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Waste Identification at Fabric Production Line in Textile Company in Indonesia

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ABSTRACT

In the last four years, the price of fabric raw materials has increased globally supported by fluctuations in the price of the Dollar exchange rate causing the costs required by textile companies to increase by 81.97%. Based on production data obtained from the company, product quality decreased by 10.28% from 2019 to 2022. Poor product quality accompanied by increasing costs of production raw materials adversely affect company finances, so this study aims to reduce the costs required in the production process. The cost of this production process can be reduced by reducing the waste that occurs during the production process. To deal with this problem, this research was conducted on one of the textile companies in Indonesia that produces fabric. The research began by identifying the existing waste problem by conducting a special questionnaire survey called waste assessment questionaire (WAQ). The respondents in this survey were three people from the textile company who were responsible for the course of the fabric production process in the factory. The results of this questionnaire were used to model the relationship between the types of waste and the types of waste that occurred the most. The results of data analysis showed that there were four types of waste that significantly occurred, namely idle time by 23.9%, unnecessary processes by 20.7%, waste due to product defects by 20.1%, and waste due to excess production by 18.9%. These four types of waste will be further analyzed to eliminate the waste effectively and efficiently.

Keywords: *Waste, Textile Company, Raw Material Cost, WAQ*

1. INTRODUCTION

In the last four years, the price of cotton as a raw material for cloth has increased supported by the increase in the price of the Dollar exchange rate against the Rupiah [1], [2]. These two factors of price increase have an impact on the costs required by textile companies in purchasing raw materials up to 81.97% higher. The increased cost of raw materials is supported by increased operational costs during the production process due to the poor quality of the fabric produced. Based on data obtained from the company, from 2019 to 2023, an increase in the number of defects in fabric products increased by 10.28% from the previous percentage of 15.48% in 2019. Both of these factors result in an increase in production costs required by the company, where in this case operational costs increase due to a longer process and longer time in producing a fabric with quality that is in accordance with standards.

According to Rawabdeh [3], waste that occurs can lead to other types of waste which means that each waste will synergize with other types of waste. A model of the relationship between these types of waste can be seen in Figure 1.

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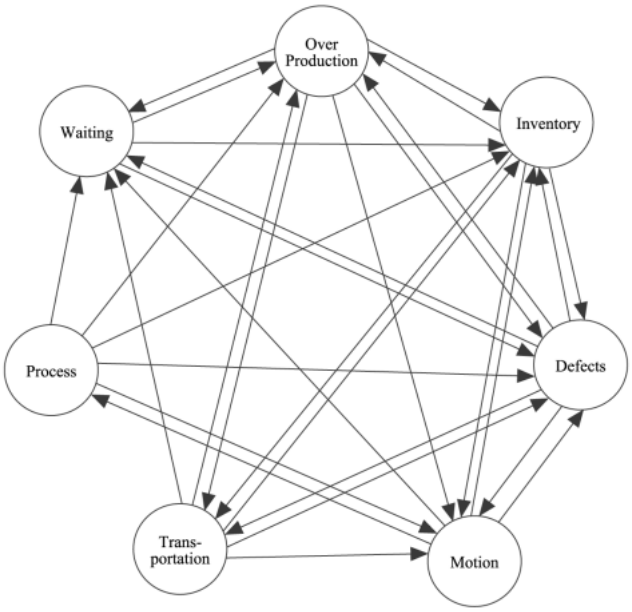

Figure 1. Direct Relationship Model for Every Type of Waste [3]

Based on the model shown in Figure 1, 31 direct relationships are obtained between one type of waste and another. If related to the context of the existing problem, the problem of product defects will cause other types of waste such as overproduction, inventory, motion, transportation, and waiting. Then other types of waste such as inventory, overproduction, waiting, process, transportation, and motion can cause types of product defect waste. The conclusion that can be drawn is when waste due to product defects results in five types of waste, but all types of waste can cause types of product defect waste. In the end, each type of waste synergizes with each other to form a causal loop that continues to rotate if not resolved as quickly as possible.
To deal with this problem, this research was conducted to reduce production costs and reduce production process time by improving existing processes so that they can run more effectively and efficiently. The main objective of this study is to identify and reduce the amount of waste that occurs in the production process so that production costs can be reduced and production process time can also be reduced.

