



## Benefits of Lean Model with Value Stream Mapping as an Application in Subitec Sdn Bhd

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### Abstract

Value stream mapping will help industrial engineers, manager who still support gross manufacturing techniques of lean manufacturing. VSM is the removal waste in manufacturing, production and business process by separating and eliminating non value added activities. VSM frames the current and future state of production process in an organization. It allows people to know where wastes are eliminated. People then turn the current state to future state by using Lean Manufacturing Principles. The non-value added activities are identified by the waste of resources and area. The process must be estimated to reduce and simplify the necessary actions needed. By reducing the excessive amount of time, process can achieve the proportional value added time in the process. The redesigned process is usually more effective and efficient if done according to the lean principle. This process is charted according to the flow of company's processes in the future state with the steps and information in a simplified and understandable manner. Value Stream Mapping (VSM) will help engineers and managers in the industry which follow the manufacturing philosophies of the lean Manufacturing.

**Keywords:** Lean Manufacturing, Performance improvement, Value adding and non-value adding activities, Value Stream Map, Efficiency

### 1.0 Introduction

#### 1.1 Background Study

In order to survive in a very competitive industry, an organization must strive hard in getting more work, orders in much lesser time and a more comfortable workplace. The vision set by an

organization can be done if waste generated can be reduce to achieve flawless process flow to provide ultimate customer's satisfaction by providing the right product at the right time, quantity and quality with a reasonable price. This can be achieved by implementing lean manufacturing system which is more efficient than a cost reduction program. The main concern of lean manufacturing is at eliminating wastes which could be seen as excess production and inventory, redundant movement of material, waiting, over production, excess worker motion, rework and corrections.

Manufacturing offers many types of tool to be used for improvement. Lan manufacturing is one of the options that manufacturers can use to achieve their targets. In Asia, manufacturing plants have made their way to improvements with the use of Lean Manufacturing. In Malaysia especially, Lean system has been widely acknowledged by manufacturers since the year of 80s. Manufacturer implements lean manufacturing in order to remain competitive in an increasing globally competitive market. Lean production can be in terms of many features such as different subsequent levels of projection and multi-applications can be defined as a philosophy, which is consumed of combination of principles and practices in daily manufacturing routine. The principle view of Lean production can be defined as outlined by (Spear and Bowen, 1999). However, the crucial view and method in describing and measuring Lean production rests on a set of practices and tools used in eliminating waste (Shah and Ward, 2003)

Subitec is a leading company in manufacturing cable jointing kit for Tenaga Nasional Berhad, Malaysia that was formed in 1997. With the rising volume of population nowadays and the growing demand of lead, the company is seeing a dramatic increase in sales which demands the need to accelerate production in such a way so that there is minimal of waste and increased flow with ease thereby increasing throughput. The company manufactured several product families. Subitec adopts the traditional concept of mass production in batches where the product is produced in batches despite the quantity ordered. This creates high level of inventory, long lead time and a reduction of available floor space. Although a lot of companies started implementing lean concept, according to (Bashin and Burcher, 2006), only 10% or less of the companies succeed in implementing Lean manufacturing practices.

## **1.2 Problem Statement**

Subitec is a manufacturing company that runs a production of cable kit accessories and packaging process to produce a set of jointing kit that can be delivered to TNB. With the growing demand of cable kits, Subitec wants to introduce and implement lean flow technologies by using VSM(Value Stream Map) so that customer demand can be met by increasing throughput and capacity. It presently works on the batch processing system with longer lead time and cycle time. This has thereby led to increased inventory and higher cost.

## **1.3 Purpose of Study**

This research main focused is to identify the non-value added activities and waste so that it can be reduced and eliminated, reduce production lead time and to enhance once-piece workflow

in small batches instead of large batches. Its ultimate aim is to introduce lean flow in the workflow with respect to the concept of value stream map in Subitec so that continuous improvement can be made and has the minimum level of inventory based on customer demand.

#### **1.4 Research Objectives**

RO1 : To investigate how VSM can be used in the factory and production line to see the flow of working values and relate it with room of improvement.

RO2 : To investigate the effectiveness of implementing value stream map as a tool for lean manufacturing.

#### **1.5 Research Questions**

RQ1 : Is there any relationship between room of improvement and VSM?

RQ2 : What are the types of working values that can be improved?

RQ3 : What are the tools to measure the effectiveness of value stream map?

RQ4 : Is value stream map a reliable tool to increase company's efficiency?

#### **1.6 Significance of Study**

As a preferred vendor by TNB, Subitec needs to sustain an effective productivity and quality manufacturing in enhancing a better opportunity chances in the future. Lean management is the perfect tool to be used in order to determine the reason for ineffectiveness in company's production. Significance in this study is to examine the entire process to identify problems which are hard to see without a proper analysis and thus making a room for improvement for a better performance.

### **2.0 Literature Review**

#### **2.1 What is Lean?**

Lean manufacturing, by definition is "A Systematic approach to identifying and eliminating waste through continuous improvement by delivering the product just when the customer demanded.(Ohno,1988)". Taiichi Ohno was a knowledgeable Japanese businessman, who was the father and founder of the Toyota Production System once said that "Lean Manufacturing is all about looking at the time line from the moment the customer gives us an order to the point when we collect the cash and we are reducing that time line by removing the non-value added wastes" (Ohno,1988).

Lean concept is a combination three processes which are identifying and eliminating waste and having the activities fully utilized which will resulted in adding value to the final product. The value seen in the manufacturing is considered as the value seen from customer's point of view of something which they are willing to pay for the return services or products. There is also value from supplier's point of view which is defined as value adding activities that can be found from resources but not necessarily contribute directly to the product or services. It has been said by (Jared Lovelle, 2001), if there is value adding activities, there will also be a non-value adding activities that are considered as waste.

Waste generated should be eliminated by doing continuous improvements such as Kaizen and 5S as seen on Figure 1 on the product's lead time. By reducing lead time, organization can obtain operational benefits such as enhancement of productivity, reduction in work-in –process

inventory, improvement in quality, and reduction of space utilization. Administrative departments also can benefit the lean concept implemented in the production. They benefit it in terms of reduction in errors in order and customer service.

According to Ohno, Lean applied in the administrative departments shall benefits the entire organization, with respect to the elimination of each waste determined(Ohno,1988). The concept could be applied to many types of industries.

