International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

Improve Productivity and Quality Using Value Stream Mapping Method. A Case Study in LED Bulbs Factory

Le Thien Quoc[1], Minh Ly Duc[2,*]
[1]*HCMC University of Technology and Education, Faculty for High-Quality Training, Department of Industrial Management, Ho Chi Minh City, Vietnam*
[2]*Faculty of Commerce, Van Lang University, Ho Chi Minh City, Vietnam*

***Abstract*— The business environment for businesses is expanding, and at the same time, competition is also increasing. This creates opportunities for businesses to grow, while also containing challenges that threaten businesses. This research paper proposes to use the Value Stream Mapping (VSM) method in the LED bulb manufacturing process to analyze, improve, and enhance the productivity and quality of LED bulbs. The results of the study showed that productivity increased by 5% (the cycle time of the light testing process went from 15 seconds to 4.85 seconds) and the defect ratio decreased from 3% per month to 0.5% per month. This research model can be used in different industries to improve business efficiency.**
***Keywords*—Productivity, Quality, LED bulb, Value Stream Mapping, VSM.**

INTRODUCTION

In Vietnam, the lighting market has many development prospects. According to data from market research group IMARC Group, Vietnam's LED lighting market will reach 647.6 million USD by 2022, and is expected to reach 647.6 million USD in 2022. increasing to reach 982.8 million USD in 2028, the growth rate (CAGR) is 7% in the period 2023–2028.

Dien Quang Lamp Joint Stock Company is a company that produces and sells products and services related to the field of lighting and electrical equipment in Vietnam. The company was established in 1971 and has become a famous brand in the production of domestic lighting equipment with more than 40 years of experience and a nationwide presence.

LED lighting production in Vietnam has grown strongly in recent years, attracting many domestic and foreign companies to invest in this industry, and creating a large number of high-quality and diverse LED lights. The Vietnam-European Union Free Trade Agreement (EVFTA) was signed and applied for on August 1, 2020, EVFTA has opened up opportunities to export Vietnam's LED lights to Union member countries. Europe. This agreement reduces import taxes and creates fair conditions for accessing the European market for Vietnamese LED products, Along with ASEAN agreements and the agreement establishing the Association of Southeast Asian Nations. (RCEP) has helped the LED lamp export market become more open and created conditions for the lamp manufacturing industry to develop.

The research article is organized as follows: Section 2 presents the theoretical basis and research methods. Section 3 specifically presents the research results. Section 4 presents the discussion and conclusions of the study.

RAW MATERIAL AND METHODOLOGY

Star (1978) defined production activities as the arrangement of work activities of people, machines, raw materials, and energy, through which the form of work is agreed upon and then completed. Chase (1981) stated in the book Production and Management Operations later updated by many recent authors in 2021, thereby defining production activities as a process that begins with the transformation of physical objects. materials and then through technological processes to become products and services that meet customer needs. Manufacturing activities include production

DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

planning, resource management, supply chain management, and many other activities to ensure production efficiency and satisfy customer needs.

Production efficiency is defined by Tejvan Pettinger (2019) as the production of goods and services to achieve maximum output and minimum cost with an optimal combination of input factors. According to Wikipedia, production efficiency is not concerned with whether the product portfolio chosen for production is producing goods in an appropriate proportion but only focuses on optimizing output with the product portfolio. selected for production. To achieve greater output with the same amount of inputs and production technology, businesses must improve management and technology. Efficient production causes businesses to expand production capacity and increase output.

The production process is defined by Johnson (2019) as a production system that operates according to a plan in sequences and related steps, the ultimate purpose of which is to transform raw materials into products. or services. According to the Indeed Editorial Team (2023), simple manufacturing is a way to efficiently and effectively produce products for sale to reach customers quickly without sacrificing product quality.

A. Value stream mapping

Value Stream Mapping is mentioned by John (2009) Value Stream Mapping is all the activities required (non-added and value-added) currently to move products through essential flows such as raw materials to customers and the process from product design to launch. Langstrand (2016) believes that Value Stream Mapping (VSM) is a method of logical analysis and visual illustration of the production process through which 7 wastes can be identified: transportation, inventory, overproduction, product quality, and measures to reduce processes that cause waste. According to the UCI Institute of Business Administration (2018), "Value Stream Mapping (VSM) is a method of visually mapping the product manufacturing process (raw materials and information) from door to door.

