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Identification and Minimization of Waste with the Application of Lean Manufacturing in the Cireng Production Process at PT Brexelle Berkah Uniti

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Abstract. Based on the results of observations and the 7 waste questionnaires at PT Brexelle Berkah Uniti production, it was found that the waste of defects occurs such as cireng are shapeless, destroyed, and do not pass through the metal detector machine. Waste of waiting occurs during the cooling process, when starting the engine, and waiting for the pressing process. Waste of transportation occurs due to circular and non-consecutive process flows. This research aims to minimize production time and increase production result by simulating the cireng production process of PT Brexelle Berkah Uniti using the Lean Manufacturing and System Simulation method. Based on the simulation results with the proposed improvements, the results obtained from the simulation were that the total production lead time was reduced by 10,97 minutes from 40.45 minutes to 29,48 minutes. The NVA and NNVA time on FVSM also decreased by 10.81 minutes from the activity time on CVSM. Based on the simulation results, production results increased by 80% after the proposed improvements, from 4,671,945 pcs per month to 8.429.679 pcs per month.

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1 Introduction

PT Brexelle Berkah Uniti, this company needs to pay more attention to each production line. Based on the percentage of defects in products produced by PT Brexelle Berkah Uniti, there were the highest defects in April and January at 0.156% because these months coincided with the new year holidays and the month of Ramadan so the demand for cireng products also increased. Based on the results of interviews with Quality Control staff, the percentage of these defects has exceeded the company's target of 0.050%.

In addition to waste defects, there is waste transportation as a result of rotating and non-consecutive process flows, resulting in waste of transportation between cooling work stations and expiration date manufacturing work stations. In addition, workers are required to take the dough and return the tray to the room they came from. This has an impact on increasing worker transportation time so that production time becomes longer. Based on processing time data, a total transportation time of 134.427 seconds is obtained with a distance of 42 m so the distance is expected to be reduced and transportation time can be reduced.

Therefore, to reduce waste, a proposed improvement is needed to maintain quality and increase productivity in the cireng production process. With this research, it can be seen how the proposed improvements can minimize waste with the Lean Manufacturing method and know the output of the proposed improvements with the System Simulation approach.

2 Research Method

The research was conducted by examining waste at PT Brexelle Berkah Uniti, starting with the preparation phase, the data collection phase, as well as the data processing and analysis phase. appropriate place in the text.

2.1 Preparation

The preparation phase includes field studies and literature studies related to Lean Manufacturing, production processes, 7 Waste, Value Stream Mapping (VSM), Value Stream Analysis Tools (VALSAT), 5 Whys, and System Simulation to formulate problems and determine objectives and benefits of research.

2.2 Data Collection

You Data collection methods that used in this research include interviews, questionnaires, observation, and literature study. The types of data and procedures used for data collection in this study are described as follows:

2.2.1 Primary Data

Primary data contained from observation, interview and questionnaire. The data obtained from the observations is data regarding conditions that related to the research problem, such as the flow production process, layout, and transportation flow during the production process.

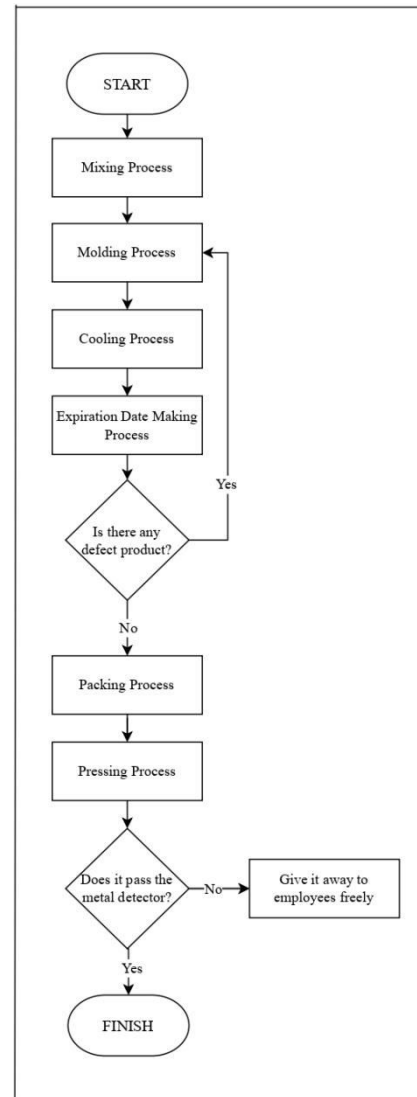


Fig. 1. Flow Production Process.

