

Optimization Production Process with VSM and Line Balancing on Glove Manufacture

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Abstract. PT. XYZ is glove manufacture in Indonesia which use push system as their primary production system. This paper will focus to analyse production system in PT. XYZ and propose the improvement production system to increase their productivity. This study focusing to reduce lead time and WIP in the production area. Identification of waste start from create the current state map, and then analyse the waste into 7 waste categories then propose the new design of the production layout. The variables observed in this research are cycle time, VSM, and production layout. By analyse these indicators, the researcher found that there are several causes of the waste in the production floor. After mapping the operation chart, relay out and improve the line balancing. The researcher found that in garment industry, relay out has bigger impact to reduce the lead time than eliminate the motion. Because eliminate motion need more skill and investment in automatic process in garment industry.

Keywords: Optimization, VSM, takt time, 7 waste, Line balancing, cycle time

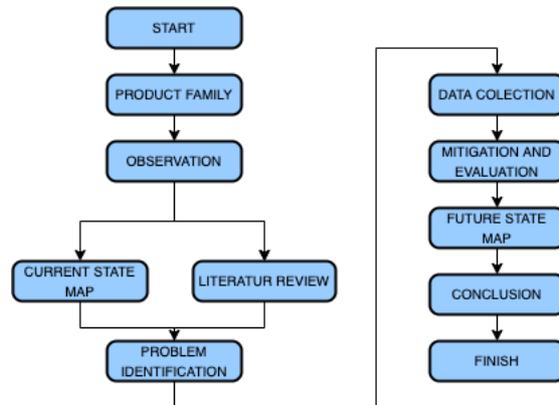
7. Introduction

Lean manufacturing is a philosophy that Toyota developed in the 1950s to compete with the US automotive giants. The aim was to minimize excess or non-value added. Lead time is the key point for manufacture to execute global market demand. Every manufacture has a propose to maintain process and reduce cost in production process. [1] Most of manufacturing are struggling to decide the perfect production system that suitable for their product and condition. many consideration that influences the production process, such as tooling, skill, layout, and method. Sustainable manufacturing involves not only the making of more sustainable product but also using more sustainable process to produce those products. The major purposes of the use of lean production are to increase productivity, improve product quality, reduce inventory, reduce lead time, and eliminate manufacturing waste or non-value-added activities [2].

Establish in June 2012, PT. XYZ is glove manufacturing in Semarang Indonesia with more than 3000 employees. Using push system and progressive bundle system as current production method provide some issue on their customers. Long production lead time, less production elasticity, and unable ability to produce small quantity is costumer's feedback. From the internal employee feedback, huge WIP, and long distance is their common issue.

To support company mission, this paper will provide information about problem, mitigation, and suggestion to reduce the production lead time in the production floor. In the production process, PT. XYZ processes customer PO with a progressive bundle system. In a progressive bundle system, each operator performs a different garment operation. All the sewing machines needed to make a garment are laid out in one line. The cut parts are feed in the form of a bundle. When an operator receives a bundle of truncated components, it opens the bundle and performs its operations (jobs) for all parts of the bundle. After finishing his work, he moves the bundle to the next operator who performs the next operation.

8. Methods



Starts from analyse the product by classified the product family to determine product type that will be observed. After product family being classified, observe current production system by do gemba in production floor to collect information flow, material flow, lead time, & processing time. After the information are collected, create current state map to understand current production situation. After analysing the current state map and identification the problem base on literature review, do Gemba in the production floor to collect cycle time, Inventory, and operation chart data that related with production process.

Next step is classified the process in two categories, Value added (VA) & Non-Value Added (NVA). Identified and mitigate the waste in production process and propose recommended action to reduce production lead time. Create future state map and new layout to improve the current production process. After the improvement plan are create make a conclusion for the new production process

9. Result and Discussion

3.1 Product Family

Product family is a group of products that has similar processing step and machine in manufacturing the product. Because PT. XYZ is produce several unique products, therefore the classify product as listed in Table 1

Table 1. Product Family

	Warehouse	Cutting	Distribution	Sewing	Packing	Stuffing
Sport glove	√	√	√	√	√	√
Industrial glove	√	√	√	√	√	√
Dress glove	√	√	√	√	√	√

From the Table 1, all the product has the same process. The different of the product is on the element of process. In cutting area, panel quantity of each product is different. In distribution, each product has different printing process and accessories. In sewing area, each product has different machine and sewing methods. But most of that, in packing and stuffing area has the same elements.

