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Using VSM to Improve Manufacturing Efficiency in Developing Countries: A Case Study of a Beverage Manufacturing Company in the Caribbean

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--ABSTRACT---
Lean manufacturing concepts have been successfully applied in many manufacturing organizations to reduce the lead time, decrease cost and improve quality. One lean tool utilized to eliminate non-value adding activities is value stream mapping (VSM). A beverage manufacturing company, operating in a Caribbean island was looked at as they were faced with the challenge of producing higher quality, low cost products to their customers within a shorter timeframe in order to enhance their competitive advantage. This work thus looked towards determining how VSM could be effectively used within the company to improve performance and reduce lead time. Process observations, time studies and informal employees' interviews were utilized to obtain data for the map generation. The current state was developed and analyzed using appropriate software. From the findings obtained, seven (7) categories of waste were identified. Improvement initiatives, which were supported by an extensive literature of most of the techniques, were suggested and the future state map was developed. The findings revealed that the lead time could be reduced from twenty six (26) days to fourteen (14) days and the value added ratio could be increased from 0.50% to 0.88%. The expected costing saving per year is approximately four million, twenty nine thousand, five hundred and forty two dollars (USD 4,029,542.00).
***KEYWORDS** -Lean Manufacturing, Value Stream Mapping (VSM), seven wastes, manufacturing*

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I. INTRODUCTION

Manufacturing companies in the Caribbean are subjected to the challenge of competing with various multinational companies due to increased globalization. The manufacturing company chosen for this work is one of the oldest and largest manufacturers of nonalcoholic beverages within the English speaking Caribbean. They are now required to produce varying quantities of high quality product within a shorter manufacturing period in order to remain competitive within their respective markets. In response to this global challenge, the company is desirous of reducing waste elements within its operating processes thereby reducing the lead time and thus the cost of the finished product. Over the past two years, the number of competitors within the beverage market has significantly increased. The variations in the customer demands have also been amplified and the acceptable lead time reduced. In order to ensure the company does not lose its customers to competitors, it is critical that their customers are provided with an affordable, high quality product within a shorter timeline.

Currently, one of the company's main problems is the inability to deliver the customer orders in a timely manner resulting in the loss of sales. Its fill rate, which is a measure of the ability to satisfy the customers, was at 70%. Another major problem was the overstocking of items leading to expired products or products being damaged due to excessive material handling. As a result, it was forced to condemn fourteen thousand dollars (US$14,000) in raw materials and finished goods inventory. Apart from this problem, the overstocking of unnecessary items resulted in the rental of warehouses for the storage of these items. The company spent thirty thousand dollars (US$30, 000) per year for the rental of storage space. The high inventories as well as the rental cost for warehouses resulted in lower cash flow within the organization.

This study therefore examined how VSM could be used to improve the performance and reduce the lead time to manufacture. It was geared towards the identification of the various waste elements within the manufacturing company's current processes.

II. METHODOLOGY

Data was collected via process observations, time studies and informal interviews with employees at the company. The VSM was developed using Minitab Companion. Areas of waste were identified using this and a future state VSM was done focusing on areas for improvement. Trial testing and surveys were administered to determine the practical implementation of the improvement initiatives and the cost benefits of the initiatives were examined.

III. CURRENT STATE VSM

An overview of the manufacturing process for the beverage manufacturer is shown in Figure 1 below.