The data obtained from the interview results are data on the sequence of production activities, the number of operators for each production activity, the distance of each workstation, the working hours of all workers, and the target defect of the company. The data obtained from the results of the questionnaire is the score or weight data from the 7 waste questionnaire.

2.2.2 Secondary Data

In this study, the secondary data used is production data and defect products data by PT Brexelle in July 2021 – August 2022. The researchers obtained this data from the company's internal data for 2021 and 2022.

Table 1. Output Production Data

Month	Total of Production Each Month	Total of Defect Products	Percentage of Defect Products
August 2021	5245240	5160	0.098%
September 2021	4875460	4840	0.099%
October 2021	4406880	4740	0.108%
November 2021	4345620	5080	0.117%
December 2021	5196300	7580	0.146%
January 2022	4366280	6800	0.156%
February 2022	3933140	4500	0.114%
March 2022	5018240	5220	0.104%
April 2022	6052900	9420	0.156%
May 2022	3816140	5580	0.146%
June 2022	4527360	5220	0.115%
July 2022	4279780	4960	0.116%

3 Results and Discussion

3.1.1 Score Results and Waste Rating from the Questionnaire

The following is the result of data recapitulation and the results of the 7 Waste Questionnaire:

Table 2. Summary of Results Score 7 Waste Questionnaire

Respondents	Over Production	Defects	Inappropriate Processing	Excessive Transportation	Unnecessary Motion	Waiting	Unnecessary Inventory
1	0	1	0	1	0	1	1
2	0	5	0	1	1	5	0
3	0	1	1	2	1	0	1
4	0	1	0	1	0	1	1
5	1	0	0	1	0	1	0
6	1	1	0	3	0	1	1
7	0	1	0	1	1	1	1
8	0	0	0	1	1	0	0
9	0	1	0	1	0	0	0
10	4	4	3	2	1	5	0
Average	0.6	1.5	0.4	1.4	0.5	1.5	0.5
% Waste	0%	0%	0%	0%	0%	0%	0%
Ranking	4	1	7	3	5	2	6

Based on the questionnaire above, by taking the 3 wastes with the highest percentage of waste, improvements can be made for 68% of the waste in the company or more than half of the waste in the company. It means more than half of the waste will be identified and proposed improvements.

3.1.2 Value Stream Analysis Tools (VALSAT)

The following is the result of the VALSAT calculation by multiplying the average waste with the multiplier waste correlation value according to the VALSAT table.

Table 3. Calculation of Value Stream Analysis Tools

Waste	Average of Waste	Process Activity Mapping	Supply Chain Response Matrix	Production Variety Funnel	Quality Filter Mapping	Demand Amplification Mapping	Decision Point Analysis	Physical Structure
Over Production	0.6	0.6	1.8	0	0.6	1.8	1.8	0
Defects	1.5	1.5	0	0	0	0	0	0
Inappropriate Processing	0.4	3.6	0	1.2	0.4	0	0.4	0
Excessive Transportation	1.4	12.6	0	0	0	0	0	1.4
Unnecessary Motion	0.5	4.5	0.5	0	4.5	0	0	0
Waiting	1.5	13.5	13.5	1.5	0	4.5	4.5	0
Unnecessary Inventory	0.5	1.5	4.5	1.5	0	4.5	1.5	0.5
TOTAL	37.8	20.3	4.2	5.5	10.8	8.2	1.9	

Based on the calculation above, it is known that Process Activity Mapping is the selected tool that has the highest score, which is 37,8.

3.1.3 Actual Process Activity Mapping (PAM)

Based on the actual Process Activity Mapping table, it can be seen the total number of all types of activities (Operation, Transportation, Inspection, Storage, Delay), activity time, and activity categories (Value Added, Necessary Non-Value Added, Non-Value Added). Here is the recapitulation:

Table 4. Recapitulation of Actual Activity Time

Activity	Total of Activity	Time (Second)	Percentage
Operation	17	306.05	12.61%
Transportation	17	134.43	5.54%
Inspection	2	8.52	0.35%
Storage	0	0.00	0.00%
Delay	3	1977.78	81.50%
TOTAL	39	2426.77	100%

Based on the table above, it can be seen that there are 39 activities with a total lead time of 2426,769 seconds. From the table, it is obtained that the domination of activity time is delayed activity.

