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Analysis of waste in the flow process warehouse using the lean warehousing method: case in an animal feed company

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ABSTRACT

Waste that occurs in the flow of warehousing of premix animal feed raw materials in animal feed companies can reduce the effectiveness and efficiency of company activities. The large number of raw material needs also increases warehousing activities. The complexity of activities and types of raw materials is what causes warehouses to often experience wasteful activities with a total time exceeding the company's standard of 420 minutes. Therefore, the purpose of this study is to determine what waste occurs in the warehouse using the lean warehousing method and to provide suggestions for improvement with Plan, Do, Check, Action and Seiri, Seiton, Seiso, Seiketsu, Shitsuke. The analysis carried out using the lean warehousing method is important for the category of activities that provide added value, the category of activities that are needed, the category of activities that are not needed, and the time of the warehousing flow can be known through value stream mapping both before and after improvement. From the analysis carried out, it was obtained that there were 52 warehouse flow activities with an activity time of 556 minutes, which after being given a suggestion for improvement in the warehouse flow activity process decreased to 39 activities with a total time of 304 minutes.

1. Introduction

Today's modern industry focuses on speed, productivity, and efficiency in logistics activities which are very important in the industrial economy (Hashemkhani et al, 2023). In logistics activity operations, warehousing plays an important role in being the key to maintaining a company's competitive advantage by utilizing resources effectively and delivering the right product, to the right place and at the right time (Rakhman et al, 2023). Storing goods requires a system and location that is used as a means of storing both products and spare parts (Nuryono et al., 2024). In its activities, the warehouse has several challenges that must be considered, namely waste which is considered an operation that does not provide added value such as waiting, transportation, excessive processing, inventory excess, motion, defect (Ketchanchai et al, 2021), non-utilized employees (Chaitien & Ramingwong, 2024) and searching time (Dzulkifli & Ernawati, 2021). If this waste is not handled properly, it can result in waste of efficiency in the warehouse flow process which causes customer dissatisfaction (Augusto et al, 2022), this dissatisfaction has the potential to damage the company's reputation (Biesok & Wróbel, 2024). By saving warehouse flow, it will minimize the risk of storing a product (Haque et al, 2024).

One of the companies in Indonesia that has not paid attention to the flow of warehousing which results in waste in its warehouse 1 is ABC Company. This Company is engaged in the manufacturing industry with production results in the form of animal feed. Warehouses 2, 3, 4, 5, 7, 11 raw materials

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for premix animal feed have warehousing activities with a cycle time of 420 minutes per day, while warehouse 1 raw materials for premix animal feed have warehousing activities with a cycle time of 556 minutes per day. Warehouse 1 of premix raw materials has a larger cycle time per day when compared to other premix raw material warehouses because it is indicated that there is waste in its warehousing flow, namely waste of searching time with the activity of searching for an empty place to put raw materials into the warehouse, waste of defects occurs in expired products due to the accumulation of inventory, waste of waiting occurs in the activity of waiting for warehouse workers, waste of inventory excess occurs in raw materials placed outside the warehouse floor demarcation, waste of excessive processing occurs in the activity of repackaging raw materials due to damaged sacks, waste of non-utilized employees occurs in the activity of workers stacking raw materials from trucks to pallets carelessly, waste of transportation occurs because of the long distance between the loading dock and the product to be taken, waste of motion occurs in the activity of identifying raw materials that takes a long time, waste of searching time. If this waste is not eliminated, it will result in delays in the production process of raw materials for animal feed which can be detrimental to the company. Therefore, it is important to improve waste in the activities of warehouse 1 of premix raw materials for animal feed.

Warehousing can combine various tools based on lean philosophy in the company's warehousing system to increase effectiveness and efficiency (Quiroz-flores et al, 2023). The role of lean in warehousing that can help increase effectiveness and efficiency is lean warehousing which is based on reducing waste in the warehouse to provide warehouse flow value by producing utility in place and time (Pachauri Carbajal et al, 2023; Muri et al, 2019). The use of lean warehousing is superior to the waste assessment model in analyzing warehouse waste, because the waste assessment model in the simplicity of the matrix and questionnaire covers many things and is able to contribute to achieving accurate results in identifying the root causes of waste (Sudri et al, 2021) by assessing whether the waste is good or not using a percentage, while lean warehousing can identify warehouse flows more specifically on the amount of waste time by looking at the value stream mapping (VSM) and process activity mapping so that lean warehousing does not only assess the good or bad performance of the existing waste. With lean warehousing, you can see a representative overview of activities in all areas and easily identify activities that add value, do not add value and are not needed which result in waste, as well as activities that do not add value but are still needed (Augusto et al, 2023).

In several previous studies, they did not focus on the attributes that caused waste but rather focused on the types of waste that caused the analysis carried out on the waste to be less than optimal. In addition, the proposed improvements provided only utilized the use of Seiri, Seiton, Seiso, Seiketsu, Shitsuke (5S) without paying attention to planning and checking which caused the implementation of 5S not to be carried out properly in the work environment. Therefore, this study was conducted by focusing on the attributes of the types of waste in warehousing activities so that the causes of waste in warehousing activities can be known in more depth and the use of the Plan, Do, Check, Action (PDCA) method in the proposed improvements provided so that the implementation of 5S with a sustainable PDCA approach (Nirwana et al., 2024).

