ISSN 2347 - 3983
Volume 8. No. 1.2, 2020
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter0781.22020.pdf
https://doi.org/10.30534/ijeter/2020/0781.22020

Lean Manufacturing Implementation To Reduce Waste On Weighing Scale Assembly Line

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ABSTRACT

Scale manufacturing assembly line plays a critical role in enabling a factory to supply on time and at the right volume and quality. The production assembly line encounters many problems in manufacturing to produce the scale. In order to full fill the on-time delivery to the customer to trap the shipment delivery, production needs to do extra time to whole it. The value stream mapping approach will use to try and overcome the problem, discover the waste thru the manufacturing processes, material flow and put in force lean manufacturing tools. Current value stream mapping has recognized various troubles and determined that material preparation flow contributed a lot to the trouble as a result of decreased productivity. During manufacturing running, part preparation a mix between mainline and sub-assembly into 1 large trolley which is for the duration of changing model, mainline is waiting until the sub-assembly part material is completed put together by the material handle. Daily production target was once described base on estimation between the line leader and manufacturing supervisor as an alternative of the base on the assembly line process bottleneck. Lack of production arrangement, poor production layout, and product defect flow has been created excessive WIP in the production assembly line due to there used to be a contraflow. The lean implementation through Single minutes change of dies (SMED) and the Kaizen method has deployed to reduce higher exchange over time, improve yield, increase productivity, cost reduction and future state map will be recorded. Future state map shows, 2 racks single point scheduling system implementation reduces exchange over time by a mean of 60 %, layout optimization reduces 2 manpower and reduces WIP by a mean of 40.6 %, yield improvement to 98%, and reduce production lead time by a mean of 29.06%.

Key words : Lean manufacturing, Value stream mapping, SMED, Process balancing, Layout optimization.

1. INTRODUCTION

The basic idea with lean manufacturing is to use less of the whole thing in contrast to mass production, less human effort, engineering hours, space in the manufacturing facility, and so on, which requires less stock and defects to succeed. Lean refers to principles and strategies that focal point on the systematic identification and removal of non-value-added activity involved in producing a product or providing service to the customer. The author argues that though the success of lean has been established in the manufacturing world, there are nevertheless some challenges to face on the lean implementation process [1]. Challenging to ask employees to exchange their way of wondering to focus on value preferred by way of the purchaser and discover waste. The definition of lean manufacturing and how it coincides with the Toyota Production System (TPS) are now not usually regular when reading current research and it has changed over time. The author argues that there are several special definitions to lean manufacturing, leading to confusion of what is protected by means of the concept [2]. Lean manufacturing thought used to be developed for maximizing the useful resource utilization via minimization of waste, later on, lean was formulated in response to the fluctuating and aggressive enterprise environment. Due to a rapidly altering business environment, agencies are pressured to face challenges and complexities. Any organization whether manufacturing or service-oriented to survive may additionally in the end depend on its potential to systematically and consistently reply to these changes for improving the product value. Lean is not just linked to machines in the production; all the production assets of the business enterprise are included, for example, personnel, capital, and energy. Today the lean concept is used in many different areas concerning up-grades and the original meaning of the concept might also have lost its meaning. The majority of the study find out about focuses on a single aspect of lean element, only very few focuses on greater than one factor of lean elements, but for the profitable implementation of lean, the organization had to focus on all the factors such as Value Stream Mapping (VSM), Cellular Manufacturing (CM), U-line system, Line Balancing, Inventory control, SMED, Pull System, Kanban, Production Levelling.

2. MATERIALS AND METHODS

2.1 Lean Manufacturing

Lean manufacturing additionally called “Lean production”, “Just-In-Time (JIT) system” or ”Toyota production system” is a philosophy of consistently lowering waste in all types and all areas of manufacturing for greater effectivity [3]. Becoming “Lean” is a process of eliminating waste with the aim of creating value. “The concept of Lean production as the best way for people to make things. It gives a better product in a wider variety at a lower cost. Equally important, it offers more difficult and gratifying work for employees at each level, from the manufacturing facility to headquarters. There are three different levels of obstruction. First, on the strategic level, it represents a philosophy and the way of thinking. Second, a set of standards categorical Lean on the tactical level. Third, on the operational level, Lean is realized via tools, techniques, and practices. To acquire excessive-quality, lowest cost, and shortest lead time, lean used to be used as tools and practices [4]. The Impact of lean manufacturing implementation is to enlarge shop floor discipline, clean, enhance time management, and improve productivity [5].

2.1.1 Five Lean Thinking Fundamental

Understanding of five key lean thinking principles is very important to attain lean manufacturing goals. These principles will assist the way how to perform lean implementation. The five Lean principles are the following [6], [7]:

1. Specific value
2. Identify value streams
3. Make value flow continuously
4. Let the customer pull value
5. Pursue perfection

The Lean manufacturing goal is to eliminate non-value-added activities. Cost and cycle time reduction got significant results, customer responsiveness and more organization competitiveness [8].

2.1.2 Value Stream Mapping (VSM)

VSM has emerged as the most reliable technique to implement lean manufacturing in factories and has been used to identifying waste. Value stream mapping is one of the important tools in implementing lean manufacturing on manufacturing organizations [9]. VSM is a visual tool that facilitates the process of lean production by helping to identify the value-added (VA) steps and eliminating the non-value (NVA) waste [10]. To implement lean principle manufacturing organization, have to utilize the value stream mapping [11]. Several advantages have been offered by VSM compare to other mapping methods. In order to achieve effective implementation of the lean principle, VSM works as a foundation to provide a link among the manufacturing process. The goal of the value stream map is to reduce wastes in the production line as much as possible. These wastes prevent the constant movement of material and information [12]. In the organization, VSM useful to improve productivity & quality and reduce whole manufacturing cost and production lead time. Value-added and non-value added process was identified by Value stream mapping start from raw material coming from the supplier, manufacturing assembly process until finish product delivery to the customer. However, although current state map developing, the possibility to make mistake give rise to new problem occurs instead of solving the problem in the organization [13]. The lack of standardization process is difficult to develop a current state map to capture the current situation in production. VSM is very difficult to perform in a complex process such as automotive manufacturing. Simple process flow chart was proposed to simplify the current state map of process development. The author argues that to develop VSM effectively, a complete action plan needs to perform and the cross-functional team needs to involve consist VSM expert, production, and workplace facilitator [14]. The finding from this study is increasing capacity is solved with the lean principle and increasing the cost is also minimized with the gradual increase in customer demand. A case study in the textile industry conclude that applying VSM made the company more productive and effective, production lead time was removed by 64% and this decrease leads the company to deliver the order earlier thus the company can receive more orders and produce more [15]. Reduce manufacturing cost, production lead time work in progress inventory control has been proved by VSM besides improving productivity and quality. VSM application was showed that quality and productivity improved and reduce production lead time, work in progress inventory [16]. However, the application of VSM in small and medium scale manufacturing organizations was conducted and analyzed by past research observation. The large scale Indian automobile and auto-ancillary industry in the

