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Applying value stream mapping and ECRS to minimizing waste in the hub and spoke distribution in Thai apparel manufacturer

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Abstract

The apparel industry is one of the strategic commodities for the Thai economy. With a less competitive center for the production of apparel, this study aims to identify the wastes in the Hub and Spoke unit (HSU) and provide recommendations to minimize the wastes. This study collected the data from 30 samples at the HSU by using qualitative methods through interviews and observation. Data was collected through recording activities with instruments and observation of the processing time of HSU process flow throughout the receiving of the raw materials from suppliers until distribution to business units. Several lean tools are applied such as root cause analysis, process activity mapping, and value stream mapping (VSM) concept to analyze the problem. The lean tool approach plays an important role in systematically carrying out the improvement based on its well- known method called; Eliminate, Combine, Simplify, and Re-arrange (ECRS). The results of the identification of wastes using the VSM show that there are activities that are non-value-added (NVA) with a total time of 245 minutes of a total time of 832 minutes or 29.45% in the process of HSU. Based on the future VSM after processed improvement by ECRS, it was found that the time of activities that NVA reduced by 105 minutes, and total time of activities from 832 minutes to 700 minutes or reduced by 15.87%. The proposal improvement provided based on the analysis of critical wastes in the form of combined activities, eliminating non-necessary activities, expanding the HSU space and re-arrange production process, making standard operating procedures (SOP), re-skill and upskilling training preventing, avoiding defective work, and organizing the information flow with well understand and acknowledge from SOP. The manufacturers, apparel HSU, or logistics managers will gain several benefits, be well organized, and continuously improve their company performance.

Keywords

wastes; value stream mapping; ECRS; hub and spoke; apparel manufacturer

1. Introduction

Apparel is one of the key products for the Thai economy in 2022, Thailand exported apparel and textile goods valued at about $6.9 billion, a rise from the previous year. In 2027, the revenue is expected to reach $7.42 billion. Compared to Vietnam, China, or Bangladesh, the country is now less competitive as a center for the production of apparel. Thailand is moving its apparel industry toward quality and sustainability, nevertheless [1]. The various impacts on the global economy resulted from the drawn-out geopolitical war. Each country's issue with inflation,

which has caused the interest rate to need to be modified, has led to a decline in consumer purchasing power. With issues with increasing energy prices and unpredictable market circumstances. A slowdown in the global economy and a decline in consumer demand could affect the textile and apparel sector in 2023. The majority of apparel retailers and brands seek to use a variety of raw material suppliers. Along with retaining a sizable seller or partner base in order to stay up with the current economic climate and any potential instability [2].

Sportswear is the major product of Company X, one of the Thai apparel producers. The company exports the majority of its goods, mostly to North America, Europe, and Asia. In the present, there is an abundance of competition. As a result, developing a competitive advantage is essential. A company has to maintain its position as a leader in product development and export. The development of exportable products requires ongoing research and development. Company X has a number of challenges that cause order completion times in the HSU to take longer. The first barrier is defective work as a result of human mistakes and improper material handling, which causes deliveries to be delayed. The second obstacle is complex movement, which is useless to the operator because of inconsistent working practices and disorganized workspaces. As a result, the process takes longer and requires more energy than is necessary. The third challenge is waiting for the supplier to deliver the material, while some supplies are occasionally seasonal. The only tool that can be used to achieve continuous enhancement is lean. Although many logistics companies are successfully implementing lean technologies in their warehouses, hub- and- spoke distribution has received minor attention.

2. Literature Review

The study aims to increase the value of process activities by reducing waste in the hub- and- spoke distribution system of Company X. It is expected that the company will enhance efficiency and accelerate the hub-and-spoke distribution process time that was improved utilizing the Ishikawa diagram and ECRS principles with the reduction of waste in the process that the process map has pointed out by VSM. This work aims to contribute to the academic community, production managers, and policymakers by exploring the possibilities of implementable improvements in Thai apparel, followed by reaping the benefits of gaining a competitive edge over their competitors. For researchers to impart knowledge and provide thorough information on this research issue, this section presents a review of the relevant literature on lean logistics, VSM, ECRS concepts, and also on hub and spoke distribution concept.

2.1 Lean Logistics

Lean is about improving one's ability to compete quickly or striving for continuous flow through a series of high-quality procedures. The term "flow" refers to the movement of information and plans as well as actual goods and services necessary for running commercial operations. The three areas that require ongoing improvement are reduced waste, value development, and people involvement [3]. Lean is viewed as a collection of operational concepts and methods designed to enhance the efficiency, speed, cost, and quality of operations in the service sector [4]. According to the Lean Enterprise Institute, the basic objective is to reduce waste while increasing consumer value. Lean simply means producing more value for consumers with fewer resources.