This study aim to finding out what waste causes suboptimal warehousing flow and reducing waste in the warehousing flow using the lean warehousing method with proposed improvements to PDCA and 5S so that warehousing activities in warehouse 1 of premix animal feed raw materials can run effectively and efficiently in a sustainable manner.

2. Methods

Assumptions

The research was conducted in warehouse 1 of animal feed company premix raw materials from August 2024 to November 2024. Data collection began with a discussion with the head of the warehouse department regarding the process flow of activities in warehouse 1 of premix animal feed raw materials and then calculating the time for each activity using a stopwatch with a time unit of minutes.

Value Stream Mapping

After data collection is carried out, VSM is carried out which can describe the overall flow throughout all warehousing operations and show how value can be created for customers and explain obstacles to the flow (King & Jennifer, 2015)

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Process Activity Mapping

Process Activity Mapping (PAM) is used to evaluate each activity carried out to run effectively and efficiently (Mukti & Alfaritsy, 2024) which is divided into categories of Value Adding Activity (VA), Non Value Adding Activity (NVA) or Necessary Non Value Adding Activity (NNVA). NVA activities should be reduced to a minimum in order to result in a reduction in wasted time (Pasha & Chin, 2024). In addition, Process Cycle Efficiency (PCE) is also calculated which is the percentage of time used to add value compared to the total time used during the process. The calculation formula for Process Cycle Efficiency (PCE) can be shown in Equation 1 (Komarian, 2022)

$$\text{PCE} = \frac{\text{Total Value Added Time}}{\text{Total Lead Time}} \times 100\% \quad (1)$$

TIM U WODS Assessment

Completion of the questionnaire by warehouse assistants who understand the warehouse conditions to determine the existence of eight types of waste (Augusto et al., 2023) according to (Chaitien and Ramingwong, 2024) is divided into 8 types, namely defects, waiting, transportation, inventory excess, motion waste, excessive processing (Taqwanur, 2021), non-utilized talent, (Pattiapon and Magdalena, 2020), searching time (Dzulkifli and Ernawati, 2021). After that, a validity test was carried out on the questionnaire results using Equation 2 to determine whether the questionnaire was able to measure respondents' knowledge well (Behavior et al., 2022).

$$r_{xy} = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{\{n\sum X^2 - (\sum X)^2\}\{N\sum Y^2 - (\sum Y)^2\}}} \quad (2)$$

Data that is declared valid will undergo a reliability test to measure the extent to which the instrument provides stable and consistent results with the Cronbach Alpha reliability index using Equation 3.

$$r_{ii} = \frac{n}{n-1}\left(1 - \frac{\sum S_t^2}{S_t^2}\right) \quad (3)$$

Fishbone Diagram

From the waste that has been identified, an analysis is carried out using a fishbone diagram. Fishbone diagrams describe various reasons that affect the process by linking one cause to another (large bones leading to the head) (Widya et al., 2023) so that the cause of waste can be identified. Identify the root cause of the method, environment (Pande et al., 2003), man, machine, materials (Muchlisin et al., 2022) indicators.

Suggested Improvements

After the indicators of the cause of waste are known, improvements are proposed with the PDCA cycle. This cycle is usually used to analyze and apply every change that occurs to improve a process, system, and product performance (Rahmawati & Tatoro, 2023). Planning is done to build a strong foundation for continuous improvement, then identify areas that need improvement and develop strategies to reduce or eliminate waste, assess implementation results, and conduct testing and evaluation on a wider scale (Qulub et al., 2024). In the Do cycle itself, there are improvements with 5S which can carry out intensive work area arrangement and maintenance used by management in an effort to maintain order, discipline, and efficiency at the work location while improving overall company performance (Poerbaninglaksmi & Budiawan, 2024).

3. Results and Discussion

Current Value Stream Mapping

This session provides an overview of the flow activity system in warehouse 1 of the initial premix type of animal feed raw materials. The process flow, information flow, and material flow can be seen in Fig.

1. From this mapping, the initial PCE value can also be seen using Equation 1 which shows the percentage of time in the activity of warehouse 1 of the initial premix type of animal feed raw materials. The Current VSM in warehouse 1 of the initial premix type of animal feed raw materials at ABC Company can be seen in Fig. 1.

