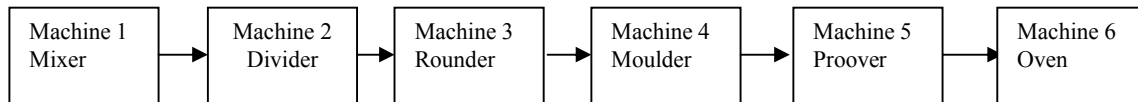


Figure 1. Product Flow Layout

The Current State Map shows the movement of materials and information from suppliers to the retailers. Most of the major raw materials are usually stored in the warehouse at another location about six kilometers away from the plant before being moved to the online storage (called the Cage) at the factory. After this material is converted into bread, the product would be temporarily stored at Dispatch for shipping to the customers for sale.

3.2 Analysis of the CSM

Using the tools discussed in the methodology, the Current State Map was drawn out and is shown in Figure 2 below.

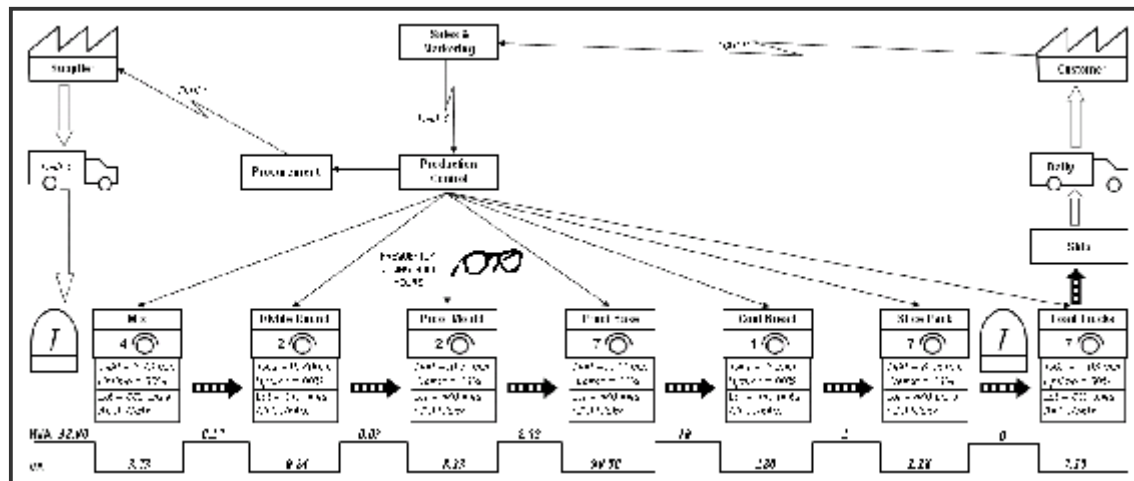


Figure 2. Current State Map of Bread Making

The map shows the movement of the product from the suppliers through to retailers. The timeline at the bottom of the CSM show the VA and the NVA process times from entry of raw materials into the line to the end product. The analysis of the CSM may be grouped into four categories namely raw material supply, inventory, production and distribution.

3.2.1 Raw Material Supply

The raw materials come from different suppliers as per the orders. Ideally, these would have had due communication of production requirements from Production Control as shown by the communication lines on the CSM. The responsibility for ensuring raw materials availability lies with Stores and Procurement. Some of the major raw materials like yeast and flour were supplied regularly according to arrangements with suppliers and excess over and above the capacity of the 'Cage'. This resulted in them being stored at the warehouse which is located 6km away from the factory.

3.2.2 Stores and Inventory

At the time of this study, the plant had no standard inventory control system. Raw materials stocks were monitored by a manual system as a duplication of the same input into the SAGE system. The CSM only shows the temporary storage at the factory and not the warehouse. It is assumed that at the start of a production shift, Stores would be having enough stocks to last that shift's requirements.

3.2.3 Production

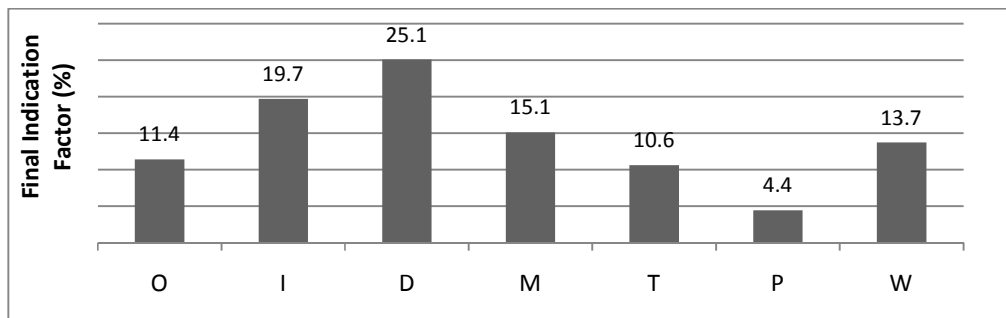
The bread production process was segregated into basic seven stages: mix, divide-round, proof-mould, proof-back, cool, slice-pack, and loading. The timeline shows that the process consumes about four-and-half hours (276.85minutes) from transferring raw materials to production until bread is loaded to the delivery truck.