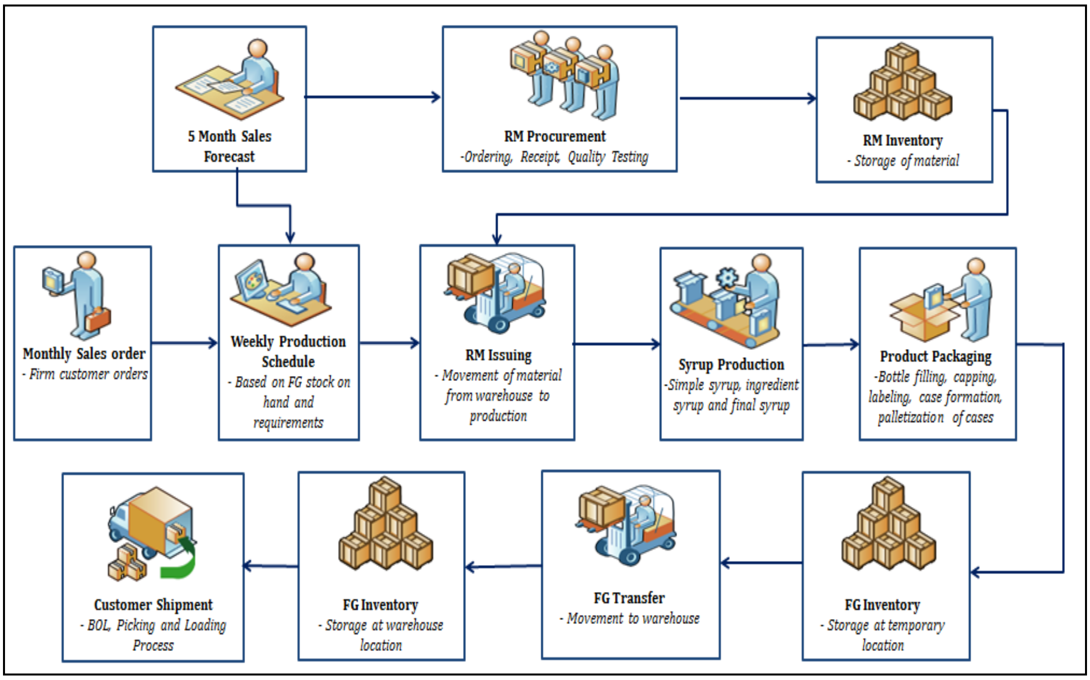

Fig 1: Process Flow Map Overview

From the data collected (Tables 1 and 2) the process lead time, (time taken for a case to make its way through the entire process) was 26.35 working days. The following assumptions were made:

- Available working Days per month = 22 days ;Number of shifts per day in the production department = 2 shifts ;Days per week = 5 days ;Number of hours per shift = 12 hours ;Actual Available working hours per day = 21.33 hours
- The raw materials department and the finished goods warehouse have the largest process lead time of 17, 282 minutes and 14,812 minutes respectively.
- The time spent executing work, also known as processing time was calculated by summing the cycle times in the current VSM. This was determined to be 920 minutes. However, only 169 minutes of the processing time could be categorized as value added time.

The current state VSM is thus shown in Figure 2.

Table 1: process Lead time for the current VSM

Section	Activity Overview	Current VSM Time (mins)
RM Department	RM Processing	1,077.0
	RM Storage	15,360.0
	RM Issuing	845.0
	Sub Total	*17,282.0*
Syrup Room	Simple Syrup Mixing	150.5
	Ingredient Mixing	286.0
	Sub Total	*436.5*
Filling Area	Syrup Carbonation	56.4
	Bottling Product	73.6
	Sub Total	130.0
Packaging Area	Case Packaging	34.9
	Palletizing Cases	120.0
	Temporary Storage	911.8
	Sub Total	1,066.8
FG Warehouse	Pallet Receipt and Storage	14,103.0
	Order Processing	94.0
	Order Picking	615.3
	Sub Total	14,812.3
Total Processing Lead Time		**33,727.5**

Table 2: Cycle time for the current VSM

Section	Activity Overview	Time (mins) Current: Cycle Time	Value Added Cycle Time
Raw Materials	RM Processing	357	0
	RM Issuing	125	0
Syrup Room	Syrup Mixing	232.5	147
Filling Area	Product Carbonation	9.75	2.95
	Product Bottling	5.6	4.1
Packaging Area	Case Packaging	0.38	0.38
	Palletizing Cases	6.05	4.62
	Temporary Storage	42	0
FG Warehouse	Pallet Receipt and Storage	23	0
	Order Processing	12	5
	Order Picking	106.25	5
Total		**919.53**	**169.05**

