

# APPLICATION OF LEAN VALUE STREAM MAPPING TO REDUCE WASTE AND IMPROVE PRODUCTIVITY: A CASE OF TILE MANUFACTURING COMPANY IN ZIMBABWE

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## ABSTRACT

*The paper outlines how the value stream mapping process was used to reduce waste in a manufacturing set up in located in Southern Africa economic region. The methods of data collection and how the samples were to be selected were designed and selected. The product family selected for the research work was the micro-concrete roof tile production (MCR). A Current State Map (CSM) of the product family was created. Data for drawing the CSM was collected primarily through site visits and field work, interviews and observations with the assistance of machine operators and supervisors. In addition, some documents and literature that gave information of the current situation and action that were implemented at the organization were reviewed to capture secondary data for use in the study. The problems with the CSM were identified by highlighted the low-hanging-fruits and problematic bottlenecks. Possible improvements were proposed and a Future State Map (FSM), which has more efficient processes and optimum space and labour utilization, was created using Microsoft Visio Software. Wasteful processes and practices were rectified which included, waste in the form of waiting time, processing, defects arising during, molding, transporting, stacking and curing of the tiles and over consumption of raw materials.*

**Keywords:** value-stream-mapping, defects, waste, tiles, productivity.

## 1. INTRODUCTION

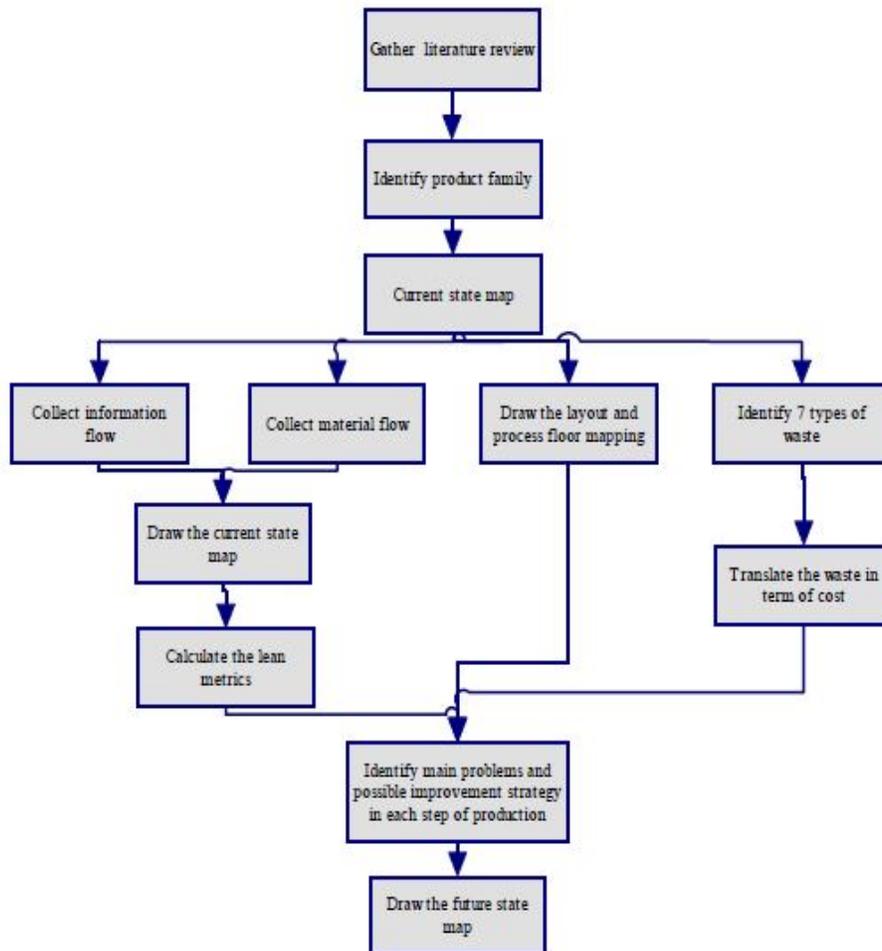
Zimbabwe Tiles Company manufactures concrete roof tiles on mass production basis. The Tile-Company is experiencing problems mainly as a result of waste in form of defects, non-value adding activities and over consumption of raw materials. In the process, Tile-Company is also failing to meet production targets. Defects arise during the following stages; molding, transporting, stacking and curing of the tiles. Defects such as shape and profile occur during the molding stage due to molding machine inconsistent vibrations. The inconsistent vibrations are caused by failure to implement a proper maintenance strategy. The wet tiles are transported in poor conditioned wheel barrows over a rugged terrain, which compromise the quality of the tiles. Tiles may also creak or break during the stacking process. An average of 225 tile defects are produced per day which translate to \$222.75 per day and \$48 114 per annum. During power shedding periods, the company also experiences waste in form of waiting time because a lot of paper work is done before the backup generator is switched on. The company experiences an average of thirty minutes downtime which translates to 112 tiles per day. Waste is also recorded in the form of overconsumption of raw materials. Tile-Company uses inaccurate measuring techniques for the raw materials which include the use of shovel, drum and wheelbarrow for measuring. As a result more raw materials such as cement, sand and water are consumed thus adding to the business production cost. The main purpose of this paper is to identify wastes in the tile making process and recommend ways of reducing the waste thus improving productivity from 23 450 to 28 350 tiles per month.