According to Wronka [5], incorporating visual management tools and lean concepts into a storage system may help to lower the amount of inventory while also making it easier to identify supplies needed for production. As stated by [6], adopting lean logistics principles and getting rid of any waste from the supply chain is crucial. Lean logistics is a concept that connects service or production operations so that they never stop. A systematic analysis of processes, production control that is compatible with the pull system, and support for ongoing operations through a number of methods typical for the Lean concept, such as VSM, Kanban, TPM, or 5S are all discussed [6] as ways to prevent process shortages.

2.2 Value Steam Mapping (VSM)

The value activities should be considered by the enterprise before setting the operation of the service together to constitute the value chain of the whole enterprise. VSM is one of the lean tools where every step of the process is documented in full detail. The three categories of value-added (VA), necessary but non-value-added (NNVA), and non- value-added and unnecessary (NVA) are used by VSM to categorize all of the production process's activities [7]. VSM is the fundamental tool for waste calculation and process improvement [8]. The research projects have used VSM in other industries to boost productivity, motivated by the manufacturing sector's VSM study and the methodology's effectiveness [9].

A lean logistics process value chain is another way to describe a value chain. Value-added and non-value- added logistics activities are separated according to the value chain concept. Lean warehousing with VSM reduces the number of stock-out conditions that are reported, improves dealer satisfaction, monitors inventory levels in real time, and provides the best use of the warehouse's space, while enhancing the distribution center's overall performance [10].

2.3 Eliminate, Combines, Rearrange and Simplify (ECRS)

The main purpose of ECRS, a lean technique, is to minimize wait times or eliminate unnecessary stages in order to enhance productivity. Eliminating (E) means removing steps from a process that are not necessary. While combine refers to the act of combining (C) specific actions in order to reduce the time or effort necessary to perform those stages. Rearrange (R) also means to put the work in a better, and more appropriate order or sequence. The final step in simplifying (S) is to design new equipment or enhance existing work processes [11]. Since reducing non-value-adding operations is the main objective of this strategy, ECRS can be used as a tool to improve administrative processes. ECRS is utilized to improve production line processes as well as warehouse operations to boost productivity. We can discover places or tasks that are unproductive because of "waste- of- space" or "waste- of- time" activities by applying the fundamental qualitative notion [12].

2.4 Hub and Spoke

O'Kelly was the first to propose the hub- and- spoke logistics network layout, which can effectively implement the centralization of transporting cargo between hubs, maximize the scale benefits of trunk transportation, and offset the cost reduction brought on by insufficient full load rate [13]. It has been extensively utilized in a variety of industries, including shipping, logistics, and telecommunications. When network resources are concentrated to their fullest extent and the economic benefits of scale are realized through trunk transportation between hubs,

a hub- and- spoke network can lower its overall operating costs [14]. The hub-and-spoke district, which is a dynamic characteristic of a dominant firm in preference to networking amongst smaller companies, is a situation wherein providers in an industrial area congregate around one or greater middle companies. this may most effectively occur whilst economies of scale permit the establishment of a leading firm production of massive quantities of a product (and associated products) for an extensive customer marketplace related to export [15].

3. Research Methodology

The case study company is a worldwide leading sportswear manufacturer. The study was performed on relevant theories and research papers on lean technical logistics. This research method starts with the process flow chart to identify the production process of the HSU of company X, including material and information data, then the Ishikawa diagram to analyze the wastes, and then ECRS to improve the production process.

This study includes the use of both primary and secondary data sources. The primary data includes the HSU process flow, cycle time, and change over time. Secondary data included general company data, production amount data, and documentation.

The process flow and number of shifts were obtained by direct observation of the HSU. Cycle time data were obtained by measuring the production process cycle time of the HSU. Using a stopwatch measuring instrument, as many as 30 samples with averaged figures were presented from April to May 2023. Utilizing a brainstorming process and keeping an eye on information and physical flows can assist in identifying waste. The crucial waste is found through a questionnaire and purposeful sampling. The HSU process production is made more efficient and effective by the improvement stage waste elimination in each phase. The future VSM, a concept developed for future lean implementation plans, aims to enhance the production flow in order to meet the necessary conditions by improving the current VSM. Figure 1 shows an illustration of the adopted methodology.