The value chain diagram shows us an overall picture of the entire system from the beginning of product production so that managers, workers, engineers, suppliers, and customers can identify waste. and the causes of that waste. The process includes mapping the "current value chain" to show what you want to see and the "future value chain" as the building blocks to build the innovation strategy the company is aiming for.

A value chain diagram provides an overview of the flow of materials and information in the production process, from when a customer places an order to when the product is manufactured and delivered to the customer. When a customer places an order, the sales department will receive the order and then agree on the quality, quantity, and delivery time. After the order information is complete, it will be received by the planning department, which will then order raw materials and proceed with product production planning for each department. Production departments will focus on planning and production to meet order needs. During the product manufacturing process, the flow of information is guaranteed between production departments and from customers to production units and suppliers.

The value chain diagram includes the flow of raw materials from suppliers to factory warehouses, how products are created and stored, how products are transported to customers, and how and when they are produced.

B. Value chain mapping process (VSM)

The goal of mapping the value chain is to create images of raw materials, orders, designs, etc. going through the value flow that meets customer needs from inputs until finished product (service) output. The value chain map (VSM) can be described in 5 steps:

Step 1: Identify products (services) to create VSM Identify the process of the product (service) that needs improvement to conduct a survey and determine the starting and ending points to draw a value chain map and thereby identify bottlenecks and unproductive steps. value. You should choose products with large production quantities or main products that bring in the main sales of the business to conduct experiments.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

Step 2: Draw a diagram of the current VSM value chain and bring together people representing process stakeholders who want to improve production, business, and logistics processes. Not only managers and leaders of groups but also direct workers must be present because direct workers will know what is happening in the production process so that the data is accurate. more and know what's going on.

Then go to the place where product production is taking place to collect data such as cycle time, takt time, inventory quantity, number of employees, number of machines, and quality rate. Arrange the flow order from raw materials to customers, and vice versa. Select and unify symbols to include in the value chain diagram, then put the collected and selected information and symbols into the current value chain diagram. The more detailed these data and information are, the more they reflect the realities happening at the factory.

Evaluate the current state of the current value chain map, consider value-adding activities and non-value-adding activities in the activity chain. Thereby, find the reasons why activities do not add value, then propose measures to overcome those activities, and, if unable to fix, consider eliminating activities that do not add value. Activities that add value need to be optimized and promoted. Consider maximum process capacity by identifying bottlenecks to minimize and eliminate them. Waste identification also needs to be done in this step to propose future solutions.

Step 3: Draw a future value chain diagram: Based on lean standards and principles, redesign the value chain map to solve outstanding problems on the current value chain map. The information in the value chain map aims to optimize the production process so that products have increasingly higher quality. Recalculate the necessary parameters and draw a future value chain map with the goal of increasing the production efficiency of the product being researched.

Step 4: Make an implementation plan: Set goals and implement the plan according to each specific step determined through the plan, control the plan through set checkpoints; and consult with experts on implementation improvements.

Step 5: Implement the plan: Conduct the implementation of the future value chain diagram. Divide the work into parts for the departments in charge, ensure the work is completed within the set time, and monitor and check to limit possible errors. Periodically evaluate the process and make adjustments as necessary.

C. Benefits of implementing value chain mapping (VSM)

Value chain mapping (VSM) provides information based on symbols, numbers, and images, thereby providing quick information for all departments to grasp the company's current process and exchange information. exchange information between departments within the enterprise.

Value chain mapping (VSM) helps each group grasp their work role through an overall picture, thereby making the cooperation of individuals and groups more effective and efficient. improve working capacity. Help employees see long-term improvements that improve business results. The VSM through the future value chain map tells businesses the vision they want to achieve, and the current value chain map shows businesses what they currently have, thereby identifying and eliminating waste and waste factors that do not create value and reducing unnecessary costs to improve productivity and product quality.

D. Definitions when using value stream mapping

Takt time is the time it takes to produce a product or service within a certain cycle to meet customer demand. This is an important concept in production and supply management. This concept helps optimize production and supply processes through synchronization of production time and output.

Cycle time is the amount of time between two consecutive completed products or the amount of time a job or process takes to complete from start to finish, it is simply the amount of time it takes for a job to be completed. Success begins when the work is done and ends when the goal is completed.

Value-added time is the amount of time that brings value to a product or service during the production process that customers are willing to pay.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

Non-value-added time is the period that does not contribute value when producing a product or service. This is the time when there is no improvement in quality, completeness, or any improvements to the product.