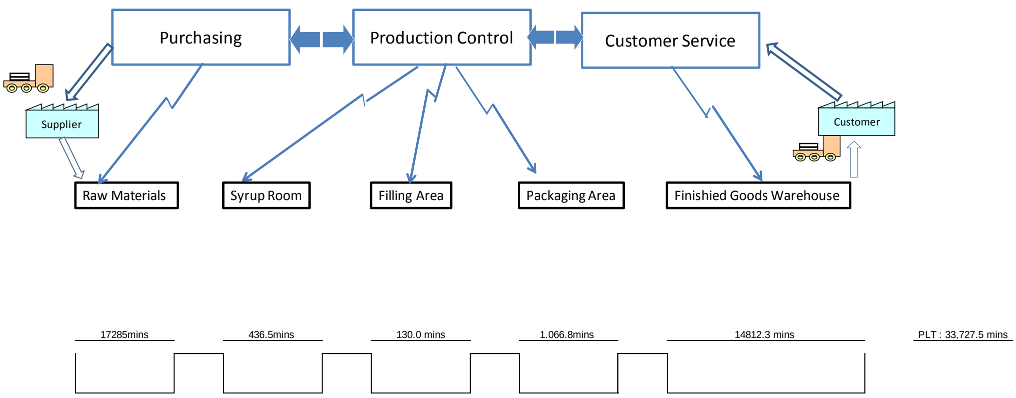

Figure 2 : Current State VSM

IV. WASTE IDENTIFIED

Table 3 shows the waste elements within the process. These include defects such as incorrect data entry, failures to meet the required syrup specification resulting in the dumping of product and unacceptable carbonation levels of the beverage. There is a high waiting time between processes such as quality testing and the receipt of finished goods within the warehouse. Wasted motion occurs frequently within the syrup and filling areas since there are tasks which incorporate excessive bending when the panels and displays are not easily accessible. Over processing occurs when syrups are blended for excessive periods and quality checks are done at an increased frequency but does not add value. Large distances are travelled within the compound during the receipt of raw materials from suppliers and issuing of materials to the production area. This results in unnecessary transportation. There is large inventory accumulation in areas such as the packaging and temporary storage. Due to the significant amount of inventory within the warehouse, there is definitely overproduction within the facility. In total there were fifty-four (54) problems or areas for improvement found. The following was found with respect to the seven (7) categories of wastes : Defects – 17; Waiting – 9; Motion- 16; Overprocessing – 4 ;Transportation- 2; Inventory- 5; Overproduction- 1.

V. FUTURE VSM AND AREAS IDENTIFIED FOR IMPROVEMENT: KAIZEN BLITZS

Table 4 summarizes the suggested improvement strategies or Kaizen Blitzs (KBs) of the Future VSM based on the seven (7) waste factors of: defects, waiting time, excess motion, over processing, transportation, excess inventory and overproduction.

Some of the general observations which were made included the untidy working areas especially within the operation areas, showing the lack of 5S (Upadhye N., Deshmukh S.G. 2010). Few visual management controls were implemented within the manufacturing area such as the overall target efficiency of the entire plant. However, the individual efficiency for the lines and machines were not visible and unknown to operators. This is a critical area of improvement especially in the attempt to implement lean manufacturing principles (Ortiz, Chris A. and Park 2010). Employee engagement and empowerment is a key factor to ensure the successful implementation of lean manufacturing tools within organizations (James P. Womack and Jones 2003). One of the overall suggested improvements is the implementation of performance measurement boards in each division. These can take the form of Safety, Quality, Delivery and Cost (SQCD) boards (Ross, Graham and Jeffrey 2011). Figure 3 shows the future state VSM.