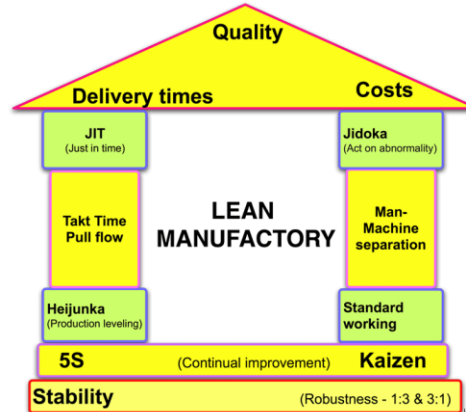


Figure 1 : Lean Manufactory of Structure

Referring to figure 1, both ‘Jidoka’ and ‘JIT’ are examples of tools which can be used to enhance more efficient process in the production. ‘Jidoka’ which is a system originally created by Japanese conclude that the method can be used to establish systems and processes such that when problem occurs, the operation stops immediately, preventing rejected services or products being delivered. ‘JIT’ which also known as Just In Time in other hand is used to utilize right resources and delivering right services just at the right time(Kannan Jayaraman, 2010).

## 2.2 Waste in manufacturing

The waste can be categorized into seven types which is commonly referred to as the “Seven Wastes”. (Ohno, 1998) suggested that these wastes contributed to up to 95% of total costs in non-Lean Manufacturing environments. These wastes are listed as below ;

- Overproduction

Overproduction is costly to a manufacturing plant since it prevents the production from having the smooth flow of materials and vitiates the quality and productivity. Overproduction manufacturing is referred to as “Just in Case” whereas Lean Manufacturing is referred to as “Just in Time” (McBride, 2003).

- Waiting

Whenever goods are not being moved or also called as idling items or processed, waiting waste will occurs which always carry a typical percentage of more than 99% of a product’s life cycle time in traditional mass production time spent. This includes waiting for material, labor,

information and many more. In order to prevent idling, lean's concept suggested that processes must be done on a just-in-time basis and linked together to promote continuous flow which also enhance reduction in waiting waste.

- Transportation or conveyance

Moving product between processes does not consider as added value to the product although it is always confused with value added and non-value added activity. It is considered non-value added due to the possibility of damages and quality reduction whenever there are too many movements to produce a product. Materials of operations should be delivered to its point of use to avoid any excessive movement and prevention of any intersection such as supermarket rack and mini storage would only generate non-value added. Point-Of-Use-Storage (POUS) is a term used to denote the assembly line that will be used when the production requires material to be shipped directly from previous station or vendor right to the next line of production where it will be used. (Lonnie, 2011).

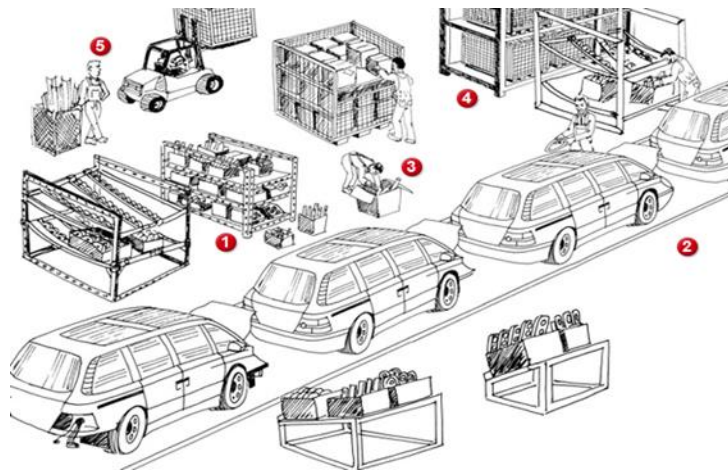


Figure 2 : Manufacturing stations(Girish and Naik, 2012)

- Over processing or incorrect processing

Over processing is considered the waste that is generated when extra steps are taken in the process to complete parts or products for example rework and recheck. This waste can be resulted from poor layout, poor tools or process planning or product design which reflects the quality of production and causing unnecessary motion and producing defects(Emil, Mihai and Ionela, 2008).

- Excess inventory

Any type of inventory either raw material, in process or finished goods does not add value to the product and it should be eliminated or reduced(William,Samson and Alphonse, 2009). Excess inventory consume valuable space in the factory and will not have the management notice that there are problems related to process incapability. The phenomena will result in longer lead time, damaged goods, storage costs and delay in delivery time.

- Defects

Defects come in two types which are usually production and service errors. Defects in the process flow bring tremendous cost to the organizations due to rework and recheck process that needs to be done to recover the errors done. Unnecessary motion is caused by poor workflow, poor housekeeping and improper working methods(Girish and Naik, 2012).

### **2.3 Lean Approach**

Lean organizations are highly focused, providing the highest quality, lowest cost products in the shortest lead time possible(Ramune and Milita, 2007). Lean always practices usage of practically proven tools and techniques to systematically implement these Lean principles. Lean principles can be briefly described as (Markus and Thomas, 2007) :

- Tools to solve customers problems
- Zero waste from customer's time
- To deliver only what is needed by the customer exactly
- On time delivery to the customer
- Supply only when it is needed
- Always have the room improvement to configure drawbacks

In order to penetrate into lean principles, one of the most practically proven tools for improvement is by using Value Stream Mapping which able to identify, demonstrate and decrease waste in the process.

### **2.4 What is VSM?**

VSM is known as value stream mapping and one of the most powerful lean tools for an organization which perceives towards lean manufacturing management for a better process and workflow. Toyota manufacturer was the first company to use VSM techniques to implement lean concepts and tools. It is a practical and graphical tool which is created by using a set of standardized symbols that will be able to assist an organization to observe and understand the flow of material, process and information as the product goes along different stages. By drawing the Value Stream Map (Figure 3), organization will be able to see the details of values exist along the process such as value added activities and non-value added activities and hence identify the opportunities available for improvement. By practicing VSM, the organization can organize its business processes and achieve the targeted waste elimination.