Lead time, or production time, is the time from the time the product is ordered until the product or service is completed and delivered to the customer. It includes all the time needed to complete the product, such as production, processing, inspection, packaging, transportation, waiting time between stages, semi-finished product transportation time, and quality inspection time. quantity of product or any time it takes for the product or service to be completed.

CASE STUDY FOR IMPROVEMENT

Summary of collected data and processed data through Input Analyzer, Table 1 Summary data of stations and Draw a current value chain diagram (Fig. 1)

Table 1. Summary data of stations

	Cycle time (giây)	Lead time (Giây)	Change over time (giây)	Number of working machines	Number of workers working	Takt time (giây)
Driver pencil	1.28	5	1		3	7.2
Install Driver	1.81	3	1		2	7.2
Welding Driver	5.2	10	1		2	7.2
Place the Driver in the plastic box	2.49	4	1		2	7.2
Apply glue to the lamp head	3.03	10	1	2	2	7.2
Weld the lamp head	5.76	10	1		4	7.2
Attach the light head to the OTT	1.41	5	1		2	7.2
Light test	11.16	20	3	1	1	7.2
Practice tests	2.9	10	1	1	0	7.2
Put on the lamp jacket	5.99	17	2	1	1	7.2
Apply CR stamp, warranty stamp, warning stamp, energy efficiency stamp	8.51	30	3		4	7.2
Attach plastic cap to head G13	1.75	5	1		2	7.2
Pack	4.45	30	7	1	2	7.2

