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Identification of Production Decline Factors using the LEAN DMAI Method

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Abstract. *PT Himalaya Mitra Sukses, is a company engaged in the cooking seasoning and flavoring industry. The products produced include tomato sauce, chili sauce, and premix flour. The company has problems achieving less than optimal productivity, which later became the basis of this research. In this research, identification of waste that occurs in the production process using the Lean DMAI method. The data in this research were processed and analyzed based on 4 main stages: (1) Big Picture Mapping (BPM); (2) making Pareto Diagrams; (3) Root Cause Analysis (RCA); (4) the Failure Mode Effect and Analysis (FMEA) method to reduce the existing waste. Based on the results of the research, it is known that the types of waste identified are overproduction, defects, waiting processes, unnecessary inventory, and excess displacement. Of these many factors, the largest waste is caused by the defect factor of the tomato sauce type product which is runny and too acidic, because the operator does not follow the existing SOP with an RPN value of 392.*

Keywords: *Big Picture Mapping; Failure Mode Effect and Analysis; Pareto Diagrams, production; decline; Root Cause Analysis waste.*

I. INTRODUCTION

The era of the industrial revolution 4.0, there are some manufacturing companies, especially in the industry. Human Resources (HR) can also affect the company because it can provide an optimal contribution. With optimal human resources, it can provide maximum productivity, especially in the production area.

This can have a good impact on waste in the production process in the form of defects and delays, so that the fulfillment of production targets does not require a long time, which ultimately limits the time and targets can be achieved. In manufacturing companies, there are several activities that have non-value-added that can lead to waste and result in inefficient use of resources (Febianti et al., 2018; Ristyowati et al., 2017) (Prasetyawati et al., 2018). The value-added is able to provide results for a company so that it can compete with other companies (Suparno & Susanto, 2021) (Rahmatillah et al., 2019). To achieve this goal, it is necessary to reduce the existing production process. Because by reducing the amount of waste, the cost of production and rework will be minimized (Santoso & Fudhla, 2018). Can be avoided by reducing the amount of waste, can minimize rework, which can emphasize high production costs (Santoso & Fudhla, 2018).

In this research, we will use the application of lean DMAI where there are four basic stages or steps in implementing this strategy, i.e. Defect-Measure-Analyze-Improve (DMAI) at PT Himalaya Mitra Sukses.

PT Himalaya Mitra Sukses, is a company engaged in the cooking spice and food seasoning industry. The products produced are tomato sauce, chili sauce, and premix flour. In reducing waste problem at PT Himalaya Mitra Sukses is to use the Lean Manufacturing method (Abdul Khannan & Haryono, 2015) (Yunita & Adi, 2019). Lean manufacturing is an approach to system efficiency by minimizing waste that occurs in the process flow (Mantiri et al., 2017). The application of lean is expected to have 3 results, namely a better process by providing value-added to customers or customers that is efficient, better working conditions, namely with a better and

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clearer work flow and can provide great ability to improve or improve something in condition, and can meet the objectives or company needs that include value and profit (Suparno & Susanto, 2021) (Ristyowati et al., 2017).

For this reason, this research aims to minimize waste of production process activities so that the target for order fulfillment can be achieved (Setiyawan et al., 2013).

II. Research Method

In this research, a quantitative approach was analyzed, where this research was conducted at PT Himalaya Mitra Sukses which is located on Jl. Raya Cangkir KM 22 Driyorejo - Gresik. The data is to identify waste that occurs in the production process by using Lean DMAI (Prakoso et al., 2017).