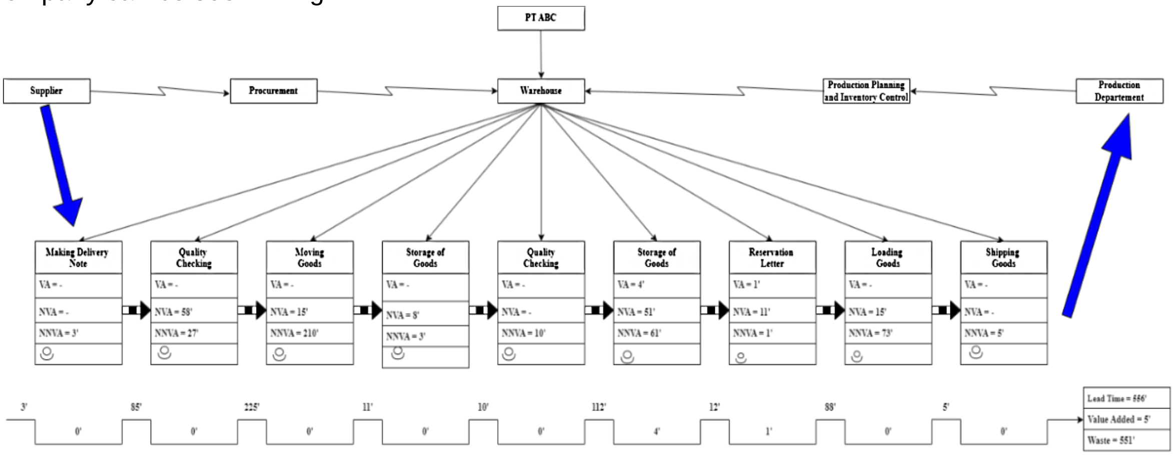

Fig. 1 Current Value Stream Mapping.

Fig. 1 illustrates that the total activity time for the process flow in Warehouse 1 of ABC Company's premix animal feed raw materials is 556 minutes. This comprises 5 minutes in the VA category, 393 minutes in the NNVA category, and 158 minutes in the NVA category. The total activity time exceeds the employee working hour capacity of 420 minutes. The Process Cycle Efficiency (PCE) value, calculated using Equation 1, is 0.89%. This value can be improved by minimizing non-value-added activities in the Non-Value-Added category and reducing time spent in the Necessary Non-Value-Added category, enabling the warehousing flow to operate more effectively and efficiently.

Initial Activity Mapping Process

The warehousing activity categories consist of VA, NVA, and NNVA categories. The types of warehousing activities consist of operation, transportation, inspection, storage, delay. The calculation of the amount and percentage of warehouse flow activities for 1 raw material for premix animal feed can be seen in Table 1.

Table 1 The number and percentage of activity categories and initial activity types

No	Description	Total Activity	Percentage of Activity	Activity Time (minutes)	Percentage
	Activity Categories				
1	Value Added (VA)	3	5.77%	5	0.89%
2	Non Value Added (NVA)	13	25%	158	28.42%
3	Necessary Non Value Added (NNVA)	36	69.23%	393	70.69%
	Type Activities				
1	Operation	30	57.69%	118	21.12%
2	Transportation	10	19.24%	129	23.20%
3	Inspection	7	13.47%	35	6.2%
4	Storage	2	3.8%	15	2.8%
5	Delay	3	5.8%	259	46.68%

Table 1 provides a detailed breakdown of activities, showing 3 VA activities (5.77%), 13 NVA activities (25%), and 36 NNVA activities (69.23%). The corresponding activity times are 5 minutes (0.89%) for VA, 158 minutes (28.42%) for NVA, and 393 minutes (70.69%) for NNVA. The table also categorizes activities by type: Operation activities dominate with 30 instances (57.69%), followed by Transportation (10 activities, 19.24%), Inspection (7 activities, 13.47%), Storage (2 activities, 3.8%), and Delay (3 activities, 5.8%). In terms of time allocation, Operation activities account for 118 minutes (21.12%), Transportation for 129 minutes (23.20%), Inspection for 35 minutes (6.2%), Storage for 15 minutes (2.8%), and Delay for 259 minutes (46.68%). This data highlights the significant time consumed by Delay and NNVA activities, suggesting potential areas for improvement to enhance efficiency.

Questionnaire Result

The questionnaire conducted in Table 2 is to determine the weight of the largest waste attribute that can disrupt the process time of warehouse flow activities or have a longer time. After weighting, a ranking will be carried out to determine the waste with the highest value in warehouse activities. This questionnaire was filled out by 8 workers who understood the contents of the questionnaire and understood warehouse activities in the field.

Table 2 Summarizes the questionnaire results

No	Waste Code	Waste Attribute	Score from Worker								To-tal	Wei-ght	Ra nk
			1	2	3	4	5	6	7	8			
1	Defect 1	A decrease in product quality caused by the accumulation of inventory.	2	1	1	1	1	1	1	2	10	1.24	22
2	Defect 2	Sacks of raw materials that are easily damaged (torn).	4	4	2	2	1	1	4	4	22	2.75	5
3	Defect 3	When the raw materials arrive the product quality is damaged or defective.	4	2	1	2	1	1	2	3	16	2.00	14
4	Waiting 1	The minimal amount of material handling available in the warehouse.	4	4	1	1	2	2	2	4	20	2.50	10
5	Waiting 2	order picking note documents .	2	2	1	2	2	2	2	4	17	2.12	12
6	Waiting 3	The production department does not schedule shipments of goods to the production floor.	5	5	2	1	3	3	2	5	26	3.25	3
7	Non-utilized employee 1	Warehouse workers are less skilled in how to move raw materials due to lack of socialization or training.	2	2	2	1	1	1	2	3	14	1.75	15
8	Non-utilized employee 2	Careless handling of products by warehouse workers.	2	1	1	1	1	1	1	2	10	1.25	21
9	Non-utilized employees 3	Warehouse workers' creative ideas go unused, which is considered a waste of human resources.	3	3	2	2	2	3	3	3	21	2.62	7
10	Transportation1	When material is moved, products fall from the pallet to the warehouse floor.	4	4	1	2	3	4	4	4	26	3.26	2
11	Transportation 2	The distance between the goods taken is due to the failure to categorize the products according to their contribution from the lot to *the cross docking* .	4	4	2	1	2	2	4	4	23	2.87	4
12	Transportation 3	Production clerks verify orders manually and remotely from the production department.	4	2	1	2	3	3	2	4	21	2.61	8
13	Inventory excess 1	There is unnecessary material in the warehouse.	2	2	1	1	2	2	2	4	16	2.01	13