Automobile sector that produces original equipment, VSM has been implemented [17]. Operation net cycle time reduction and non-value added activities were eliminated by the implementation of VSM in the casting industry [18]. Wet grinder manufacturing organization has been implemented VSM in the assembly line [19]. It deepens on the work systems that deliver value to customers and reflects the workflow from a customer's perspective; as a result, the process of VSM provides effective ways to establish strategic directions for better decision making and work design [20]

2.2 Research methodology

To locate the solutions to the research questions and create value stream maps for the case study, it was necessary to study the manufacturing steps. Before defining an appropriate road map to conduct this research, first, it is wanted to confirm the characteristics of the particular company as a late adopter and then discovering out in which step of adoption method they reject to implement lean manufacturing in their organization. Data and information regarding this study have been gathered via observing the processes of each department and the daily activities of the employees. To do this end, the researcher went to the production plant and studied the flow of the process and material on the shop floor. Observing the workflow, manufacturing steps, and routine of the factory resulted in generating data that is precious to figure out the current state of the production and identifying major wastes. When all of these become clear, it is time to recommend improvements and set future goals with the aid of applying lean tools. In this chapter, the procedure of the data collection outcomes from analysis and provide recommendations for improvement of the production will be discussed. Scale Manufacturing company which exports its products to various countries in the world broad selected as a case study for this paper. The company locates in Batam Indonesia started out in 2001 and produce a scale base on customer order. This company produces weighing scale ordinarily for the retail industry following information is about the production line: working day per week = 6, working shift per day = 1, working hours per shift = 8 hours, lunch break = 1 hour, tea break per shift = 2*15 minutes = 30 minutes, available time per shift = 9 hours, total daily demand is 140 unit per day. Data and information related to this study have been gathered through observing the processes of every department and the daily activities of the employees. To do this end, the researcher went to the manufacturing plant and studied the flow of the process and material on the shop floor. Observing the workflow, manufacturing steps and routine of the factory resulted in generating data that is precious to figure out the current state of the production and figuring out major wastes. When all of these come to be clear, it is time to recommend improvements and set future goals with the aid of applying lean tools. In this chapter, the procedure of the data collection results from analysis and provide recommendations for improvement of the production will be discussed. Figure 1 shows that the interviews and the internal documentation were used within the lean thinking framework for specifying a value and identifying the value stream. The field observations look deeper into the value stream of scale production flow is useful to define the current value stream thus all the waste through the value stream will identify clearly. Using the gathered information from all data collection methods as the input for the value stream mapping method, filed observation at the production line. In order to answer the research questions, the following methodology is proposed.

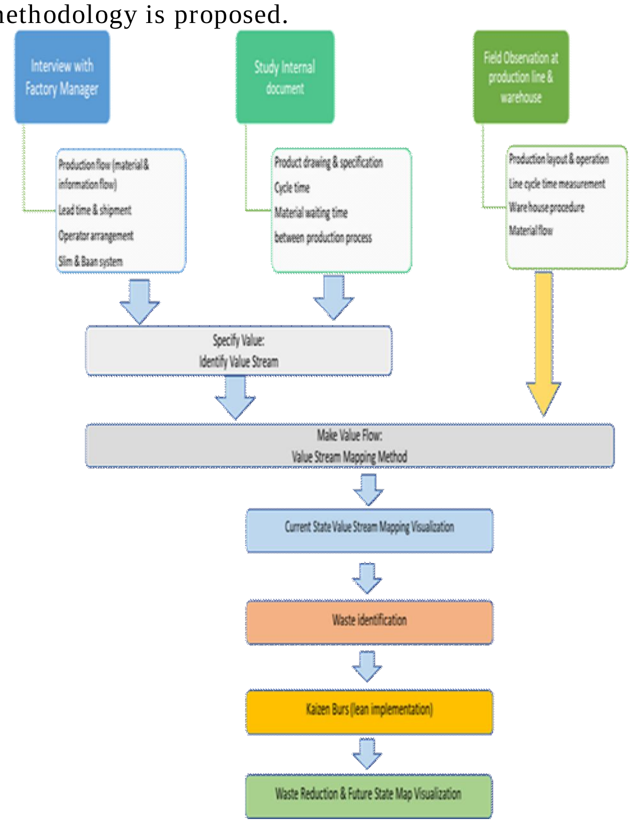


Figure 1: Research Methodology flow chart

The methodology consists of a combination of theoretical and empirical methods, which were applied within the lean thinking framework. The blocks diagram representing the data collection methods is made in the second layer. The boxes on the second layer data collection block show what kind of information was gathered in an interview and the internal scale factory documentation was used within the lean thinking framework for specifying a value and identifying the value stream. The field observations let us look deeper into the value stream of a Scale production line. Using the gathered information from all the data collection methods as the input for the value stream mapping method was constructed into the current value stream mapping (CVSM) in order to identify the wastes in the weighing scale production flow. Waste that is already identified will reduce by lean implementation using lean tools and a result of the lean implementation will describe the future state map visualization. Kaizen burs will visualize to identify the barrier of the flow then solution will be taken using lean tools implementation. As a result of the analysis, the solutions to reduce the influence of wastes were proposed and visualized in the draft of the future state map of the weighing scale production line, where the main principles of information and physical flow are shown.

2.2.1 SM-5300 Current State Value Stream Mapping

SM-5300 current state value stream map was demonstrated in figure 2. In that map, every process was shown into the small box. Cycle time, change over time, number of operators, number of shifts, production yield, reject rate is in the box. All the data and time were collected in accordance with recent pass data and cycle time is a period required to complete the task into one process. Timeline under the map which indicates the two-element, the first line shows the processing time and the second line shows the production lead time that spends during the production flow. Scale manufacturing companies give orders to the supplier by electronic information thru the MRP system. The supplier will produce and deliver PCBA to the factory for 5 days. After receiving, PCBA will keep on the store and distribute it to the PCBA section, line 5, kit line printer and mainline. PCBA section has 8 operators with WIP 545 pcs equal to 3.4 days.