Table 3: Summary of the Identified waste and respective measurements based on the analysis of the Current VSM

Waste	Section Area	Activity	Area for Improvement	Current Measurement
Defect	Raw Materials	AX RM Receipt Process	Incorrect data entry into the ERP system	Inventory Accuracy- 90.5%
		Material Issuing to Production	Generation of manual picking list leading to incorrect material delivered to the production area	Incurred downtime- 1.2%
				Acceptable: 0.3%
	Syrup Room	Simple Syrup Testing	High defect rate resulting in the reworking or dumping of syrup	Defect Rate- 0.81%
				Acceptable: 0.65%
		Syrup Testing	High defect rate resulting in the reworking or dumping of syrup	Defect Rate- 1.25%
				Acceptable: 0.65%
	Filling	Syrup Carbonation	High defect rate resulting in the dumping of syrup	Defect Rate- 0.96%
				Acceptable: 0.65%
		Product Filling and Capping	High defect rate resulting in excess wastage	Defect Rate- 1.10%
				Acceptable: 0.76%
		Bottle Coding	High defect rate due to incorrectly coded bottles and no coded bottles	Defect Rate- 1.74%
				Acceptable: 0.5%
	Packaging	Stretch Wrapping of Pallets	Poor stretch wrapped pallets	Defect Rate- 1.28%
				Acceptable: 0.5%
Waiting	Raw Materials	QA Testing	Delay in testing due to unavailability of COA and poor communication	Acids, sugar, sweeteners waiting time: 6 hours
				Raw sugar waiting time: 11 hours
	Syrup Room	Simple and Final Syrup Testing and Transfer	Delay in poor communication between compounders and QA technician	Waiting Time: 30.4 hours per month
		Inspection of Batched Ingredients	Delay in poor communication between compounders and QA technician	Waiting Time: 6.9 hours per month
	Filling	Bottle Filling	Delay in the carbonation and filling	Waiting Time: 16.2 hours per month
	Finished	Receipt into	Unavailability of designated	Waiting Time: 21 hours per

Waste	Section Area	Activity	Area for Improvement	Current Measurement
	Goods Warehouse	warehouse	personnel for the process	month
		Goods Picking and Inspection	Generation of batches of picking list	Waiting Time: 49 hours per month
			Delay in final inspection	Waiting Time: 27 hours per month
Motion Over-processing	Bottle Coding	Inputting the relevant data into the machine control to generate the required code	a) Machine's keypad is difficult to access and not stored at height level	Cycle Time 5
			b) Difficult to obtain the knife and orientate the bag to cut the seal	
	Bottle Warmer	Adjust the temperature settings to control the overall bottle temperature	a) Location of the machine's control results in excess bending	Cycle Time1.5
			b) System monitor extremely small resulting in strained eye-sight to view icons	
	Bottle Labelling	Operator is required to obtain the material and adjust machine settings	a) Tools are difficult to access due to disorganized work area b) Excess bending required for obtaining material	Cycle Time15
	Picking of finished goods	Forklift driver must search for the required items by viewing the week number sticker and the pallet tag	a) Weekly sticker difficult to view since the orientation of some pallets obstruct the viewing of the sticker b) Pallet difficult to locate within warehouse to the disorganized layout	Cycle Time-95
	Raw Materials	Adjust AX Inventory	Repetitive task due to current inaccuracies	Cycle Time: 65 mins
	Syrup Room	Simple Syrup and Ingredient Mixing	Excessive blending	Blending Time: 130 mins Recommended Time: 100 mins
	Filling and Packaging	Quality Checks	Occur every 1 hour	Cycle Time: 7 mins
	Packaging	Application of Weekly Pallet Sticker	Use of 2 stickers	Cycle Time: 0.55 mins
Transportation	Raw Materials	Transfer to Staging Area	Excessive transportation between staging and storage area	Cycle Time: 45 mins
				Damaged RM: $23,224 per month
		Material Issuing to Production	Lengthy picking process between warehouses and FIFO principles not applied	Cycle Time: 90 mins
				Damaged RM: $23,224 per month
Excess Inventory	Raw Materials	Raw Material Ordering	Excess inventory within warehouses	Damaged RM: $23,224 per month
				Obsolete RM: $15,876 per month
	Packaging Area	Stretch Wrapping of Pallets	Accumulation of WIP inventory - Waiting time for forklift to move the pallets from 1 machine to another	Inventory Time: 78 mins
		Loading pallets onto	Batch transportation	Inventory Time: 13 hrs

