IDENTIFICATION OF WASTE USING WASTE ASSESSMENT MODEL METHOD IN THE APPLICATION OF LEAN MANUFACTURING AT PT.X

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Abstract

PT X is a company that produces animal feed for poultry such as chickens, ducks, quails, and pigs. The animal feed products offered are in accordance with the nutritional needs of each growth period. The form of animal feed produced by PT X can be in the form of concentrates, mash, pellets or crumble. The challenge faced by PT X is that with the variety of products produced and the relatively large scale of production, the products produced often experience defects, so the products must be held in the warehouse for further processing. Forms of defects detected include abnormal texture, high moisture, and mixing. In addition, defects due to torn sacks also cause non -value-added activities because the products must be repackaged, resulting in delays in the delivery of orders for these products. The problem will be analyzed using the waste assessment model method to find critical waste, then a fishbone diagram is used to find the root of the problem and improvement proposals will be made using the 5W1H method. from the results of the calculation using the WAM method, the final results of the calculation using the Waste Assessment Model (WAM) method show that the highest waste in the animal feed production process is waste defects with a percentage value of 29.20%, waste inventory with a percentage of 19.63% and waste motion with a percentage of 13.20%. Then, improvement proposals will be given, including increasing operator training and evaluating the production process, implementing a digital-based monitoring system such as ERP / WMS for real-time stock visibility, adding conveyors or handlifts in the loading area to minimize manual load lifting movements to make it more effective. From the proposed improvements given, it can reduce the lead time by about 373.33 seconds or 6 minutes and 13 seconds.

Keywords: Waste, Waste Assessment Model, Lean Manufacturing

INTRODUCTION

The progression of the Manufacturing industry in Indonesia has led to inevitable competition among companies. Entrepreneurs are required to improve productivity and company performance in order to survive in the manufacturing industry competition. To survive the competition, entrepreneurs need to maximize the processing by implementing Lean Manufacturing, which focuses on streamlining the production process by elimination of waste. Waste refers to anything that does not provide added value (Afriandi, 2023).

PT X is a factory which is a production company of animal feed for poultry including chickens, ducks, quails and pigs. The animal feed products are also offered according to the nutritional needs of each growth period. The form of animal feed produced by PT X can be in the form of concentrate, mash, pellets or crumble. PT. X, as one of the leading companies in animal feed production, continues to strive to improve its operational effectiveness to meet the growing market demand. The challenge faced by PT X is that with the variety of products produced and the relatively large scale of production, often the products produced experience defects / remixes, so that the product must be held in the warehouse for further processing. The forms of defects detected include upnormal texture, high moisture and mixed up. In addition, defects due to torn sacks also cause non-value added activities because the product must be repacked, as a result, shipments for these product orders are often delayed.

This waste is a problem that should be solved by the company to optimize the production process. From the description of the problems above, a lean manufacturing analysis with the Waste Assessment Model (WAM) method will be carried out on the poultry feed production line at PT X to reduce non-value-added activities by identifying waste or waste that occurs in the production circuit, and balancing time, labor, and inefficient work stations so that the production process can be efficient.

From the existing references, the implementation of Waste Assessment Model (WAM) in PT X aims to highlight the production areas that are most prone to waste and require improvement. This method uses a simple and effective matrix model supported by a comprehensive questionnaire covering various aspects. This allows WAM to achieve optimal and accurate critical identification results. Thus, this research is supposed to increase the effectivity and efficiency of the animal feed production process, focusing on poultry feed as the highest demand product in the company, through the adoption and adaptation of appropriate Lean Manufacturing methods.

