



Analysis of Waste in Finished Feed Product Warehouse Using Lean Warehouse Approach

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Abstract— Inefficient warehouse operations often generate various forms of waste, including excessive waiting times, unnecessary transportation, and redundant activities, which ultimately increase lead times and reduce operational performance. Despite the critical role of finished feed product warehouses in maintaining supply chain responsiveness, studies addressing waste reduction in this context remain limited. This study aims to identify non-value-added activities in the finished feed product warehouse process and propose improvement strategies to enhance warehouse efficiency using a Lean Warehouse approach. The study integrates Value Stream Mapping (VSM), Value Stream Analysis Tools (VALSAT), fishbone diagram analysis, and the 5W+1H method to systematically identify, analyze, and eliminate waste within warehouse operations. The findings reveal that the current warehouse process has a total lead time of 447 minutes. Following the implementation of the proposed improvements, the future-state lead time is reduced to 269 minutes, representing a 39.8% reduction. In addition, Process Cycle Efficiency (PCE) improves from 20.81% to 34.57%, indicating a 13.76 percentage-point increase in operational efficiency. The identified improvements primarily address delays, excessive movement, and procedural redundancies in the warehouse flow. These results demonstrate that the Lean Warehouse approach provides an effective framework for minimizing waste and improving the performance of finished feed product warehouses. The study contributes practical insights for warehouse managers seeking to enhance operational efficiency and supports the broader application of lean principles in warehousing environments.

Keywords— Lean Warehouse; Value Stream Mapping; VALSAT; Process Cycle Efficiency; Waste Reduction; Finished Feed Warehouse.

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I. INTRODUCTION

The rapid of the animal feed industry has increased the demand for efficient logistics and warehouse management systems to ensure product availability, quality, and timely distribution. A company's supply chain relies heavily on warehouses to facilitate product delivery, storage, and transportation [1]. Warehouses can help with inventory control, avoid surplus inventory, and speed up product distribution for increased productivity [2].

Effective warehouse management may boost market competitiveness and speed up distribution [3].

There are two finished feed product warehouses owned by the animal feed industry. Completed feed products in the form of concentrates, pellets, and crumbles are stored at these warehouses. Because they hold a lot of goods and distribute them to direct farms, agents, and partners, warehouses are strategically important. The finished goods warehouse still faces a number of issues, including an overabundance of inventory that requires stacking for storage. Because unloading must be done again before loading, this procedure increases the possibility of product flaws and results in waste in the form of overprocessing. Due to the company's failure to adopt product grouping based on turnover, there is also an issue with transportation waste during stock inspections and product retrieval. This leads to longer wait times in all warehousing processes, including loading trucks.

A lean warehouse is used to minimize waste in the supply chain, both upstream and downstream, in response to these issues [4]. Value Stream Mapping (VSM), Value Stream Analysis Tools (VALSAT), Process Activity Mapping (PAM), fishbone diagrams, and 5W+1H are additional methods used to minimize waste in the warehouse flow process. The finished feed product warehouse should be able to identify waste, cut it down, and put the suggested changes into practice thanks to this research.

II. RELATED WORKS

A. Supply Chain Management

Supply Chain Management (SCM) refers to the integrated management of material, information, and financial flows from suppliers to end customer to create value and enhance organization performance. One system that is connected with a company's business operations is supply chain management. Ensuring that client needs and requests are satisfied through effective resource utilization is the goal of supply chain management. To attain efficiency and effectiveness, supply chain management must be implemented throughout a company's complete operations, including suppliers, manufacturers, warehouses, and points of sale [5].

Suppliers, manufacturers, warehouses and inventory management, distribution and transportation, customers and consumers, technology and information, and relationship and coordination management are some of the essential elements that make up the supply chain [6].

B. Warehouse

A warehouse is a place to store goods in an orderly manner for efficient management and upkeep [7]. In addition to supporting the production process, warehouses also lower production and transportation costs, balance supply and demand, and satisfy market demands [8]. Raw material warehouses, semi-finished goods warehouses, goods warehouses, terminal warehouses, distribution warehouses, break-bulk operations, cross docking, and public warehousing are among the several kinds of warehouses [9].