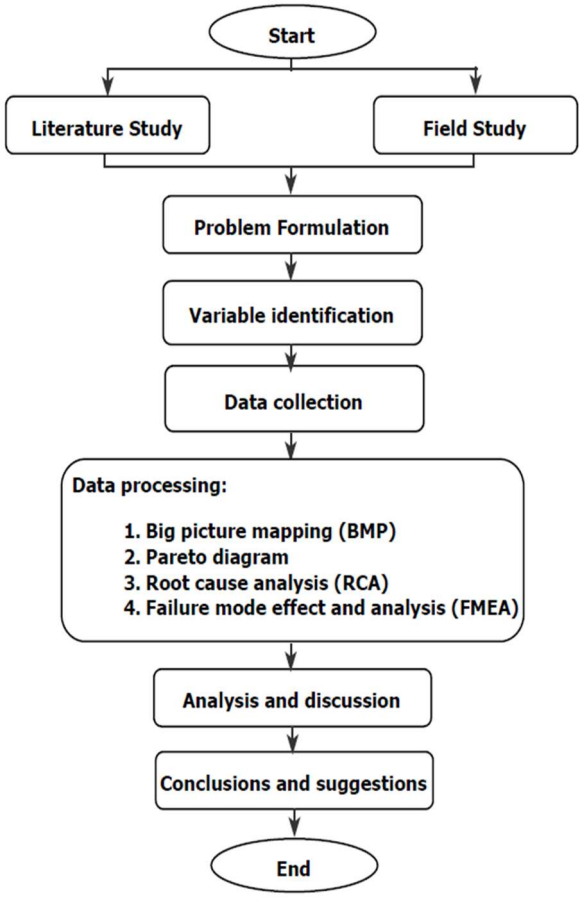

Figure 1. Research Flowchart (Prasetyawati et al., 2018) (Abdul Khannan & Haryono, 2015)

Data processing with DMAI

In this research using the data processing stages as follows (Figure 1):

1. **Identification.** The process of identifying problems related to waste in the production process carried out with material flow data from goods to suppliers, PPIC, production, packaging, warehouses by making Big Picture Mapping (BPM) which contains the lead time of each work station and adds flow information on the process under review (Febianti et al., 2018) (Prakoso et al., 2017).
2. **Measurement.** Measure the waste that has been identified, by making a Pareto diagram.
3. **Data Analysis.** It is an activity to analyze the problems that occur, along with their causes. The tools used are Root Cause Analysis (RCA) and Failure Mode Effect and Analysis (FMEA).
4. **Recommendations and improvements.** Is the stage of providing recommendations for improvements to the problems that have been researched (Prasetiyo et al., 2022).

III. Result and Discussion

Identification

At this stage, targeting and identification of the total number of product defects will be carried out. At this stage also defined the type of waste found in the production of tomato sauce at PT Himalaya Mitra Sukses Driyorejo-Gresik.

Big Picture Mapping (BPM)

Based on the Big picture mapping above, it can be seen that pr Productoduct requests come from customers who place orders to the Head of Marketing, the marketing department forwards information to the Head of Production for production planning.

The Head of Production checks the material stock in the warehouse, if the stock of material runs out, the Head of Production will contact the supplier to purchase the material. Then the supplier will send the material to be stored in the warehouse and prepared for the production process. The production process will run, at work station 1 which is taking all raw materials, at work

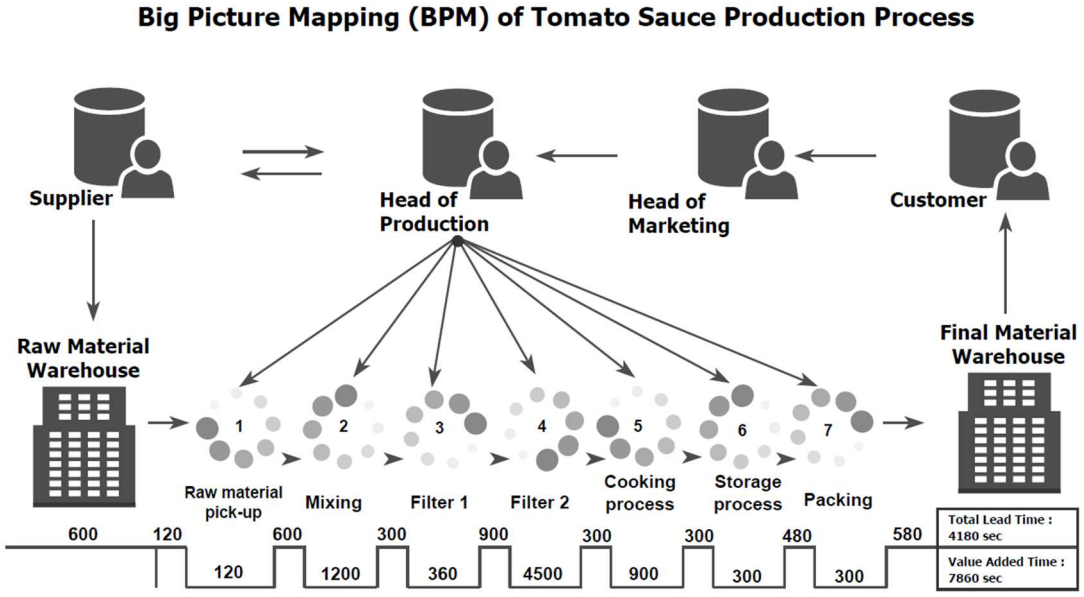

Figure 2. Big Picture Mapping Tomato Sauce Production (Abdul Khannan & Haryono, 2015)