REVIEW OF LITERATURE

Lean Manufacturing

Lean manufacturing is a technique of efficiency management that focuses on eliminating waste by reducing the mismatch between internal and external resources. This systematic reduction enables organizations to improve efficiency and yield throughout production, thereby achieving competitive advantage. Companies today are using Lean Manufacturing concepts to improve their capability to create new value for their activities and eliminate all forms of expenditure and waste, making them more competitive. Flex thinking in organizations is one of the effective strategies to improve operations. The term Lean Manufacturing originated in World War II, specifically from the Japanese automaker Toyota. Toyota has been developing a system to identify the best methods for managing activities and organizing manufacturing processes into an integrated and holistic operation, and since then it has become known as the Toyota Production System. (Rahamneh, et al., 2023). According to (Liker, in Salsabila, 2021), the Toyota Production System is a typical production method used by Toyota. This system is the cornerstone of the various "Lean Production" movements that have dominated production trends in the last decade. The Toyota Production System is a sophisticated production system in which all components are interconnected. The entire system is fundamentally designed to support and encourage people to continuously improve their work processes. Lean manufacturing is all about reducing waste and non-value-added activities. Internally, in production, this is demonstrated through efficient, stable, and standardized processes, minimal inventory, integrated product flow, production based on actual market demand, short preparation times, and employees engaged in continuous improvement efforts. All these aspects can contribute to improving various dimensions of operational performance, such as product, quality and production costs, lead times, flexibility, and reliability. (Buer, et al., 2021).

Waste

Waste is a Japanese term known as "Muda" which was developed by Taiichi Ohno as the core of Toyota's production system, which is also known as lean manufacturing.Waste is categorized into 7 types, namely: overproduction, waiting, transportation, inappropri -ate processing, unnecessary inventory, unneces-sary motion, and defects. (Krisnanti & Garside, 2022). In the manufacturing industry, waste is one of the phenomena that companies often experience, whether it occurs scientifically or human factors when carrying out production activities. Waste that occurs can result in losses to the company, one example of the losses incurred due to waste is the time in product completion that is longer than planned, where the waste does not provide added value or non-value added in carrying out these activities (Herlingga, 2021). When talking about waste, it is necessary to have a clear definition of the types of waste and the types of activities that often occur in a production flow system. The types of waste that often occur in production flow are overproduction, defects, waiting, unnecessary inventory, unappropriate processing, unnecessary motion, transportation and overproduction.

Waste Assesment Model Method

The Waste Assessment Model is a systematic approach that was developed to simplify the search for waste problems and identify ways to reduce waste. This systematics describes the relationship between seven wastes (O: Overproduction, P: Process, I: Inventory, T: Transportation, D: Defects, W: Waiting, and M: Motion). The stages that occur in the Waste Assessment Model (WAM) are making the Seven Waste Relationship (SWR), after that the Waste Relationship Matrix (WRM) and finally the Waste Assessment Questionnaire (WAQ). The identification results using the Waste Assessment Model are then analyzed using fishbone diagram to find the root cause of the problem of waste that occurs. If the root cause of the problem is known, it will make it easier for the improvement process. (Nazihah et al., 2022).

Value Stream Analysis Tools (VALSAT)

Value Stream Analysis Tools (VALSAT) is used in the selection of detailed mapping tools based on previously defined waste. Detail mapping tools are detailed value stream mappings that focus on value adding activities so that the waste that occurs and its causes can be defined. There are seven kinds of detail mapping tools including: Process Activity

Mapping, Decision Point Analysis, Supply Chain Response Matrix, Product Varlety Funnel, Quality Filter Mapping, Physical Structure, and Demand Amplification Mapping (Setiawan, 2021).

RESEARCH METHOD

The method used in the following research is to use quantitative methods with primary and secondary data types. Primary data is generated from questionaire distributed to target research respondents, namely workers in the company, cycle time production activity, processing time, set-up, transportation time, data on distance between workstations. this research also incorporated secondary data collection through a general company information, enterprise production process information, product defect data, etc. This research uses a lean manufacturing approach with a waste assessment model method based on questionnaire analysis to obtain critical waste that occurs in the company, the data from the questionnaire is processed through Microsoft Excel, which results in a total percentage of each waste and will be analyzed for the 3 largest waste percentages.