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

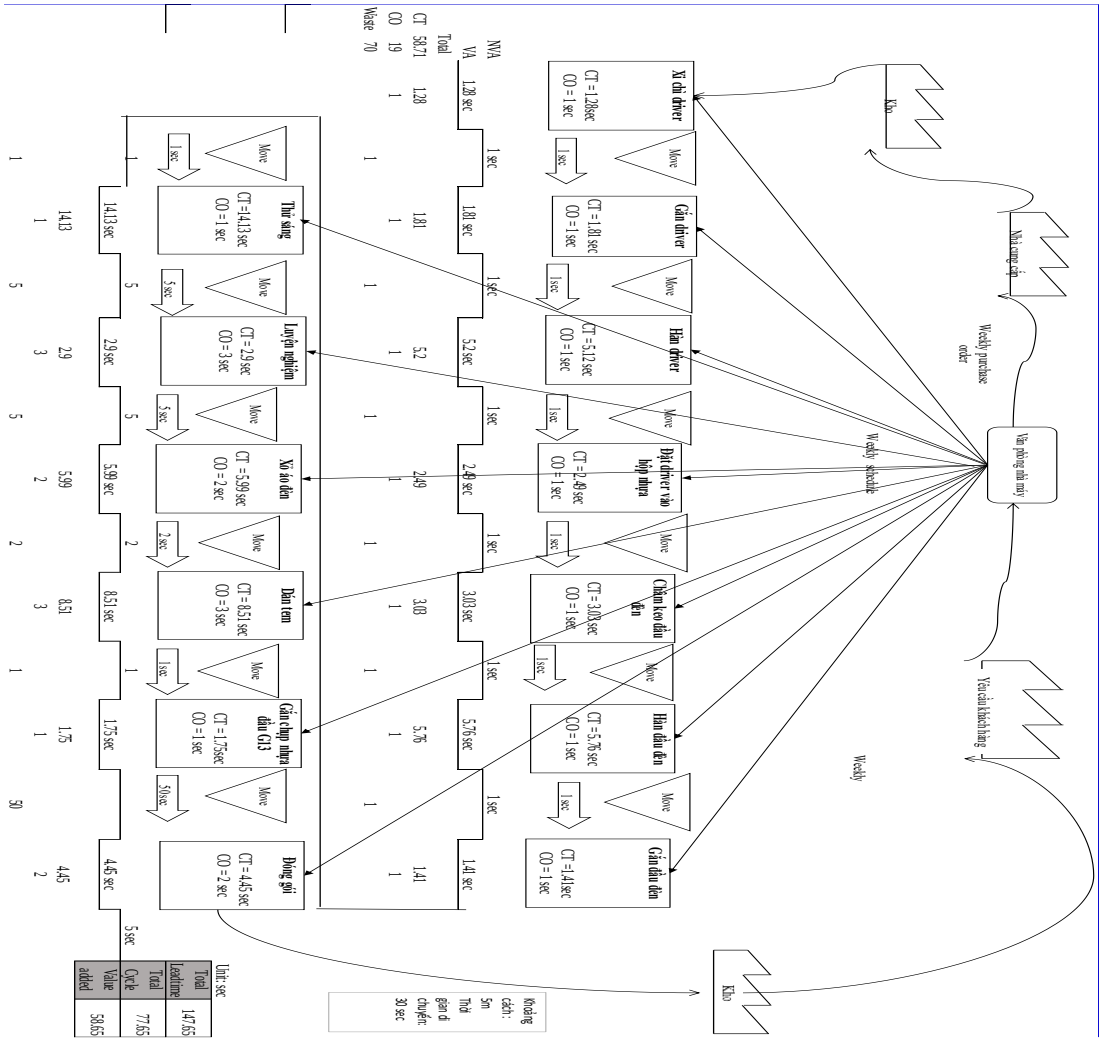

Figure 1. Current value chain diagram (Tubbe TU06 LED product)

Analyze the current status of the value chain map

Building a current value chain map is an important step in identifying waste or problems that arise during the production process and working towards building a more effective future value chain map. Compare cycle time and takt time (Tab. 2)

Table 2. Comparison table of Cycle Time and Takt Time through each stage

Process	Cycle Time (Second)	Takt Time (Second)
Driver pencil	1.28	7.2
Install Driver	1.81	7.2
Welding Driver	5.2	7.2
Place the Driver in the plastic box	2.49	7.2
Apply glue to the lamp head	3.03	7.2
Weld the lamp head	5.76	7.2
Attach the light head to the OTT	1.41	7.2
Light test	11.16	7.2
Practice tests	2.9	7.2

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

Put on the lamp jacket	5.99	7.2
Apply CR stamp, warranty stamp, warning stamp, energy efficiency stamp	8.51	7.2
Attach plastic cap to head G13	1.75	7.2
Pack	4.45	7.2

The time between stages is not uniform. There is a large difference between stages, some stages have a large processing time, and some have a small processing time. The light testing stage has the largest processing time (11.46 seconds), and the lamp head mounting stage has the smallest processing time (1.41 seconds).

Processing time is lower than the production rate in the following stages: attaching the driver (1.81 seconds), welding the driver (5.19 seconds), attaching the plastic box (2.49 seconds), welding the lamp head (5.76 seconds), applying glue to the lamp head (3.03 seconds), attaching the lamp head to the OTT (1.41 seconds), waxing the driver (1.28 seconds), testing (2.9 seconds), inserting the lamp jacket (5.99 seconds), attaching the plastic head cover G13 (1.77 seconds), packaging (4.45 seconds).

The light test stage has a high processing time (11.16 seconds) because workers have to spend a lot of time operating, mainly due to the long lighting time of the bulb. The stamping process has a high processing time (8.51 seconds) because workers have to paste each type of stamp. The company has not yet applied machinery for the stamping process, which requires manual stamping and affects production time.

The light testing stage takes a lot of time to perform. When the semi-finished light bulb is brought to the stage, workers must check and test the light to see if the light bulb glows effectively. To make improvements, we have 2 short-term and long-term plans to implement: Short-term: We can rotate a worker from the stage of attaching the lamp head to supporting the light testing work. Long-term: We can hire an additional worker to do light testing or we can buy more machines to support light testing work

Grouping workstations: Through analysis of takt time and cycle time, we see that there are stages that can be grouped while still ensuring takt time. Grouping processes can help make better use of factory resources and labor. The stages with close locations and appropriate times are grouped according to Table 3 and the proposed figure to improve the grouping of stages and After applying the right solution, the lead time of some stages will be significantly reduced (Tab. 4).

Table 3. Workstation groups

New stage after grouping	Old component stage	Processing time of component work	A lead time of component jobs	New process processing time	Lead time for new stages	Number of new stage workers	Cycle time after application
Install Driver	Install Driver	1.81	3	7	13	4	2
	Welding Driver	5.2	10				
Apply glue to the lamp head	Place the driver in the plastic box	2.49	4	5.52	14	4	2
	Apply	3.03	10				

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

	glue to the lamp head						
Attach the light head to the OTT	Weld the lamp head	5.76	10	7.17	15	6	2
	Attach the light head to the OTT	1.41	5				
Pack	Attach plastic cap to head G13	1.75	5	6.22	35	4	8
	Pack	4.45	30				

Table 4. Comparison of estimated Lead time before and after application

Process	Lead time before improvement (Second)	Lead time after improvement (Second)
Install Driver	13	10
Apply glue to the lamp head	14	12
Attach the light head to the OTT	15	12
Driver pencil	5	5
Light test	20	18
Practice tests	10	10
Put on the lamp jacket	17	14
Apply CR stamp, warranty stamp, warning stamp, energy efficiency stamp	30	20
Pack	35	30