2. RESEARCH METHOD

To deal with this problem, this research was conducted on one of the textile companies in Indonesia that produces fabric. This research began by making a special questionnaire made to identify the type of waste that exists in the production process. There are two questionnaires used in this study, namely the questionnaire used to model the relationship between types of waste and the questionnaire used for the final analysis of the percentage of waste that occurs [4].
The first questionnaire consists of six specific questions between one type of waste against another type of waste. Based on the model shown in Figure 1, the number of questions on the questionnaire to create a waste relationship matrix (WRM) model is 186 questions for 31 relationship combinations in each type of waste. The following questions on the questionnaire to create a WRM model can be seen in Table 1.

Table 1. The criteria for Evaluating the Strengths of Waste Relationship in Questionaire

Question	Answer	Weighting Score
Does i produce j?	Always	4
	Sometimes	2

	Rarely	0
What is the type of the relationship between i and j?	As i increases, j inreases	2
	As i increases, j reaches a constant level	1
	Random depends on conditions	0
The effect of j due to i:	Appears directly and clearly	4
	Needs time to appear	2
	Not often appears	0
Elimination the effect of i on j is achieved by:	Engineering methods	2
	Simple and direct	1
	Instructional solution	0
The effect of j due to i mainly influences:	Qualtiy of products	1
	Productivitity of resources	1
	Lead time	1
	Quality and productivity	2
	Productivity and lead time	2
	Quality and lead time	2
	Quality, productivity, and lead time	4
In which degree does the effect of i on j increase manufacturing lead time?	High degree	4
	Medium degree	2
	Low degree	0
Note: i stands for any type of waste which has an effect on the other type of waste j		

Each answer in this first questionnaire will be processed to create a WRM model, where WRM values the effect of one type of waste on another type of waste [5]. Each score obtained on the questionnaire will be converted into a relationship range table starting with 6 letters, and each letter has a certain score weight as input into the waste relationship matrix as can be seen in Table 2.

Table 2. Convert Answers on Questionnaire into Relationship Scores

Relationship Range			**Conversion Score**
Range	**Type**	**Symbol**	**Score**
0	No Relationship	X	0
1-4	Tidak Penting	In the	2
5-8	Usual	Or	4
9-12	Penting	I	6
13-16	Very Important	And	8
17-20	Absolutely Necessary	A	20

The second questionnaire that will be used is the waste assessment questionnaire (WAQ), where this questionnaire contains 68 questions specifically designed to determine the type of waste based on the type of question and its category. The following questions contained in the WAQ can be seen in Table 3.

Table 3. Waste Assessment Questionnaire [6]

No.	Question	Question Type	Category
1	Does the company's management often roll or transfer operators for all jobs so that one type of work can be done by all operators?	To Motion	B
2	Does the production manager set standards for production time and product quality (SOPs) targeted in production?	From Motion	B
3	Are workers well supervised during night shifts?	From Defects	B
4	Do positive steps taken by the company (such as training programs, recreation, familiarity, etc.) improve morale and morale?	From Motion	B
5	Is there a training program for new employees?	From Motion	B
6	Does the worker instill a sense of responsibility in his job?	From Defect	B