Table 2 Continue

No	Waste Code	Waste Attribute	Score								To-tal	Wei-ght	Ra nk
			1	2	3	4	5	6	7	8			

14	Inventory excess 2	Excess product quantity causes excess stock in the warehouse.	5	5	2	4	2	2	2	5	27	3.37	1
15	Inventory excess 3	There are damaged goods in the warehouse.	3	2	1	3	2	2	2	4	19	2.37	11
16	Motion 1	Plot workers carry out several moving activities manually, thus adding a lot of time to their activities.	2	2	1	1	1	1	2	2	12	1.51	18
17	Motion 2	When storing materials in a warehouse, forklift *operators* have difficulty identifying the type of material because not all of the stored materials are identified and sometimes the placement does not match the identity.	2	2	1	1	1	2	2	2	13	1.62	17
18	Overproc essing 1	Improper transfer of goods from stacks (lots or trucks) to pallets causes additional processes.	4	4	2	2	1	1	3	4	21	2.62	9
19	Overproc essing 2	The raw material products are not stacked properly so they fall easily.	2	2	1	1	1	1	2	2	12	1.50	19
20	Overproc essing 3	Raw materials are not palletized during storage.	3	1	1	1	1	1	1	2	11	1.37	20
21	Search time 1	How often do operators go back and forth looking for the location of the raw materials needed on the plot?	3	1	1	1	2	1	1	4	14	1.74	16
22	Searchin g time 2	How often do you search for items or tools (pallets) that are hard to find?	4	3	2	3	2	2	3	3	22	2.74	6

Table 2 highlights the top five waste attributes based on their weighted impact. The highest weight, 3.37, corresponds to excess product quantity leading to overstock in the warehouse (waste code: Inventory 2). The second largest weight, 3.26, occurs during material transfer when products fall from the pallet onto the warehouse floor (waste code: Transportation 1). The third-ranked waste, with a weight of 3.25, is attributed to the production department not scheduling timely deliveries to the production floor (waste code: Waiting 3). The fourth, with a weight of 2.87, involves inefficient transportation caused by miscategorized products, leading to longer distances from the lot to cross-docking areas (waste code: Transportation 2). Lastly, the fifth waste, with a weight of 2.75, is due to easily damaged raw material sacks (waste code: Defect 2). These top-ranked wastes will be analyzed further to identify their root causes and develop strategies to mitigate them.

Identifying Causes of Waste

To find out the causes and effects caused by waste that occurs in warehouse 1 of premix animal feed raw materials at ABC Company by identifying using a fishbone diagram. The following is an identification of causes and effects using a fishbone diagram .

A. Excess product quantity causes excess stock in the warehouse

An analysis using a fishbone diagram to determine the cause of Inventory 2 waste can be seen in Fig. 2. Based on Fig. 2, the quantity of raw materials in the warehouse often experiences excessive storage with indications of accumulation of raw materials in warehouse lots without pallets. This excessive quantity of raw materials can increase the time in the process of moving materials or additional treatment of raw materials that will be moved from lots to pallets or from pallets to lots.

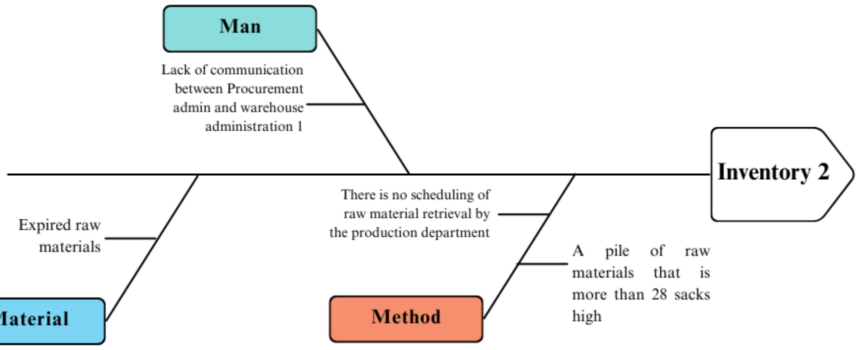

Fig. 2 Fishbone diagram *of inventory* waste 2.

B. When material transfer occurs, products fall from pallets to the warehouse floor.

Analysis using *a* fishbone diagram to determine the cause of Transportation 1 waste can be seen in Fig. 3. Based on Fig. 3, the movement of premix animal feed raw materials when transported by forklift operators often falls from the pallet to the warehouse floor. This can add time to the activity of moving materials from cross docking to lots or from lots to cross docking.