4. Data Analysis and Results

4.1 Hub and Spoke Unit (HSU) Process Flow

In the HSU, there are five processes following;

1) Receiving: It' s the initial step involved in delivering an order to a business unit of the company. The vendor relays raw material documents, and sorting to the business unit. Receive the material by count, check the type and color of raw material, record to the system, and notify the Business Units (BUs) of the receiving.

2) Put away: The raw material demands warehouse personnel to pack on pallets by BUs identification, arranging, and storing new raw material.

3) Sorting: After raw materials are received, they must be sorted and placed in the correct location. The warehouse personnel will need to sort them by item before putting them away in the storage location. For outbound to BUs, the warehouse personnel will sort the performing BUs picking, meaning multiple orders are picked for sorting together. The warehouse staff will then sort them according to the correct BUs individual orders.

4) Consolidate: The task of consolidating the station is to combine loads. These hubs and spoke centers group multiple BUs individual orders into a single distribution to reduce the number of

dispatches. The warehouse requires the organization and sorting of orders before distribution.

5) Distribution: With the hub and spoke system, distribution centers, or warehouse (Hub) in Bangkok, the raw material will be delivered to the BUs (Spoke) in the region respectively.

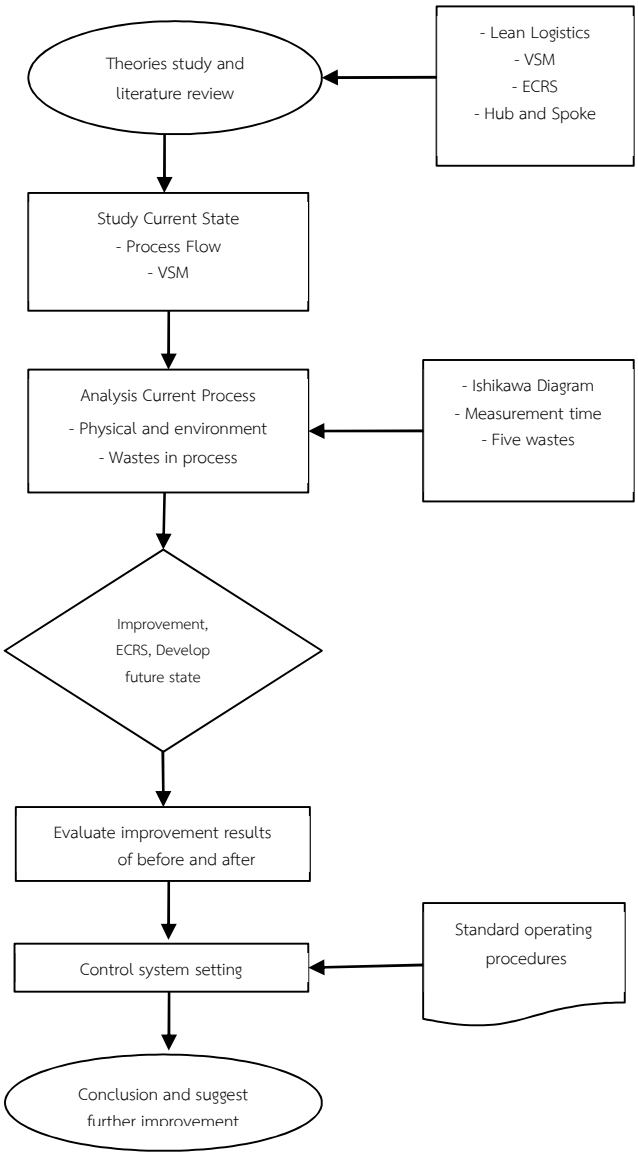

Figure 1 Research Methodology

4.2 Process Activity Mapping (PAM)

The data was collected by taking personnel visits to the company over a period of 30 days. Based on direct observation and interviews with HSU staff. For the purpose of considering improvements, this technique is used to identify all production process activities by identifying which activities include VA, NVA, and NNVA. This tool is designed to find waste, remove NVA, accelerate the process to increase its efficiency and identify adjustments that will minimize waste. PAM consists of five distinct types of activities: operation, transportation, storage, delay, and inspection. Based on the activities that the PAM tool identified, it is known that the total production time for HSU for a single shift per day is 832 minutes. There are a total of 20 activities involved in the production process, including 9 operation activities, 6 transportation activities, 1 storage activity, 2 delay activities, and 2 inspection activities. 8 VA activities and 12 NVA events are included. It is also known that the working time for VA activities is 587 minutes, whereas the working time for NVA activities is 245 minutes as shown in Table 1.