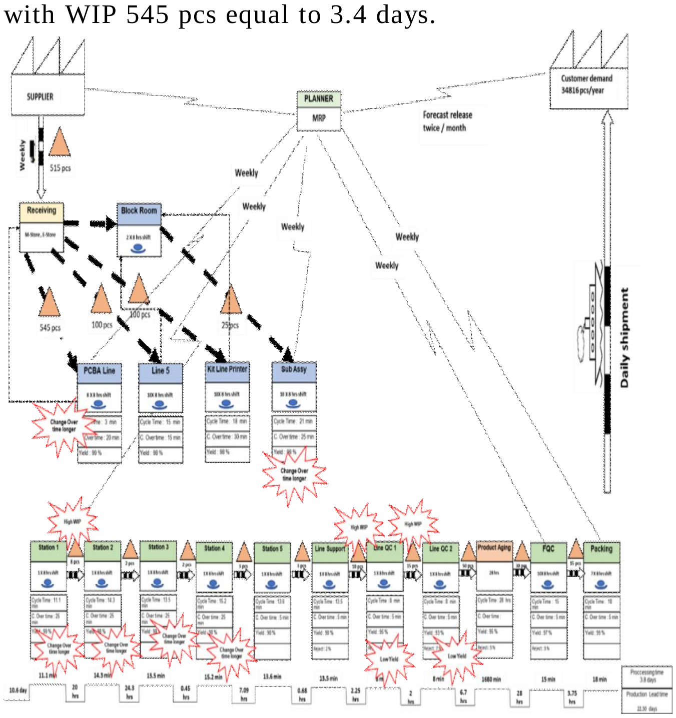


Figure 2: SM5300 Current state value stream map

Line 5 has 10 operators with WIP 100 pcs equal to 3.1 days, the kit line printer has 10 operators with WIP 100 pcs equal to 4 days, and mainline has 8 operators with WIP 25 pcs equal to 1 day. The product goes through the mainline which is station 4 is bottleneck 15.2 minutes and line QC is the lowest yield 93% due to assembly mistake. After mainline finish, the product will deliver to aging to perform a reliability test for 28 hours then go to the final QC to do functional check and visual inspection. Once finish the process the product will send to the packer to pack and ship by sea to the customer. The processing time is 3.8 days and the production lead time is 22.50 days.

2.2.2 SM-5300 Current State Value Stream Mapping Analysis

Current state map was analyzed and the following gap was identified for improvement:

1. High change over time duration occurs on the PCBA, Sub Assy kit line and mainline.
2. High WIP in mainline due (rework flow impact)
3. Low yield in line QC (Assembly mistake)
4. Unnecessary motion (operator)
5. Processing time 3.8 days and the total lead time is 22.50days, the aging process is the longest time due to all the product need to test to get high performance in the market.

2.2.2.1 Data Analysis.

Identified the wastes of SM-5300 flow by visualizing the current state value stream map. In the process of SM-5300 VSM, the following empirical methods were applied: interviews with management, the study of internal documentation and direct observations in the production line and warehouse. As a result of the application of the mentioned methodology, we were able to identify the problem following waste identification. Table 1 shows that there were 5 big issues on SM-5300 value stream flow in the factory that impacts a lot to the line efficiency.

Table 1: SM-5300 Waste identification

Kaizen Burs	Problem	Type of Waste
1	High change over time duration occur on the PCBA, Sub Assy kit line and main line.	WAITING
2	High WIP in main line due (rework flow impact)	INVENTORY
3	Low yield in line QC (Assembly mistake)	DEFECT
4	Unnecessary motion (operator)	MOTION

2.2.3 Improvement And Suggestion

All the waste and their influencer will be summarized on the action plan table. In order to be more focused on the implementation. from 4 types of waste there several action plans that need to be done to reduce and improve SM5300 current state value stream mapping.

2.2.4 Change Over Time Longer.

Base on the data collection average changing over time SM5300 is 23.33 minutes. To reduce change over time, the SMED concept needs to be performed.
There is 4 step method of SMED:

1. Document and separate into internal and external
2. Convert internal to external
3. Streamline internal and external
4. Eliminate adjustment and standardize

2.2.4.1 Step 1: Document And Separate Into Internal And External

All the events or steps of the process then define internal and external activity. Material handle activity will record start from taking part from trolley staging, transportation to the production line, distribute the part to each station and put back the trolley into the trolley staging area.

Table 2: Set up time table separate internal to external

SEQ #	Start Time	Event	Elapse Time	INT	EXT
1	0:00:00	Take part from staging (2 rack)	004:35		0:04:35
2	0:04:35	Put the trolley into the lift (2 rack)	0:03:30		0:03:30
3	0:08:05	Lift up the material (by Lift)	0:02:00		0:02:00
4	0:10:05	Take the trolley from lift (2 rack)	0:03:00		0:03:00
5	0:13:05	Bring the trolley to main line (2 rack)	0:06:23		0:06:23
6	0:19:28	Separate the part follow each station needed	0:25:40	0:25:40	
7	0:45:08	Put the part to the station	0:04:05	0:04:05	
8	0:49:13	Put Hi-Rack part to the station	0:06:33	0:06:33	
9	0:55:46	Put back empty carton to the trolley	0:04:00		0:04:00
10	0:59:46	Bring the trolley from main line to the lift	0:06:23		0:06:23
11	1:06:19	Lift bring down the empty trolley	0:02:00		0:02:00
12	1:08:19	Put the trolley to the staging area	0:04:35		0:04:35
		Total Time	1:12:44	0:36:18	0.36:26
		Saving			50%

Table 2 shows that Separate internal and external events from the total activity will get a 50% reduction from 1.12 hours to 36.26 minutes due to some activity tha can be performed external meaning that activity is no impact on production operation time.

2.2.4.2 Step 2 : Convert Internal And External Events.

To improve the current condition, a staging rack needs to change to become a 2 Rack Single point scheduling system. Figure 3 shows that 2 racks single point scheduling system basically is 2 bin systems are common on assembly and move on manufacturing lines where components are added to the product or item being built.

Figure 3: SM5300 Current state value stream map

The material handle will prepare material and full fill all the bin follows the SCM schedule from the planner. Figure 4 shows that 2 racks single point scheduling flow replenishment to supply production line. When the bin on the rack is full, material handles no need to replenish the part to production.