RESULTS AND DISCUSSION

Before starting the analysis, an overview of the current state mapping production flow will be given, which aims to find out the initial description of the production process that occurred before the improvements were made.

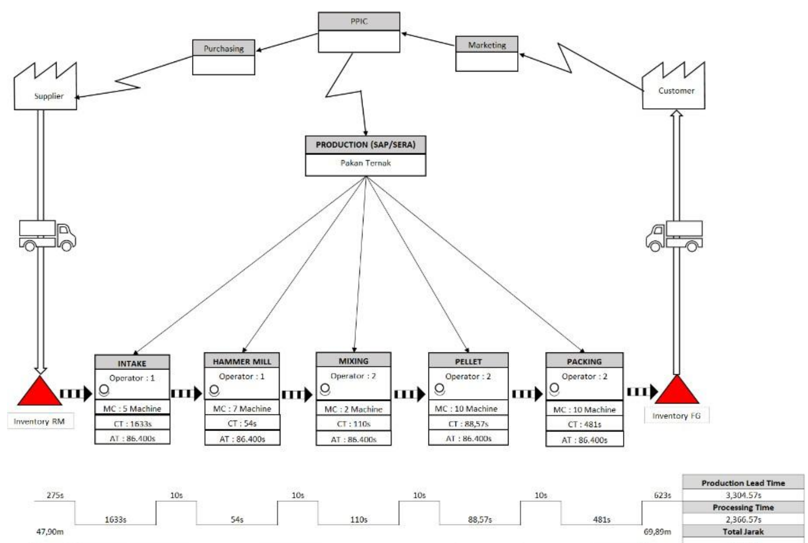

Figure 1.
Current State Mapping
Source: Data processed (2025)

Based on the results of the questionnaire obtained from the supervisors and operators of PT X. The results of the 7 Waste Questionnaire are in this Table I:

Table 1.
The Result of Questionaire Seven Waste

No	I	J	Notations	Respondents			Avg	Convert
				1	2	3		
1	Overproduction	Inventory	O_I	10	10	15	11.67	I
3	Overproduction	Motion	O_M	9	9	6	8	O
4	Overproduction	Transportation	O_T	9	9	13	10.33	I
5	Overproduction	Waiting	O_W	3	3	1	2.33	U
6	Inventory	Overproduction	I_O	7	7	7	7	O
7	Inventory	Defect	I_D	15	9	20	14.67	E
8	Inventory	Motion	I_M	18	18	18	18	A
9	Inventory	Transportation	I_T	11	11	13	11.67	I
10	Defect	Overproduction	D_O	4	4	4	4	U
…	…	…	…	…	…	…	…	…
31	Waiting	Defect	W_D	11	11	11	11	I

Source: Data processed (2025)

As shown in the table, the three respondents' answers were averaged and converted to letter form according to the following standards. The conversion value is a categorization of the importance of the relationship between the two wastes which is symbolized by the letter A (Rent score 17 to 20) which means the relationship between the waste is very strong, the letter E (Rent score 13 to 16) which means the relationship between the waste is strong, the letter I (Rent score 9 to 12) which means the relationship between the waste is quite strong, the letter O (Rent score 5 to 8) which means the relationship between the waste is normal, the letter U (Rent score 1 to 4) which means the relationship between the waste is weak. After obtaining the results of the weighting of the relationship between waste in Table I. Next is the Waste Relationship Matrix (WRM) stage by converting the total weight of the Seven Waste Relationship numbers into letters and used as input into the Waste Relationship Matrix.