C. Lean Warehouse

Through continuous improvement, the lean methodology seeks to find and reduce waste in non-value-adding operations [10]. Overproduction, defects, needless inventory, improper processing, excessive transportation, waiting, and needless motion are the seven categories of waste that can arise in lean [11]. The goal of the lean warehouse method is to reduce waste and activities that don't bring value to the process of keeping items [12].

D. Value Stream Mapping (VSM)

Value Stream Mapping (VSM) is a technology that provides a full representation and visualization of the information and activity sequence [13]. Value Stream Mapping (VSM)

aims to distinguish between activities that actually provide value and those that don't [14]. Value Stream Mapping (VSM) comes in two types: current value stream mapping and future value stream mapping. In Value Stream Mapping (VSM), the Process Cycle Efficiency (PCE) is also calculated using the following formula:

$$\text{Process Cycle Efficiency} = \frac{\text{Value Added Time}}{\text{Total Lead Time}} \quad (1)$$

Value added time is time spent performing value-added processes and total lead time is time spent performing all processes [15].

E. Value Stream Mapping Analysis Tools (VALSAT)

Value Stream Analysis Tools (VALSAT) is a detailed tool for identifying waste in process flows [16]. In Value Stream Analysis Tools (VALSAT), there is a selection matrix.

Tabel 1. Mapping Tools VALSAT

Mapping Tools							
Waste	PAM	SCRUM	PVF	QFM	DAM	DPA	PS
Overproduction	L	M		L	M	M	
Waiting	H	H	L		M	M	
Transportation	H						L
Inapropriate Processing	H		M	L		L	
Unnecessary Inventory	M	H	M		M	M	L
Unnecessary Motion	H	L		H			
Defect	L						

- H = High Correlation and Usefulness = 9
- M = Medium Correlation and Usefulness = 3
- L = Low Correlation and Usefulness = 1

In Value Stream Analysis Tools (VALSAT), there is a waste weight calculation as follows:

$$\text{VALSAT} = \text{Waste Weight} \times \text{Value Correlation} \quad (2)$$

F. Process Activity Mapping (PAM)

Process Activity Mapping (PAM) is a tool used to identify activities that add value and activities that do not add value [17]. Operation, Transportation, Inspection, Delay, and Storage are the five categories into which Process Activity Mapping divides operations [18]. Process Activity Mapping also classifies activities into three types: Value Added Activity (VA), Necessary but Non Value Added Activity (NNVA), and Non Value Added Activity (NVA) [19].

G. Fishbone Diagram

Fishbone diagrams are a sort of analysis that aids in the methodical organization and grouping of ideas to make them easier to understand [20]. Fishbone diagrams demonstrate a variety of reasons of challenges, including machine, method, material, man, measurement, and mother nature/environment [21].

H. 5W+1H

5W+1H is an analytical strategy for issue solving that involves asking basic questions such as what, why, when, where, who, and how [22]. 5W+1H acts as a guide for developing the proper questions, broadening the scope of research, and gathering accurate data, which finally leads to excellent answers [23].