There are eight steps involved in the production of micro concrete roof tiles. These are sieving, mixing, molding, demolding, stacking, sand blasting and painting. Sieving involves the use of a container with a mesh or perforated bottom to grade particles. During the mixing stage sand, cement and water are mixed. The mortar is transported to the molding area where it is placed on interface paper and placed in molding casing for twenty four hours. The polythene sheet prevents fresh mortar from sticking to the mold and makes demolding easier (International labor organization, 1992). The demolding process involves the removal of the tiles from the mold casings as well as the interface paper. They are then taken to the curing tanks which are filled with water and then left for seven days. The stacking process involves laying the tiles on the ground for sand blasting. Sand is blasted on tiles through a flicker machine and the tiles

are covered by black polythene for binding and left for three days. Finally the tiles are painted by spray painting. The sieving process consumes a cycle time of 180 seconds and a lead time of 420 seconds. This is due to the use of a manual method to grade the particles. The major problem at the mixing stage is overconsumption of raw materials where an average of 697,5kgs of sand is used instead of 630kgs and an average of 200l of water is used instead of 160l of water. The raw materials being over consumed can contribute 168 tiles per day which translate to \$166, 32 per day. During the molding stage, defects arise due to inconsistent vibrations of the molding machine causing distortion of the shape and profile of the tile. An average of 50 tiles produced does not meet the required standard. The cycle time is high because there is no proper method of monitoring machine processing time since the operator determines how much time to spend on the machine. At the stacking stage an average of twenty tiles can break or crack as the tiles are being laid on the ground. Wheelbarrows are used for transportation of raw materials between various work stations. The terrain on which they are moved is ragged hence tiles vibrate vigorously leading to cracks and damages.

## 2. METHODOLOGY

Figure 1 below shows the VSM methodology that was used. It starts with gathering relevant literature on the subject. The product family was then identified as the micro concrete roof tile. The current state map was drawn for the product. Data for drawing the current state map was gathered through site visits, motion studies, observation, interviews and document review. The current map was then used to identify problems and possible improvements



**Fig 1:** Methodology for Value stream mapping

### 2.1 Analysis of the current state map

Figure 2 shows the movement of raw materials and product within the tile manufacturing plant. The times shown at the bottom of the CSM show the value added and the non-value added process times. The analysis of the CSM led to identification of the takt time, bottlenecks, characterization of the types of waste and identification of areas that require improvements.