No.	Question	Question Type	Category
7	Have safety protection devices been used in the work area?	From Process	B
8	Can lead time from suppliers (including from previous processes) be applied to production scheduling?	To Wait	B
9	Has there been a schedule check for the availability of raw materials (including work in process from the previous process) before starting the production process?	From Waiting	B
10	Are raw materials taken in one picking process?	From Transportation	B
11	Does the company's management routinely provide information or reports regarding irregularities in goods storage activities (including stock) in the warehouse?	From Inventory	B
12	Is there a notification to workers in the warehouse if there is a change in the storage / inventory plan?	From Inventory	B
13	Is there an excess accumulation of material (fabric) waiting to be repaired, reworked, or returned from the process afterwards (including from consumers)?	From Defect	A
14	Are there piles of raw materials that are not needed around the pile area of raw materials (yarn) both in the production area and in the warehouse?	From Inventory	A
15	Do production workers have to wait in the production area to wait for the arrival of materials (fabric, yarn, etc.)?	From Waiting	A
16	Is there a frequent transfer of material than is usually done?	To Defect	A
17	Does material damage often occur during the removal process?	From Defect	A
18	Are the goods in the temporary storage area (work in process area) mixed with materials that are being used or finished products that will be moved to the next process?	From Transportation	A
19	Is the loading and unloading of materials or raw materials handled manually?	To Motion	A
20	Whether the process of calculating the amount (weight of cloth, number of threads, number of needles, etc.) and the movement of goods using containers before reaching the packaging process (cloth wrapped in sacks to be stored in warehouses, etc.) to make moving easier?	From Waiting	B
21	Are similar goods or raw materials stored in one area to simplify and reduce the time needed in the search process?	From Motion	B
22	Are there large containers that are easy to carry around to avoid repeated movement of goods (cloth, needles, etc.) and raw materials (threads)?	From Transportation	B
23	Is there any material or raw material check (thread, needle, etc.) received from the supplier to determine the conformity of quality and quantity standards of goods?	From Defect	B
24	Are materials or goods labeled for easy identification?	From Motion	B
25	Do workers store goods that are still in process (work in process) in the production process area?	From Inventory	A
26	Is the order of raw materials to be stored in the inventory warehouse still carried out even though it is not needed immediately?	Fron Inventory	A
27	Is there a time allowance for items that are still in process before entering the next stage of the process?	To Wait	B
28	Is there a rework process for the size/mass/shape/color of the fabric that does not match?	From Defect	A
29	Did the ordered raw materials arrive on time?	From Waiting	B
30	Is there a buildup of raw materials in the storage warehouse but not scheduled to fulfill orders from customers?	From Overproduction	A
31	Are raw materials and equipment stored properly?	To Motion	B
32	Is there periodic testing of the efficiency of production machines?	From Process	B
33	Can the workload of each machine be clearly estimated?	To Wait	B
34	After the machine is installed, is there any testing if the machine is working according to its specifications?	From Process	B
35	What is the capacity of the moving equipment (such as forklifts, carts, etc.) Is it enough to carry the heaviest items?	From Transportation	B
36	If you use a means of moving goods or raw materials (such as forklifts), is the amount of material carried enough?	To Motion	B
37	Is there a policy from management to produce more than needed in order to maximize capacity and use of machines?	From Overproduction	A
38	Does the machine stop frequently due to technical/mechanical problems (such as broken threads, broken needles, etc.)	From Waiting	A
39	Are the necessary tools available and sufficient for the production process of each part?	From Waiting	B
40	Is the equipment for moving goods (such as forklifts, carts, etc.) responsible for product damage?	To Defect	A
41	Does the long machine setup time (the process of setting the fabric motif pattern on the machine, inserting yarn, etc.) cause delays in the production process?	From Waiting	A

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No.	Question	Question Type	Category
42	Are there still damaged or unused tools in the work area (broken needles, broken machines, rejected fabrics, etc.)?	To Motion	A
43	Are there any considerations for reducing machine setup time by adjusting scheduling and design?	From Process	B
44	Is the storage area enough so that there are no obstacles in the process?	To Transportation	B
45	Is there numbering or labeling in material picking to make it easier to find, pick, and store raw materials?	From Motion	B
46	Is the storage space used effectively for storing with the help of shelves and trolleys?	From Waiting	B
47	Is there a division of warehouse area, active area for most frequent orders and reserve area for other orders?	To Motion	B
48	Is the production time adjusted to the number of needs and orders from customers?	To Wait	B
49	Is the production schedule communicated to all parts so that the contents of the schedule can be understood in general?	To Defect	B
50	Is there a production standard or SOP for the use of machines in carrying out the production process?	From Motion	B
51	Is there a quality control system in place for each department (or every process) to guarantee its quality?	From Defect	B
52	Is there a set standard time for each operation or job?	From motion	B
53	If there is a delay or delay, is the delay communicated to all parts?	To Wait	B
54	Are there any regulations regarding schedules for the needs of each type of product so that there is no need to repeat the process of setting the machine to reproduce the same product?	From Process	B
55	Is it possible to combine the steps of the working process into a simpler one?	From Process	B
56	Are there procedures for inspection or inspection of returned products?	To Defect	B
57	Are inventory records used to determine raw material purchases and schedule production?	From Inventory	B
58	Are the alleys always cleaned and tidyed up properly?	To Transportation	B
59	Are storage areas marked and labeled in certain sections?	To Motion	A
60	Is the alley area sufficient for free movement?	To Transportation	B
61	Is there material storage that should not be stored in the warehouse area?	To Motion	B
62	Is there a rution schedule to clean the production area as a whole	To Motion	B
63	Whether the production flow flows in one direction (there is no reverse direction for any process including repairs and reproductions)	From Motion	B
64	Is there management that handles design, recipes, and standardization of lead time?	From Motion	B
65	Do work standards have clear and specific objectives?	From Motion	B
66	Is work imbalance predictable?	From Overproduction	B
67	Are existing work procedures able to eliminate unnecessary or excessive work?	From Process	B
68	Are the results of quality control, production tests, and evaluations carried out with engineering science?	From Defect	B

Each question in Table 2 has a specific assessment group with a different category. In general, there are 11 question groups with the number of questions each which can be seen in Table 4.