Table 2.
The Result of Waste Relationship Matrix Value Letter Conversion

F/T	O	I	D	M	T	P	W
O	A	I	E	O	I	X	U
I	O	A	E	A	I	X	X
D	U	A	A	A	A	X	I
M	X	U	O	A	X	U	I
T	U	U	I	O	A	X	I
P	O	A	I	I	X	A	I
W	U	O	I	X	X	X	A

Source: Data processed (2025)

Based on Table II. there is a waste relationship matrix table, the symbol F indicates "From" and T means "To". To make the matrix easier to understand, a simplification of the matrix is done by converting letters into numbers or percentages with reference to A = 10, E = 8, I = 6, O = 4, U = 2 and X = 0. It is important to noted that the conversion values between the seven waste questionnaire in table I and the waste relationship matrix in table II are different. It should be noted that the conversion value between the seven waste questionnaire and the waste relationship matrix has a difference. This difference is due to the seven wastes for direct quantification of 7 wastes, waste relationship matrix (WRM) for relationships and influence weights. After the conversion of the waste relationship matrix value letters, the next step is to make the results of the conversion of the waste relationship matrix value by converting the waste relationship matrix value letter symbols into the form of numerical weights in accordance with the provisions that have been determined, the results of this numerical conversion will later be used for the calculation of waste weighting. The following is the conversion of Waste Matrix Value letter symbols into the form of numerical weights, namely:

Table 3.
The Result of Waste Relationship Matrix Value Conversion

F/T	O	I	D	M	T	P	W	Score	%
O	10	6	8	4	6	0	2	36	15.00
I	4	10	8	10	6	0	0	38	15.83
D	2	10	10	10	10	0	6	48	20.00
M	0	2	4	10	0	2	6	24	10.00
T	2	2	6	4	10	0	6	30	12.50
P	4	10	6	6	0	10	6	42	17.50
W	2	4	6	0	0	0	10	22	9.17
Score	24	44	48	44	32	12	36	240	100
%	10.00	18.33	20.00	18.33	13.33	5.00	15.00	100	

Source: Data processed (2025)

As shown in the table, it is recognized that the value of From Defect (D) row has the highest value and percentage, which is 20%. This shows that if waste Defect occurs, it will have a significant contribution to the appearance of other waste. While in the matrix column, To Defect (D) also has the highest score and percentage value of 20%. This indicates that waste To Defect is the waste that is most impacted by other wastes.

After conducting the weighting results on the Waste Relationship Matrix (WRM), then weighting using the Waste Assessment Questionnaire (WAQ) algorithm. Waste Assessment Questionnaire (WAQ) is an assessment questionnaire used for the identification and allocation of waste that occurs in the production line. This assessment questionnaire consists of 68 different types of questions, where each questionnaire question shows an activity, a condition or a trait that may cause a certain type of waste. The WAQ questionnaire is divided into two types of questions, namely "from" and "to".

The "from" question means that the waste can affect the emergence of other types of waste. While the "to" question means that the waste occurs because it is influenced by other types of waste. The three types of questionnaire answer choices can be categorized into two categories, namely: Category A is the answer if "yes" which means that there is an indication of waste, the answer score for category type A is if "yes" is worth 1, if 'medium' is worth 0.5 and if "no" is worth 0. Category B is the answer if "yes" which means that there is no indication of waste occurring, the answer score for category type B is if "yes" is worth 0, if 'medium' is worth 0.5 and if "no" is worth 1.

Table 4.
The Result of Waste Assesment Questionaire Average

No	Category	Question Type	Waste Relationship	Respondents			Avg
				1	2	3	
1	Man	To Motion	B	0.5	0.5	0.5	0.5
2		From Motion	B	0.5	0.5	0.5	0.5
3		From Defect	B	0.5	0.5	0.5	0.5
4		…	…	…	…	…	…
8	Material	To Waiting	B	0.5	0.5	0.5	0.5
9		From Waiting	B	0	0	0	0.0
10		From Transportation	B	1	1	1	1.0
11		…	…	…	…	…	…
32	Machine	From Process	B	0.5	0.5	0.5	0.5
33		To Waiting	B	0.5	0.5	0.5	0.5
34		From Process	B	0.5	0.5	0.5	0.5
35		…	…	…	…	…	…
44	Method	To Transportation	B	0	0	0	0.0
45		From Motion	B	0	0	0	0.0
46		From Waiting	B	0	0	0	0.0
47		…	…	…	…	…	…
68		*From Defect*	B	0	0	0	0