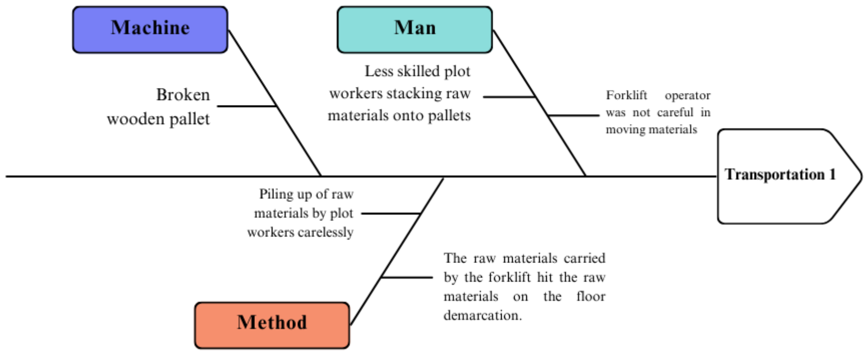

Fig. 3 Fishbone diagram of transportation waste 1.

C. The production department does not schedule the delivery of goods to the production floor.

Analysis using a fishbone diagram to determine the cause of the waste of Waiting 3 can be seen in Fig. 4. Based on Fig. 4, the schedule for sending raw materials from the raw materials warehouse to the production floor is not *scheduled*, so that warehouse 1 must wait for confirmation from the production clerk to send the reservation form to the warehouse. This will certainly increase activity time because of waiting for confirmation from the production department.

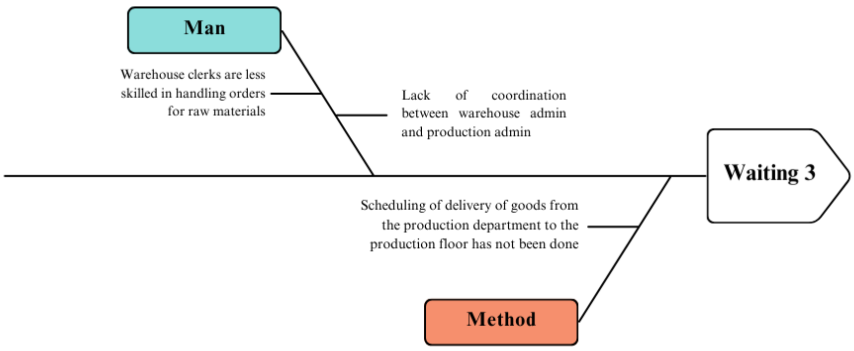

Fig. 4 Fishbone diagram of waiting waste 3.

D. The distance of the goods taken is due to the product not being categorized according to its contribution from the lot to the cross docking.

Analysis using a fishbone diagram to determine the cause of Transportation 2 waste can be seen in Fig. 5. Raw materials taken by forklift operators often take a long time because the raw materials that contribute greatly are often located far from the loading area, this makes forklift *operators* have to take raw materials from a long distance when the goods are to be loaded.

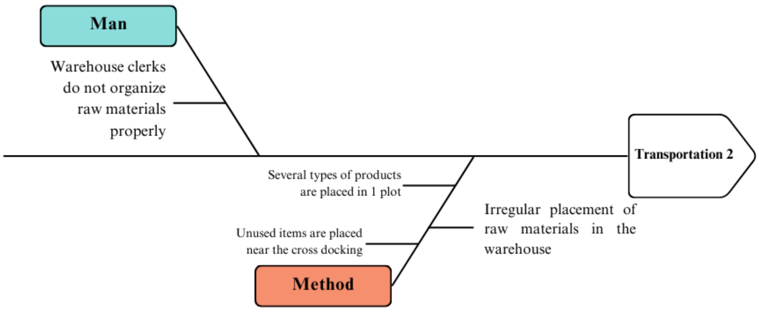

Fig. 5 Fishbone diagram of transportation waste 2.

E. Sacks of raw materials that are easily damaged (torn)

Analysis using a fishbone diagram to determine the cause of waste in Defect 2 can be seen in Fig. 6. Based on Fig. 6, the waste of raw material sacks is easily torn due to the inappropriate working methods of the plot workers and forklift operators on the raw materials, resulting in additional time for sewing the raw material sacks.

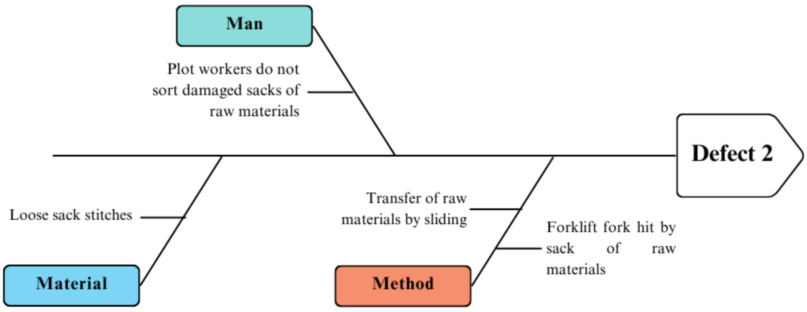

Fig. 6 Fishbone diagram of defect waste 2

Suggested Improvements based on Factors Causing Waste

Waste 1, identified as excess product quantity leading to overstock in the warehouse (*Inventory 2*), is addressed through proposed improvements outlined in the fishbone diagram. Detailed recommendations for each contributing factor are presented in Table 3.