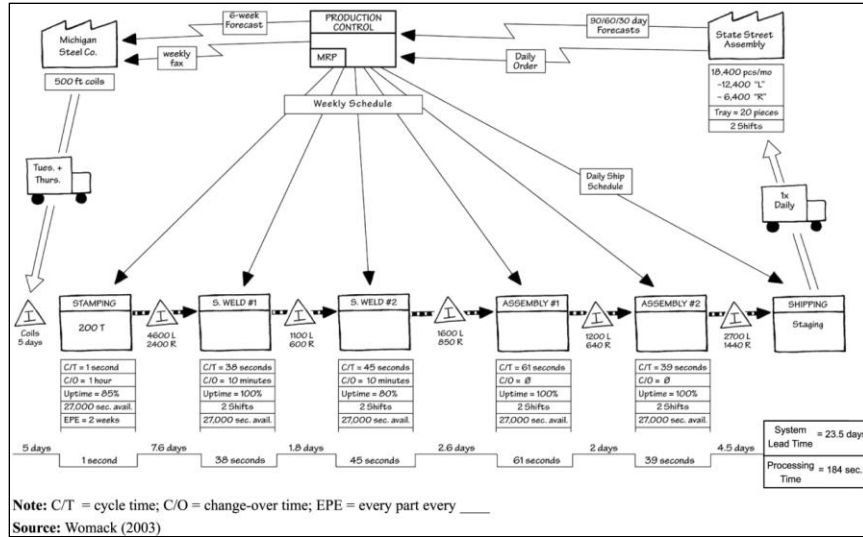


Figure 3: Value Stream Map example

Implementing VSM requires six stages which are (Markus and Thomas, 2007):

1. Identify family of product that needs to be mapped. Product may be chosen by using Work Unit Routing Analysis (WURA).
2. Define the scope of implementation.
3. Draw the current stage of processes on value stream map (Current State Map)
4. Identify room and opportunities for improvement.
5. Draw the future VSM map based on improvements planned.
6. Implement and monitor

After developing the future VSM, an implementation plan is drawn which then can be used as a reference when employing either lean tools or techniques (Romero and Chavez, 2004). This plan identifies each activity that requires achieving future state, the responsible persons and due date for the applied process on the map. A basic tool for planning a schedule can be used such as gantt chart or by using Microsoft Project or WBS. These tools will ensure all activities go according to schedule since the implementation of VSM needs to be scheduled so that every process of improvement can be done according to time schedule and organized. The end result of VSM usually proves the increment of company's productivity and reduction in waste (Sanjay and Peter, 2010).

### 3. Methodology

The research methodology has been concluded in figure 4. The figure shows that the research methodology is started by selecting the subject and determines the scope.

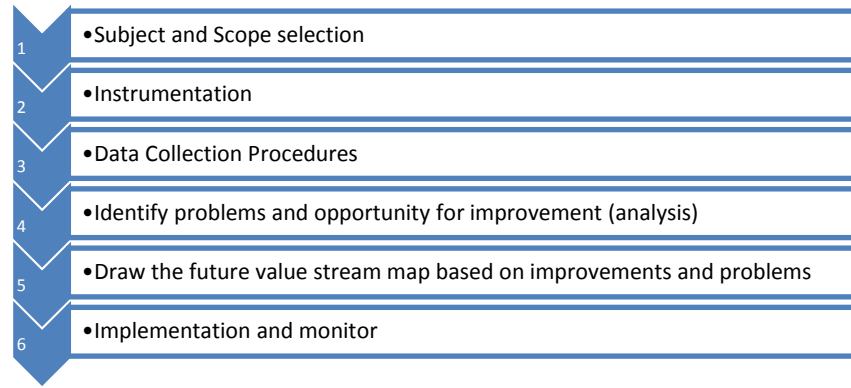


Figure 4: Research Methodology

### 2.3 Subject and Scope Selection

The study will focus on the most influenced product family as it comprises 65% of the customer demand. There are several product families but as soft lead product family contributes to a major portion of the customer demand, it is a good product family to focus the study on. Project scope also must be determined in order to specify the area of research which shall be conducted. Figure 5 shows the scope of project that was covered during the project.

In order to choose which product family to select for the mapping, product family for the highest demand was selected. A product matrix with related processes was developed with the different products manufactured on the left hand side column and the process operations toward the right hand row. It enables to see the different processes followed by different products. This is called Work Unit Routing Analysis and is conducted to see the potential service or product that can be improvised in order to influence the total performance of a company.

Table 2 shows the (WURA) for the project which selects product Jointing Kit type Straight Through CAM2 11Kv 150mm<sup>2</sup>/240mm<sup>2</sup> 3C for XLPE Cable. As shown, among the products produced by Subitec, this model has the highest demand among all by their main customer, which is TNB. The total value of WURA collected was the highest thus been chosen to be analyzed and implemented by using VSM as an improvisation tool.



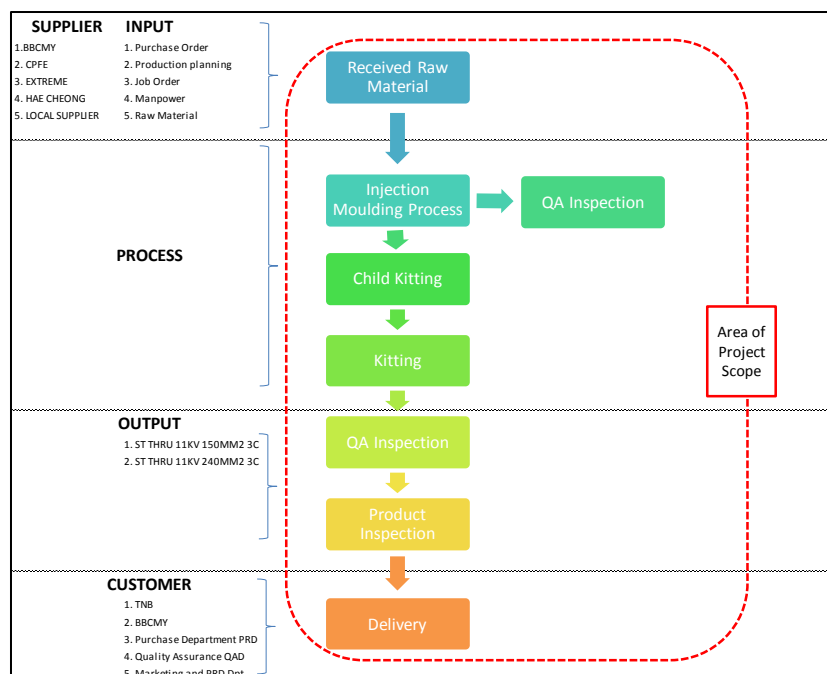


Figure 5 : Project Scope

Table 1 : Work Unit Routing Analysis (WURA)