Source: Data processed (2025)

Table 5.
Waste Assesment Questionaire (WAQ) Question Grouping

No	Question Type	The Number Of Questions
1	*From Overproduction*	3
2	*From Inventory*	6
3	*From Defect*	8
4	*From Motion*	11
5	*From Transportation*	4
6	*From Process*	7
7	*From Waiting*	8
8	*To Defect*	4
9	*To Motion*	9
10	*To Transportation*	3
11	*To Waiting*	5
Total		68

Source: Data processed (2025)

The table above contains the type and number of questions listed on the questionnaire submitted to the three respondents. In total, there are 68 questions in the questionnaire. Then, proceed to enter the initial weight of each type of waste obtained from the Waste Relationship Matrix Value conversion results table.

Table 6.
The Result of Initial Weight Based on Waste Relationship Matrix

No	Category	Question Type	Weight for each type of waste						
			O	I	D	M	T	P	W
1	*Man*	*To Motion*	4	10	10	10	4	6	0
2		*From Motion*	0	2	4	10	0	2	6
3		*From Defect*	2	10	10	10	10	0	6
4		....	....	....	....	....	....	....	....
8	*Material*	*To Waiting*	2	0	6	6	6	6	10
9		*From Waiting*	2	4	6	0	0	0	10
10		*From Transportation*	2	2	6	4	10	0	6
11		....	....	....	....	....	....	....	....
32	*Machine*	*From Process*	4	10	6	6	0	10	6
33		*To Waiting*	2	0	6	6	6	6	10
34		*From Process*	4	10	6	6	0	10	6
35		....	....	....	....	....	....	....	....
44	*Method*	*To Transportation*	6	6	10	0	10	0	0
45		*From Motion*	0	2	4	10	0	2	6
46		*From Waiting*	2	4	6	0	0	0	10
47		....	....	....	....	....	....	....	....
68		*From Defect*	2	10	10	10	10	0	6
Total *Score*			218	430	500	456	294	200	340

Source: Data processed (2025)

The next step is to divide each question weight by the number of each question type (Ni), then calculate the total score (Sj) of each waste type column, as well as the frequency (Fj) of the occurrence of values in each waste type column by ignoring the value 0 (zero).

The next step is to divide each question weight by the number of each question type (Ni), then calculate the total score (Sj) of each waste type column, as well as the frequency (Fj) of the occurrence of values in each waste type column by ignoring the value 0 (zero). Then the last is to calculate the Yj and Pj scores to get the final Yj and the highest percentage of waste. Yj is the initial indication factor for each waste. While Pj is the probability factor of influence between types of waste, obtained by multiplying the percentage of "from" with "to" in the WRM value according to each waste. If the Yj and Pj values have been obtained, then Yjfinal is obtained by multiplying Yj and Pj.

Table 7.
The Final Result Of The Waste Assessment Questionnaire Calculation

	O	I	D	M	T	P	W
Score (Yj)	0.3873	0.4068	0.4388	0.4408	0.4307	0.4170	0.4240
Score (Pj)	0.015	0.029	0.040	0.018	0.017	0.009	0.014
Final Result (Yj *Final*)	0.00581	0.01180	0.01755	0.00793	0.00732	0.00375	0.00594
Final Result (%)	9.67	19.63	29.20	13.20	12.18	6.24	9.88
Ranking	6	2	1	3	4	7	5

Source: Data processed (2025)

The table show, that the order of the highest to lowest waste in the animal feed production process at PT X starts from waste defects which have a final value of 0.01762 with a percentage of 29.20%, followed by inventory which has a final value of 0.01185 with a percentage of 19.64%, motion which has a final value of 0.00798 with a percentage of 13.22%, this shows that waste defects, inventory and motion are included in the 3 highest waste categories with waste defects being the highest or most dominant waste.