Table 1 Process Activity Mapping (PAM) Results

No.	Process	Activities Details	Code	Process Activities					Time (Min.)	Distance (M.)	VA/NVA /NNVA
				Operation	Transportation	Storage	Delay	Inspection			
1	Receiving	Suppliers relay documents	R1	x					5	-	VA
2		Checking documents	R2	x					15	-	NVA
3		Sorting documents with business units	R3	x					10	-	NVA
4		Moving pallets to receiving area	R4		x				5	40	NVA
5		Receiving raw material	R5	x					30	-	VA
6		Quality checking	R6					x	20	-	NVA
7	Put away	Unloading raw material	P1		x				10	2	NVA
8		Put the inspected raw material on pallet	P2	x					10	-	NVA
9		Hang the destination business unit sign	P3	x					3	-	VA
10		Moving pallet to storage area	P4		x				5	30	NVA
11		Recording the receipt material to system	P5	x					18	-	VA
12	Sorting	Waiting for other raw materials	S1				x		20	-	NVA
13		Sorting for same business unit destination	S2	x					25	-	VA
14	Consolidate	Consolidate raw materials for same business unit destination	C1			x			22	-	VA
15	Consolidate	Moving consolidated raw materials to loading area	C2		x				30	30	NVA
16		Counting raw materials	C3					x	25	-	NVA
17		Loading raw materials to vehicle/container	C4		x				35	3	NVA
18		Sealing the container	C5	x					4	-	VA
19	Distribution	Waiting for transport to business unit	D1				x		60	-	NVA
20		Dispatch to business unit	D2		x				480	-	VA

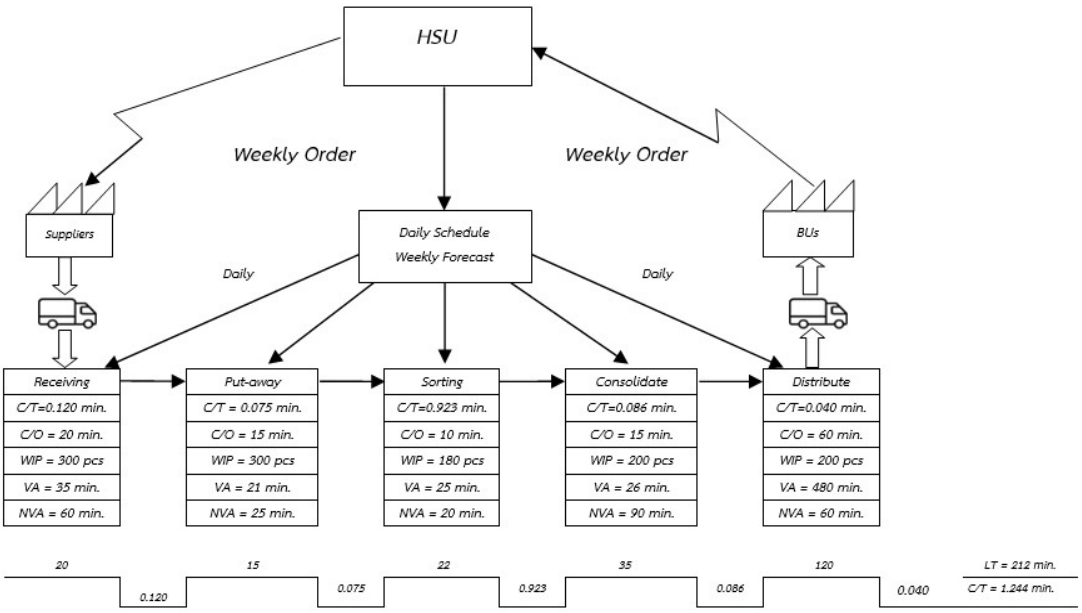

Figure 2 Current VSM Diagram

4.3 Analyzing the current state of VSM data

The researchers displayed the current state of the HSU with VSM diagram in Figure 2 taking the data from Table 1 as a reference. Cycle time (C/T), change over time (C/O), lead time (L/T), NVA, and VA data were collected.