After improvement, the lead time for some stages has been reduced. The packaging step is reduced from 35 seconds to 30 seconds, the stamping step is reduced from 30 seconds to 20 seconds, the lamp jacketing step is reduced from 17 seconds to 14 seconds, and the light testing step is reduced from 20 seconds to 18 seconds, The process of attaching the lamp head is reduced from 15 seconds to 12 seconds, the process of applying glue to the lamp head is reduced from 14 seconds to 12 seconds, and the process of installing the driver is reduced from 13 seconds to 10 seconds. The two stages are the testing stage with no change (10 seconds), the Driver penciling stage without change (5 seconds)

Having more workers and improvements at the light testing and stamping stations will help reduce processing time for these two stages. Successful implementation of 5S will help the stamping and testing process take place faster because workers have a convenient space to operate and can find objects more easily, thus reducing time by 17%. machining.

DISCUSSION AND CONCLUSION

After making improvements, the machining time of the two initial stages with a machining time greater than Takt time has been shortened, the light test stage after changing the machining time from 11.16 seconds is reduced to 4.85 seconds, and the stamping processing time has been reduced from 8.51 seconds to 7.06 seconds and after implementing the above solutions, the data for the future value chain map (Tab. 5) and After building the new value chain map, the workstations were combined, so the original 13 states were reduced to 9 stations. After having data, map the future value chain (Fig. 2). After improvements in the mixing and stamping stages, the processing time of these two stages was initially greater than the changed Takt time (Tab. 6).

Table 5. Future value chain map data

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

	Cycle time (giây)	Lead time (Giây)	Change over time (giây)	Number of working machines	Number of workers working	Takt time (giây)
Driver pencil	7.01	10	2	1	4	7.2
Install Driver	5.52	12	2	2	4	7.2
Welding Driver	7.17	12	2		4	7.2
Place the Driver in the plastic box	1.28	5	1		3	7.2
Apply glue to the lamp head	4.85	18	3	1	1	7.2
Weld the lamp head	2.9	10	1	1	0	7.2
Attach the light head to the OTT	5.99	14	2	1	1	7.2
Light test	7.06	20	3		4	7.2
Practice tests	6.2	30	8	1	4	7.2

Table 6. Improvement level of post-improvement stages

Process	Initial machining time (Second)	Processing time after improvement (Second)	Level of improvement (Second)
Light test	11.16	4.85	56.55%
Paste stamp	8.51	7.06	17.4%