Work-Unit Type		Average Volume (monthly)								TOTAL
			Machining	Trimming		QAD	Production 2			
				Plastic	Silicone		Checking	Storage	CK	
NTT	22KV 1C 70MMP XLPE CABLE (OUTDOOR)	10	x	x		x	x	x	x	60
	22KV 1C 70MMP XLPE CABLE (INDOOR)	10	x	x		x	x	x	x	60
	22KV 1C 150MMP XLPE CABLE (OUTDOOR)	10	x	x		x	x	x	x	60
	22KV 1C 150MMP XLPE CABLE (INDOOR)	10	x	x		x	x	x	x	60
	22KV 1C 240MMP XLPE CABLE (OUTDOOR)	20	x	x		x	x	x	x	120
	22KV 1C 240MMP XLPE CABLE (INDOOR)	20	x	x		x	x	x	x	120
	22KV 1C 500MMP XLPE CABLE (OUTDOOR)	20	x	x		x	x	x	x	120
	22KV 1C 500MMP XLPE CABLE (INDOOR)	20	x	x		x	x	x	x	120
	11KV 1C 70MMP XLPE CABLE (OUTDOOR)	100	x	x		x	x	x	x	600
	11KV 1C 70MMP XLPE CABLE (INDOOR)	700	x	x		x	x	x	x	4200
	11KV 1C 500MMP XLPE CABLE (OUTDOOR)	200	x	x		x	x	x	x	1200
	11KV 1C 500MMP XLPE CABLE (INDOOR)	200	x	x		x	x	x	x	1200
	11KV 3C 95MMP XLPE CABLE (OUTDOOR)	100	x	x		x	x	x	x	600
	11KV 3C 95MMP XLPE CABLE (INDOOR)	100	x	x		x	x	x	x	600
	11KV 3C 150MMP XLPE CABLE (OUTDOOR)	300	x	x		x	x	x	x	1800
ST THRU	11KV 3C 150MMP XLPE CABLE (INDOOR)	300	x	x		x	x	x	x	1800
	11KV 3C 240MMP XLPE CABLE (OUTDOOR)	300	x	x		x	x	x	x	1800
	11KV 3C 240MMP XLPE CABLE (INDOOR)	300	x	x		x	x	x	x	1800
	CAM2 11KV 95MM <sup>2</sup> 3C FOR XLPE CABLE	300	x	x	x	x	x	x	x	2100
	CAM2 11KV 150MM <sup>2</sup> 3C FOR XLPE CABLE	700	x	x	x	x	x	x	x	4900
	CAM2 11KV 240MM <sup>2</sup> 3C FOR XLPE CABLE	700	x	x	x	x	x	x	x	4900
	CAM2 22KV 150MM <sup>2</sup> 1C FOR XLPE CABLE	30	x	x	x	x	x	x	x	210
	CAM2 22KV 240MM <sup>2</sup> 1C FOR XLPE CABLE	200	x	x	x	x	x	x	x	1400
	CAM3 11KV 500MM <sup>2</sup> 1C FOR XLPE CABLE	30	x	x	x	x	x	x	x	210
	CAM3-XB 11KV 500MM <sup>2</sup> 1C FOR XLPE CABLE	20	x	x	x	x	x	x	x	140
	CAM3 22KV 500MM <sup>2</sup> 1C FOR XLPE CABLE	20	x	x	x	x	x	x	x	140
	CAM3-XB 22KV 500MM <sup>2</sup> 1C FOR XLPE CABLE	20	x	x	x	x	x	x	x	140
	11KV 95/120MMP	100	x	x	x	x	x	x	x	700
	11KV 150/185MMP	100	x	x	x	x	x	x	x	700
	11KV 240/300MMP	200	x	x	x	x	x	x	x	1400
JT TRANS	22KV 240/400MMP	10	x	x	x	x	x	x	x	70
	22KV 150/185MMP	10	x	x	x	x	x	x	x	70
	TYPE JD 4C-300/120MM <sup>2</sup> INJ/1KV	20				x	x	x	x	80
BREECHES	TYPE JD 4C-300/185MM <sup>2</sup> INJ/1KV	20				x	x	x	x	80
RIB	TYPE CUB 17.5KV 35/400, 3C XLPE CABLE	500	x	x		x	x	x	x	3000

### **3.2 Instrumentation**

Value stream mapping was used as a tool to map the process and depict the scenario with the aim of reducing lead time and increase throughput. Details of each processes involved in the production line will be shown in the map to help the next analysis process to be carried out. Mapping the value stream always starts with the customer demand. With the product family and the data gathered during the previous steps, the value stream map is carried out through until the product is delivered to the customer.

### **3.3 Data Collection Procedures**

In order to collect the data to draw the current and future value stream map, a real process will be observed thoroughly. Data was obtained from the respective departments as the value stream map was drawn. Factory tour with the key person of a process was done prior to the employees' discussion so that the researcher could have a better and clear understanding of the process and the entire scenario. Active participation in discussions with employees and correct information being disseminated assisted in drawing an accurate value stream map for the company. Below are the lists of data needed in order to produce a complete value stream map :

- Data collection on total cycle times, waste generated, queue time
- Cycle and Processing Time
- Changeover Time
- Percentage of rejects and work-in-process

The existing method is analyzed to analyze the comparison and efficiency of the current process and information on actual manufacturing activities in comparison to the standard working method proposed through direct observation. Subsequent to that process, line manufacturing process is conducted to acknowledge the current process and the importance of removing waste that has been identified. The initial data calculated is then tabulated in the map and calculated in desired units.

### **3.4 Analysis**

The last step was to analyze the current state map and suggest room for improvisation such as lean techniques and Kaizen that is suitable for the process involved in order to reduce lead time and increase throughput. This analysis was conducted by comparing performance of the assembly line before and after the implementation of selected manufacturing tools such as Kaizen.

### **3.5 Future Value Stream Map**

After the analysis, findings of opportunities and problems can be identified and thus improvised. The improvisation shall be done and eliminated before developing a new value stream map. Value stream map must consist of a better production associated with calculated data.

### 3.6 Implementation and Planning

Completed state map is then continued with an implementation plan which will then convert the details in current state map to future state map by identifying the waste and bottleneck from the observed process. Hence, a sequenced plan of improvement projects can be carried out. The plan shall consists of clear and brief details of improvement that will be done and prioritize.