Table 3 Proposed improvement for Inventory 2

No	Factor	Reason	Suggested improvements
1	Man	*Procurement* department admin and warehouse administration 1.	Utilizing the Enterprise Resource Planning system with SAP software, namely Material Management
2	Material	Expired raw materials are still in piles in the warehouse	The procedure for placing raw materials in such a way that the first material to arrive is the first to be sent to the production floor (First Come First Serve).
3	Method	Planning for raw material retrieval by the production department has not been properly scheduled.	Scheduling the delivery of raw material requirements is carried out H-1 before the required goods are sent to the production floor.
		Stack raw materials that are more than 28 sacks high in 1 plot	Throwing away damaged wooden pallets and unused sacks that occupy the plot outside the warehouse, so that there is a place to put raw materials.

Waste 2, identified as product falls from pallets to the warehouse floor during material movement (*transportation 1*), is addressed through proposed improvements. Detailed recommendations for each contributing factor are outlined in the Transportation 1 waste fishbone diagram, as shown in Table 4.

Table 4 Proposed improvements for Transportation 1

No	Factor	Reason	Suggested improvements
1	Machine	Broken wooden pallet	Conduct regular checks on wooden pallets before they are used to transport raw materials and replace them with new pallets.
2	Man	Plot workers are less skilled in stacking raw materials from plots to pallets and from trucks to pallets.	Provide direction to the plot workers to stack the raw materials neatly so as to speed up the transfer of raw materials.
		Forklift operator was not careful when moving raw materials.	Provide direction to forklift operators so that the transfer of raw materials can be carried out immediately.
3	Method	Stacking of raw materials that are not tidied up on pallets.	Provide direction to plot workers.
		The raw materials carried by the forklift hit the raw materials on the floor demarcation.	Tidy up the layout of raw materials according to floor demarcation.

Waste 3, identified as the production department does not schedule the delivery of goods to the production floor (*waiting* 3), is addressed through proposed improvements. Detailed recommendations for each contributing factor are outlined in the waiting 3 waste fishbone diagram, as shown in Table 5.

Table 5 Proposed improvements to waiting 3

No	Factor	Reason	Suggested improvements
1	Man	Warehouse clerks are less skilled in serving orders.	The warehouse clerk will immediately schedule the delivery after the request is sent by the production admin.
		Lack of coordination between production admin and ware-house admin in scheduling delivery of raw materials to the production floor.	The production admin coordinates with the warehouse admin regarding the goods needed on that day before 8.30 WIB using the SAP Enterprise Resource Planning software system, namely production planning.
2	Method	The work standards in the raw material delivery schedule from the production department to the warehouse floor have not been carried out.	Create work standards in scheduling from the warehouse to the production department

Waste 4, identified as the distance of the goods taken is due to the product not being categorized according to its contribution from the lot to *cross docking* (*Transportation 2)*, is addressed through proposed improvements. Detailed recommendations for each contributing factor are outlined in the Transportation 2 waste fishbone diagram, as shown in Table 6.

Table 6 Proposed transportation improvements 2

No	Factor	Reason	Suggested Improvements
1	Man	Warehouse clerks are not good at arranging raw materials	Provide direction to warehouse clerks to organize raw materials according to demarcations in the warehouse.
2	Method	Several types of products are placed in 1 plot.	Allocate one lot for one type of raw material so that sorting of raw materials is not necessary.
		Unused items are placed near *the* cross docking.	Remove unused items near the cross docking so that they can be used as a place to store raw materials so that the distance between the movement of raw materials and the loading area is close.

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		Placing raw materials irregularly in the warehouse.	Place raw materials in the warehouse according to the signs so that the loading of raw materials is ready to be carried out.

Waste 5, identified as raw material sacks are easily damaged or torn (Defect 2), is addressed through proposed improvements. Detailed recommendations for each contributing factor are outlined in the Defect 2 waste fishbone diagram, as shown in Table 6.

Table 7 Proposed improvements *to defect* 2

No	Factor	Reason	Suggested Improvements
1	Man	Unloading workers do not sort damaged sacks of raw materials	Sorting is done before workers move raw materials from trucks to pallets.
2	Material	Loose sack stitches	Sorting raw materials that have loose seams before loading or unloading.
3	Method	Shifting of raw materials	Create standards for moving raw materials by lifting them so that the sacks of raw materials do not tear.
		Forklift fork hit by sack of raw materials	Changing the working method when picking up pallets by lowering the forklift fork base .