Table 1. Over Production Data

No	Month	Production Targets (Pcs)	Production Result (Pcs)	Over Production (Pcs)	Percentage (%)
1	January	315,000	325,500	10,500	3.33
2	February	365,000	370,100	5,100	1.40
3	March	505,500	520,005	14,505	2.87
4	April	445,050	450,000	4,950	1.11
5	May	445,050	450,000	4,950	1.11
6	June	505,550	518,500	12,950	2.56
7	July	487,800	489,115	1,315	0.27
8	August	345,500	350,000	4,500	1.30
9	September	400,050	400,255	205	0.05
10	October	500,500	503,250	2,750	0.55
11	November	426,000	426,950	950	0.22
12	December	449,000	450,000	1,000	0.22
Total Production per Year		**5,190,000**	**5,253,675**	**63,675**	**15.00**

station 2 is the mixing process, work station 3 is the first filter process, at work station 4 is the cooking process, then at work station 5 is the second filter process, the storage process in work station 6, and the last work station is on the packaging process.

Measurement

In carrying out the production process at PT Himalaya Mitra Sukses there are several wastes identified from company data including:

1. **Over Production.** This waste occurs because the company produces more than the production target and customer demand (Rahmatillah et al., 2019). From Table 1, it can be seen that in one year PT Himalaya Mitra Sukses was able to produce 5,253,675 Pcs of sauce or 15% of the initial production target, The highest production occurred in March with a result of 520,005 Pcs, the lowest in January with a result of 325,500 Pcs,
2. **Defect Product.** This waste occurs because the resulting product does not meet the

Table 2. Product Defect Data

No	Month	Production Result (Pcs)	Reject (Pcs)	Percentage (%)
1	January	325,500	3,397	1.04
2	February	370,100	7,000	1.89
3	March	520,005	4,811	0.93
4	April	450,000	3,529	0.78
5	May	450,000	4,789	1.06
6	June	518,500	6,130	1.18
7	July	489,115	5,136	1.05
8	August	350,000	4,990	1.43
9	September	400,255	4,155	1.04
10	October	503,250	5,100	1.01
11	November	426,950	4,180	0.98
12	December	450,000	3,280	0.73
Total Production per Year		**5,253,675**	**56,497**	**13.13**

Table 3. Waiting Process

No	Month	Production Result (Pcs)	Waiting (Pcs)	Percentage (%)
1	January	325,500	3,500	1.08
2	February	370,100	3,050	0.82
3	March	520,005	5,000	0.96
4	April	450,000	2,500	0.56
5	May	450,000	2,550	0.57
6	June	518,500	5,000	0.96
7	July	489,115	3,500	0.72
8	August	350,000	3,550	1.01
9	September	400,255	4,050	1.01
10	October	503,250	3,000	0.60
11	November	426,950	4,000	0.94
12	December	450,000	3,500	0.78
Total Production per Year		**5,253,675**	**43,200**	**10.00**

specified standards (damaged). From Table 2, it can be seen that in one year the total product defects were 56,497 Pcs. With the highest level of product defects occurred in February with a total defect of 7,000 Pcs of production.

3. **Waiting Process.** This waste occurs because the WIP must wait for the next process. From Table 3, it can be seen that in one year the total WIP waiting for the next process is 43,200 Pcs. The highest number of waiting WIPs occurred in June and March of 7,000 Pcs, while the lowest number of waiting WIPs occurred in April and May of 2,500 Pcs.
4. **Unnecessary Inventories.** This waste occurs because the company provides too many raw materials so that it exceeds the capacity of the storage warehouse. From Table 4, it can be seen that in one year the total remaining inventory of raw materials is 10,837 Kg. The most remaining inventory of raw materials was in March with the amount of 1,100 Kg.
5. **Transportation.** Transportation is a type of waste that occurs due to discarding reject products throughout the production process. In one such transportation activity, 500 defective products can be loaded (See Table 5).