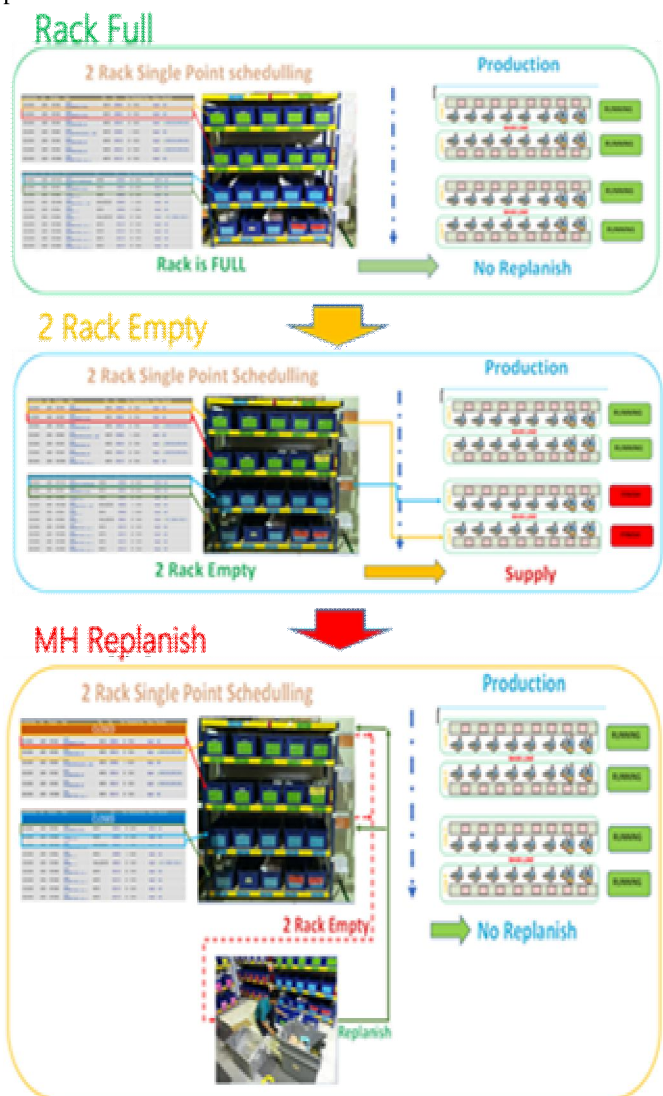


Figure 4: 2 rack single point scheduling flow system

Once production finishes 1 schedule, production will trigger the material handle to deliver the material for the next schedule. The part that already prepared will be arranged into the small bin with dedicated to each station, so the material handle just put to each station without disturbing the operator, operator no need to out of the station to support the material handle to segregate the material. By doing those actions, material preparation on the trolley was reduces become 1 trolley and material preparation time reduces 25.40 minutes from a total of 1.12 hours to 10.38 minutes, which is reduces 85% of change over time.

2.2.4.3 Step 3: Streamline Internal Event (simplify, reduce, eliminate, and external).

Step 3 was simplified the change over time step to get optimum time during perform production changing model. Table 3 shows that 2 racks single point scheduling system will eliminate step separate the part and follow each station because all the activity can do externally. The total set up reduction is 62.06 minutes or equal to 85.7 %.

Table 3: Set up time table separate internal to external

SEQ #	Event	Step 1	Step2,3& 4
1	Take part from staging (2 rack)	0:04:35	
2	Put the trolley into the lift (2 rack)	0:03:30	
3	Lift up the material (by Lift)	0:02:00	
4	Take the trolley from lift (2 rack)	0:03:00	
5	Bring the trolley to main line (2 rack)	0:06:23	
6	Put back empty carton to the trolley	0:04:00	
7	Bring the trolley from main line to the lift	0:06:23	
8	Lift bring down the empty trolley	0:02:00	
9	Put the trolley to the staging area	0:04:35	
10	Separate the part follow each station needed		0:25:40
11	Put the part to the station		
12	Put Hi-Rack part to the station		
13	Put back empty carton to the trolley		
14	Bring the trolley from main line to the lift		
15	Lift bring down the empty trolley		
16	Put the trolley to the staging area		
	SET UP REDUCTION BY STEP	0:36:26	0:25:40
	TOTAL SETUP REDUCTION (STEP1,2,3 & 4)	1:02:06	
	(BST) BEGINNING SETUP TIME	1:12:44	
	% SETUP REDUCTION	85.7%	

Table 4 shows that 2 racks single point scheduling system implementation will impact to cost-saving 4506.5 USD with the return of investment 0.05 year, equal to 1 month.

Table 4: SMED cost saving

No	Parameter	Description	Total Saving	Remarks
1	Number of setup/day	4		Change Model
2	Set up saving	62.06 min		
3	Setup time saving/year (Hrs)	(62.06 X 4 X 296)/60	1224.6 hrs	
4	Setup saving /year (USD)	1224.6 X 3.68 USD	4506.5 USD	Hourly Rate: 3.68 USD
		Investment		
1	Steel Rack	150 USD		
2	Play Wood	75 USD		
	Total	225 USD		
3	Return of investment		225/4506.5 USD	0.05 year (1month)

2.2.4.4 Step 4: Eliminate Adjustment Internal To Setup And Standardize

Elimination of adjustments and trial runs by turning intuition and guessing into facts and settings. In these steps, all the action will verify and standardization and fine-tune during implementation have to be confirmed to prove that all action plan is done and as per identification in step 1 until step 4. Adjustment and test run are normally due to Inaccurate bin use for each line and Inaccurate part inside the bin for each station.

2.2.5 High WIP In Main Line Due (Rework Flow Impact)

Rework flow is the cause of high WIP in the mainline. The product needs to return back to the mainline after a repair which is created WIP.