Improvement Proposal Based on PDCA and 5S

The proposed improvements to the waste that occurred were carried out using the PDCA concept, with the Do concept containing the 5S concept, namely Seiri (tidy), Seiton (clean), Seiso (neat), Seiketsu (maintain), and Shitsuke (diligent) as follows:

1. Plan (Planning)
   Conduct training and direction to all employees in the production department, warehouse department, quality control department, procurement department regarding the implementation of 5S in the work environment. Conduct socialization to determine goals, targets, and phases implementation of 5S (starting from punishment to reward for implementing 5S). Forming a 5S supervisor who will monitor the implementation of 5S in the work environment.
2. Do (Execute)
   a. Seiri (Abridged)
      - Arrange the raw material warehouse with one lot for one type of raw material to make it easier for workers to identify which materials are used or not used.
      - Delivering goods from the warehouse to the production floor using the First Come First Serve system .
      - Create procedures for how to transport forklift platforms and procedures for moving raw materials as well as providing signs that can be seen by all workers in the warehouse.

   b. Seiton (Neat)
      - Storing raw materials by placing high-contributing raw materials near the loading area so that the retrieval process is faster.
      - Schedule the delivery of goods from the warehouse to the production department.
      - Tidy up the layout of raw materials to match the warehouse floor demarcation.
      - SAP software's Enterprise Resource Planning system in the material management and production planning modules so that the number of goods entering the warehouse can be recorded properly and the scheduling of goods delivery from the warehouse to the production department can be recorded properly.

   c. Seiso (Clean)
      - Conduct warehouse cleaning before unloading or loading activities are carried out. Cleaning is carried out with items such as broken pallets and unused sacks so that the lot is cleaner and the warehouse is wider in accommodating raw materials in larger quantities.
      - Perform initial sorting on raw material sacks when new goods arrive.

   d. Seiketsu (Treatment)
      - Conduct regular checks on machines used for raw material transfer activities such as wooden pallets and replace fragile wooden pallets.

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e. Shitsuke (Diligent)
   - Provide direction to plot workers, forklift operators , warehouse clerks.
   - Implementing a culture of discipline for all warehouse workers and implementing punishment for those who violate the rules and providing rewards for warehouse workers who have the best performance every month in order to increase worker productivity.

3. Check (Checking or inspection)
   Conduct an assessment of the implementation of 5S in the warehouse work environment by conducting an internal audit of the implementation of 5S.
4. Action (Implementing or doing)
   supervisor who assesses and determines whether 5S has become a habit in the performance activities of workers or not. Periodically the supervisor also checks the actual goals to be compared with the goals that have been set.

Future Value Stream Mapping
This sub-chapter provides an overview of the flow activity system in warehouse 1 of the future premix animal feed raw materials. The process flow, information flow, and material flow can be easily seen in Fig. 7. From this mapping, the future PCE value can also be seen which can show the percentage of time in the initial premix animal feed raw material warehouse 1 activity. For Future VSM in warehouse 1 of the premix animal feed raw materials at ABC Company, it can be seen in Fig. 7.

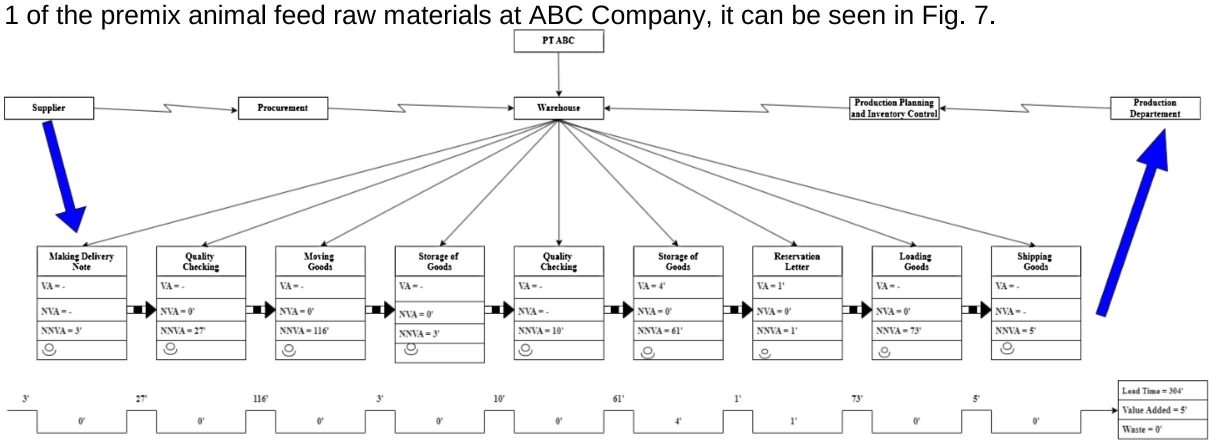

Fig. 7 Future Value Stream Mapping.

From the various flow of activity processes in warehouse 1 of ABC Company's premix animal feed raw materials, the total activity time listed in Fig. 7 is 304 minutes. The time in the warehousing flow activity category is VA for 5 minutes, the NNVA category for 299 minutes, and the NVA category for 0 minutes. The total time is 304 minutes, which is smaller than the employee working hour capacity of 420 minutes. The phenomenon of the PCE value of 1.65% is higher than the initial PCE value of 0.89% because NVA activity category are eliminated and the time in the NNVA activity category is reduced.