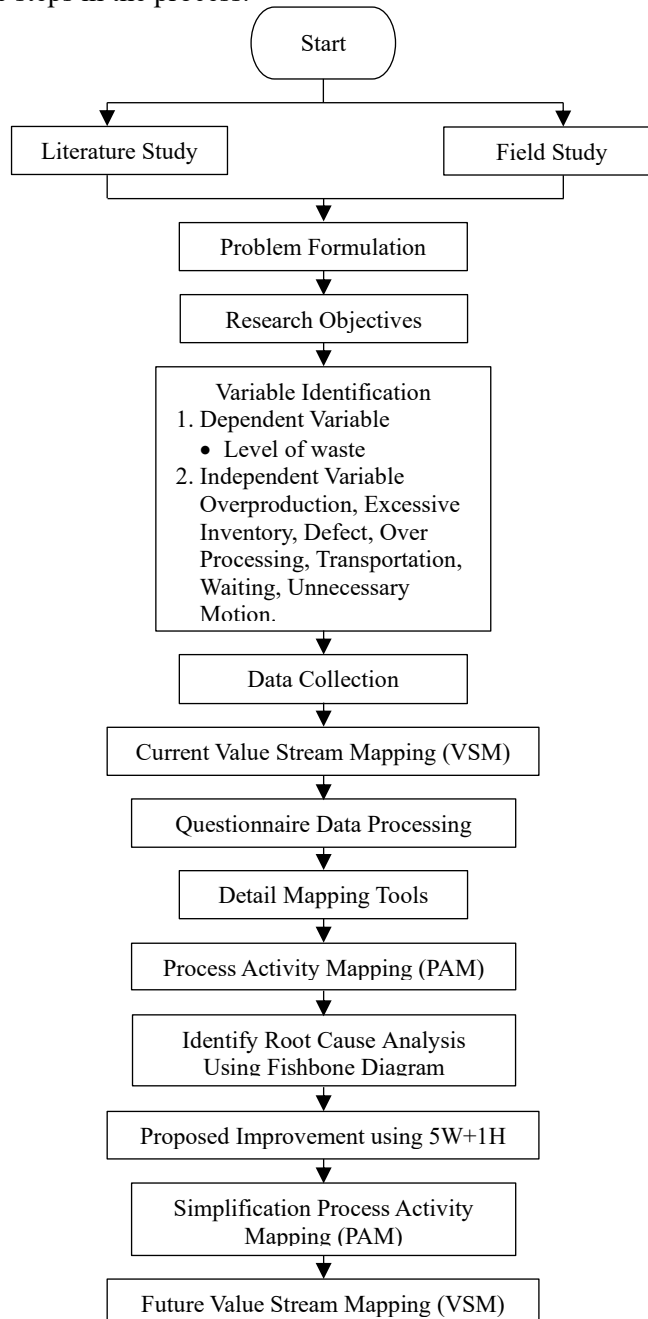
III. METHOD

A. Data Collection Methods

Data from questionnaires, waste drivers, warehouse activity flow, warehouse information flow, and warehouse time were all gathered. The process activity flow and warehouse information data were used to generate an initial Value Stream Mapping (VSM). After ranking waste scores using questionnaire processing, the findings were examined in Value Stream Analysis Tools (VALSAT) to determine which tool was best. In order to find wasteful processes within the process flow, Process Activity Mapping (PAM) was chosen for this research. After identifying waste drivers using a fishbone diagram, improvement designs were proposed using the 5W+1H technique.

B. Data Processing Method

A flowchart is a visual depiction of a process flow that it used to help people comprehend the steps in the process.



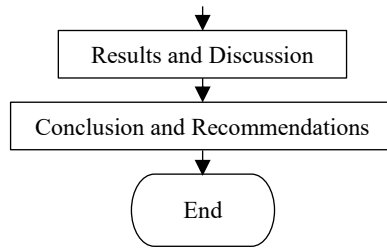


Figure 1. Flowchart

IV. RESULT AND DISCUSSION

A. Data Collection

The primary data used is the warehouse flow process, which is categorized into Value Added Activity (VA), Necessary but Non Value Added Activity (NNVA), and Non Value Added Activity (NVA).