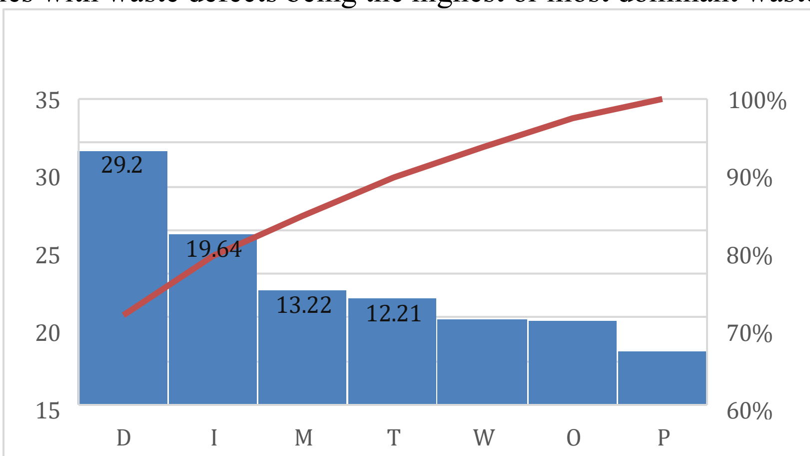

Figure 2.
Pareto Diagram Of 7 Waste
Source: Data processed (2025)

After the process of identifying waste has been carried out, the next step is to determine the valsat mapping tools used to find activities that are value-added or not. The final result (%) obtained from the waste assessment model is entered into the VALSAT weighting and multiplied by the weighting on each tool with a predetermined reference.

Table 8.
Analysis Of Valsat Tools

Waste	Weight	PAM	SCRM	PVF	QFM	DAM	DPA	PSM	Total
Overproduction	0.09	0.09	0.27	-	0.09	0.27	0.27	-	
Inventory	0.19	0.57	1.71	0.57	-	1.71	0.57	0.19	
Defect	0.29	0.29	-	-	-	-	-	-	
Motion	0.13	1.17	0.13	-	1.17	-	-	-	
Transportation	0.12	1.08	-	-	-	-	-	0.12	
Overprocessing	0.06	0.54	-	0.18	0.06	-	0.06	-	
Waiting	0.09	0.81	0.81	0.09	-	0.27	0.27	-	
Total		4.55	2.92	0.84	1.32	2.25	1.17	0.31	13.36
Persentase (%)		34%	22%	6%	10%	17%	9%	2%	100%

Source: Data processed (2025)

Based on the results of data processing Value Stream Analysis Tools obtained the largest final percentage (%) is PAM by 34%, SCRM by 22%, PVF by 6%, QFM by 10%, DAM by 17%, DPA by 9%, and PSM by 2%. So that the tools chosen to map activities are Process Activity Mapping (PAM) which has a percentage of 34%.

Process Activity Mapping is a tool used to map waste in detail to determine which activities in the company are value adding, non-value adding, or necessary non-value. Activities are categorized whether they include Operation (O), Transportation (T), Inspection (I), Delay (D), and Storage (S). (Krisnanti & Garside, 2022).

Table 8.
Recap of PAM Tools Before Improvement

Aktivitas	Jumlah	Waktu (detik)	Persentase
VA	6	1,664.57	50%
NVA	5	71	2%
NNVA	16	1,569	47%
Total	27	3,304.57	100%

Source: Data processed (2025)

By analyzing the PAM tools, it can be seen that the time required for the overall activity of the animal feed production process is 3,304.57s with a total of 27 activities, including 6 value- added activities with a percentage of 50%, 5 non-value-added activities with a percentage of 2% and necessary non-value-added activities as many as 16 activities with a percentage of 47%. From these results there are non-value added activities that need to be reduced.