3.2 Current State Map

A value stream is a collection of all the data pertaining to the production process activities, that is, value adding, non-value adding and identifying the wastes such as inventory, over-production, defects, waiting time, motion, transportation, over processing and eliminating the waste. [4] Current state map is a tool that helps us to understand current condition of production process and identified the process improvement for the future state map. VSM consists of two types, namely the current state map and the future state map. The current state map describes the entire process before the repair is carried out, while the future state map describes the entire process after repairs are made [5]

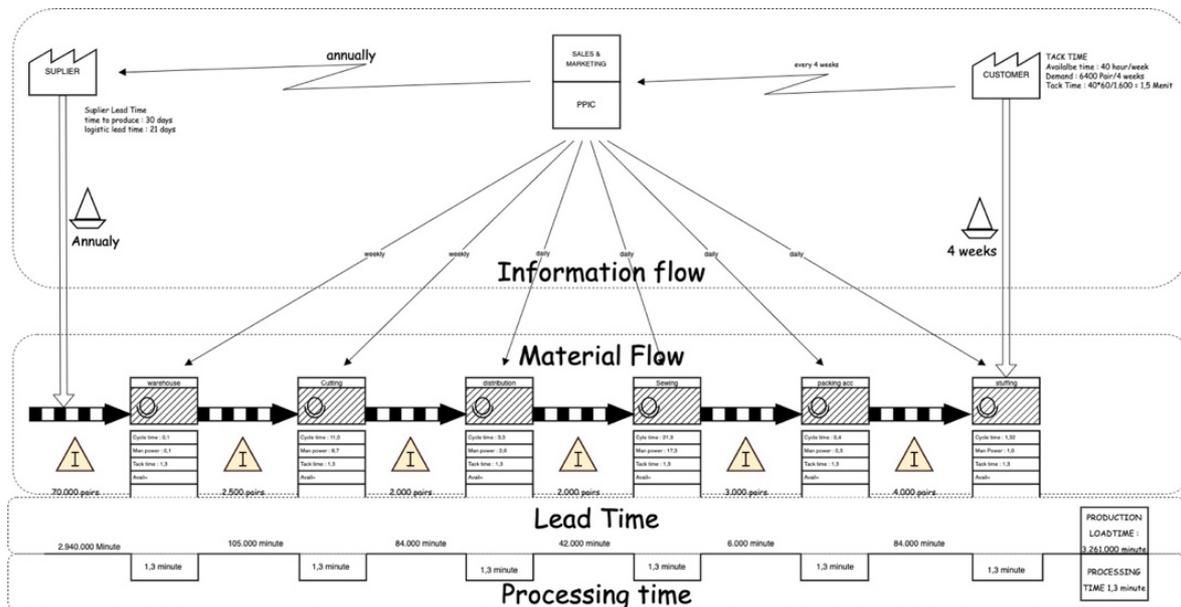


Figure 1. current state map

In the current state map, there is 4 important information. First is information flow. Information flow is information about customer demand until this information received by the factory, and how factory delivered this information to each process in production flow. Second is material flow. Material flow is how factory handling their material movement from raw material until finish product. Third is lead time. Lead time is how long factory need to execute the customer demand from the raw material until finish product. The fourth is process time. Process time is total time that factory need to finish the complete process to produce the goods.

Figure 1 shows that Factory dedicated 29 workers to produce this product. With processing time was 38 minute/pair/worker, and available time was 40 hours/week, factory could produce 6.628 pairs per month. It closes to customer demand with 6.400 pair/month. But factory has a huge inventory level in each process.

3.3 Current State Map Analysis

Time study is the most widely method that used to determine standard time. It is a technique of establishing an allowed time standard to perform a given task, based upon measurement of work content of the prescribed method, with due allowance for fatigue and personal and unavoidable delays [3] Calculating the manufacturing lead time of the production process is done by adding all the standard Time for each activity [6]. The identification of value and the definition of value propositions for specific customers is the starting point [7]. Understanding customer value. Only what the customers perceive as value is important [8]. Determine the process of each workstation and classified the activity into value added (VA) & Non-Value Added (NVA) in Table 2. This activity to identify waste in production process.