Table 4. Raw Material Inventory Data

No	Month	Production Result (Pcs)	Before production (Kg)	After production (Kg)	Percentage (%)
1	January	325,500	45,650	650	0.20
2	February	370,100	49,288	986	0.,27
3	March	520,005	69,789	1,100	0.21
4	April	450,000	61,525	1,025	0.23
5	May	450,000	61,525	700	0.16
6	June	518,500	68,462	590	0.11
7	July	489,115	63,100	1,050	0.21
8	August	350,000	48,469	725	0.21
9	September	400,255	56,005	1,000	0.25
10	October	503,250	67,024	971	0.19
11	November	426,950	59,451	1,015	0.24
12	December	450,000	61,525	1,025	0.23
Total Production per Year		**5,253,675**	**711,813**	**10,837**	**2.50**

Table 5. Transportation Waste Data

No	Month	Production Result (Pcs)	Reject (Pcs)	Incident	Percentage (%)
1	January	325,500	3,397	7	0.0021
2	February	370,100	7,000	14	0.0038
3	March	520,005	4,811	10	0.0019
4	April	450,000	3,529	7	0.0016
5	May	450,000	4,789	10	0.0021
6	June	518,500	6,130	12	0.0024
7	July	489,115	5,136	10	0.0021
8	August	350,000	4,990	10	0.0029
9	September	400,255	4,155	8	0.0021
10	October	503,250	5,100	10	0.0020
11	November	426,950	4,180	8	0.0020
12	December	450,000	3,280	7	0.0015
Total Production per Year		**5,253,675**	**56,497**	**113**	**0.03**

Priority Improvement Based on Pareto Diagram

In this stage the waste that occurs in the tomato sauce production process at PT Himalaya Mitra Sukses will be sorted based on the number of incident that occur so that it can be focused on the direction of problem solving,

Based on the results shown by the Pareto Diagram above, it can be concluded that the three highest types of waste are based on the 80/20 principle, namely 20% of the causes are responsible for 80% of the problems that arise or vice versa. Referring to the 80/20 principle, the highest waste taken for analysis is overproduction with Cumulative 34% then defect with cumulative 66% and the last is waiting waste with Cumulative 91%.

Data Analysis

Root Cause Analysis (RCA)

At this stage, using the Root Cause Analysis (RCA) method, identification of the root causes of waste and corrective steps or suggestions can be applied to minimize the number of defective products in the production process and product quality (Nisanti & Puspitasari, 2021) (Tri Irawan et al., 2018) (Setiyawan et al., 2013). The waste that occurs in the Tomato Sauce production process at

Table 6. Waste Data

No	Waste	Total	Percentage (%)	Cumulative (%)
1	Over Production	63675	28	28
2	Defect Product	56497	24	52
3	Waiting Process	43200	19	71
4	Unnecessary inventories	10837	5	76
5	Transportation	56497	24	100

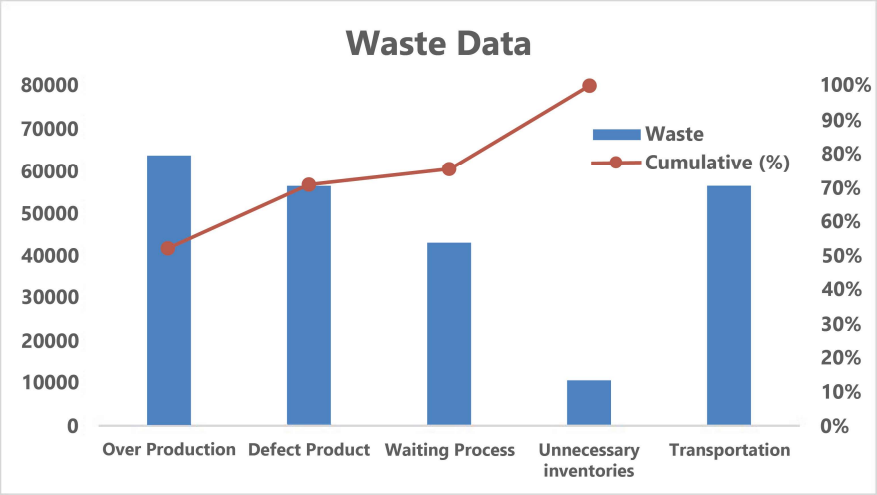

Figure 3. Pareto Diagrams of Waste Data (Nur Asnan & Fahma, 2019)

PT Himalaya Mitra Sukses will be identified as the cause and effect so that it can make repairs easier.