Tabel 2.
Warehousing Process Data

No	Detail Activity	Time (minutes)	Type of Activity
Receiving			
1	Collection of products from Production Dept.	2	VA
2	Inspection of the physical condition of product before transfer.	1	NNVA
3	The Production Dept. sends products to finished goods warehouse.	2	VA
Storage			
4	Searching for empty lots for product placement.	6	NVA
5	Placing products in the storage area.	2	VA
6	Recording products delivered to the warehouse on the bagging off form.	2	NNVA
7	Reporting on product shipments from Production Dept.	3	NNVA
Record			
8	Checking the suitability of location, quantity, and type of products received.	31	VA
9	Verifying the suitability of the product receipt results.	5	NNVA
10	Recording products that are suitable in terms of location, quantity, and type in the Production Report Book.	4	NNVA
11	Checking the overall stock of products in the warehouse.	79	NNVA
12	Checking the conformity of physical stock documents and bagging off forms.	7	NNVA
13	Recording and reporting the overall daily stock in the system.	7	NNVA
14	Warehouse officers report the stock in warehouse to PPIC Dept.	2	NNVA
Inspection			
15	Quality Control Dept checks the condition of feed products.	122	NNVA
16	Quality Control Dept issues feed products condition documents.	2	VA
Processing			
17	Forklift operators retrieve forklifts from the equipment room.	5	NVA
18	Warehouse staff & forklift operators wait for the pickup fleet.	3	NVA
19	Trucks queue to enter the company area.	2	NNVA
20	Trucks enter Pos 6 and officers verify the driver's and vehicle identity.	2	NNVA
21	Pos 6 officer hand over the KIM (Kartu Izin Masuk) to driver.	1	NNVA
22	The driver heads to the company parking lot.	5	NVA
23	The driver waits for Delivery Order (DO) at the Sales Dept.	3	NVA
24	The driver receives Delivery Order (DO) document from Sales Dept.	6	VA
25	The driver waits in line and proceeds to weighing process 1 (empty truck weight).	5	NVA

26	The truck undergoes weighing (1) for empty weight.	2	VA
27	The truck leaves weighing (1) and heads to the front parking area of the loading dock.	1	NVA
28	The truck queues in the front parking area of the loading dock and opens the cargo compartment.	63	NNVA
29	Warehouse staff check the cleanliness of the truck before loading.	1	NNVA
Loading			
30	Warehouse staff receive Delivery Order (DO) from Sales Dept.	1	VA
31	Adjust the product batch & stock for the products to be picked.	4	VA
32	Search for the storage location of the requested products.	3	VA
33	Pick the orders product in storage area.	7	VA
34	Place the products in the loading dock area.	1	NNVA
35	The product waiting workers for the transfer process.	15	NVA
36	Check the condition of products and sort out defect product.	2	NNVA
37	Retrieve replacement for the defect product.	7	VA
38	Worker moving suitable product from pallet into truck.	15	VA
39	The driver closes the door and cargo compartment.	3	NNVA
Shipping			
40	The driver heads to weighing room (2).	3	NNVA
41	Performing weighing (2) weight after loading.	2	VA
42	The weighing room officer adjusts the driver's Delivery Order (DO) in the system.	2	VA
43	The admin creates a waybill based on the weighing results.	2	VA
44	The driver waits to collect the validated waybill & Delivery Order (DO).	1	NVA
45	Collects the waybill and the truck leaves the company premises.	3	VA

B. Current Value Stream Mapping (VSM)

Based on physical flow and information flow data, the warehouse flow process is illustrated in Value Stream Mapping (VSM).