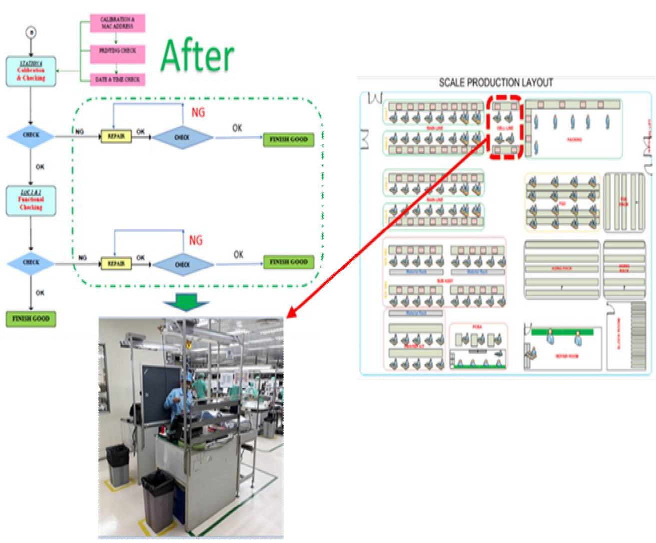


Figure 5: Product rework flow (after improvement)

Figure 5 shows that the defect flow needs to change to avoid non-conformity products back to the line and assign dedicated people to perform reassembly the nonconformity product from repair. Impact of dedicated people to do non-conformity products from repair, lay-out need to change by eliminate cell line & combine with line 5 to running the small quantity model. The benefit of process defect flow and layout optimization was reduced WIP 10 unit and reduce 2 operators with a total cost saving is 118,543 USD.

2.2.6 Defect (Assembly mistake)

Scale assembly mostly is human dependent, with an average cycle time of almost 15 minutes, the operator need fully concentrate during the assembly process. Since the defects occur mainly due to human errors. Figure 6 shows that the 6-month assembly mistake trend out of the target of 0.3 %.

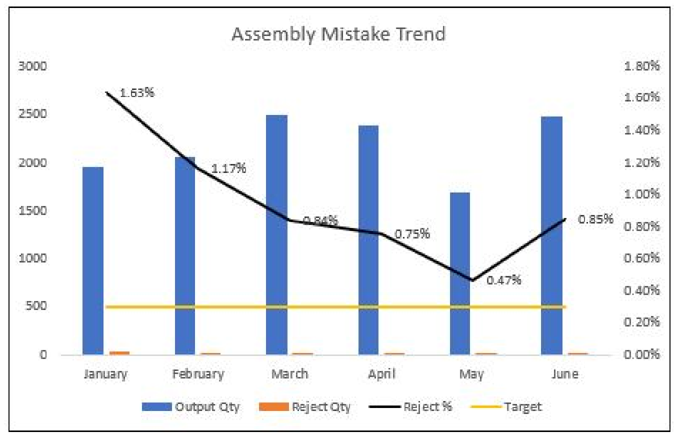


Figure 6: Assembly mistake trend chart

2.2.6.1 Pareto Chart

Figure 7 shows that breakdown of the assembly mistake data classification describes on the Pareto chart, the working mistake is high defect follow by connection fail and adjustment NG, take top 3 to define the root cause and analysis.

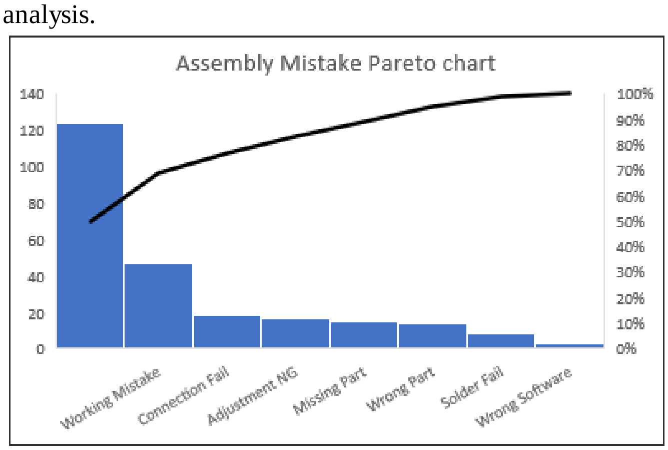


Figure 7: Assembly mistake Pareto chart

Table 5 shows that the assembly mistake action plan has been classified into 2 classifications which are Man and Method. There were 4 action plans that are going to implement to reduce the waste according to the analysis.

Table 5: Assembly mistake action plan list

Class	Sub Defect	Cause	Action
Man	New Operator	Training not proper	Training programme for new operator
Man	Operator lack of training	No regular training for operator	Conduct regular training for all operator
Method	No guidance	No Jig	Provide template jig
Method	Checking method	No Template	Provide connection template
		Check list not clear	Provide detail check list with picture

2.2.6.2 Solution 1 (New Operator and Operator Lack of Training).

To reduce assembly mistake there is 2 training program as follow:

1. New operator Training

Create a training program is a solution to educate the new operator before working into the production line. The new operator will be trained by trainer 3 days to approach 5S, Safety, and assembly actual product so that they will have a skill before start production. All training will review 1 month after training and record into the training record. Figure 8 shows that operator training both theory and practical conduct by training before work in production.

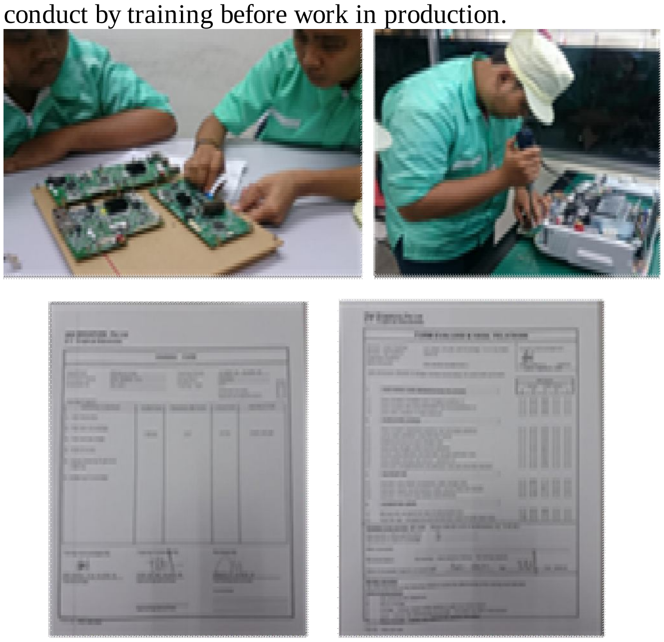
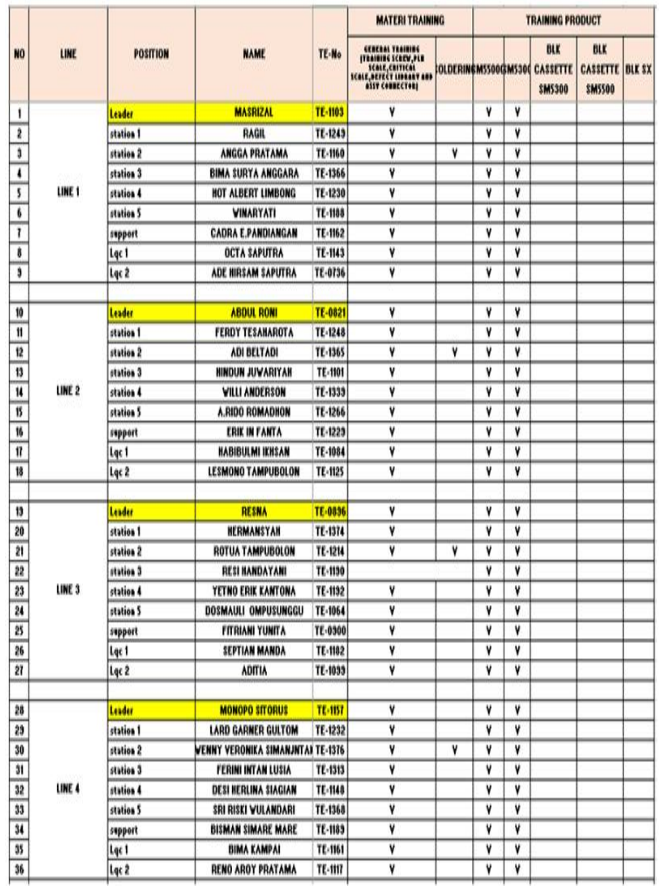