Table 5. Recapitulation of Actual Activity Time

Activity	Total of Activity	Time (Second)	Percentage
Value Added (VA)	14	307.16	12.66%
Non Value Added (NVA)	4	164.44	6.78%
Necessary Non Value Added (NNVA)	21	1955.17	80.57%
TOTAL	39	2426.77	100%

3.1.4 Current Value Stream Mapping (CVSM)

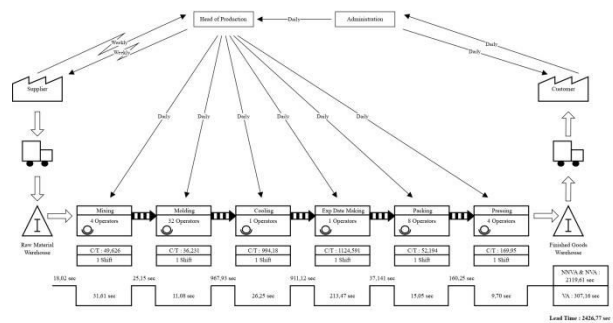


Fig. 2. Current Value Stream Mapping

3.1.5 Identification of Critical Waste

Based on the results of the 7 waste questionnaires, 3 critical wastes were obtained, namely Defects, Waiting, and Excessive Transportation. The following is the result of the analysis of critical waste identification that occurs based on field observations, interview results, and Process Activity Mapping results.

1. Defects
 - a. Dissimilar Product Shape
 - b. Destroyed Product
 - c. Product Does Not Pass the Metal Detector Machine
2. Waiting

- a. Waiting for Cooling Down Process
 - b. Waiting for Press Process
3. Excessive Transportation
 - a. Inefficient Material Handling for Packing Process from Cooling Workstation to Packing Workstation.
 - b. Excessive Transportation when Taking the Dough and Returning the Tray to the Origin Room.

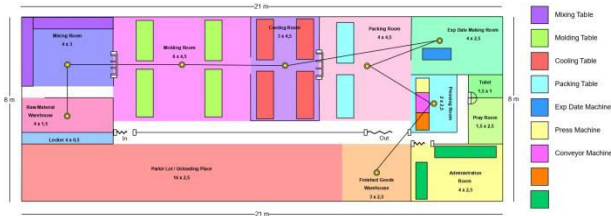


Fig. 3. Actual Production Layout of PT Brexelle Berkah Unit

3.1.6 Root Cause Analysis with 5 Whys

Based on the three waste that have the highest score of 7 waste questionnaire, the following is a root cause analysis using the 5 Whys method to identify the root causes of the PT Brexelle Berkah Unit production unit:

1. Defects

Table 6. 5 Whys Analysis Waste Defect

No	Analysis 5 Whys	
1	Dissimilar Product Shape	
	Why 1	Lack of operator accuracy when molding the dough
	Why 2	Operators in rush when molding the dough
	Why 3	Operators are chasing time so that there is no delay in the molding process
	Why 4	The molding process is still manual with human hands so the process takes a long time
	Why 5	There is no machine that is suitable for molding cireng in the shape desired by the company and the company does not have a standard diameter or size for cireng with defects
2	Destroyed Product	
	Why 1	The cireng dough is too thin
	Why 2	Operators in rush when molding the dough
	Why 3	Operators are chasing time so that there is no delay in the molding process
	Why 4	The molding process is still manual with human hands so the process takes a long time
	Why 5	There is no machine that is suitable for molding cireng in the shape desired by the company and the company does not have a standard diameter or size for cireng with defects
3	Product Does Not Pass the Metal Detector Machine	
	Why 1	There is contamination of the production from operator's pins/needles as well as pieces of iron or wire from the flour sieves during the molding process
	Why 2	Lack of carefulness from the operator that they did not realize that there was pins/needles
	Why 3	Operators are not aware of the dangers of using pins/needles in the food industry and pieces of wire that are not visible to the eye
	Why 4	There is no socialization and prohibition on the use of safety pins/needles in the production process
	Why 5	There is no SOP regarding the use of pins/needles during the production process