Table 2 Five Wastes identification in HSU

No.	Type(s) of Waste(s)	Details of Wastes
1	Overproduction	- Overproduction occurs with limited space at HSU, making moving raw materials redundant and unnecessary.
2	Waiting	- Waiting periods for raw materials from suppliers since they did not follow the rules on delivering the required raw materials. - Waiting times brought on by staff errors, such as records of raw materials received that do not match actual receipts because staff members were negligent, or staff members' incapacity to work long hours, which resulted in delays when it came time to double-check the receipt of raw materials. - There is a waiting time to receive raw materials due to the excessive delivery of raw materials from suppliers at the same time.
3	Transportation	- Traffic jam on the roads caused delay in transportation as well as unpredictable weather.
4	Non-effective process	- The HSU materials equipment needs to have damage fixed before it can be used. It is creating delays because it occasionally needs to be fixed before being used. - Moving is delayed when waste from faulty packing is discovered and needs to be fixed before being used.
5	Defect/Rework	- Delivery of the products to BU is delayed due to defects or rework brought on by damaged work and packaging. - Rework from sending goods and raw materials to the wrong destination

Additionally, the product's movement, WIP, and inventory were tracked, as well as the product's monthly and daily requirements. After the data was analyzed, it became apparent that there was a high rate of rework, rejections, and inventory levels.

4.4 Wastes Analysis

We performed team brainstorming to investigate NVA activities. Table 2 shows the five types of wastes that predominantly occur in HSU, which include overproduction, waiting, transportation, non-effective process, and defect/rework

4.5 Root Cause Analysis of the Lean Wastes

In this step, the researcher brainstormed with the HSU supervisor and staff in order to analyze and determine related causes or ideas for specific problems grouped them together into categories, and organized them into an Ishikawa diagram that resembles the skeleton of an Ishikawa diagram [16]. The root cause analysis of various types of lean wastes points toward insufficient mainly in six categories, namely: materials, machinery, methods, management, man, and environment. We found probable root causes that are input in the HSU after brainstorming with a cause-and-effect diagram over the waiting and delay in Figure 3.

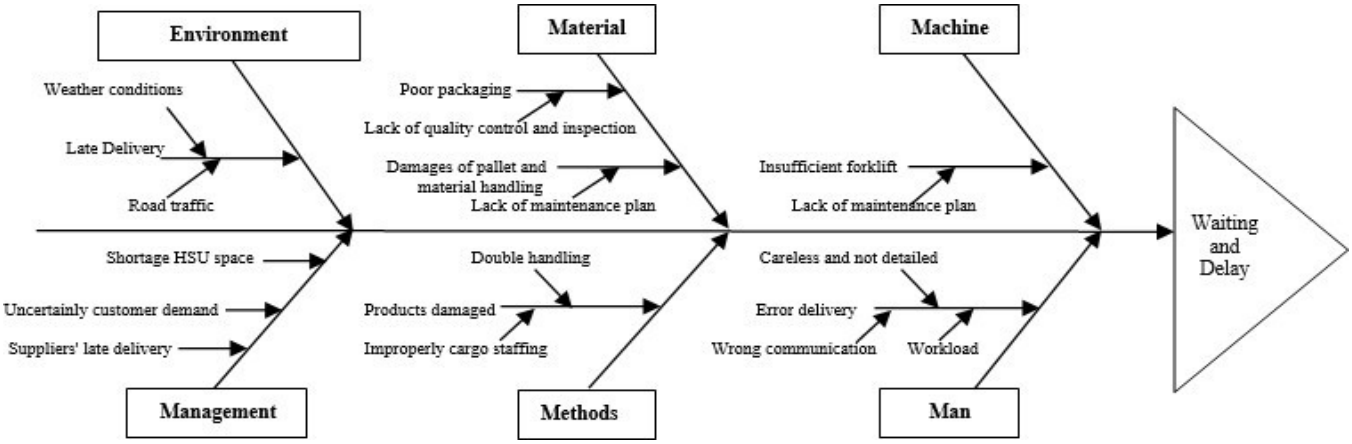

Figure 3 Ishikawa Diagram

4.6 Proposed improvement

Based on the PAM results, the five wastes at HSU, and root cause analysis utilizing the Ishikawa diagram, the researcher presented the following suggestions for improvement.

First, there are two methods for removing overproduction. 1) A temporary solution that involves making new batches of the product and managing raw material suppliers based on real demand rather than BU projections by mean pull system such as “just-in-time” (JIT). 2) an extension of the HSU facility is the long-term solution.

Second, the establishing of the SOPs, preventive maintenance, and staff training are all intended for assisting achieve the second waste, which is to shorten wait times. Crucial performance measures, such as lead time, order accuracy, and defect rate, can be obtained from suppliers by the company even in the case of unsatisfactory vendors.

Third, take advantage of technology options for route optimization such as telematics, GPS, or other delivery timings to avoid congestion. Adopt weather management systems, such as alerts for hazardous weather, rerouting, and weather warnings, in addition

to ongoing maintenance and driver emergency preparedness training.