Table 2. VA & NVA

Workstation	Process Number	Cycle Time (Minute)	Category
Warehouse	Material preparation	0,04	NVA
Warehouse	Move raw material from warehouse to cutting	0,02	NVA
Cutting	Cutting index finger gusset	0,1	VA
Cutting	Bundling (C-1)	1,5	NVA
Workstation	Process Number	Cycle Time	Category
Cutting	Move Panel C-1 to setting	0,2	NVA

Cutting	Cutting middle finger gusset (C-2)	0,2	VA
Cutting	Bundling (C-2)	1,5	NVA
Cutting	Move panel C-2 to setting	0,2	NVA
Cutting	Cutting ring finger gusset (C-3)	0,14	NVA
Cutting	Bundling C-3	1,5	NVA
Cutting	Move panel C-3 to setting	0,02	NVA
Cutting	Cutting pinkie finger gusset (C-4)	0,14	VA
Cutting	Bundling C-4	1,5	NVA
Cutting	Move Panel C-4 to setting	0,02	NVA
Cutting	Cutting bottom finger gusset (C-5)	0,40	VA
Cutting	Bundling C-5	1,5	NVA
Cutting	Move panel C-5 to setting	0,02	NVA
Cutting	Cutting label	0,13	VA
Cutting	Bundling label	1,5	NVA
Cutting	Move label to setting	0,02	NVA
Cutting	Setting process	0,02	VA
Cutting	QC panel	0,78	VA
Cutting	Move bundle to distribution	0,02	NVA
Distribution	Cutting wrist elastic	0,46	VA
Distribution	Stitch label and size label	0,67	VA
Distribution	Hot press logo on body back small press	0,45	VA
Distribution	Hot Press logo on body back big press	0,57	VA
Distribution	Deboss logo on wrist	0,92	VA
Distribution	QC logo	0,27	VA
Sewing	Stitch index finger palm to body palm	0,37	VA
Sewing	Stitch thumb palm 1 to body palm	0,36	VA
Sewing	Stitch thumb palm to thumb back	0,37	VA
Sewing	Stitch top finger gusset and bottom finger gusset	0,35	VA
Sewing	Stich finger gusset to body back	0,63	VA
Sewing	Stitch body back to body palm	2,64	VA
Sewing	Stitch wrist to body	2,57	VA
Sewing	Stitch finger gusset to body palm	2,71	VA
Sewing	Stitch overlock around wrist	3,2	VA
Sewing	trimming	0,64	VA
Sewing	Stitch label to body	0,33	VA
Sewing	top stitch side seam	2,41	VA
Sewing	Stitch label	2,66	VA
Sewing	Ironing	0,78	VA
Sewing	QC Visual	0,53	VA
Sewing	Measuring	0,47	VA
Sewing	Production code stamping	0,14	NVA
Packing accessories	Metal detector process	0,07	NVA
Packing accessories	Clean the leaflet	0,14	NVA
Packing accessories	Insert glove to polybag	0,15	VA
Packing accessories	Scan barcode	0,40	VA
Stuffing	Metal detector process	0,07	NVA
Stuffing	Carton preparation	0,8	NVA
Stuffing	Insert glove to carton	0,08	VA
Stuffing	Seal the carton an attach SHU sticker	0,06	VA

Table 2 show that the total of Value-Added Time (VA) is 27,8 minute and total Non-Value-Added Time (NVA) is 10,3 minutes. Figure 3 shows the comparison between both of them. Where Non-Value-added Time takes 27% of total time to produce the product. This figure show there is opportunity to improve the Non Added Value (NVA) activity become Added Value (AV) activity.

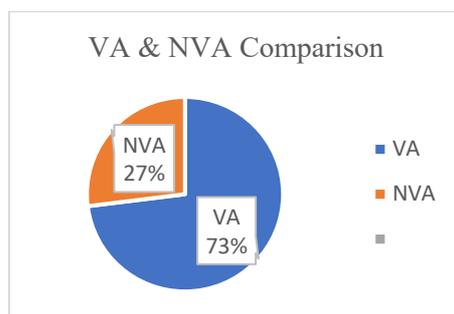


Figure 3. VA & NVA Comparison

3.4 Waste Analysis

According to lean manufacturing principles, the cause 7 Waste is: overproduction, inventory, waiting, motion, defects (reworks), overprocessing, transportation. To make the process more efficient and more productive, identification waste in production process is needed as below:

Over production: With dedicated 29 workers for this product, factory can produce 6,628 pairs/month, it is close with customer demand (6.400 pair/month). this factory doesn't have too much over production. **Waiting Time:** In this process there is no waiting time. **Transportation:** Takes 30 minute to move after bundling process to setting process because distance of the cutting machine to setting table is move from one to another building. **Packing accessories process** is 5 meters from sewing process.