Table 4. Total Questions for Each Grouped Assessment Questions [6]

Type of Question	Total Questions
From overproduction	5
From inventory	6
From defects	8
From motion	11
From transportation	4
From process	7
From waiting	8
To defects	4
To motion	9
To transportation	3
To waiting	5

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In WAQ there are also category A and category B. Because each question consists of Yes, Medium, and No answers, categories A and B have different weighting scores for each answer. The following weighting scores for each answer for categories A and B can be seen in Table 5.

Table 5. Weighting Score for Each Question Categories

A		B	
Yes	1	Yes	0
Maybe	0,5	Maybe	0,5
No	0	No	1

The results of the WAQ will be combined with the results from WRM for a final analysis containing an overall analysis on each type of waste. The results of this analysis can be used to model the most types of waste and give priority to improvements with Pareto diagrams [6]

3. RESULTS AND DISCUSSIONS

The questionnaire that has been made is filled out by the company responsible for the production process that takes place in its factory. The following results of the initial questionnaire to create a WRM model can be seen in Table 6.

Table 6. Results of Conversion of Questionnaire Answers to Relationship Range Scores

Relationship Between		Score	Relationship	Final Relationship Score
i	j			
O	I	2	U	2
O	D	1	U	2
O	M	2	U	2
O	T	4	U	4
O	W	13	E	8
I	O	2	U	2
I	D	1	U	2
I	M	2	U	2
I	T	2	U	2
D	O	15	E	8
D	I	10	I	6
D	M	1	U	2
D	T	2	U	2
D	W	15	E	8
M	I	6	O	4
M	D	8	O	6
M	P	2	U	2
M	W	4	U	4
T	O	1	U	2
T	I	1	U	2
T	D	1	U	2
T	M	1	U	2
T	W	1	U	2
P	O	17	A	10
P	I	17	A	10
P	D	19	A	10
P	M	6	O	4
P	W	17	A	10
W	O	4	U	4
W	I	1	U	2
W	D	4	U	4

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The results of the final relationship score will be made into a waste relationship matrix to show the strength of the relationship between each type of waste as shown in Table 7.

Table 7. Waste Relationship Matrix

From/To	O	I	D	M	T	P	W	Skor	Percentage
O	10	2	2	2	2	0	8	**26**	**13,54%**
I	2	10	2	2	2	0	0	**18**	**9,38%**
D	8	6	10	2	2	0	8	**36**	**18,75%**
M	0	4	4	10	0	2	2	**22**	**11,46%**
T	2	2	2	2	10	0	2	**20**	**10,42%**
P	10	10	10	4	0	10	10	**54**	**28,13%**
W	2	2	2	0	0	0	10	**16**	**8,33%**
Skor	**34**	**36**	**32**	**22**	**16**	**12**	**40**	**192**	**100,00%**
Percentage	**17,71%**	**18,75%**	**16,67%**	**11,46%**	**8,33%**	**6,25%**	**20,83%**	**100,00%**	

Based on the results in the waste relationship matrix, the most common types of waste are overprocessing, defects, and overproduction. While waste that occurs as a result of other waste with the highest percentage is waiting, inventory, and overproduction. In the waste of overproduction, it is concluded that overproduction causes waste of waiting. In waste of defects, the most waste due to this waste is overproduction, inventory, and waiting. In overprocessing, waste that occurs with a very close relationship with this waste is overproduction, inventory, defects, and waiting. Meanwhile, if you look at waste that is the impact of other waste, overproduction is most strongly caused by overprocessing and defects. Meanwhile, waste of inventory is most strongly caused by overprocessing and defects. Waste of waiting is most strongly caused by overprocessing, defects, and overproduction.
The following results of the WAQ can be seen in Table 8.