3.2.4 Loading and Distribution

This process consumes less than ten minutes of work in the production line if done under the standard work conditions. The ideal method in use required seven employees, bread-laden crates piled in tens, and assuming the workforce has been trained in how to handle the crates.

3.3 Waste Ranking

The waste ranking algorithm was employed and it has shown that the wastes that really need to be minimized are as shown in Figure 3 below.



O=Overproduction, I=Inventory, D=Defects, M= Motion, T=Transportation, P= Inappropriate processing, W= Waiting
Figure 3 - Waste Ranking bar chart

3.4 Waste Reduction Methods

In view of the Future State Map and utilisation of the Tools of Value Stream Mapping highlighted earlier on and in Table 1, the following methods were outlined.

3.4.1 Defects

The state maps helped visualise the whole process and pinpoint areas where defects were emanating from. It was identified that the cooling stage is a bottleneck and was the source of major breakages since bread units would be sent for slicing before they are ready for slicing. This would lead to breakages and poorly handled products being relegated to defects.

3.4.2 Unnecessary Inventory

Ranked the second major waste, inventory is caused by defects and poor planning in transportation, motion and unbalanced process flow. Line balancing techniques were used to develop the Future State Map. Also the implementation of First-In-First-Out (FIFO) between cooling and packing ensures that no unnecessary product units would be kept waiting; the first to be cooled will be taken away for slicing and packing immediately when they dry.

3.4.3 Motion

Breakages that occur on the slicing machine and during loading indicate that inappropriate and weak motion techniques were being used. This is because the wastes occur mostly on the manual process of loading and less so on the semi-automated process of slicing and loading. The “cage” (on line storage) needs to be considered for redesigning. This would facilitate the linking of Production, Stores, Sales and Marketing together so as to avoid unnecessary motion. The development of an economic batch quantity to be transferred optimises the motion required for bread. This would reduce movement and fatigue, which contributes much to the consequent motion waste and subsequently to defects.

3.5 The Future State Map

The Future State Map was developed and it outlines the envisaged improvements that are as a result of using the VSM tool. Results of the comparison of the CSM and the FSM are shown in Table 2 below.

3.5.1 Comparison of CSM and the FSM

Table 3.1 shows a comparison of the Current State Map and the Future State Map to highlight the improvements in Value addition and ultimately throughput.

Table 2 Comparison of Current State and Future State maps.

	Current State Map	Future State Map
Non Value Adding time	43.2 min	10.56min
Value Adding time	231.13min	193.98min
% of NVA/VA time	18.7%	15.2%
Increased Throughput		16%
Average Takt	9.90min	10.56 min
Standard deviation from Takt	3.79min	0.97min

The Future State Map indicates an average 25% waste reduction in the critical areas of defects, unnecessary inventory and motion. This will translate directly to cost savings per given time and will be passed on from batch to batch and if extended to other product lines, it will yield profitability for the company. There is also an envisaged 16% increase in throughput in the Future State Map.

4.0 Conclusion

The study set to use the Value Stream Mapping tool in troubleshooting waste generated in Bread Manufacturing and identify ways of reducing this waste while at the same time increasing the proportion of the processes that add value to the product. This was achieved through the development of the Future State Map which has an increased throughput of 16%. It is however noted that there is a significant cost to complete any changes required but the increased throughput against the takt time will pay back for the improvements. The CSM helped identify areas of potential improvement while the FSM suggested ways to reduce waste and increase throughput. Although the analysis has been limited to bread production Line 1, a similar analysis on other bread lines may show similar trend of events. The Value Stream Mapping tool is not limited to manufacturing organizations but can also be applied to service industries like banks, hospitals, and the transport sectors with necessary adjustments. This paper contributes to the advancement of World Class Manufacturing practices in developing countries with emphasis to Zimbabwe. Coming from a difficult period of low capacity utilization and hyper-inflation, waste reduction is of paramount importance in economic growth. Future research should look at application of this tool in the Small to Medium Enterprises (SMEs) in the baking industry. Any tools to eliminate waste would contribute positively to the bottom line.

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