Fourth, the suggestions that follow to minimize or completely do away with the delays brought on by machinery and material handling equipment (MHE). Establishing the MHE handbook correctly, provide ongoing SOP training, conduct routine maintenance and inspections (e.g., check for pallets or forklifts every week), and regulate speed and safety. Additionally, by correctly educating the effective packaging process and stringent safety regulations, the organization can prevent the inspection of substandard packaging.

Fifth, to minimize defects or rework resulting from faulty deliveries, damaged goods, and defective packaging, the researcher would recommend taking the following procedures. Pallets should be securely fastened during storage to prevent overturning; adopting safety traps will keep moisture away from the goods; and first, consider the kind of packaging that will best protect it from damage. Since the raw material is part of sportwear, the greatest threat to the strength of the packaging is excessive moisture or water. To place a legible and understandable sign alerting staff on the move to their responsibilities and possible risks.

On the other hand, a number of errors can lead to wrong delivery, including inaccurate data from suppliers, or receiving process, mislabeled products, erroneous items and faulty packaging and packaging from sorting and consolidate process, and poorly designed HSU due to space constraints.

The methods to avoid wrongful delivery vary as, as previously indicated, errors can arise in variety of process. In this case, taking realistic measures to remove as many of these processes as possible could maximize efficiency. 1) Evaluate the correctness of sorting. 2) A better HSU design can decrease errors and speed up the sorting and consolidate processes. 3) Establish an organized structure with labeling, traffic movement, and inventory zoning. 4) Install a warehouse management system (WMS) and use First in- First- out (FIFO) to appropriately arrange the destination and queue for containers. 5) Provide through training, develop an incentive program, activities to foster teamwork, and a continuous improvement program. Re- skill or up- skill staff to produce high- performing personnel. 6) Frequent audits- weekly or monthly- are essential to retaining control.

4.7 The implemented of ECRS principle

The method used to improve HSU's operational procedures is based on the ECRS philosophy. The ECRS concept is applied to enhance productivity and the HSU process. Reducing staff waste and improving overall operation efficiency are the ultimate goals of ECRS. The outcome of the thorough discussions and brainstorming sessions with the concerned HSU members. JIT pull system implementation will create effective supplier management. The goods must be delivered JIT since they are required for sorting, consolidation, and distribution. In order to successfully apply lean concepts, the HSU can select the most reliable supplier for effective JIT or FIFO implementation, SOPs creation, staff training on new work flows, technology adoption, MHE maintenance plan, HSU layout reorganization for each BU, and long- term HSU space expansion. All of the mentioned could increase HSU's efficiency by reducing wastes and NVA and by using damaged stock that isn't being used. Table 3 presents the various areas of previous and new where lean approached and the ECRS concept have improve working

methods. In conclusion, there were two activities-activities codes S1 and D1- that might be eliminated. Six activities can be combined to produce three: R2, R3, R5, R6, S2 and C1, while D2 needs to be rearranged as shown in Table 4.

Table 3 Previous and new working methods

Previous Activities	Activities Code (s)	ECRS	New working methods
Checking documents Sorting documents with BUs	R2 R3	C	After receiving training and new SOP, HSU members are able to simultaneously check and sorting document by the BUs.
Receiving raw material Quality checking	R5 R6	C	The HSU staff can then simultaneously receive and inspect the raw material.
Waiting for other raw materials	S1	E	Waiting for additional raw materials can be eliminated at HSU by using JIT and supplier delivery time scheduling.
Sorting for same BU destination Consolidate raw materials for same BU destination	S2 C1	C	Staff members are assigned to work for each BU and can combine sorting and consolidation at specified HSU locations at a time that works most effectively for each BU.
Waiting for transportation to BUs	D1	E	Utilizing WMS, GPS, and effective communication, the truck will arrive as soon as the raw materials are ready for loading and delivery to BU, given waiting for transportation can be eliminated at HSU.
Dispatch to BUs	D2	R	Staff members rearrange the container for each BU using the FIFO technique, seal them, and then distribute them, bringing the incorrect destination reduction.