## 4.0 Results

### 4.1 Current State Map

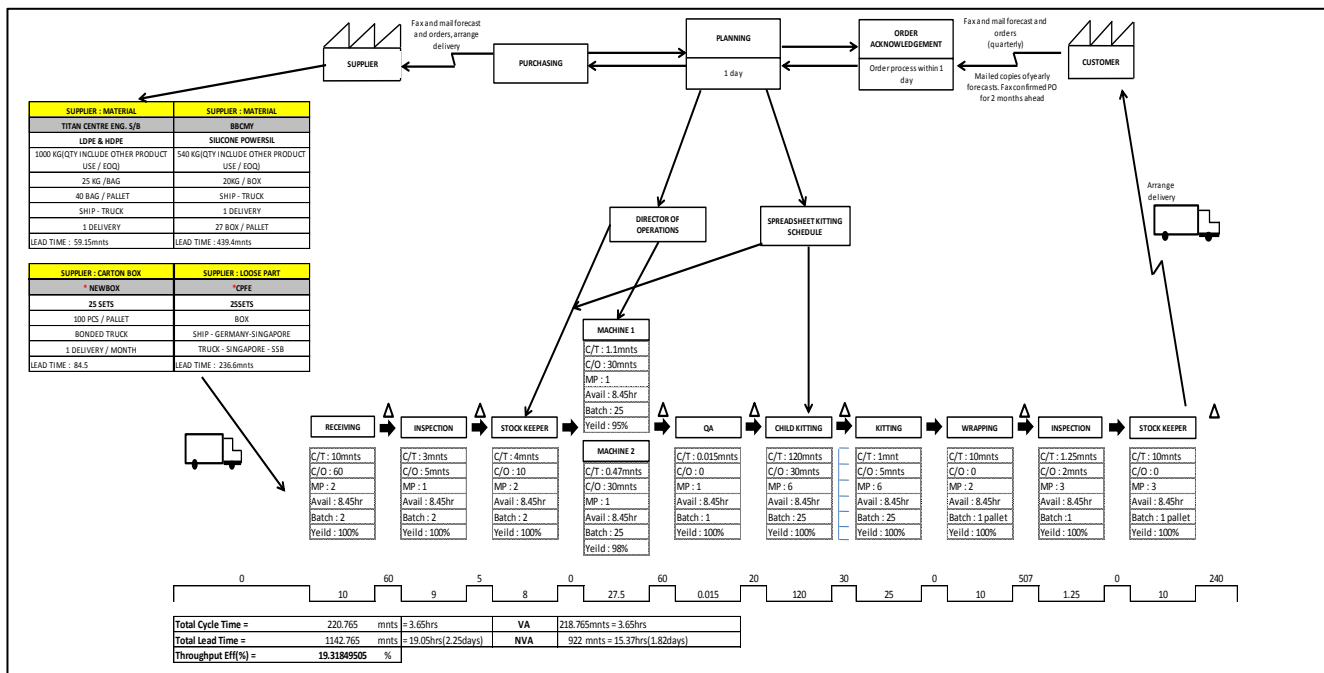


Figure 6: Current State Map

As shown in the current state map in Figure 6, daily, weekly, monthly and annual orders are taken by customer service by the forecast received. Thereafter, information is sent to the planning department to plan the subsequent parts or process needed and delivery the information to the respective departments. Materials needed are ordered and delivered to Subitec's warehouse for production and packaging. Processes go on from handling material received from supplier in the warehouse to quality checking, production and packaging. As seen in the current state map that has been developed, there is waiting time or queue time in between each process that is noted by the triangle symbol. The intersection from child kitting to kitting process uses supermarket method which is known as suspended transfer to transfer work-in-process goods to the kitting area. This method was useful until the problem of space usage occurred. Thereafter the packaging process, quality inspector from TNB will come to have the goods checked before going to customer's warehouse. There's a delay in transportation process where transport agent needs to wait for the quality officer to finish approving the goods. The result from current state map is accumulated and calculated to produce efficiency of the whole process.

Table 2 : Current State Map data calculation

TYPE	FIGURES (minutes)	FIGURES(days and hours)
Total cycle time	220.765mnts	3.65hrs
Total lead time	1142.765mnts	3.17days
Value added	218.765mnts	3.65hrs
Non-value-added	922mnts	15.37hrs
Throughput efficiency	19.318%	

## 4.2 Problems Discovered

Red boxes are the discovered problems in the production line. Most of the wastes encountered were waiting and process time. Each problem was perceived and taken into counter for the analysis part in order for researcher to find solution for it. Referring to table below, those are the suggested way of resolving the problems that existed in the production line. Each problem found is directed to a suggested solution, with reference to a responsible employee who will be responsible to handle it. To find the correct root cause for each problem, a why-why analysis is conducted until the ultimate root cause is found. Why-why analysis is an iterative question-asking technique used to explore the cause-and-effect

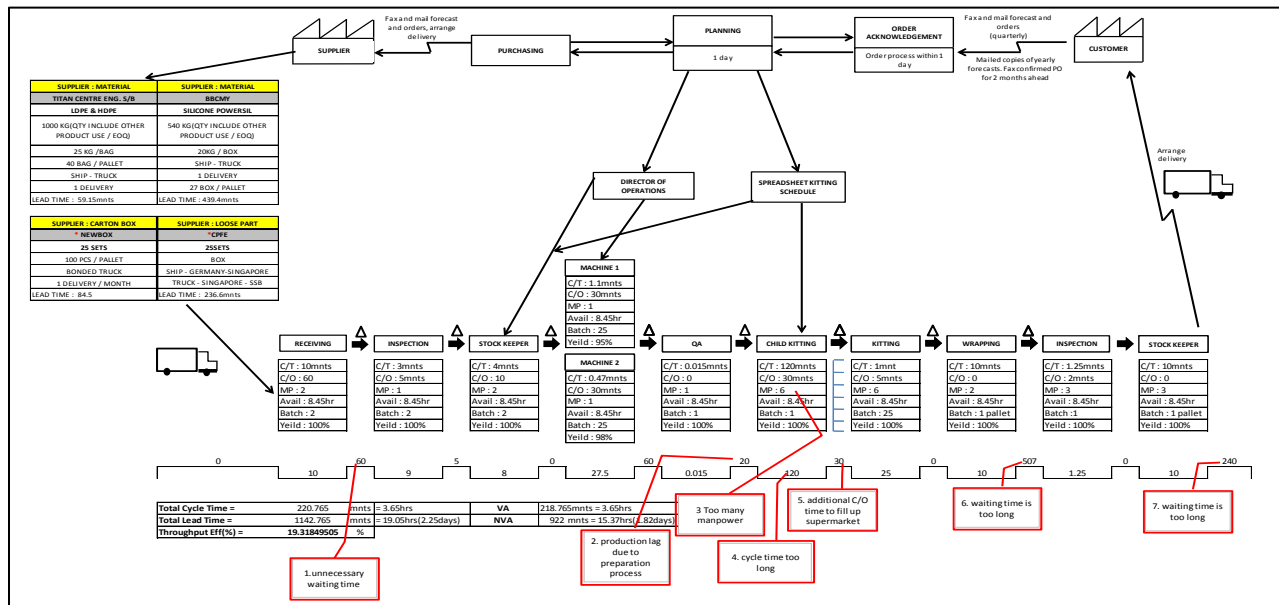


Figure 7: Problems Discovered

relationships underlying a particular problem (Taiichi Ohno, 1988). By carrying this technique, the root cause of a problem can be detected clearly. The usual question for this scenario is taken to a third level where the answer of the question asked towards the process is not working well or does not exist.