Waste	Section Area	Activity	Area for Improvement	Current Measurement
		truck		
	Finished Goods Warehouse	Shipment of FG	Accumulation of FG inventory within warehouse	Inventory Time: 11 days
Overproduction	Overall Process	-	Batch production	Inventory Time: 11 days

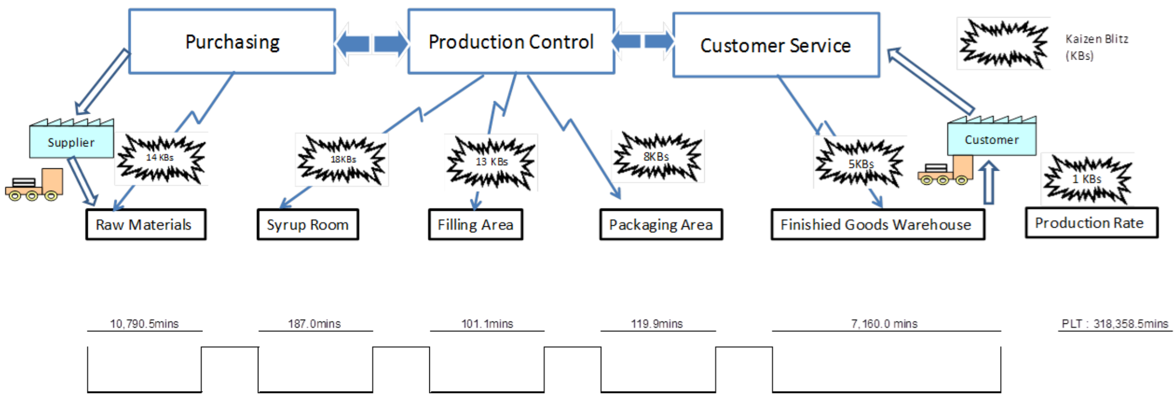

Figure 3: Future State VSM

Table 4: Suggested Improvements or Kaizen Blitz (KB)

KB No.	Area	Waste Category	Problem	Lean Tool used for improvement	Improvement
1	RM – Inventory Accuracy	Defects	Inconsistency	Cross functional teams	Identification of Problem
2	RM – Inventory Accuracy	Defects	Inconsistency	Standardization	Modify Standard Operating Procedure (SOP)
3	RM- Materials issuing to Production	Defects	Incorrect Materials issued;	Poke-Yoke	Picking list automatically generated
4	RM- Materials issuing to Production	Defects	Cycle time to issue materials	Poke-Yoke	Picking list automatically generated
5	Simple Syrup Testing	Defects	Variation of recipes	Cause and effect	Standardization – Standard Recipe
6	Simple Syrup Testing	Defects	Variation of recipes	Poke-Yoke	Adjusted Equipment
7	Simple Syrup Testing	Defects	Variation of recipes	Employee Involvement-Training	Trained operators in Standardized Recipe
8	Simple Syrup Testing	Defects	Unawareness of Defect Rate	Visual Management-Boards	Implement Visual Board to trend abnormalities
9	Simple Syrup Testing	Defects	Defective raw sugar	Supply chain management	Customer –Supplier agreement
10	Syrup Room –Syrup Testing	Defects	Dumping of product	Lean Supermarket	Reduction in Human Error
11	Filling – Syrup Carbonation	Defects	High defect rate	5 Why Analysis	Implementation of Centerlining
12	Filling – Product Filling and Capping	Defects	Low filled bottles	Fishbone Diagram	Improved valve maintenance,
13	Filling – Product Filling and Capping	Defects	Low filled bottles	Fishbone Diagram	Implementation of Centerlining ,
14	Filling – Product Filling and Capping	Defects	Low filled bottles	Fishbone Diagram	Modified SOP and associated training
15	Filling – Bottle Coding	Defects	Incorrect Coding on bottles	Visual Management-Inspector	Verification of inputted code