Overprocessing. Workstation Process Number Cycle Time (Minute) Category [9] There is 5 layer of quality check point. Start from after cutting, logo, end line QC, visual and measurement. Compare to customer requirement that only need 2-layer quality process. After cutting and end line QC.

There is twice metal detector process. Where customer only require one time metal detector process before stuffing.

Inventory, because factory buy the raw material annually, impact to big inventory level on the warehouse and each process.

Motion, combine cutting panel process and bundling process is possible. Because there is idle time of operator during cutting machine operated.

Defect, there was no defect issue in this production process since defect rate target was 3% and the achievement was achieved at 1%.

3.5 Root Cause Analysis & Recommended Action

Next step is to analyse the root cause of waste that found in Table 3:

Table 3 Root Cause Analysis

Waste Category	Waste Found	Root cause	Recommended action
Transportation	Takes 30 minute to deliver after cutting to setting process	Each process has different building cause distance of each process is very long	Change the layout into small group of production to reduce transportation lead time
Overprocessing	There is process cleaning leaflet in packing accessories	Some leaflet found dirty because storage is not covering	provide storage for leaflet in sewing area to keep in clean
Waste Category	Waste Found	Root cause	Recommended action

overprocessing	There is 5 layer of quality check point where the customer only requires 2 check point	Each quality check has different part to check	Combine process of checking point to reduce the process and motion
motion	There is idle time on cutting process.	While the machine start, the operator is wait 15-25 second to complete process	Combine process cutting and bundling process to reduce the cycle time
Overprocessing	There is two metal detector process	Packing is free metal zone. There is requirement to do metal detector test before the goods enter the area	Move packing accessories proses to sewing area and use only one metal detector
Inventory	There is huge amount of Work In process in warehouse and others area	Takes 7 week for supplier to produce the raw material and need 4 weeks for factory to produce the finish good, but factory decide to purchase the material annually	Use supermarket to decrease the inventory on warehouse

Transportation, overprocessing, motion, and inventory were the waste that found after analysing the production process and do Gemba walk in the production floor. The improvement process appears in future state map and cycle time as listed in Table 4.

Table 4. VA & NVA after improvement

Workstation	Process Number	Cycle Time (Minute)	Category
Warehouse	Material preparation	0,04	NVA
Warehouse	Move raw material from warehouse to cutting	0,02	NVA
Cutting	Cutting index finger gusset	0,1	VA
Cutting	Move Panel C-1 to setting	0,2	NVA
Cutting	Cutting middle finger gusset (C-2)	0,2	VA
Cutting	Move panel C-2 to setting	0,2	NVA
Cutting	Cutting ring finger gusset (C-3)	0,14	NVA
Cutting	Move panel C-3 to setting	0,02	NVA
Cutting	Cutting pinkie finger gusset (C-4)	0,14	VA
Cutting	Move Panel C-4 to setting	0,02	NVA
Cutting	Cutting bottom finger gusset (C-5)	0,40	VA
Cutting	Move panel C-5 to setting	0,02	NVA
Cutting	Cutting label	0,13	VA
Cutting	Move label to setting	0,02	NVA
Cutting	Setting process	0,02	VA
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Workstation	Process Number	Cycle Time (Minute)	Category
Cutting	Move bundle to distribution	0,02	NVA
Distribution	Cutting wrist elastic	0,46	VA
Distribution	Stitch label and size label	0,67	VA
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Distribution	Hot Press logo on body back big press	0,57	VA
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Sewing	Stitch index finger palm to body palm	0,37	VA
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Sewing	Stich finger gusset to body back	0,63	VA
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Sewing	Stitch finger gusset to body palm	2,71	VA
Sewing	Stitch overlocks around wrist	3,2	VA
Sewing	trimming	0,64	VA
Sewing	Stitch label to body	0,33	VA
Sewing	top stitch side seam	2,41	VA
Sewing	Stitch label	2,66	VA
Sewing	End QC	0,76	VA
Sewing	Ironing	0,78	VA
Sewing	Measuring	0,47	VA
Sewing	Production code stamping	0,14	NVA
Packing accessories	Insert glove to polybag	0,15	VA
Packing accessories	Scan barcode	0,40	VA
Stuffing	Metal detector process	0,07	NVA
Stuffing	Carton preparation	0,8	NVA
Stuffing	Insert glove to carton	0,08	VA
Stuffing	Seal the carton an attach SHU sticker	0,06	VA

Cycle time after improvement reduce 26% (10 minute) compared to the previous cycle time. This result impacts to the number of operators where previous operator had 38 workers, with the new process, number of workers become 19 operators (reduced by 50%) with the same output.