2. Waiting

Table 7. 5 Whys Analysis Waste Waiting

No	Analysis 5 Whys	
1	Waiting for Cooling Down Process	
	Why 1	Table capacity to accommodate cireng is inadequate
	Why 2	The cooling process tends to take a long time (around 15 minutes)
	Why 3	The table that made of stainless steel so that the heat from the bread is sent back by the table frame
	Why 4	Cooling table that does not have good air circulation
	Why 5	The cooling table has no cavity for air circulation
2	Waiting for Pressing Process	
	Why 1	There are unfinished cireng in the Pressing Process
	Why 2	Too many of targeted production have to be finished on that day
	Why 3	The rising of consumer demand that resulting in an piled up production
	Why 4	The lack of the number of machines and resources provided by the company causes piling up of the cireng
	Why 5	

3. Excessive Transportation

Table 8. 5 Whys Analysis Waste Excessive Transportation

No	Analysis 5 Whys	
1	Inefficient Material Handling for Packing Process from Cooling Workstation to Packing Workstation	
	Why 1	The layout between workstations is not unidirectional or rotating
	Why 2	Workstations are in separate rooms and enclosed by walls
	Why 3	Lack of application of optimal layout knowledge for placing work stations and lack of socialization of the use of material handling
	Why 4	Lack of competent human resources for production layout knowledge
	Why 5	The company does not provide knowledge related to production layout
2	Excessive Transportation when Taking the Dough and Returning the Tray to the Origin Room	
	Why 1	Operators go back and forth to return the dough container
	Why 2	There are not many container, so the container must be returned to the room where they came from, thus increasing the transportation time
	Why 3	The distance between stations is quite far and there are no resources to carry the goods
	Why 4	None operator collects containers from the molding table
	Why 5	There is no tool provided by the company to be able to deliver the container back to the room of origin

3.1.7 Proposed Improvements

Based on the root causes of the 5 Whys method, researchers can provide suggestions for improvements related to the root causes. The following is a proposed improvement of the 3 critical wastes:

1. Defects

- a. Dissimilar Product Shape
Making written SOPs related to the standard size of cireng (15 grams in weight and 1 cm in thickness or half the index finger's thickness).
- b. Destroyed Product

Procure a divider machine to divide the dough into 15 grams per piece of *cireng* and a dough sheeter machine to flatten the dough into 1 cm thick.

c. Product Does Not Pass the Metal Detector Machine

Making written SOPs (Standard Operating Procedures) regarding the use of safety pins, and other sharp objects in the production unit so that no sharp items accidentally enter the food processing.

2. Waiting

a. Waiting for Cooling Down Process

Procure 2 stacks of cooling racks and exhaust fans to cool down the product in a short time. The dough can be placed on a cooling rack so that the cooling process can be more even. The exhaust fan is used to suck in and throw away the hot air that is on the rack so that the hot air will be sucked out.

b. Waiting for Pressing Process

Add 2 machines so that the number of machines becomes 6 machines. This is done to reduce the waiting time for the press machine.

3. Excessive Transportation

a. Inefficient Material Handling for Packing Process from Cooling Workstation to Packing Workstation.

Set the layout of the cooling, packing, and expiration date work stations to be directional and sequential; placing chili sauce on each operator table; as well as moving the work station for making expiration dates to be between the cooling work station and the packing work station.

b. Excessive Transportation when Taking the Dough and Returning the Tray to the Origin Room.

Set the layout of the divider machine closer to the dough room, and set the layout of the dough sheeter machine closer to the divider machine.