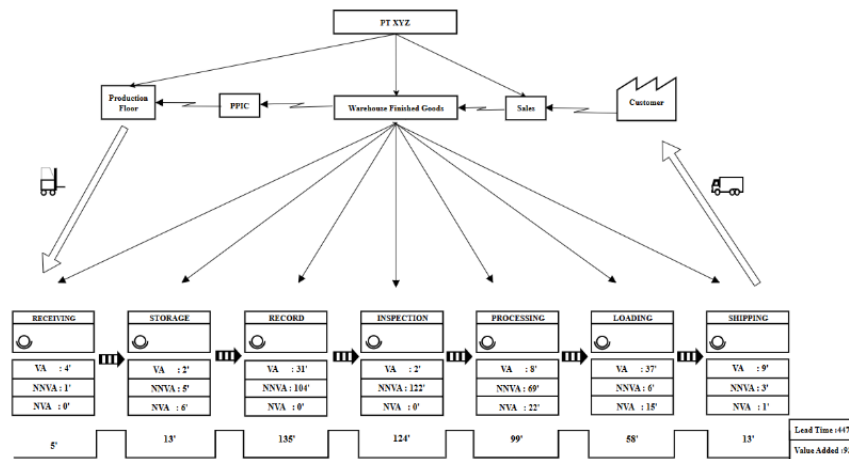


Figure 2. Current Value Stream Mapping

Process Cycle Efficiency (PCE) in this current Value Stream Mapping (VSM) is 20,81%. As a result, the warehouse flow process at the finished goods is inefficient.

C. Questionnaire Data Processing

The questionnaire data was given to 5 employees directly involved in the warehouse flow process at the finished goods warehouse PT XYZ. Next, the questionnaire results were weighted.

Tabel 3. Questionnaire Weight

Waste	Respondent					Total	Weight	Rank
	R1	R2	R3	R4	R5			
Waiting	4	3	3	3	5	18	0,20	1
Over Processing	4	2	3	3	4	16	0,17	2
Transportation	4	3	2	2	3	14	0,15	3
Excessive Inventory	4	3	2	3	1	13	0,14	4
Defect	3	2	3	2	2	12	0,13	5
Unnecessary Motion	3	2	2	2	1	10	0,11	6
Over Production	2	2	2	2	1	9	0,10	7
Total						92		

D. Detail Mapping Tools

Value Stream Analysis Tools (VALSAT) are tools that can be used to identify waste in detail and in depth. The following is a Value Stream Analysis Tools (VALSAT) matrix used to calculate waste weight.

Tabel 4. Result Score VALSAT Selection Matrix.

Waste	Mapping Tools						
	PAM	SCRM	PVF	QFM	DAM	DPA	PS
Overproduction	0,10	0,30		0,10	0,30	0,30	
Waiting	1,80	1,80	0,20		0,60	0,60	
Transportation	1,35						0,15
Over Processing	1,53		0,51	0,17		0,17	
Excessive Inventory	0,42	1,26	0,42		0,42	0,42	0,14
Unnecessary Motion	0,99	0,11		0,99			
Defect	0,13						
Total	6,32	3,47	1,13	1,26	1,32	1,49	0,29

Then sorted from highest to lowest score, indicating the level of suitability of each tool to be used.

Tabel 5. Ranking Tools VALSAT.

Determination of VALSAT Tools			
No	VALSAT	Total Score	Ranking
1	Process Activity Mapping	6,32	1
2	Supply Chain Response	3,47	2
3	Decision Point Analysis	1,49	3
4	Demand Amplification Mapping	1,32	4
5	Quality Filter Mapping	1,26	5
6	Production Variety Funnel	1,13	6
7	Physical Structure	0,29	7

Based on the table above, the highest scoring mapping tool is Process Activity Mapping (PAM) with a score of 6,32. Therefore, Process Activity Mapping (PAM) was selected for further analysis.

E. Process Activity Mapping (PAM)

Process Activity Mapping (PAM) is a mapping tool used to identify activities that provide added value. The following are the results of calculating the frequency and time percentage for each activity.

Tabel 6. Result Process Activity Mapping (PAM)

Activity	Frequency	Time	% Frequency	% Time
Activity				
Operation	23	51,11%	246	55,03%
Transportation	6	13,33%	29	6,49%
Inspection	7	15,56%	123	27,52%
Storage	3	6,67%	16	3,58%
Delay	6	13,33%	33	7,38%
Type of Activity				
VA	17	37,78%	93	20,81%
NNVA	19	42,22%	310	69,35%
NVA	9	20,00%	44	9,84%

F. Identify Root Cause Analysis Using Fishbone Diagram

Fishbone diagrams are tools used to identify the root causes of waste. There are three main types of waste for cause effect analysis using fishbone diagrams. In this study, there are 3 types of waste that are considered the most significant: Waiting, Over Processing, and Transportation. Waiting waste is waste that occurs due to waiting time.