Table 3 : Suggested Solution

NO	ISSUE / PROBLEM	TYPE OF WASTE	PROCESS	REASON	WHY 1	WHY 2	WHY 3	ACTION	P.I.C	TARGET COMPLETION
1	Waiting	Time waiting	Incoming	Re-arranging store	Limited space	Not enough racks for storage	-	Build up high racking sytem for storage and do inspection simultaneously during incoming	WM (Nazira)	September, 2013
2	Waiting	Time waiting	Production	Unprepared parts for production	Improper system	Unspecified PIC	-	Introduce runner to supply continuous stock for daily production according to schedule	WM (Nazira)	November, 2013
3	Excessive man power	Manpower	WIP (CK)	Jobs are done in a bulk	Improper flow of system	Lack of tools to implement lean	No budget until move to new factory	Introduce auto feed shutter rack with runner to top up stock,do 1 kit at a time instead of the whole batch and split manpower to 2 section	WM (Nazira)	October, 2013
4	Excessive cycle time	Time Process Efficiency	WIP	Motion waste when all TO are doing the same thing and transfer to next job	TO waste time on motion and getting the area cleared	Space are limited	No suitable rack or working station	Implement Kanban and shutter rack that connects CK and Kitting by placon roller that feeds the parts without causing TO to move. Simultaneous process remove buffer hence produce 1 kit in 1.37mnts with balance process	WM (Nazira)	February, 2014
5	Waiting	Time Process Efficiency	WIP (CK)	Supermarket requires TO to spend time arranging parts in bin to supply to Kitting	Supermarket needed to reduce bulk in finished WIP area	Lack of tools to feed direct supply	No budget until move to new factory	Using lean shutter rack, WIP parts are produced by 1 full set kit and are fed directly to Kitting section. Runner is introduced.	WM (Nazira)	March, 2014
6	Waiting	Time waiting	Inspection process	Inspection application always done on the next day	Rearrange space and clean up area for PI	Space are limited and need to re-arrange goods	-	Area for finished goods' been introduced. Goods are placed according to the section and will not be transferred or moved.	WM (Nazira)	April, 2014
7	Waiting	Time waiting	Finishing process	Unavailability of transportation	Improper planning/last minute planning	-	-	Planning for shipment done right after inspection	WS (Haniiff)	August, 2014

### 4.3 Future State Map

In proposing suggestions and recommendations for a better version of an ideal value flow, a future state map will serve the purpose. Several lean techniques are adopted to reduce lead time and increase throughout. With the aim of continuous improvement, Subitec is suggesting seven items shown in table for implementation so that the production can be conducted in an efficient way. For the first problem of storage, it has been suggested that Subitec build up high rack system for storage and so simultaneously during receiving the items for supplier. This is to prevent warehouse from being crowded and to reduce time taken to re-arrange the space. Second problem of unprepared parts for production has been introduced with runner who is also known as Mizusumashi. Mizusumashi is considered as a helper in the factory and is the most talented and knowledgeable employee who manages to do almost every job given. They have knowledge on every part that is needed by each work station. The third and fourth problem which has been encountered is the excessive manpower and cycle time in child kitting section due to the technique of completing the job. The job is done in bulk without planning or just-in-time concept. This is due to improper flow of system in child kitting department. Thus, to encounter this problem, an auto-feed lean shutter rack with runner to top up stock will be introduced.

With lean rack, operator will need to finish one task completely before moving on to the next task. Thus, the excessive manpower previously will be divided into two groups respectively. Fifth problem encountered is the existing supermarket concept in between child kitting and kitting area. Supermarket concept is held to store parts which in work-in-process area before transferring them to the actual working stations. In certain scenario, supermarket would be

helpful if it does not contribute to waste. In this case, operators are wasting their time arranging kits in the supermarket rack and spend more time arranging and checking kits to ensure that they are doing it correctly. Thus, this problem is taken care by using the same lean shutter rack. Next problem encountered in the production line is during the product inspection by TNB officer before the delivery of the product. The reason for the problem is minimum space for finished goods. In order to tackle this problem, area of finished goods is introduced so that finished goods can be placed according to the section and will not having trouble to re-arrange for product inspection process. For the finishing process, production line is facing drawbacks of unavailability of transportation. This is due to the improper planning for transportation. The suggested planning for production line is to ship all finished goods right after the product inspection is done. This is done to avoid the space usage in the warehouse and reduce the waiting time for production to start new task.

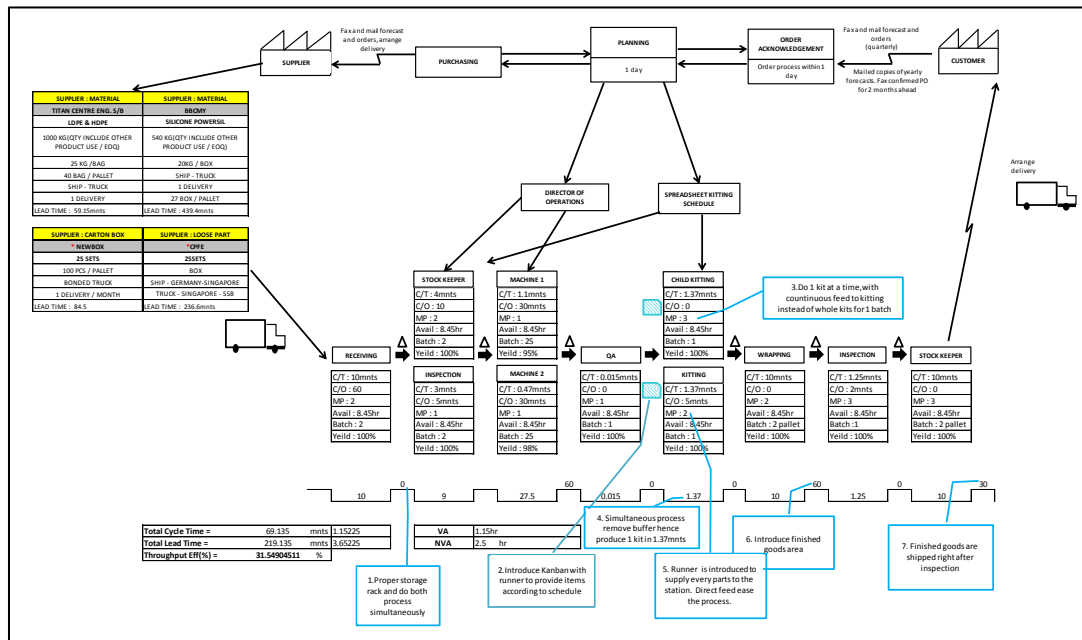


Figure 8 : Future State Map

As a result from the future state map, the data has been re-calculated and it has proven that the improvisation done on the process has reduced total cycle time on the production line, total lead time and increase efficiency of the process.