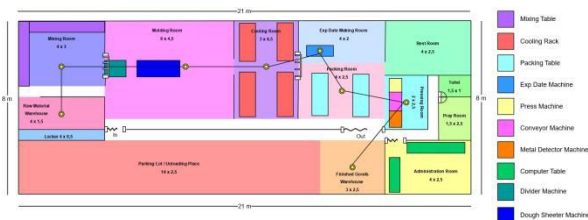


Fig. 4. Proposed Production Layout of PT Brexelle Berkah Uniti


 Standard Operation Procedure (SOP) Proses Produksi PT Brexelle Berkah Uniti	
Background	1. The need for operational standards for the production process of PT Brexelle Berkah Uniti. 2. These are products that have dissimilar shape, destroyed, and there is a metal content in the product. 3. There is a waiting time due to machine preparation.
Definition	Standard operational for production processes to ensure continuity production and improve quality in accordance with established standards.
Purpose	1. Ensuring the production process runs well and in accordance with procedures. 2. Ensuring <i>cireng</i> is produced according to product size standards. 3. Ensuring <i>cireng</i> products do not contain sharp objects or harmful metal content. 4. Ensuring machine preparation is appropriate and can be used when the production process begins.
General SOP	1. Workers are required to arrive on time and work according to the working hours (09.00 - 18.00). 2. Each production worker is responsible for every use of the machine and its production process. 3. Workers are prohibited from carrying sharp objects, using pins, needles, or other sharp objects to avoid the potential for sharp items to accidentally mix into <i>cireng</i> during the production process. 4. The machine must be turned on 30 minutes before the production process begins and the machine operator must be responsible for setting up the machine 30 minutes before the production process begins so that the machine is ready to be used when the production process begins (09.00 AM).
Specific SOP	<p>Mixing Process</p> 1. The mixing operator ensures that the ingredients used must comply with the determined recipe composition in order to get the dough results as the desired. 2. Before starting the mixing process, make sure the operators wash their hands and clean the mixing table from dangerous objects that have potentially to mix with the dough.
	<p>Molding Process</p> 1. The molding operator ensures that the machine is working properly and the product output from the machine is not defects. 2. The molding operator ensures that the product conforms to the <i>cireng</i> size standards, which are 15 grams in weight and 1 cm thick or half the index finger's thickness.
	<p>Cooling Process</p> 1. The cooling operator ensures that the products do not overlap on the cooling rack. 2. Cooling operators ensure that the product is completely cold so that it can be given to packing operators.
	<p>Expired Date Making Process</p> 1. The operator for making the expiration date ensures that the printed date matches the expiration date of the product (1 month after the production process).
	<p>Packing Process</p> 1. The packing operator ensures that the plastic packing has an expiration

Fig. 5. Standard Operating Procedure (SOP) of Production Process

3.1.8 Process Activity Mapping (PAM) Improvements

The following are some changes in production time based on proposed improvements and Process Activity Mapping Improvements to the production unit of PT Brexelle Berkah Uniti.

Table 9. Improvement in Process Time

No.	Activity	Activity Time (Second)			Improvements
		Actual	Proposed	Difference	
1	Mold the dough into round and flat + Put the dough into the <i>cireng</i> container	13,258	1,65	11,608	Procurement of a Divider machine to divide the dough into 15 grams per piece of <i>cireng</i> , and a dough sheeter machine to flatten the dough into 1 cm thick.
2	Waiting for Cooling Process	933,18	373,27	466,59	Procurement of 2 stacks of cooling racks and exhaust fans.
3	Waiting for Pressing Process	144,6	96,4	48,2	Procurement of 2 press machines.
4	Picking up the sambal from the sambal storage area + Returning the sambal box to the storage box + Taking cooled <i>cireng</i> from the cooling process window + Returning the <i>cireng</i> tray to the cooling process window + Taking plastic that has an expiration date in the expiration date making room	28,578	8,909	19,669	Setting the layout of the cooling, packing, expiration date work stations to be unidirectional and sequential; placing chili sauce on each operator table; as well as moving the work station for making expiration dates between the cooling work station and the packing work station.
5	Taking the dough from the mixing room to the molding table + Returning the dough tray to the mixing room	20,238	0	20,238	Organize layout of the divider machine close to the mixing room, layout of the dough sheeter machine close to the divider machine.

Based on the improvement Process Activity Mapping table, it is known that there are several changes in activity time and reductions in activities without added value (Non-Value Added).

Table 10. Comparison of Actual and Proposed Production Time

Production Process	Production Time (Second)		Difference
	Actual	Proposed	
Mixing Process	49.63	51.29	1.66
Molding Process	36.23	6.64	29.59
Cooling Process	994.18	434.27	559.91
Expired Date Making Process	1124.591	1124.591	0.00
Packing Process	52.19	30.27	21.92
Pressing Proses	169.95	121.75	48.20
Lead Time	2426.77	1768.80	657.97

With the proposed improvements, the production time for each production process is reduced. Total production lead time was reduced by 657.97 seconds or 10.97 minutes from 2426.77 seconds or 40.45 minutes to 1768.80 seconds or 29.48 minutes.