KB No.	Area	Waste Category	Problem	Lean Tool used for improvement	Improvement
16	Packaging – Stretch Wrapping of pallets	Defects	Inconsistent machine settings	Standardization	SOP generated and associated training
17	Packaging – Stretch Wrapping of pallets	Defects	Inconsistent machine settings	Visual Management-Inspector	Reduction in defect identification
18	Raw Materials – QA Testing	Waiting	Delay in conducting tests	5- Why Analysis	Certificate of Analysis from a Customer Supplier Agreement
18	Raw Materials – QA Testing	Waiting	Delay in conducting tests	5- Why Analysis	Electronic mail
20	Syrup Room- Simple, Testing and Transfer	Waiting	Delay in testing and transfer	Employee Involvement-feedback and observation	Self-checking by compounders
21	Syrup Room- Final Testing and Transfer	Waiting	Delay in testing and transfer	Visual management – Andon lights	Improved communication
22	Syrup Room – Inspection of Batched Ingredients	Waiting	Delay between weighing and inspection	Kanban – Active Decoupler Unitizing room	Waiting periods eliminated
23	Filling –Bottle Filling	Waiting	Delay between carbonation and filling	Visual Management – Andon Lights	Waiting time eliminated
24	Finished Goods Warehouse	Waiting	Delay in receipt of pallets	Employee involvement –new job	Waiting time eliminated
25	Finished Goods Warehouse	Waiting	Delay between manufacture and picking	Continuous Flow	Waiting Time eliminated
26	Finished Goods Warehouse	Waiting	Delay between picking and inspection	Employee involvement – Visual Management	Waiting Time eliminated
27	Syrup Room- Simple Syrup Mixing	Motion	Excess bending and lifting	One Point Lesson (OPL) to use forklift	Reduce bending and lifting
28	Syrup Room- Simple Syrup Mixing	Motion	Unavailability of cutting tool and orientation of bag to cut	On-Site location-locating knife on site	Reduced Cycle time
29	Syrup Room – Transfer of mixtures	Motion	Operators must stretch to access machinery	SMED- Stand put in place	Reduced Cycle time
30	Syrup Room – Transfer of mixtures	Motion	Small monitor resulting in strained eyes	SMED – Large Monitor	Reduced Cycle time
31	Syrup Room— Ingredient Weighing	Motion	Congested and disorganized layout	5S	Reduced Cycle time
32	Syrup Room-Ingredient Mixing	Motion	Excess bending and lifting	One Point Lesson (OPL) to use forklift	Reduce bending and lifting
33	Syrup Room-Transfer to Storage, Carbo	Motion	Hose clamps difficult to access	SMED- Designated, easy to access containers	Reduced Cycle time
34	Syrup Room- Transfer to Storage, Carbo	Motion	Location of manifold –excess bending	SMED –relocation of manifold	Reduced cycle time
35	Filling and Packaging Area- Syrup Carbo	Motion	Control panel difficult to access/not labeled	SMED – Stand installed/Panel labelled	Reduced cycle time
36	Filling and Packaging Area-Bottle coding	Motion	Machine keypad difficult to access	SMED – Install shorter stand	Reduced cycle time
37	Filling and Packaging Area-Bottle warmer	Motion	Excess bending due to location of machine's control panel	SMED – Relocation of machine's control panel	Reduced cycle time
38	Filling and Packaging Area – Bottle labelling	Motion	Tools difficult to access due to disorganized work area	SMED, 5S – Reorganization , Cleanliness	Reduced cycle time
39	Filling and Packaging	Motion	In obtaining	SMED, 5S –	Reduced cycle time