Table 8. WAQ Result

No.	Question Type	Category	Answer	Shoes
1	*To Motion*	B	Yes	0
2	*From Motion*	B	Yes	0
3	*From Defects*	B	Yes	0
4	*From Motion*	B	Yes	0
5	*From Motion*	B	Yes	0
6	*From Defect*	B	Maybe	0,5
7	*From Process*	B	Yes	0
8	*To Waiting*	B	Yes	0
9	*From Waiting*	B	Yes	0
10	*From Transportation*	B	No	1
11	*From Inventory*	B	Yes	0
12	*From Inventory*	B	Yes	0
13	*From Defect*	A	No	0
14	*From Inventory*	A	No	0
15	*From Waiting*	A	Yes	1
16	*To Defect*	A	Maybe	0,5
17	*From Defect*	A	No	0
18	*From Transportation*	A	No	0
19	*To Motion*	A	Yes	1
20	*From Waiting*	B	Yes	0
21	*From Motion*	B	Maybe	0,5
22	*From Transportation*	B	Yes	0
23	*From Defect*	B	Yes	0
24	*From Motion*	B	Yes	0
25	*From Inventory*	A	Yes	1

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26	*Fron Inventory*	A	Maybe	0,5
27	*To Waiting*	B	No	1
28	*From Defect*	A	Yes	1
29	*From Waiting*	B	Yes	0
30	*From Overproduction*	A	Maybe	0,5
31	*To Motion*	B	Yes	0
32	*From Process*	B	Yes	0
33	*To Waiting*	B	Yes	0
34	*From Process*	B	Yes	0
35	*From Transportation*	B	Yes	0
36	*To Motion*	B	Maybe	0,5
37	*From Overproduction*	A	Yes	1
38	*From Waiting*	A	Maybe	0,5
39	*From Waiting*	B	Yes	0
40	*To Defect*	A	No	0
41	*From Waiting*	A	Yes	1
42	*To Motion*	A	No	0
43	*From Process*	B	Yes	0
44	*To Transportation*	B	Yes	0
45	*From Motion*	B	Yes	0
46	*From Waiting*	B	No	1
47	*To Motion*	B	Yes	0
48	*To Waiting*	B	Yes	0
49	*To Defect*	B	No	1
50	*From Motion*	B	Yes	0
51	*From Defect*	B	Yes	0
52	*From motion*	B	Yes	0
53	*To Waiting*	B	Yes	0
54	*From Process*	B	Maybe	0,5
55	*From Process*	B	No	1
56	*To Defect*	B	Yes	0
57	*From Inventory*	B	Yes	0
58	*To Transportation*	B	Yes	0
59	*To Motion*	A	Yes	1
60	*To Transportation*	B	Yes	0
61	*To Motion*	B	Maybe	0,5
62	*To Motion*	B	Yes	0
63	*From Motion*	B	Yes	0
64	*From Motion*	B	Yes	0
65	*From Motion*	B	Yes	0
66	*From Overproduction*	B	Maybe	0,5
67	*From Process*	B	Yes	0
68	*From Defect*	B	No	1

The results obtained on the WAQ will be combined with the results from WRM, and the calculation process is attached to the appendix section. The following final analysis results from WRM and WAQ can be seen in Table 9.

Table 9. Final Results of WRM and WAQ Analysis

	O	I	D	M	T	P	W	Total
Skor (Yj)	0,6200907	0,3290126	0,5070748	0,3345607	0,3229292	0,9297069	1,0840471	4,1274219
Pj *Factor*	239,80035	175,78125	312,5	131,2934	86,805556	175,78125	173,61111	1295,5729
Final Result (Yj *Final*)	148,69796	57,834238	158,46088	43,925608	28,032046	163,42505	188,20261	788,57839
Final Result Percentage	18,86%	7,33%	20,09%	5,57%	3,55%	20,72%	23,87%	100,00%
Rank	4	3	5	2	1	6	7	