The results of the RCA analysis show the causes of waste that occur among others, as follows:

1. Over Production. The reason is the absence of a production scheduling system. Because there is no department/section that specifically handles the production planning function. The root cause is a function that is still held by the company's leadership.
2. Defect Production. There are several causes for different product weights:
   - The first cause is the packing machine settings are always changing. Which is because the machine is often disturbed and the lack of maintenance of the packing machine. The root cause is that there is no packing machine maintenance schedule
   - The product packaging often shrinks, which is because the seal on the packing machine is too hot, the lack of maintenance for the packing machine. The root cause is that there is no packing machine maintenance schedule
   - The the tomato sauce is not thick and sour. Due to improper product formulation. The root of the problem was due to operator carelessness in mixing the ingredients which, due to the existing SOPs, was difficult to understand.
   - fibrous tomato sauce, Because the raw material for cassava dregs flour is too fibrous and the receipt of raw materials is not checked carefully. The root of the problem is that the process of taking raw materials takes too long is that there is no SOP for receiving raw materials.
3. Waiting Process. WIP waiting for the packing process. Due to the accumulation of unpackaged WIP. The root of the problem is that WIP packaging takes too long due to lack of manpower. And the other reason is the raw

Table 7. Root Cause Analysis (RCA) (Tri Irawan et al., 2018) (Setiyawan et al., 2013)

No	Waste	Sub Waste	Why1	Why2	Why3	Why4	Why5
1	Over production		No production scheduling system	There is no specific department that handles the production planning function	Its function is still being handled by the company's leadership		
2	Defect Product	Different product weight	Packing machine settings are always changing (not fixed)	The machine often has trouble	Lack of packing machine maintenance	No scheduling of packing machine maintenance	
		Product packaging often shrinks	The seal on the packing machine is too hot	Packing machine settings are always changing	The engine is worn	Lack of packaging machine maintenance	No scheduling of packaging machine maintenance
		Tomato sauce is not thick and sour	Incorrect product formulation	Operator error	Cooking operators do not follow the SOP	SOP is hard to understand	
		Fibrous tomato sauce	Tepung onggok terlalu berserat	Quality of raw materials is not good	Receipt of raw materials is not checked carefully	There is no SOP for receiving raw materials	
3	Waiting Process	Waiting for the packing process	Production process time increases	WIP stack	Many WIPs have not been packaged	WIP packaging is too long	Lack of manpower
				Late raw materials	The process of taking raw materials is too long	Location of scattered raw material warehouses	

material that arrives late. Due to the root of the problem, the location of the raw material warehouse is scattered.

Failure Mode Effect Analysis

After knowing the root cause of the problem from the sub-waste that occurred, further discussions were carried out with the authorized superiors to determine the severity, occurrence, and detection values to obtain the RPN (Risk Priority Number) value (Setiyawan et al., 2013). With the aim of knowing the priority of improvements that can be made. At this stage, the failure mode effect analysis (FMEA) method is used (Nisanti & Puspitasari, 2021). For more details will be explained in the Table 8.

Based on the FMEA method, it can be seen that the highest value is in defects due to the

Table 8. Failure Mode Effect and Analysis (FMEA) (Nisanti & Puspitasari, 2021)

No	Waste	Sub Waste	Effect	Sev	Cause	Occ	Control	Det	RPN
1	Over production		Storage volume is too big	4	No integrated production scheduling system	4	Visuals on the arrangement of items	5	80
			Product storage is too long	4	No integrated production scheduling system	4	Visuals on the shape of the item	4	64
2	Defect Product	Different product weight	Product weight is not the same	4	No machine maintenance scheduling system	4	Visuals on the shape of the item	4	64
		Product packaging often shrinks (product defects)	Packaging display is not attractive	6	No machine maintenance scheduling system	4	Visuals on the shape of the item	4	96
		Tomato sauce is not thick and sour	Discarded	8	Cooking operators do not follow the SOP	7	Physical Observation	7	392
		Fibrous tomato sauce	Discarded	5	There is no SOP for receiving raw materials	4	Visuals on the shape of the item	4	80
3	Waiting Process	Waiting for WIP packaging process	WIP stack	3	Lack of human labor	4	Visual	4	48

tomato sauce being not thick and sour due to the cooking operator not following the SOP with an RPN value of 392. And the second highest value is defects due to product packaging often shrinking because there is no packaging machine maintenance scheduling system with an RPN value of 96.