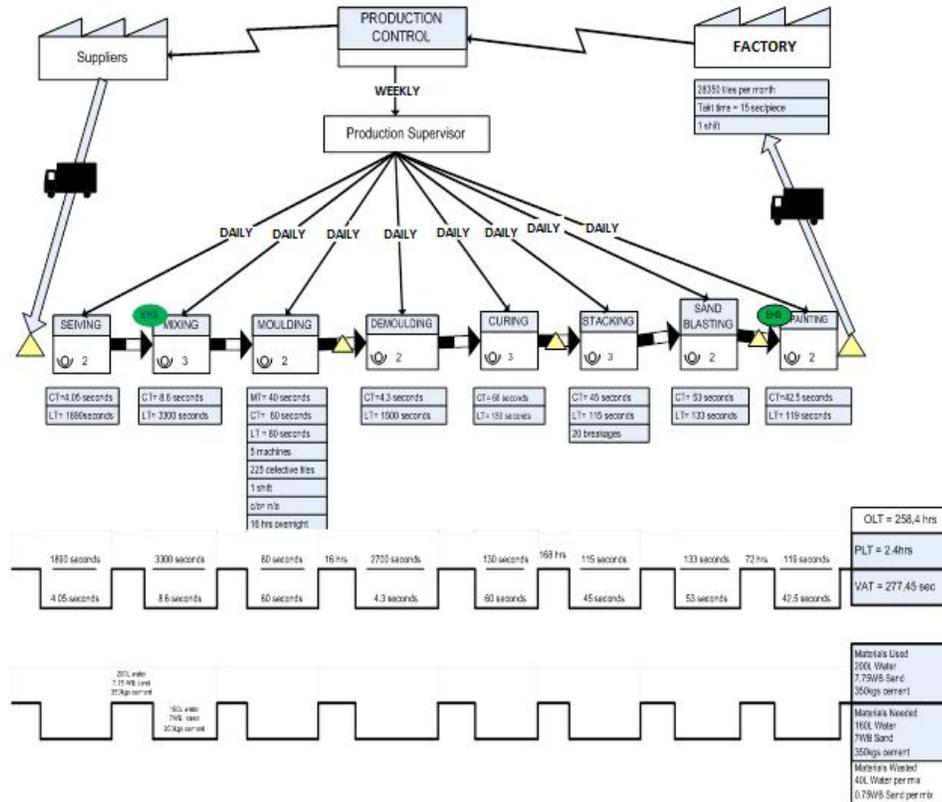


Figure2: Tile-Company Current State Value Stream Map

2.2Takt time

The takt time provides the relationship between the work time available and the customer requirements which enable us to be aware of the time available to complete the job (Rotaru A, 2008).

Table 1Takt Time Calculations

A shift = 4 days x 8 hours					
<b>Net Available Time</b>			<b>Customer Demand</b>		<b>Units</b>
Working shifts / day	1	Shifts	Customer demand / day	1575	Pieces
Hours / shift	8	Hours			
Available time / shift	480	Minutes			
Break time / shift	30	Minutes			
Lunch time / shift	60	Minutes	Net available time / day	23400	seconds / day
Planned downtime / shift	0	Minutes	Customer demand / day	1575	pieces / day
Net working time / shift	390	Minutes			
Net working time / shift	23400	Seconds			
Net available time / day	23400	Seconds	TAKT TIME	15	seconds / piece

Therefore Takt time is 15 seconds/piece as shown in Table 1. The company needs to produce a micro-concrete roof tile every 15 seconds.

### 2.3 Bottlenecks

The bottleneck process is the operation with the longest cycle time and the sieving stage had a cycle time of 180 seconds.

### 2.4 Characterization of the types of waste

The ranking waste algorithm was used to show the areas that need waste reduction. This is shown in Figure 3 below.

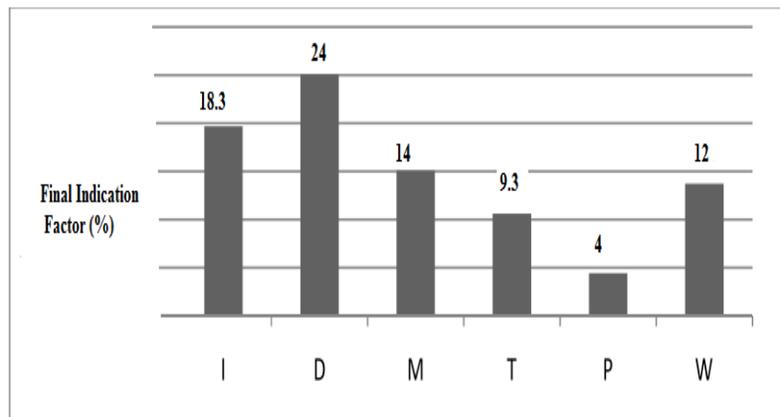


Fig 3: Ranking waste chart

I – Inventory

D – Defects

M – Motion

T – Transportation

P – Inappropriate processing

W -waiting

### 2.5 Process Improvements

The areas that need process improvements are sieving, mixing, molding and stacking.