Other studies have implemented lean warehousing in warehouses which can reduce time by 0.35% in its activities and in Value Added activities there is a decrease of 0.672% (Ramadhanti et al., 2023). And with the lean warehousing method, the highest waste can be identified with a total of 20 wastes, which are then given suggestions for improvements given for waste in this study, namely implementing the seiri, seiton, seiso, seiketsu, shitsuke (5S) culture. Suggestions for improving movement waste which is the biggest waste are throwing away unnecessary items around the warehouse to facilitate transportation, providing area boundaries for each work station and improving the warehouse layout, especially the work station area, making a cleaning schedule every few hours, especially in the work station area (Nur and Setiawan, 2024).

Process Activity Mapping The Future
The warehousing activity categories consist of VA, NVA, and NNVA activity categories. While the types of warehousing activities consist of operation, transportation, inspection, storage, delay. The calculation of the amount and percentage of warehouse flow activities 1 of premix animal feed raw materials can be seen in Table 8.

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Table 8 Calculation of the number and percentage of activity categories and types of future activities

No	Description	Total Activity	Percentage of Activity	Activity Time (minutes)	Percentage
	Activity Categories				
1	Value Added (VA)	3	7.7%	5	1.65%
2	Non Value Added (NVA)	0	0 %	0	0%
3	Necessary Non Value Added (NNVA)	36	92.30%	299	98.35%
	Type Activities				
1	Operation	23	58.69%	45	14.81%
2	Transportation	8	20.51%	120	39.48%
3	Inspection	5	12.82%	20	6.6%
4	Storage	2	5.1%	15	4.9%
5	Delay	1	2.6%	104	34.21%

Based on Table 8, it can be seen that there are 3 Value Added (VA) activities with a percentage of 1.65%, 0 Non Value Added (NVA) activities with a percentage of 0%, 36 Necessary Non Value Added (NNVA) activities with a percentage of 98.35%. From Table 8, it can also be seen that the Value Added (VA) activity time is 5 minutes with a percentage of 1.65%, the Non Value Added (NVA) activity time is 0 minutes with a percentage of 0%, and the Necessary Non Value Added (NNVA) activity time is 299 minutes with a percentage of 98.35%. It can be seen from Table 8 that the number of Operation activities is 23 activities with a percentage of 58.69%, the number of Transportation activities is 8 activities with a percentage of 20.51%, the number of Inspection activities is 5 activities with a percentage of 12.82%, the number of Storage activities is 2 activities with a percentage of 5.1%, the number of Delay activities is 1 activity with a percentage of 2.6%. It can be seen from Table 8 that the total time of Operation activities is 45 minutes with a percentage of 14.81%, the total time of Transportation activities is 120 minutes with a percentage of 39.48 %, the total time of Inspection activities is 20 minutes with a percentage of 6.6%, the total time of Storage activities is 15 minutes with a percentage of 4.9%, the total time of Delay activities is 104 minutes with a percentage of 34.21%.

For the research to be more focused, the problems in this study need to be limited, namely the research was conducted in warehouse 1 of ABC Company's premix animal feed raw materials, the research was conducted until the preparation of proposals for improvements to the ABC Company's premix animal feed raw material warehouse and did not take into account the costs of the recommendations provided, the research was conducted excluding the application simulation stage in the ABC Company's premix animal feed raw material warehouse.

4. Conclusion

So the activity time of warehouse 1 process of raw materials of premix animal feed from 556 minutes decreased by 252 minutes to 304 minutes after being given a suggestion for improvement with the initial number of activities of 52 activities decreased by 13 activities to 39 activities which increased the PCE value from 0.89% to 1.65% after being given a suggestion for improvement. The five waste attributes in the process flow activity of warehouse 1 of raw materials of premix animal feed are excess quantity of raw materials which causes excess stock in the warehouse with a weight of 3.37; when the material is moved, the product falls from the pallet to the warehouse floor with a weight of 3.26; the production department does not schedule the delivery of goods to the production floor with a weight of 3.25; the long distance of goods because raw materials are not categorized according to their contribution from lot to cross docking with a weight of 2.87; and sacks of raw materials that are easily damaged or torn with a weight of 2.75. A total of 13 waste activities that do not provide added value and are not needed are eliminated and 2 waste activities that do not provide added value but are still needed which simplify the process of these activities with the suggestion for improvement. The proposed improvements given to warehouse 1 activities for premix animal feed raw materials begin with PLAN, namely conducting training and direction to all employees in related departments regarding the implementation of 5S in the work environment, conducting socialization to determine targets, conducting DO, namely the implementation of 5S (starting from punishment to reward for the implementation of 5S), conducting CHECK to form a 5S supervisor who will monitor the implementation of 5S in the work environment, and ACTION by implementing a culture of discipline for all warehouse workers and implementing punishment for those who violate the rules and providing rewards for warehouse workers who have the best performance each month, assessing the implementation of 5S in the warehouse work environment by conducting an internal audit regarding the implementation of 5S.

For further research, researchers are expected to be able to apply the Waste Assessment Model method with proposed improvements using the linear programming method which can take into account the proposed costs.

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