Figure 8: New operator training

2. Operator regular training

All operators will get regular training by the trainer to improve their skills and reduce assembly mistakes. Training will con-duct follow the product running in the line per station, meaning each operator will get more detailed training regarding the screwing process, checking method, 5S, etc. Training will conduct 2 times per week every Monday and Friday with a 1-hour duration. Figure 9 shows that operator training status will describe a matrix of operator skill to do the daily job.



NO	LINE	POSITION	NAME	TE-No	MATERI TRAINING: GENERAL TRAINING (TRAINING SCREW,PLB SCALE,CRITICAL SCALE,DEFECT LIBRARY AND ASSY CONNECTOR)	MATERI TRAINING: OLDERING	TRAINING PRODUCT: SM5500	TRAINING PRODUCT: SM530	TRAINING PRODUCT: BLK CASSETTE SM5300	TRAINING PRODUCT: BLK CASSETTE SM5500	TRAINING PRODUCT: BLK SX
1		Leader	MASRIZAL	TE-1103	V		V	V			
2		station 1	RAGIL	TE-1249	V		V	V			
3		station 2	ANGGA PRATAMA	TE-1160	V	V	V	V			
4		station 3	BIMA SURYA ANGGARA	TE-1366	V		V	V			
5	LINE 1	station 4	HOT ALBERT LIMBONG	TE-1230	V		V	V			
6		station 5	WINARYATI	TE-1188	V		V	V			
7		support	CADRA E.PANDIANGAN	TE-1162	V		V	V			
8		Lqc 1	OCTA SAPUTRA	TE-1143	V		V	V			
9		Lqc 2	ADE HIRSAM SAPUTRA	TE-0736	V		V	V			
10		Leader	ABDUL RONI	TE-0821	V		V	V			
11		station 1	FERDY TESAHAROTA	TE-1248	V		V	V			
12		station 2	ADI BELTADI	TE-1365	V	V	V	V			
13		station 3	HINDUN JUWARIYAH	TE-1101	V		V	V			
14	LINE 2	station 4	WILLI ANDERSON	TE-1339	V		V	V			
15		station 5	A.RIDO ROMADHON	TE-1266	V		V	V			
16		support	ERIK IN FANTA	TE-1229	V		V	V			
17		Lqc 1	HABIBULMI IKHSAN	TE-1084	V		V	V			
18		Lqc 2	LESMONO TAMPUBOLON	TE-1125	V		V	V			
19		Leader	RESNA	TE-0836	V		V	V			
20		station 1	HERMANSYAH	TE-1374	V		V	V			
21		station 2	ROTUA TAMPUBOLON	TE-1214	V	V	V	V			
22		station 3	RESI HANDAYANI	TE-1190			V	V			
23	LINE 3	station 4	YETNO ERIK KANTONA	TE-1192	V		V	V			
24		station 5	DOSMAULI OMPUSUNGGU	TE-1064	V		V	V			
25		support	FITRIANI YUNITA	TE-0900	V		V	V			
26		Lqc 1	SEPTIAN MANDA	TE-1102	V		V	V			
27		Lqc 2	ADITIA	TE-1099	V		V	V			
28		Leader	MONOPO SITORUS	TE-1157	V		V	V			
29		station 1	LARD GARNER GULTOM	TE-1232	V		V	V			
30		station 2	WENNY VERONIKA SIMANJNTAI	TE-1376	V	V	V	V			
31		station 3	FERINI INTAN LUSIA	TE-1313	V		V	V			
32	LINE 4	station 4	DESI HERLINA SIAGIAN	TE-1148	V		V	V			
33		station 5	SRI RISKI WULANDARI	TE-1368	V		V	V			
34		support	BISMAN SIMARE MARE	TE-1189	V		V	V			
35		Lqc 1	BIMA KAMPAI	TE-1161	V		V	V			
36		Lqc 2	RENO AROY PRATAMA	TE-1117	V		V	V			

Figure 9: Operator training status

2.2.6.3 Solution 2 (Next Station Checking Previous Station Job)

Implementation of the next station checking previous station job is a checking method to confirm the previous station is doing correctly before pass to the next station. By doing this method operators have the responsibility to guaranty their working results to reduce assembly mistakes. The checking method is used marking to check all the steps from the previous station. By using a checking step picture to guide the operator during checking and also provide judgment criteria if the operator found any unconformity during checking the product. Figure 10 shows that guidance for the operator during checking the product.