Table 4 : Future state map data

TYPE	FIGURES (minutes)	FIGURES (hours and days)
Total cycle time	220.765mnts	1.15hrs
Total lead time	1142.765mnts	3.65hrs
Value added	218.765mnts	1.15hrs
Non-value-added	922mnts	2.5hrs
Throughput efficiency	31.55%	

#### 4.4 Improvements

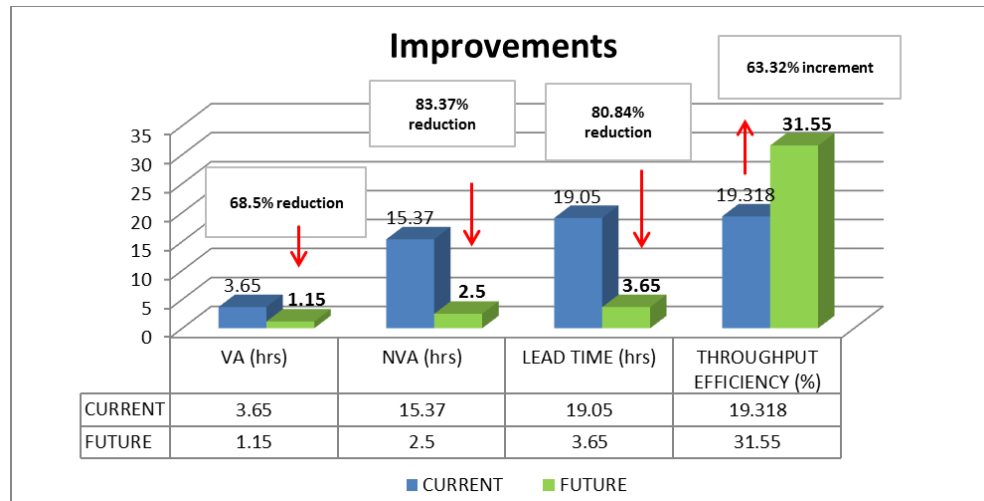


Figure 9 : Improvements comparison between current and future state map

Figure 9 shows graphical info on the data comparison between current and future value state map which has been carried out in this project. Results obtained was found tally with hypothesis created for research purpose as listed :

**RH1 :** There is a relationship between VSM and there's a chance for improvement which can be discovered.

**RH2 :** There are two types of working values that can be improved which are value added and non-value added type of work.

**RH3 :** Tools to measure the effectiveness of VSM is by analyzing the throughput efficiency of overall process.

**RH4 :** Value Stream Map is a reliable tool to increase efficiency provided every plan is done according to the current phase data and standard working procedures.

Reduction and Value Added and Non-Value Added of 68.5% and 83.37% have actually influenced the total lead time needed for the whole process. Note that lead time calculated in the current phase was 19.05 hours to complete the whole batch of 25 kits. Process includes receiving until delivery. In future phase, after implementation, lead time was reduced dramatically from 19.05 hours to 3.65 hours which bring the percentage of reduction to 80.84%. The reason for the reduction is due to the process that has been design to go in parallel instead of series, as shown in Figure 8 (Future state map). Process has been design to produce output simultaneously to avoid extra space for material storage as encountered in the current phase when the production is using supermarket method to store child kitting parts. Efficiency of the production has increased from 19.318% to 31.55%. Throughput efficiency is a figure which has been calculated from the beginning phase of production including the efficiency of the machines until the phase of delivery. In this project, it is shown that throughput efficiency has increased by 63.32% which

resulted in a better and leaner productivity. Operators are working in an efficient way ergonomically, with less lead time and more output.

#### 4.4.1 Motion Analysis

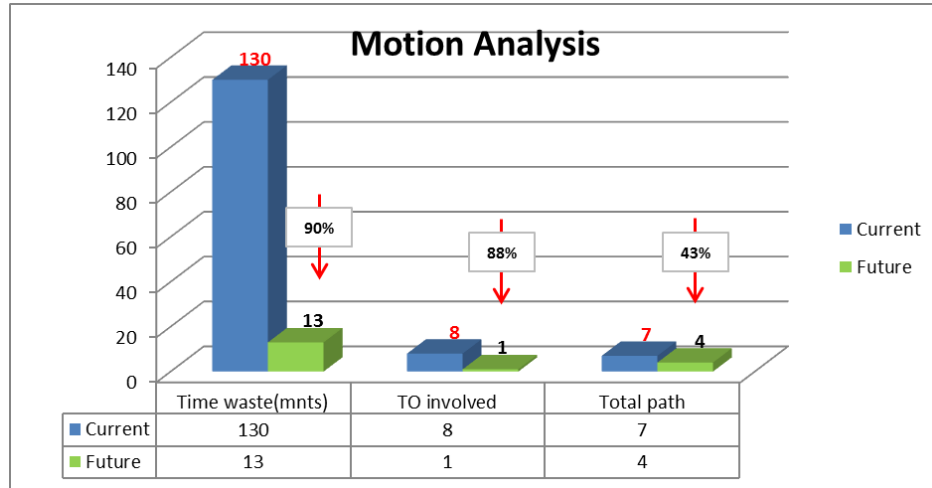


Figure 10 : Motion analysis

Besides improvements in terms of time and efficiency, Subitec's production line has managed to improve their motion which happened to be the main source of time wastage in the line. Waste generated is not realized until a map of motion flow is drawn throughout the flooring operation of the entire process in daily basis for current and future. Figure 11 and 12 below show both current and future motion path drawing respectively. Current phase shows untidy flow of movements by operator involved in the production line including goods transfer from one to another station. Future phase shows a tidy flow of process and clear work flow from one station to another. Previously, motion wastes are generated by all the operators. Hence, to prevent more waste generated, motion is accumulated and transferred to the Mizusumashi which is introduced in the research earlier. Table 6 shows the calculated time wastage based on motion, traveled by operators involved in the operation.