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

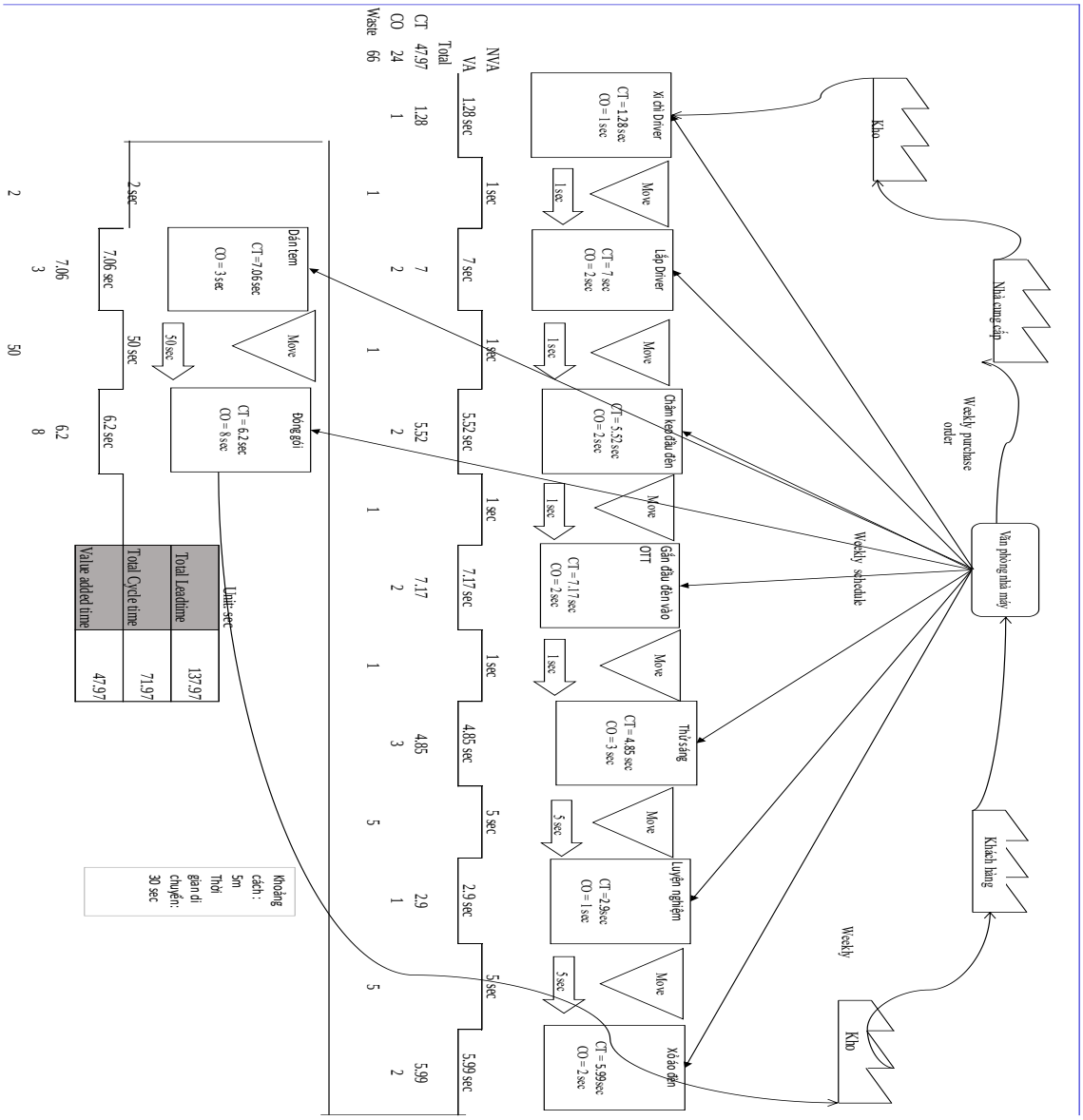

Figure 2. Future value chain diagram

Forming 9 new workstations compared to the previous 13 workstations. The total lead time has been reduced from 147.65 seconds to 141.99 seconds, a decrease of 3.63%. The total machining time has been reduced from 77.65 seconds to 75.99 seconds, a decrease of 2.13%. After making improvements, cycle time values have been improved, solving outstanding problems that take up a lot of time and affect order processing time.

By applying theory combined with company documents and practical observations, the report has performed the following tasks: Describe and evaluate the company's production process, from raw materials to finished products. warehouse. Learn and evaluate the 5S implementation process at the company. Propose solutions to help develop 5S in the company. Collect and analyze actual data on machining times through the input analyzer tool. Build a value chain diagram for LED tube product TU06. Proposing solutions to help support line balancing. Proposing technological solutions to increase productivity and reduce processing time. Build a future value chain map. Thereby, Cycle time and lead time are also improved.

Acknowledgments:
The authors are extremely grateful to HCMC University of Technology and Education and Van Lang University, Vietnam, for supporting this research.

DOI:10.46647/ijetms.2024.v08i02.046 ISSN: 2581-4621

References

[1] ASQ (2023), WHAT IS VALUE STREAM MAPPING (VSM)?, https://asq.org/quality-resources/lean/value-stream-mapping (23/11/2023)

[2] Lean Enterprise (2022), Value Stream Mapping, https://www.lean.org/lexicon-terms/value-stream-mapping/ (23/11/2023)

[3] Achmadi, F.; Harsanto, B.; Yunani, A (2023). Improvement of Assembly Manufacturing Process through Value Stream Mapping and Ranked Positional Weight: An Empirical Evidence from the Defense Industry.

[4] Menik, I.; Raja, R.; Bambang, S.; Sofian, H (2023). Identifying and Eliminating Waste in a Coal Mining Industry: The Value Stream Mapping Analysis

[5] Chase, R. B., Jacobs, F. R., & Aquilano, N. J. (2021). Production and Operations Management. New Age International (P) Ltd., Publishers.

[6] Førsund, F. R., & Hjalmarsson, L. (2014). On the measurement of productive efficiency. The Swedish Journal of Economics, 141-154.

[7] Johnson, A. (2019). Production process and quality management. Production Engineering Magazine, 32(3), 215-230.

[8] Langstrand, J. (2016). An introduction to value stream mapping and analysis

[9] Govind Ramu (2022). The ASQ Certified Six Sigma Yellow Belt Handbook