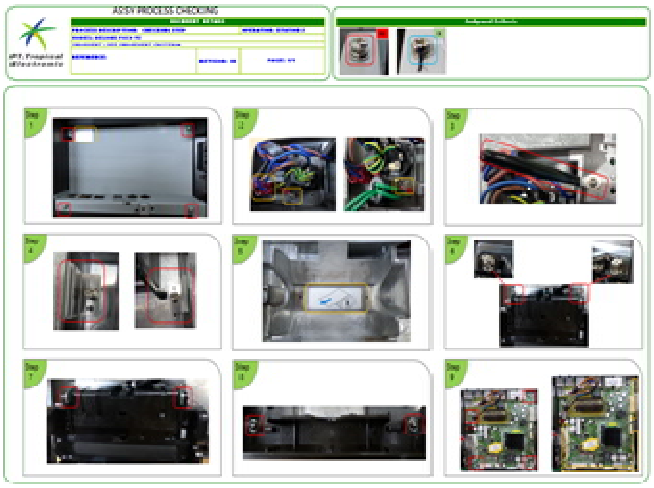


Figure 10: Process step checking template

2.2.6.4 Solution 3 (Connection Template)

Many assembly mistakes were found due to the connector not connect properly. During assembly operator difficult to differentiate NG condition because of the only plugin but actually, after the functional test found connection NG. Figure 11 shows that the connection template to check the assembly connection in the correct position. Connection template is helpful for the operator during assembly product, they can justify using the template and put marking before pass to the next station.

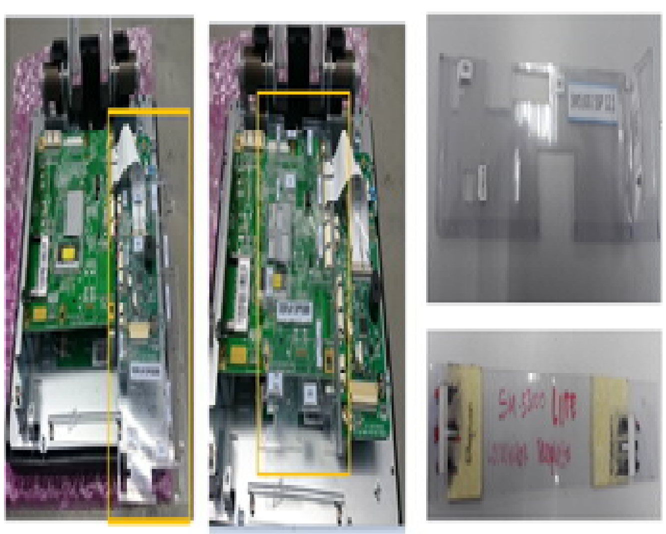


Figure 11: Connector checking template

2.2.6.5 Solution 4 (Label Pasting Template)

Assembly mistake occurs during paste the label mostly the problem is label slant, label reverse, and label missing. In order to solve the issue, the label template was created as a guide to the operator during pasting the label. Figure 12 shows that the label template to avoid slanting and missing.

Figure 12: Label checking template

2.2.6.7 Solution 5 (Defect library system)

The defect library system is a system to remain operator of the previous defect that need to take care during running production. The defect library contains all the defects that occur in the previous month. In the defect library system can find why the issue is occurring and what the action is already taken to solve the issue. The defect library will be explained by the line leader to the operator before start working and during the changing model to remainder thus operator aware of what the defect already occurs in the past. The defect library can use as training material for new operators. Figure 13 shows that the defect library with the complete picture so easy for the operator to understand.

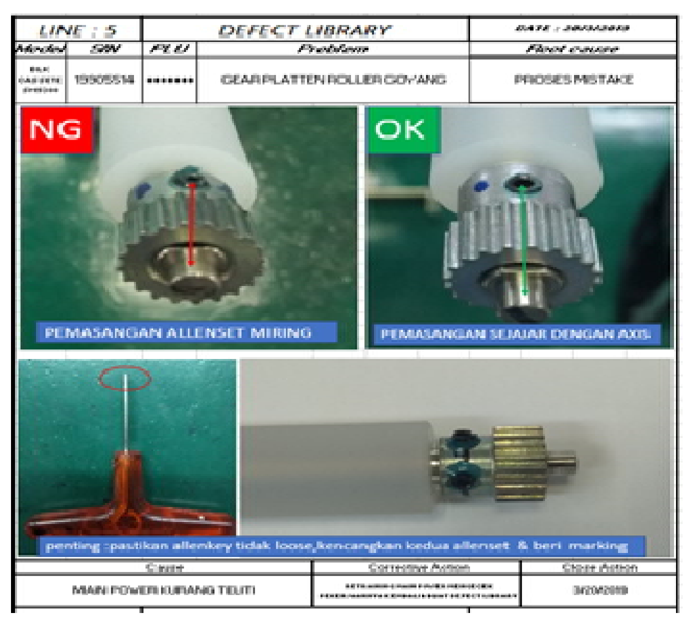


Figure 13: Defect library system

3. RESULT AND DISCUSSION

After doing the action plan, the assembly mistake percentage was getting lower form December onward. The average assembly mistake percentage in 2019 is 0.25 %. Figure 14 shows that the assembly mistake percentage trend maintains below 0.3 % in 2019 reaches below the target 0.3 %.

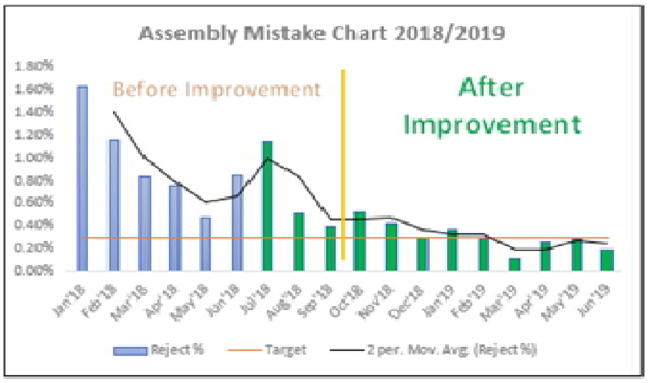


Figure 14: Assembly mistake improvement result chart

3.1 Future State Value Stream Map (FSVSM)

The future state map is the map that shows the future of the organization after implementing lean tools. There are multiple changes that can improve production in different ways, these changes are presented along with the possible effect on the production..