Table 4 Activities after applying the ECRS principle

No.	Activities Code (s)	VA/NVA/NNVA	E	C	R	S	Current Time (Min.)	After ECRS (Min.)	Reduced Time (Min.)
1	R1	VA					5	5	-
2	R2	NVA		C1			15	20	5
3	R3	NVA		C1			10		
4	R4	NVA					5	5	-
5	R5	VA		C2			30	40	10
6	R6	NVA		C2			20		
7	P1	NVA					10	10	-
8	P2	NVA					10	10	-
9	P3	VA			3	3	-	P3	VA
10	P4	NVA			5	5	-	P4	NVA
11	P5	VA			18	18	-	P5	VA
12	S1	NVA	E1		20	-	20	S1	NVA
13	S2	VA		C3		25	40	S2	VA
14	C1	VA		C3		22		C1	VA

Table 4 Activities after applying the ECRS principle (Continue)

No.	Activities Code (s)	VA/NVA/NNVA	E	C	R	S	Current Time (Min.)	After ECRS (Min.)	Reduced Time (Min.)
15	C2	NVA			30	30	-	C2	NVA
16	C3	NVA			25	25	-	C3	NVA
17	C4	NVA			35	35	-	C4	NVA
18	C5	VA			4	4	-	C5	VA
19	D1	NVA	E2		60	-	60	D1	NVA
20	D2	VA			R1		480	D2	VA
		Total					832	700	132
After ECRS - Total count of activities in the HSU process									15
After ECRS -Total time									700

4.8 Future VSM

The visualization of VSM's future state is the last step. Future VSM is used to investigate differences that develop following advancements with a faster overall production time. Eliminating pointless actions and combining tasks that take too long in the HSU process reduces the waste of extra motion. Initially, it is known that HSU's total production time, from the time that raw materials are received until they are distributed to BUs. After improvement with the employ of the lean techniques, and ECRS principle, the future VSM diagram shown in Figure 4. The aggregate production time, production activities, the NVA, the WIP inventory, L/T and C/T was reduced while the production output increased are shown in Table 5.

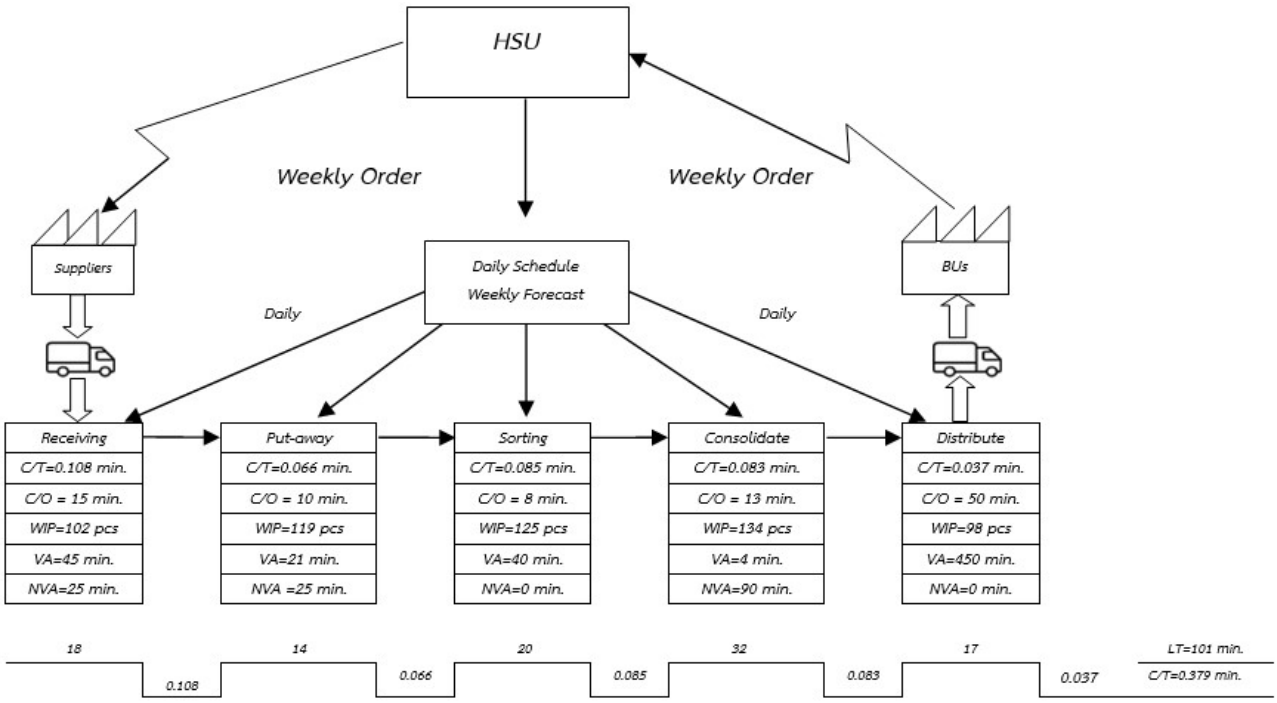

Figure 4 Future VSM Diagram

Table 5 Comparison of Current and Future VSM output

Output	Current	Future	Performance		Scale measurement
			Increase	Decrease	
Aggregate production time	832	700		132 (15.87%)	Minutes (Percentage)
Production activities	20	15		5 (25%)	Activities (Percentage)
NVA	29.45	20.00		9.45	Percentage
WIP inventory	1,180	578		51.02	Percentage
Productivity/hour	4,150	4,508	8.62		Percentage
L/T	212	101		111 (52.36%)	Minutes (Percentage)
C/T	1.244	0.379		0.865 (69.53%)	Minutes (Percentage)