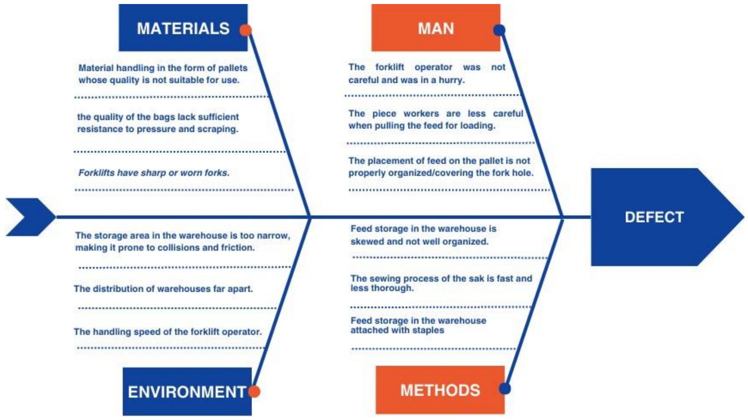

Figure 3.
Fishbone Diagram Defect
Source: Data processed (2025)

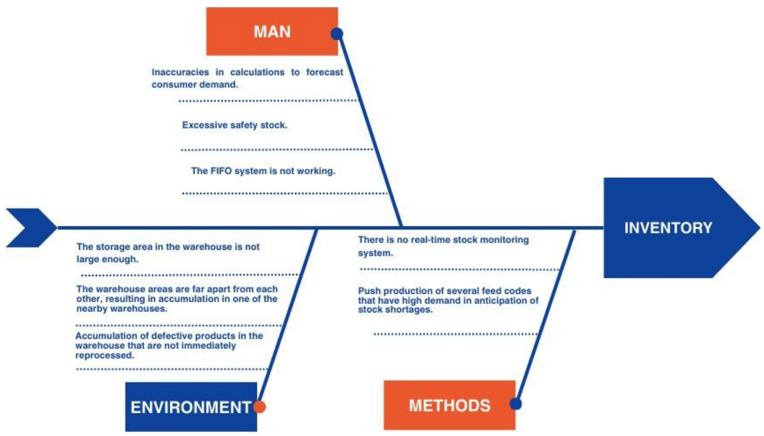

Figure 4.
Fishbone Diagram Inventory
Source: Data processed (2025)

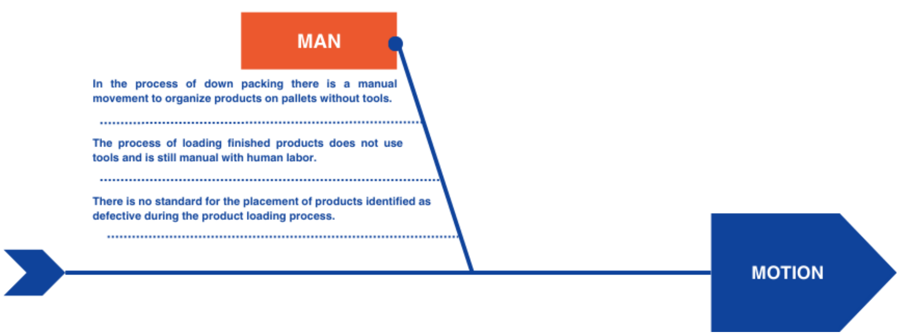

Figure 5.
Fishbone Diagram Motion
Source: Data processed (2025)

Proposed improvements that can be given for waste defects are Increased operator training and evaluation of the production process, Using pallets with good conditions to support finished product bags, using a protector for forklift forks made of plastic so that they are not too sharp, and providing briefings and training for forklift operators, Implementing Preventive Maintenance optimally. Proposed improvements that can be given for waste inventory are Improving the accuracy of production planning with the right demand forecasting method and periodic evaluation of safety stock needs, Implementation of digital-based monitoring systems such as ERP / WMS for real time stock visibility by utilizing QR codes affixed to product pallets, Creating special SOPs for product rework / repack, and making weekly evaluation schedules for product hold status. Proposed improvements that can be given for waste unnecessary motion are Using an inclined roller conveyor system from the 2nd floor to the 1st floor to minimize manual movements, Adding a conveyor or handlift in the loading area to minimize manual heavy lifting movements to make it more effective, thereby reducing loading time, Creating and implementing SOPs and providing special areas for defective products, which are easily accessible and clearly marked.