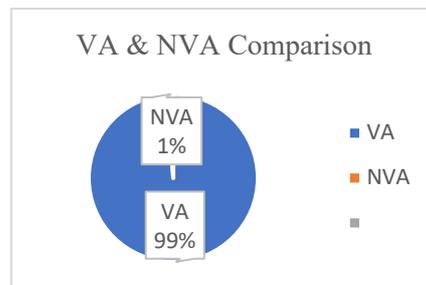


Figure 4. VA & NVA Comparison

Reducing bundling process, transportation from cutting to setting, and change the layout of packing accessories from stuffing to sewing process, impact to the amount of non-added value process from 27% become 1%.

Figure 5 shows the future state maps according to previous analysis.

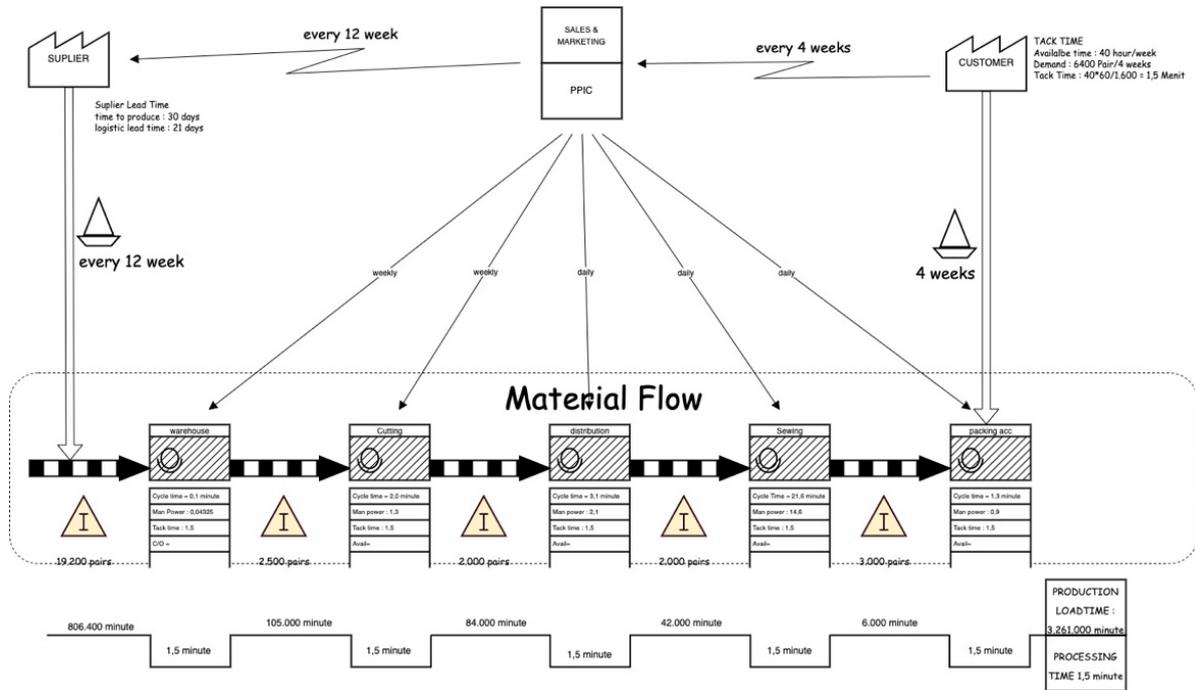


Figure 5. Future State Map

Change the supply method from annually to quarterly, impact to the number of inventories in production work in process (WIP). Figure 6 shows the before and proposed layout by combining sewing process and packing accessories process impact to the number of inventory and number of operator as well. Because there is no double metal detector process before stuffing process.