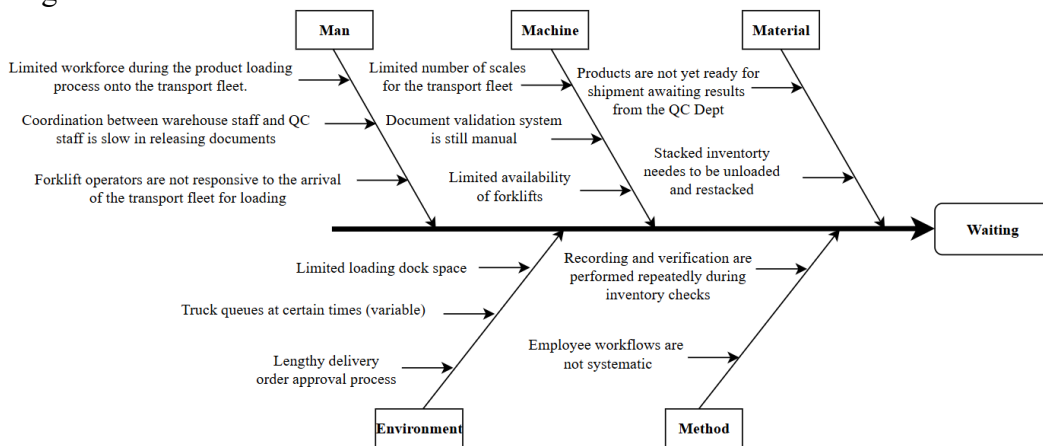


Figure 3. Fishbone Diagram Waste Waiting

G. Proposed Improvement Using 5W+1H

A proposed improvement plan using 5W+1H can be developed after identifying the factors causing waste in the fishbone diagram.

Tabel 7. Proposed Improvement 5W+1H

5W+1H	Question	Answer
What	What are the areas of waste?	According to the results of the investigation, the three most common types of waste are Waiting (0,20), Over Processing (0,17), and Transportation (0,15).
Why	Why does waste need to be addressed?	Because of the total time required of 447 minutes, there are 93 minutes of Value Added Activity (VA) (20,81%), 310 minutes of Necessary but Non Value Added Activity (NNVA) (69,35%), and 44 minutes of Non Value

		Added Activity (9,84%). As a result, warehouse finished feed product flow procedure remains ineffective and inefficient.
Where	Where stage does most waste occur?	According to Process Activity Mapping (PAM), waste happens most frequently in Operations (246 minutes or 55,03%), Inspection (123 minutes or 27,52%), and Delay (16 minutes or 7,38%). If this waste is not addressed, it will result in increased Waiting, Over Processing, and Transportation waste.
When	When is the right time to make improvement?	The implementation time for improvements based on the highest waste categories, beginning with Waiting, Over Processing, and Transportation, is decided by working with relevant parties to make continuous improvements with regular evaluation and monitoring of design outcomes.
Who	Who is responsible?	The warehouse flow process is the responsibility of all relevant parties, including the Sub-Warehouse Manager, Warehouse Staff Coordinator, and Warehouse Staff, who have collaborated with the Head Plant managing the Warehouse Sub-Dept.
How	How the recommendations for improvement	<p>The following are some examples of improvement recommendations for each type of waste occurring in the finished feed product warehouse:</p> <ul style="list-style-type: none"> • Waiting: Workforce adjustments, addition of forklifts, implementation of visual management, and arrival scheduling. • Over Processing: Preparation of job descriptions, utilization of barcode technology with RFID, addition of pallets, and standardization of product calculations. • Transportation: Utilization of barcode systems, implementation of product classification based on turnover rates, and implementation of visual management. • Excessive Inventory: First In First Out (FIFO) audit, warehouse capacity evaluation, and interdepartmental coordination. • Defect: Implementation of SOPs, training of forklift operators, and minimizing stacking. • Unnecessary Motion: Implementation of visual management, addition of forklifts, and layout arrangement. • Over Production: Improved coordination between departments and implementation of forecasting strategies.