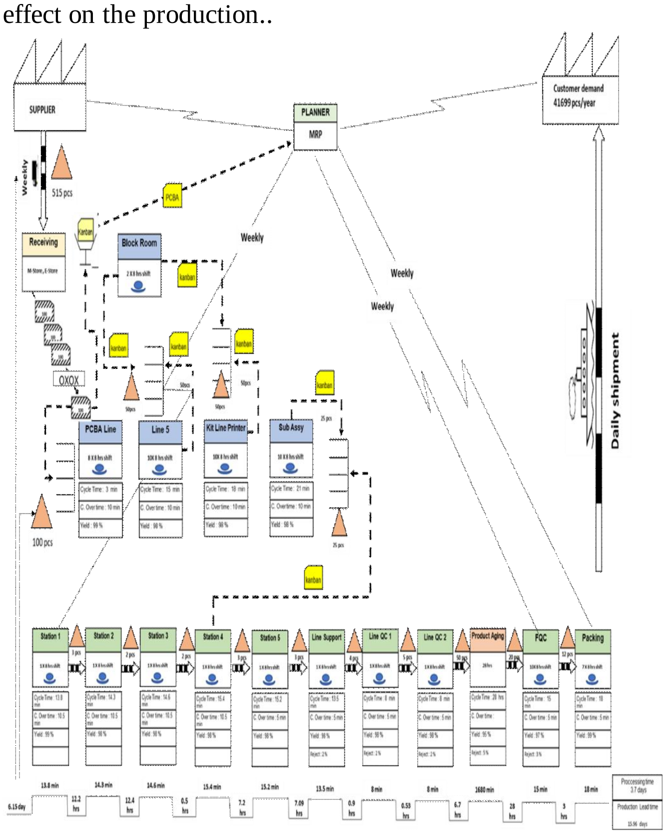


Figure 15: SM5300 Future state value stream map

After analyzing the current state map of SM5300 has been found that material WIP inventory takes a long time. Receiving and PCBA day of inventory is 10.6 days, line 5 inventory is 20 hours equal to 2.5 days, and the kit line printer is 24.3 hours equal to 3 days. The future state VSM that was used for improving the production can be seen in Figure 15 show that the main improvements from the current state are the implementation supermarket and Kanban system

Implementation pull method instead of push method and supermarket for PCBA board. The store will implement Kanban arriving in batch 100 pcs to PCBA then will trigger pull to the planner to release the schedule base on PCBA batch in the supermarket. By doing these actions, days of inventory was reduced to 6.15 days. Line 5 and printer kit line block assembly has consolidated in the block room after produce. To reduce WIP in line 5 and the kit line printer, The Kanban system has been implemented. Figure 16 shows that Kanban flow from line 5 and kit line printer to the block room, after finish produces in the production, the part will deliver to the block room by using PDA scanner display for the transaction to make sure the quantity is correct. Supermarket quantity control WIP is 50 units equal to 2 days production schedule. If 1 schedule is finished, the planner will release the next batch to full fill the Kanban rack. WIP in line 5 was reduced 12.4 hours equal to 1.6 days and kit line printer WIP reduce to 1.6 days.

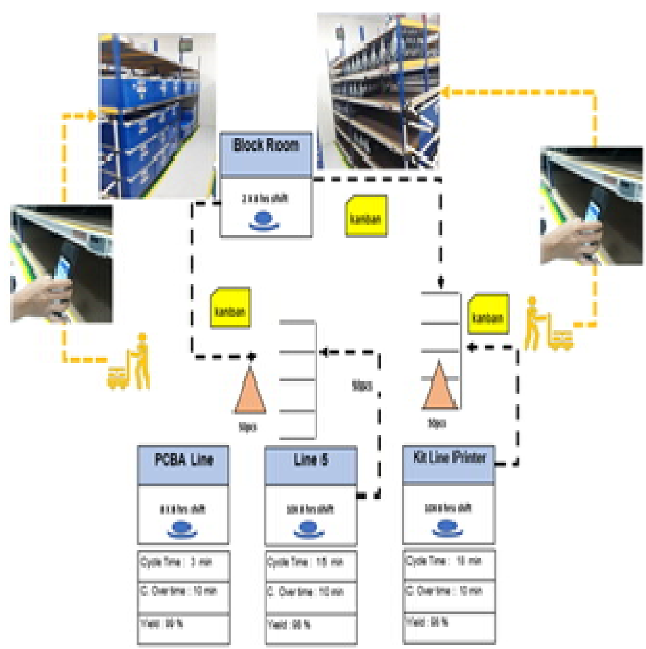


Figure 16: Kanban Flow to Block Room

All the action plan improvement was impacted to reduce change over time by 85.7 %, reduce 2 operators, production out-put increase with potential cost-saving 830 K USD, assembly mistake reduces to 0.25 % in the year 2019. All the results will be reflected in the future state map, material replenishment will improve to reduce processing time 2.6 %, and production lead time reduce 29.06 %.

Table 6: Result comparison current & future state VSM

No	Parameter	Current state	Future state	Improvement
1	Processing time	3.8 days	3.7 days	2.6 %
2	Change Over time	25 min	10 min	60 %
3	Yield	94 %	98 %	4.2 %
4	Work in progress (WIP)	1423 pcs	844 pcs	40.6 %
5	Production Lead Time	22.50 days	15.96 days	29.06 %

The following conclusions are drawn from the case study. It has been found that after implementation as shown by table 6 and figure 17 that overall lead time was reduce from 22,5 days to 15.96 days equal to 29.06 %, figure 15 shows that processing time reduce from 3.8 days to 3.7 days equal to 2.6%. change over time reduction of 6 0% and yield improve to 98% increase 4.2%.

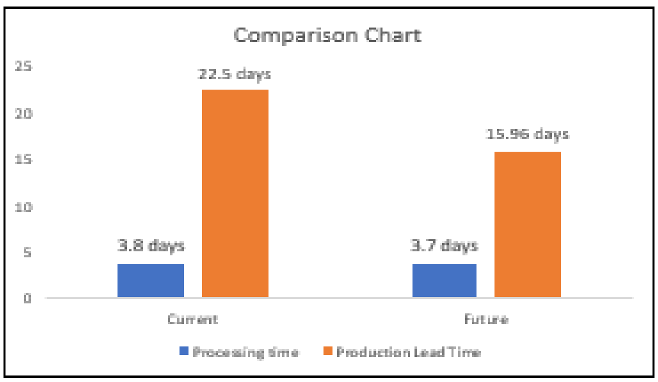


Figure 17: Production lead time improvement

4. CONCLUSION

Value stream map (VSM) methodology was power full to improve productivity and identify waste through value stream flow. Identification kaizen blitz in the current state value stream is very important to define an action plan that needs to be taken to reduce waste through the value stream. Waiting, inventory, defect, and motion have been identifying to reduce the waste on SM5300 production line. In order to reduce the waste, there were some actions to be done such as modify the Baan system, SMED, Re-layout, line balancing, line management and operator training. SMED can be adopted not only for automatic assembly but can be applied to the manual assembly as well.

ACKNOWLEDGEMENT

The authors are very grateful to Universiti Tun Hussein Onn Malaysia for support and encouragement in publishing this research.

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