5. Discussions

Previous research has highlighted the importance of lean logistics in response to gain competitive advantage such as [5-6, 12]. There has been growing research to integrate operation efficiency with warehouse performance through lean principle [13] mostly by extending the VSM [9-10]. However, there is a dearth of empirical research, which has performed analysis of HSU while increasing performance with integrating lean and ECRS approach for continuous improvement.

This research has contributed to the existing body of literature by performing empirical research on VSM and ECSR in HSU and yield an overall synergistic positive result. Within the context of the studied organization results obtained from the pilot study indicated that the concurred deployment to HSU through our proposed methodology and the VSM and ECRS tool, is a simple, practical and effective approach to improve performance of HSU. A key insight can be observed from the results, for instance, aggregate production time were reduced substantially through new process proposed with 15.87%, which similar to earlier finding of [11] by applying ECRS frozen crab stick products, waste reduce in the process of inspection is 77.92%. Furthermore, as expected, the 25% reduction of activities, similarly to [17], they applied ECRS in clinical chemistry laboratory, was found the reduction activities by 20%. In addition, in line with [18], they used ECRS and eliminated two workstations in the gas store manufacturing process. This study combined the VSM idea with the research of [19], which examined Peruvian warehouse tool service levels and discovered that they had dropped from 43% to 24%, to lower NVA from 29.45% to 20%, respectively.

This study reported a 51.02% reduction in WIP inventory, which is comparable to a previous study [20] that used the VSM approach to improve WIP and found a 90.48% reduction in WIP. Furthermore, this study discovered an 8.62% gain in productivity, which is comparable to a recent study [21] that discovered an 8.81% increase in line efficiency in Indonesian hard disk manufacturing due to the implementation of ECRS. Last but not least, the overall delivery lead time was shortened by 52.36%. this is based on earlier research by [8], which used lean six sigma in Indian electrical OEMs and discovered that the shortened by 47.12%. Additionally, [22] stated that the application

of ECRS in an Indonesian furniture business resulted in a 4.79% reduction in lead time.

Currently, lean such as VSM It is not only applied in textile [23] or apparel factories. Exploring the relationships within a production system customized for a certain firm could be a potential avenue for future research on lean concepts, with the goal of improving comprehension and application [24] . Examining the current trends and gaps in the literature on lean management could lead to further research directions, such as grounding lean studies on contemporary managerial theories, looking at lean applications in service settings, and understanding the connections between lean and safety/environmental issues [25] . Furthermore, a study focused on the obstacles to implementing lean strategies, particularly in the manufacturing sector during the COVID- 19 pandemic, could offer practitioners and policymakers valuable insights, helping them to identify critical components like supplier attitudes, resource constraints, and conflicts within the firm culture that affects the success of lean implementation [26].

6. Conclusion

In conclusion, the overall findings and results demonstrate that the research's goals were met. The results show that the process has been improved, waiting times have decreased, ineffective processes have decreased, defects and damaged work have decreased, and the HSU's productivity has increased. It was concluded that the service quality of HSU had significantly improved as a result of the workflow's use of lean methodologies. The method of data collection is the study's limitation. The primary data collection methods used to address and analyze the research issues for this study were observations and interviews at HSU. Personal interviews have the advantage of allowing participants to demonstrate complete involvement and one- on- one communication between the researcher and respondents. Although they were busy, the HSU staff were willing to conduct interviews. This study has several recommendations that can be made. Firstly, it is established, based on the overall results of this study, that the application of lean methodologies improves service quality at HSU. The use of lean methodologies and the value of services are associated. Therefore, using lean strategies is crucial for any consolidation and distribution company. Secondly, while this research focused on the HSU region, additional research might be done on the entire business unit to enhance the overall process flow. Finally, because the layouts for these two categories of warehouse institutions may differ, it is useful to compare customer satisfaction with service quality in standard warehouses and bonded warehouses. Therefore, a comparison of their lean management would be interesting.

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