Improvement Suggestions

Improve is a phase in the DMAI cycle to fix problems that have been carried out in define, measure and analyze processes based on the data obtained. The next step is to provide improvement recommendations, which is followed by selecting priority recommendations for improvement using the FMEA tool. The recommendations for improvement given will be made in order to overcome some of the waste that occurs.

From the research that has been carried out by applying the concept of Lean DMAI, the first recommendation for improvement is to make Standard Operational Procedures (SOP) for the new tomato sauce production process that is easier to understand. The proposed SOPs are as in Table 9.

From the results of the identification of waste by research data, the types of waste that occur most often to those that rarely occur are (1) overproduction: this waste occurs because the

Table 9. Proposed Improvement of Tomato Sauce Production Process SOP

Activity	Subject	Process	Location	Time Processing	Person responsible	Corrective Action
A. 1. Flour acceptance: Flour must comply with specification standards	Starch flour and Corn Starch	Sampling	Raw Material Warehouse	Every new product comes	Head of raw material warehouse	Sampling results are not up to standard >10% rejected
2. Storage	Starch flour and Corn Starch	On the pallet	Raw Material Warehouse	After received		Sseparated
3. Sifting	Starch flour and Corn Starch	Sift by machine	Sauce Processing Room	Each will be processed	Weighing Operators	Sieve check
4. Weighing	Starch flour and dan Corn Starch	Weighing with a digital scale	Raw Material Warehouse	Each will be processed after the sieve		Weigh calibration
B. 1.Condiment acceptance: Seasonings must comply with specification standards	Salt, Sugar Pasir, Vinegar + Tomato Paste, Saccharin, MSG, Extra Chili, Garlic Oil, Sunset Yellow, Citric Acid, Natrium Benzoat	Sampling	Raw Material Warehouse	After arrival	Staff R&D	Sampling results are not up to standard, rejected
2. Storage	Salt, Sugar Pasir, Vinegar + Tomato Paste, Saccharin, MSG, Extra Chili, Garlic Oil, Sunset Yellow, Citric Acid, Natrium Benzoat	On the pallet	Raw Material Warehouse	After received	Head of raw material warehouse	Separated
3. Weighing	Salt, Sugar Pasir, Vinegar + Tomato Paste, Saccharin, MSG, Extra Chili, Garlic Oil, Sunset Yellow, Citric Acid, Natrium Benzoat	Weighing with a digital scale	R&D formula room	After Stored	Staff R&D	Weigh calibration
C. 1. Production process: Mixing	Tomato paste, Corn Starch, Corn Starch or Starch flour, Water	Enter the dough mixer-double jacket	Production process room	After weighing	Mixing Process Operators	If less homogeneous, mixing time is added
2. Cooking	Tomato sauce base dough until it becomes perfect gelatinization + Citric Acid, Salt, Sugar, Saccharin, MSG, Vinegar, Extra Chili, Garlic Oil, Pewarna, Na-Benzoat.	Cooking mixer double jacket 90°C,±10 Minute	Production process room	During the production process	Cooking Process Operator	Rework
3. Cooling	Tomato Sauce	Storage 60°-70°C	Production process room	During the production process	Packaging Process Operator	Cooling time added
4. Packaging	Tomato Sauce	Packed with vertical packaging	Packing Room	After weighing process		Rework
5. Sorting	Packaged Tomato Sauce	Sorted	Packing Room	After the packing process		Separated& re-cooking
6. Storage	Tomato Sauce has been put in a ball or box	Stored at room temperature, on a plastic pallet	Finished goods warehouse	After storage	Warehouse Staff	Temperature and humidity check
7. Distribution	Tomato sauce ready to be sent	Visual Check	Finished goods warehouse	After storage	Warehouse Staff	Transportation equipment is not up to standard, returned/ replaced with another

company produces more than the production target and customer demand; (2) defects product: this waste occurs because the resulting product does not meet the specified standards (damaged); (3) unnecessary inventory; (4) unnecessary movements; (5) excess displacement; (6) waiting and inappropriate processes.

IV. CONCLUSION

The types of waste identified in the tomato sauce production process at PT Himalaya Mitra Sukses are: overproduction, defect production, unnecessary Inventories, unnecessary motion and transportation. From the research that has been done by applying the Lean DMAI method, the recommendation for improvement is to create a Standard Operational Procedure (SOP) for the new tomato sauce production process that is easier to understand. Of these many factors, the largest waste is caused by the defect factor of the tomato sauce type product which is runny and too acidic, because the operator does not follow the existing SOP with an RPN value of 392.

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