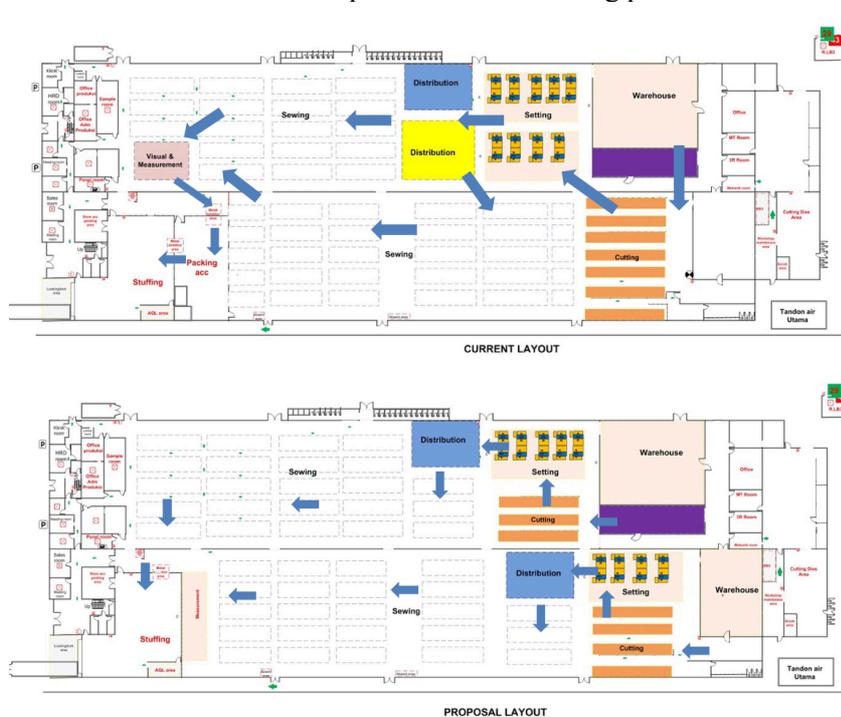


Figure 6. Before and Proposal Layout

Before, all process centralizes in one place, where there is huge WIP in each process and transportation lead time is quite long. The motion of worker is a lot because the workers should move the goods from one building to another building. And back again to the previous building.

The new layout makes each building has their own production process. Small inventory in each process and short transportation will impact to the productivity. Move the packing accessories process to the sewing process will impact to the reducing metal detector process and increasing number of sewing lines.

10. Conclusion

From this research we found that eliminating non-value-added activity and relay out by analysing the waste in production system can reduce the cycle time of production. before the cycle time was achieved at 38 minutes but with the new system, the cycle time becomes 28 minutes. Because the takt time of production has meet with customer demand, reducing the lead time impact to the number of workers. Before the number or worker was 30 people, with the new production system can be reduced with 19 workers only. By reducing 11 workers impact to the production cost. With the supermarket, inventory in production process becomes more efficient. Because the number of purchase material decreases and increases the space of production and warehouse. This paper contributes to the factory by reducing the leatime, manpower, and also increase the factory space. This paper also contributes to the academic where this topic as one of the requirements for graduation.

11. Reference

- [1] M Mohan Prasad, et al 2020 *A framework for lean manufacturing implementation in Indian textile industry*, India 1
- [2] Lijalem Mulugeta, 2020 *Productivity improvement through lean manufacturing tools in Ethiopian garment manufacturing company*. Ethiopia 1
- [3] Lusiana Permata Sari Hartanti 2016 *Work Measurement Approach to Determine Standard Time in Assembly Line*. 2 10 192
- [4] Suman Kundgol, Praveenkumar Petkar, V N Gaitonde 2020 *Implementation of value stream mapping (VSM) upgrading process and productivity in aerospace manufacturing industry*. 1
- [5] Bambang Suhardi 2020 *Implementation of value stream mapping to reduce waste in a textile products industry*. 3
- [6] Muhammad I A, Nina A M, 2022 *Integrating Lean Implementation and Relayout Design for Efficiency Improvement*. 21 248
- [7] Melton T, 2005, THE BENEFITS OF LEAN MANUFACTURING What Lean Thinking has to Offer the Process Industries, 665
- [8] Anvari Alireza, Hojjati S M H, Ismail Md Yusof, 2011, A Study on Total Quality Management and Lean Manufacturing: Through Lean Thinking Approach, 1588
- [9] Taylor David, Professor Hines Peter, 2000 Going Lean, 29