H. Simplification Process Activity Mapping (PAM)

The following is a comparison table of Process Activity Mapping (PAM) before and after improvements were made.

Tabel 8. Comparison Process Activity Mapping (PAM)

Activity	Frequency	Time	% Frequency	% Time
Before Improvements				
Activity				
Operation	23	51,11%	246	55,03%
Transportation	6	13,33%	29	6,49%
Inspection	7	15,56%	123	27,52%
Storage	3	6,67%	16	3,58%
Delay	6	13,33%	33	7,38%
Type of Activity				
VA	17	37,78%	93	20,81%
NNVA	19	42,22%	310	69,35%
NVA	9	20,00%	44	9,84%
After Improvements				
Activity				
Operation	22	61,11%	171	63,57%
Transportation	4	11,11%	23	8,55%
Inspection	7	19,44%	59	21,93%
Storage	3	8,33%	16	5,95%
Delay	0	0%	0	0%

	Type of Activity			
VA	17	47,22%	93	34,57%
NNVA	19	52,78%	176	39,37%
NVA	0	0%	0	0%

I. Future Value Stream Mapping (VSM)

Based on the results of data processing and the proposed improvement plan that has been carried out, Value Stream Mapping (VSM) can eliminated NVA and reduced NNVA.

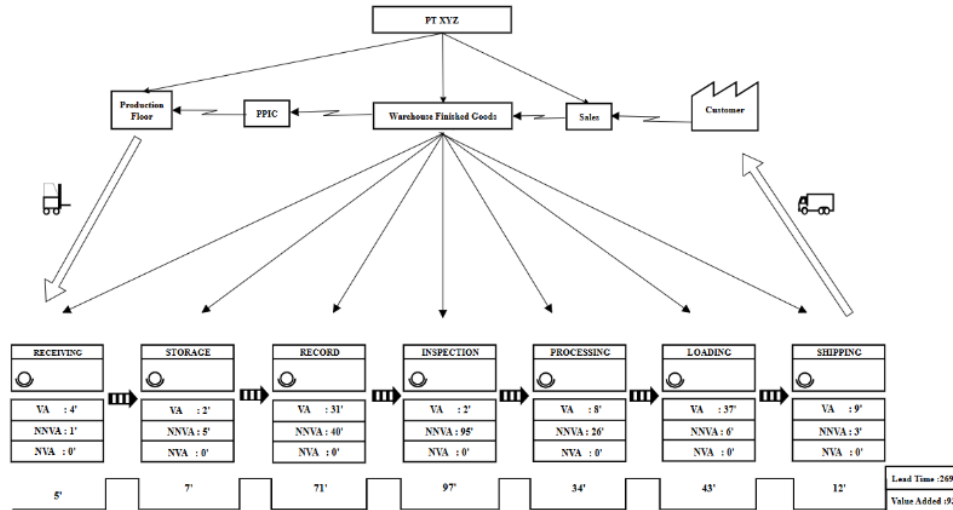


Figure 4. Future Value Stream Mapping

Process Cycle Efficiency (PCE) in this future Value Stream Mapping (VSM) is 34,57%.

V. CONCLUSION

Based on the results of the study, the finished goods warehouse flow process at PT.XYZ is still inefficient and experiences several types of waste that affect process time. The highest types of waste that occur include Waiting, Over Processing, and Transportation. The results of the analysis using Value Stream Mapping (VSM), Value Stream Analysis Tools (VALSAT), and Process Activity Mapping (PAM) show that the total processing time for warehousing decreased from 447 minutes to 269 minutes after improvements were made. The percentage of Value Added Activity (VA) also increased from 20,81% to 34,57%. The recommended improvements include the use of supporting technologies such as RFID and barcodes to improve inventory management efficiency, rearranging the warehouse layout and adding signs to facilitate the flow of goods, and implementing training and work supervision in accordance with Standard Operating Procedures (SOP) to support continuous improvement.

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