KB No.	Area	Waste Category	Problem	Lean Tool used for improvement	Improvement
	Area – Bottle labelling		material – Excess bending	Reorganization of processes	
40	Filling and Packaging Area – Bottle labelling	Motion	Manifold location results in excess bending	SMED – Relocation of manifold	Reduced cycle time
41	Finished Goods Warehouse- Picking	Motion	Weekly sticker difficult to see	Visual Management Creation of OPL to ensure visibility	Reduced cycle time
42	Finished Goods Warehouse- Picking	Motion	Pallet difficult to locate	5S- improved layout	Reduced cycle time Reduced cycle time
43	Raw Materials – AX Inventory	Over Processing	Adjustment of AX Inventory due to inaccuracy	Standardization (See KB 2)	Removal of NVAT
44	Syrup Room- Simple Syrup and Ingredient Mixing	Over Processing	Blending process too long	Standardization- blending process can be reduced	Reduced cycle time thru reduction in VAT
45	Filling and Packaging	Over Processing	Too many unnecessary quality checks	Standardization- reduce number of quality checks	Reduced cycle time thru reduction in NVA/ET
46	Packaging – Application of Weekly and AX Pallet Sticker	Over Processing	Two pallet stickers are currently use when only one is necessary	Standardization- Reduce number of pallet stickers	Reduced cycle time
47	Raw Materials – Transfer to Staging Area	Transportation	Unnecessary transportation between warehouses	Standardization of movement of Raw Materials	Reduced Cycle time
48	Raw Materials – Material Issuing to Production	Transportation	Unnecessary transportation between warehouses, disorganization	5S – Improvement of Material Flow – Layout	Reduced Cycle time
49	Raw Materials – Incoming	Inventory	Excess Incoming inventory	Reduced Lot Sizes	Reduced Inventory Cost
50	Raw Materials – Incoming	Inventory	Damaged and expired materials	Customer Supplier Agreement	Reduced reject rate
51	Raw Materials– Incoming	Inventory	Long Lead time for materials	Improved ERP	Shorter Lead time
52	Raw Materials – In process	Inventory	Bottle neck of stretch wrapped pallets	Flow – Instrallation of conveyor	Reduced cycle time
53	Raw Materials – Finished Goods	Inventory	Buildup of Finished goods	Pull – Increase frequency of delivery	Reduced inventory cost
54	Production Rate	Over Production	Batch Processing leading to over production	SMED -Smaller batch sizes	

Table 5 summarizes the expected VSM parameters for the future state. As seen, there is a 46%, 32%, 46% and 30% reduction in the processing leading time, total cycle time, WIP Inventory and changeover time respectively. There is also a 30% reduction in the changeover time. Overall there is a 38.4% improvement in the Value Added Ratio. Taking these into account, Table 6 shows that there is a cost savings of approximately four million, twenty nine thousand , five hundred and forty two dollars.($4,029,542.00US) which equates to a 55% decrease in the cost. The major reductions were as a result on the decreased inventory levels from the elimination of the temporary storage area.

Table 5: Comparison of Current and Future VSM

Parameter	Current VSM	Future VSM	% Reduction	% Improvement
Processing Lead Time	33,742 mins	18,358 mins	46%	
Total Cycle Time	919 mins	636 mins	32%	
WIP Inventory Time	32,808 mins	17,721 mins	46%	
Changeover Time	271 mins	191 mins	30%	
Value Added Ratio	0.501%	0.885%		38.4%

Table 6: Yearly Cost Benefit before and after the implementation of the improvement initiative

Waste	Cost Before Improvement Initiative (TT$)	Cost After Improvement Initiative (TT$)
Defect	$1,197,734	$589,910
Waiting	$5,635,548	$729,626
Motion	$5,387,184	$4,008,168
Over processing	$1,425,654	$360,864
Transportation	$769,500	$488,430
Excess Inventory	$27,938,328	$10,408,358
Overproduction	$8,190,000	$6,142,500
Total	*$50,543,948*	*$22,727,856*

VI. CONCLUSION

Based on the current VSM, the process lead time is approximately four (4) weeks (27 days) and the value added ratio is 0.50%. There are several elements of waste within the process such as defects, transportation, over processing and overproduction which increases the lead time. Some examples of these forms of waste include: errors in inventory accuracy and material issuing to production, long waiting periods for quality testing and inspection, excessive operator motion, unnecessary mixing operation and quality checks, redundant movement of materials within warehouses and production area, excessive raw materials and finished goods inventory.