Table 9.
Recap of PAM Tools After Improvement

Aktivitas	Jumlah	Waktu (detik)	Persentase
VA	6	1,664.57	57%
NVA	0	0	0%
NNVA	16	1,266.67	43%
Total	27	2,931.24	100%

Source: Data processed (2025)

By analyzing the PAM tools after improvement, it can be seen that the time required for the overall activity of the animal feed production process is 1,774.24s with a total of 27 activities, including 6 value-added activities with a percentage of 5%, 0 non-value-added activities with a percentage of 0% and necessary non-value-added activities as many as 16 activities with a percentage of 95%.

Table 10.
Comparison of Initial Time With Improved Time

Waktu Awal	Waktu Setelah Perbaikan
3,304.57 detik	2,931.24 detik
55 menit 5 detik	48 menit 51 detik

Source: Data processed (2025)

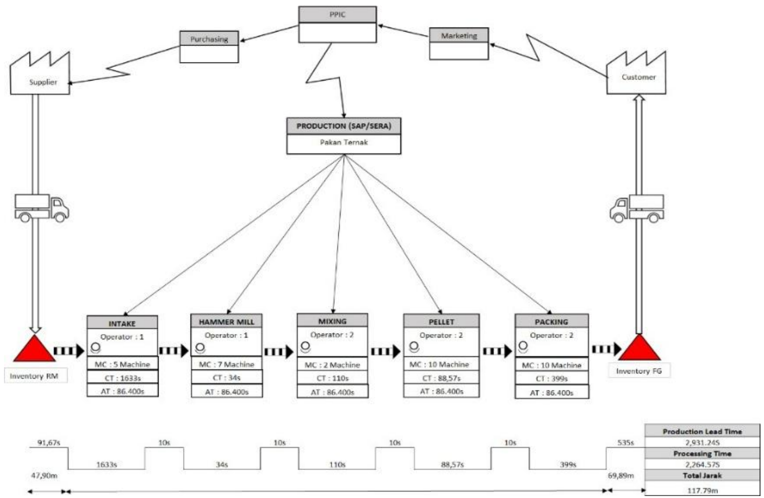

Figure 6.
Future State Mapping
Source: Data processed (2025)

CONCLUSION

The final results of the calculation using the Waste Assessment Model (WAM) method show that the highest waste in the animal feed production process includes waste defects with a percentage value of 29.20%, waste inventory with a percentage of 19.63% and waste motion with a percentage of 13.20%. The highest or most dominant waste category is waste defect. Based on the results of the analysis that has been carried out, it can be seen that the relationship between the main types of waste in the animal feed production process shows a relationship that affects each other. Through the Waste Relationship Matrix (WRM) and Waste Assessment Questionnaire (WAQ) analysis approaches, it is found that defect waste has a significant influence on the incidence of inventory and motion waste. If defective products increase, it is likely that inventory and motion waste will also increase. This finding indicates that partial improvement of one type of waste without considering the relationship with other wastes has the potential to create new inefficiencies in the production system. Therefore, a comprehensive and integrated improvement strategy is needed by considering the interrelationship between wastes to achieve optimal production process efficiency. From the improvement strategy given, it can reduce the production lead time to 6 minutes 13 seconds, so that the production process is more efficient. Suggestions that can be given for further research can be done by utilizing a variety of more complete data sources, so that the problems analyzed will be more complex and the data generated will be more accurate and should be able to study further for alternative improvement recommendations, so that they can be applied by following the times and technology.

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