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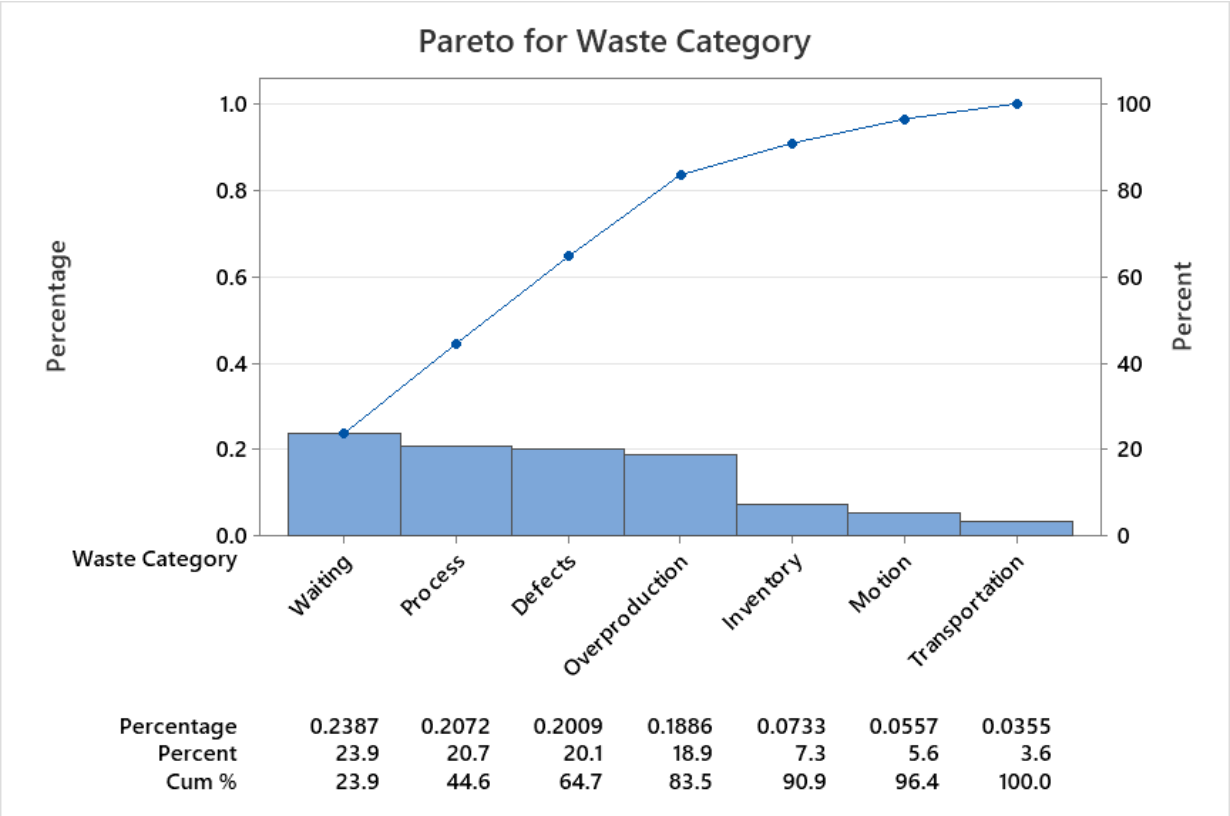
Based on the results of the final analysis obtained from Table 9 shows that the most waste is dominated by waste of waiting, waste of overprocessing, waste of defects, and waste of overproduction with a percentage of >18% and has a large gap with three other wastes with a percentage of <10%. To overcome the waste problem that has been identified, improvements will be made by prioritizing critical waste first using the Pareto diagram as shown in Figure 2.



Percentage	0.2387	0.2072	0.2009	0.1886	0.0733	0.0557	0.0355
Percent	23.9	20.7	20.1	18.9	7.3	5.6	3.6
Cum %	23.9	44.6	64.7	83.5	90.9	96.4	100.0

Figure 2. Pareto Diagram to Prioritizing Waste Elimination

The results obtained from this Pareto diagram show that there are four types of critical waste, namely waste of waiting, waste of overprocessing, waste of defects, and waste of overproduction.

4. CONCLUSIONS AND SUGGESTIONS

Each type of waste that has been identified in the results and discussion section will be resolved with further analysis to find the root of the problem in the waste. This research is still ongoing to improve work efficiency and reduce overall production costs from various aspects.

The limitation of this study lies in the aspects discussed, where this research focuses on the operational part and there are possible external factors that influence the problem of defects and waste. This study also did not evaluate the company's readiness to implement lean or six sigma.

The next research will consider aspects of the readiness of the company to implement lean six sigma and follow up on the results of the analysis of the type of waste to improve the efficiency of the fabric production process in the textile company.

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