#### Research Hypothesis

**RH1 :** There is a relationship between VSM and there's a chance for improvement which can be discovered.

**RH2 :** There are two types of working values that can be improved which are value added and non-value added type of work.

**RH3 :** Tools to measure the effectiveness of VSM is by analyzing the throughput efficiency of overall process.

**RH4 :** Value Stream Map is a reliable tool to increase efficiency provided every plan is done according to the current phase data and standard working procedures.





Figure 10 : Current motion path in the production line

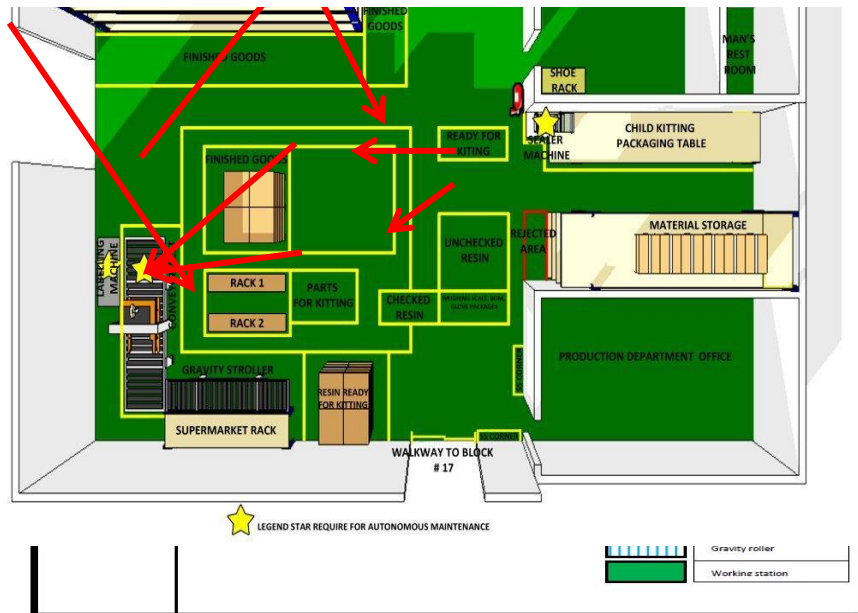


Figure 11 : Future motion path in the factory

Table 4 : Tabulated data of calculated motion path analysis

i) CURRENT					
NO	TYPE OF MOTION	TO	TIME	TOTAL	
1	Walking to supply parts from warehouse to child kitting area	2	10 mnts	20	
2	Load WIP parts from child kitting to ready-for-kitting area (back and forth)	3	7 mnts	21	
3	Transfer reject item to reject bin	1	1 mnts	1	
4,5,6	Walking to supply WIP parts to kitting section (back and forth)	4	20 mnts	80	
7	Walking to finished goods area to store completed batch	1	8 mnts	8	
			Total motion time wasted(mnts)	130	
			TO involved in motion	8	
			Total path	7	
ii) FUTURE					
NO	TYPE OF MOTION	TO	TIME	TOTAL	
1	Walking from warehouse to processing area to supply parts.	1	2mnts x 2path x 2 = 8 mnts	8	
2	Transfer finished batch from processing area to wrapping	1	1 mnt	1	
3	Transfer finished batch from wrapping machine to finished	1	2 mnts	2	
4	Walking to finished goods area to store completed batch	1	2 mnts	2	
			Total motion time wasted	13	
			TO involved in motion	1	
			Total path	4	

As per hypothesis, there is a relationship between VSM between rooms for improvements. By conducting value stream map for current phase, one can identify the drawbacks or bottleneck of company by calculating the values for each section of the process. When bottleneck or problems are identified, problems can be cater and include in plan for improvements. Working values that are identified in this study is improved as shown in the graphical data above. Both value added and non-value added values are improved when working stations are improvised based on an efficient design which cater to ergonomic and productivity. The key to a success VSM is to analyze the level of efficiency before and after improvement has been done. In this case, as shown in graph above, the level efficiency increased which relates that the VSM concept implemented in this project is effective hence it is a reliable tool to help one organization increase their performance level by making room of improvements using VSM with respect to the current phase data and standard working procedures.

#### **4.5 Implementation**

Implementation will be done in phases with respective area in order. Problems are prioritize and arranged according to the importance of the process that might give a big influence to the whole production unit. All suggestion of implementation is subjected to current scenario. Every suggestion was presented under budget planning which has been allocated for the year. The key of implementation is to ensure that it is done according to plan. For example, in order to build a warehouse rack, one need to identify the average capacity that can be calculated from monthly usage or kits produced. The capacity should not be maximized as it can lead the production to wastage of unused space.

The implementation of lean shutter rack must be done correctly according to the planning of manpower needed in one station. The working station was done to ensure that all the operators are working comfortably and ergonomically. Ergonomic is defined as the design factors, as for the workplace, intended to maximize productivity by minimizing operator fatigue and discomfort (Liker, 2004). Solution produced must be taken care by the individuals who has the responsibility for the operations.

#### **5.0 Conclusion**

The manufacturing environment indeed offers many tools available for a company to fulfill the room improvement. Lean manufacturing has proven to be the most efficient tools to be used in improvement in any process. However, the tool is often mandated by higher level management as a way to reduce waste from manufacturing systems but they missed looked the importance of having the sub-ordinates to acknowledge the tools they are implementing on a case by case basis. Providing this road map is the responsibility of operation management unit. In this case, Production manager and Supervisor play as key person to have sub-ordinates realize the efforts. A specific solution was developed from the selected concept and the process of

implementing the project using VSM as the main tool, followed by kaizen and 5S tools. Key metrics were determined and monitored. Once data were collected and compiled, they were compared to similar data collected before the implementation began and analyzed for the success of obtaining managerial objectives.

It was clear that the solution provided a method by which to eliminate a great deal of waste from the production line in Subitec. Due to this, the solution was carried to other facilities with stations that performed same or similar processes. It was determined that because of the success of the methodology in providing solution to the production line that involves kitting and child kitting, the methodology could be carried to other areas of the process and even other industries with similar success. By providing a methodology for management to determine and meet goals, operational groups can move toward road maps for the implementation of lean manufacturing projects.

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