Table 11. Comparison of Actual and Proposed Activity Time

Activity	Actual		Proposed		Difference	
	Activity Total	Time (Second)	Activity Total	Time (Second)	Activity Total	Time (Second)
Operation	17	306.047	16	294.439	1	11.608
Transportation	17	134.427	13	96.18	4	38.247
Inspection	2	8.515	2	8.515	0	0
Storage	0	0	0	0	0	0
Delay	3	1977.78	3	1369.67	0	608.11
TOTAL	39	2426.769	34	1768.80	5	657.965

Based on the table above, it can be seen from the results of the proposed improvements, it is obtained a reduction of 5 activities with details of 1 operation activity and 4 transportation activities. So with the proposed improvements, there are 34 activities with details of 16 Operations, 13 Transportation, 2 Inspections, and 3 Delays. From these data, it is known that the dominant activities are Operations and Transportation.

3.1.9 Future Value Stream Mapping (FVSM)

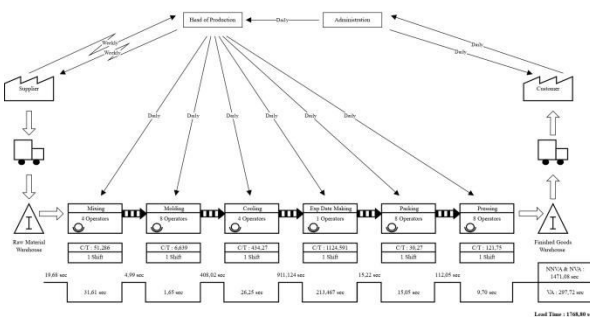


Fig. 6. Future Value Stream Mapping

3.1.10 Actual Simulation Model Design

Before do the simulation, it is necessary to do the distribution test to determine the best distribution that will be used in the simulation modeling with the Stat::Fit tool contained in the ProModel Software.

Table 12. Tool Stat::Fit Actual Simulation Distribution Results

No.	Work Station	Export Fit
1	Mixing	U(49.2, 3.23)
2	Mixing to Molding	U(20.1, 3.13)
3	Molding	14+(1.99)
4	Molding to Cooling	U(15, 2.02)
5	Cooling	889+E(90.2)
6	Cooling to Expired Date Making	10+L(1.29, 1.56)
7	Expired Date Making	U(1.11e+003, 37.5)
8	Expired Date Making to Packing	U(28.4, 3.39)
9	Packing	19+L(4.83, 3.22)
10	Packing to Pressing	U(6.88, 0.885)
11	Pressing	151+L(18.9, 59.5)

The following is the difference in the simulation output in 1 month which was replicated 12 times.

Table 13. Comparison of Real Total Production with Simulation Results

Month	Real Total Production	Simulation Results of Total Production
August 2021	5245240	4741705
September 2021	4875460	4741705
October 2021	4406880	4741705
November 2021	4345620	4741705
December 2021	5196300	4741705
January 2022	4366280	4741705
February 2022	3933140	4741705
March 2022	5018240	4741705
April 2022	6052900	4741705
May 2022	3816140	4741705
June 2022	4527360	4741705
July 2022	4279780	4741705

Wilcoxon test was performed with Minitab software. Below is the basis decision-making for the Wilcoxon test:

H0 : There is no difference between the actual simulation results and the real system results

H1 : There is a difference between the actual simulation results and the real system results

If the P-Value > 0.05, then H0 is accepted

Wilcoxon Signed Rank Test: d

Test

Null hypothesis H0: $\eta = 0$

Alternative hypothesis H1: $\eta \neq 0$

Sample	N for Test	Wilcoxon Statistic	P-Value
d	12	32.00	0.610

Fig. 7. Wilcoxon Test of Actual Simulation

Based on the Wilcoxon Test table, obtained P-Value which is 0.610 where the P-Value has exceeded the α value of 0.05, so H0 is acceptable. H0 is accepted, meaning that there is no difference between the actual simulation results and the real system results. So, based on the results of the Wilcoxon test, the model simulation is validated because there is no difference between the actual simulation results and the real system results.

3.1.11 Simulation Model Design Improvements

Improvement for simulation model design is made in order to see the overall impact of changes to the actual process and proposed improvements.