In order to reduce the lead time, improve quality and lower cost several improvement initiatives were proposed which the company can consider implementing. These approaches include: 1) 5S implementation throughout the plant to reduce excess motion in current task and changeovers, 2) SMED concept to reduce and simplify the changeover process, 3) standardization to decrease the variances in task execution and defects, 4) operators as visual inspectors to minimize the number of defects, 5) continuous flow to ensure constant movement of inventory throughout the process, 6) visual controls to lower the waiting times, 7) poka-yoke to eliminate non-conformances and 8) customer supplier agreement to reduce defects and raw material inventory.

From the findings in the development of the future VSM based on the potential improvement initiatives, the following were noted: 1) value added ratio was increased from 0.50% to 0.89%, 2) processing lead time was reduced by 46%, from twenty seven (27) days to fifteen (15) days, 3) decrease of 32% in the total cycle time for the process, 4) minimization in the WIP inventory time from 32,808 minutes to 17,721 minutes and 5) 30% reduction in the changeover time.

Several quick win items were implemented within the organization during this study. These include: 1) standardization, through the use of standard operating procedures, one point lessons and centerlining, 2) operators self-check and visual operators to reduce waiting time and non-conformances and 3) visual controls to minimize stoppages. The following long term initiatives were tested to identify the potential impact: 1) poka yoke, though the use of ERP software adjustments, 2) elimination of over processing steps and 3) continuous flow to reduce inventory accumulation. From the results obtained, the majority of the suggested initiatives can have a significant effect on the VSM parameters. For the long term improvement initiatives, a survey was conducted among the employees or trial test, to identify the feasibility of implementation and the expected impact. These includes: 1) visual controls, 2) continuous flow which were very practical to implement based on the cost analysis, 3) transportation reduction initiatives 4) 5S and SMED principles and 6) CSA were implementable based on the surveys. The expected cost savings per year from these improvements was twenty seven million, eight hundred and sixteen thousand dollars (TT$27,816,000).

Many companies consider it challenging to identify the key areas of waste within their processes. However, based on the study conducted it can be seen that VSM can be effectively applied to the beverage industry as the initial step of waste identification. One of the main contributions of this study is that other food or beverage industries can use the outcome of this research as a knowledge base to recognize their waste elements and propose suitable solutions to eliminate them. Additionally, the proposed improvement initiatives which were recommended for beverage manufacturing process can be implemented in these industries to achieve the aimed benefits. It can also be used by organizations which have the intention to implement lean manufacturing in the near future.

Some of the recommendations for the future work in this study are:

- To utilize the VSM for different product families such as other CSD's, juices and water. The only product type which was considered during this study was the 8oz carbonated soft drink. However, the other product families should also be considered since they can impact the overall operations within the company. To utilize other lean manufacturing tools to eliminate waste within SMJ's current process. Additional research can be conducted to identify other lean manufacturing tools which can be used to eliminate the waste factors.
- To increase the number of employees involved in the process of developing the VSM. In this study, a cross functional team was involved in the creation of the VSM. However, all employees should be part of the event to not only learn the concept and tools of lean manufacturing but to provide their input and expertise in their area of work. It would also allow the employees to recognize waste elements which can be eliminated through continuous improvement.
- To consider the eighth type of waste, underutilized employees within the study. Only the seven (7) types of waste were taken into consideration for this study. The additional waste should also be explored.
- To identify the behaviours required to facilitate a continuous improvement mind-set within SMJ This study did not take into consideration the behaviours required to implement lean manufacturing principles within SMJ. Therefore, further work can be done to identify the intangible requirements to create an enthusiastic environment in eliminating any waste that is found within the organization.

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