#### 2.5.1 Sieving

The sieving process had very high cycle and lead times, a vibrating screen can be used to reduce the cycle time and lead time of the process. The vibrating screen can be designed and fabricated internally in the workshop.

#### 2.5.2 Mixing

A weigh or scale can be used to measure raw materials thereby reducing overconsumption of materials. This can save the company with \$35 925.12 per annum. The cycle time is high because of manual mixing . A molding machine can be employed.

#### 2.5.3 Molding

Timers can be used on molding machines so that the machine stops when the required time is reached. The cycle time would be reduced from 60 to 20 seconds and molding non value added time by 67%.The company practices breakdown maintenance and Total Productive Maintenance strategy can be employed to eliminate inconsistent molding machine vibrations.

#### 2.5.4 Stacking

There is need for a concrete pavement to be aid down assist in place of the ragged terrain which results in reduced rejects.

## 3. RESULTS: FUTURE STATE VALUE STREAM MAP

The future state map was drawn after identifying the wastes and their associated problems. Fig 4 shows the future state map for the company.

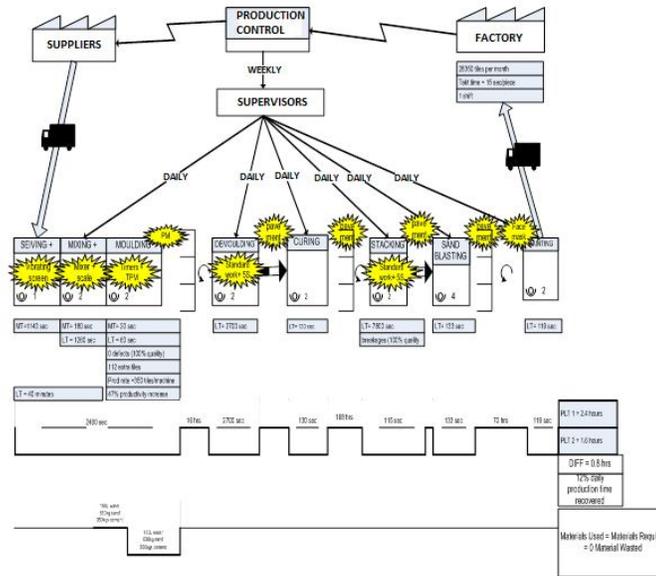


Figure 4: Future state value stream map for Tiles Manufacturing Company

**3.1 Analysis of future state value stream mapping and comparisons between current state and future state map**

A two tone sand vibrating screen introduced reduced the sieving processing time from 1890 seconds due to manual labor to 1140 seconds thus saving 750 seconds of productive time. A 0.2 cubic concrete mixture selected reduced the lead time from 3300 seconds to 1260 seconds thus saving 2040 seconds. Molding machine timers reduced the cycle time from 40 to 20 seconds. Movable weighing scale introduced reduced raw material costs by \$2993 per month. A flat concrete pavement introduced reduced the cracks and breakages. Also the 5s system promoted continuous improvement thus reducing wastes in the manufacturing process.

**3.2 Comparison of CSM and FSM**

The comparison of lead time in the sieving, mixing and molding stages, takt time and throughput are shown in Table 2 below.

Table 2: Comparison of CSM and FSM

Stage	current state map (seconds)	future state map (seconds)
Sieving	1890	1140
Mixing	3300	1260
Molding	60	40
Takt time	15	7
Throughput	20 220 tiles/month	28350 tiles/month

**4. CONCLUSION**

With the use of the CSM, areas that needed improvements were identified and the FSM was developed which showed the ways of reducing waste. Productivity increased from 20 220 tiles per month to 28 350 tiles per month. There was reduction of defects from 245 defective tiles per day to 10 defects thus saving the company up to \$4419.9 per month. Raw materials were saved which contributed to 168 tiles per day which translates to \$2993.76 per month. Lead time reduction from 8467 seconds to 5657 seconds, that is by 46.8 minutes, which contribute up to 12% of production time.

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Mwodza Caspah attained a BEng in Production Engineering in July 2013. The young man is a promising budding engineer who comes highly recommended from his industrial stints.