Table 14. Improvements of Tool Stat::Fit Distribution Result

No.	Work Station	Export Fit
1	Mixing	U(49.2, 3.23)
2	Mixing to Molding	1+L(0.66, 6.33e-003)
3	Molding	6+L(0.649, 0.459)
4	Molding to Cooling	U(15, 2.02)
5	Cooling	415+L(4.4, 2.5)
6	Cooling to Expired Date Making	10+L(1.29, 1.56)
7	Expired Date Making	U(1.11e+003, 37.5)
8	Expired Date Making to Packing	6+L(3.22, 2.7)
9	Packing	17+L(4.5, 2.89)
10	Packing to Pressing	U(6.88, 0.885)
11	Pressing	151+L(18.9, 59.5)

A performance test is conducted to find out whether there is a difference between the actual production results and the simulation production results after improvements are done.

Table 15. Comparison of Real Total Production with Simulation Results Improvements

Month	Real Total Production	Improvement Simulation Results of Total Production
August 2021	5245240	8429679
September 2021	4875460	8429679
October 2021	4406880	8429679
November 2021	4345620	8429679
December 2021	5196300	8429679
January 2022	4366280	8429679
February 2022	3933140	8429679
March 2022	5018240	8429679
April 2022	6052900	8429679
May 2022	3816140	8429679
June 2022	4527360	8429679
July 2022	4279780	8429679

Wilcoxon Signed Rank Test: d

Test

Null hypothesis	$H_0: \eta = 0$		
Alternative hypothesis	$H_1: \eta \neq 0$		
N for Wilcoxon			
Sample	Test	Statistic	P-Value
d	12	0.00	0.003

Fig. 8. Wilcoxon Test of Proposed Improvements

Based on the Wilcoxon Test table, it was found that the P-Value was 0.003 where the P-Value was less than the α value, which was 0.05, it means H_0 is rejected. H_0 is rejected, meaning there is a difference between the simulation results based on proposed improvements and the results of the real system. So, based on the results of the Wilcoxon Test, the proposed improvements have an effect on the proposed model simulation so that production increases compared to the production results of the real system.

3.1.12 CVSM and FVSM Difference Analysis

The following is the difference in the total time of Value Added, Non-Value Added, and Necessary Non-Value Added activities on CVSM and FVSM:

Table 16. Recapitulation of VA Activity Time Differences in CVSM and FVSM

Time Unit	Value Added		Time Difference (Second)
	Actual	Proposed	
Second	307.157	297.72	9.43
Minute	5.12	4.96	0.16

Based on the table above, it was found that the activity time for Value Added on FVSM was reduced by 9.43 seconds or 0.16 minutes compared to the activity time for Value Added on CVSM.

Table 17. Recapitulation of NVA and NNVA Activity Time Differences in CVSM and FVSM

Time Unit	NNVA & NVA		Time Difference (Second)
	Aktual	Proposed	
Second	2119.612	1471.08	648.53
Minute	35.33	24.52	10.81

Based on the table above, it was found that the activity time for Non-Value Added and Necessary Non-Value Added on FVSM decreased by 648.53 seconds or 10.81 minutes from the time on CVSM.

Based on the differences in FVSM and CVSM, it can be seen that in the cireng production process of PT Brexelle Berkah Uniti, companies can reduce lead time or speed up activity time if they do the proposed improvements.

3.1.13 Analysis of Differences in Simulation Results

The total results of the improvement simulation production are compared with the actual production results of the real system at the company to see any differences in production results after the repairs are carried out.

Table 18. Recapitulation of Total Actual Production and Improvement Simulation (Pcs)

Replication/ Month	Real Total Production	Improvement Simulation Results of Total Production	Difference	Increase Percentage
1	5245240	8429679	3184439	61%
2	4875460	8429679	3554219	73%
3	4406880	8429679	4022799	91%
4	4345620	8429679	4084059	94%
5	5196300	8429679	3233379	62%
6	4366280	8429679	4063399	93%
7	3933140	8429679	4496539	114%
8	5018240	8429679	3411439	68%
9	6052900	8429679	2376779	39%
10	3816140	8429679	4613539	121%
11	4527360	8429679	3902319	86%
12	4279780	8429679	4149899	97%
Average	4671945	8429679	3757734	80%

Based on the table above, it can be seen that with the same time of 1 month and 192 working hours, the proposed simulation production results are higher than the actual system production results in real conditions. The average difference in the proposed simulation production results with the real system is 3,757,734 pcs.

The increase in production from the previous 4,671,945 pcs to 8,429,679 pcs per month was due to proposed improvements in the form of reducing the time in the production process. These improvements

can increase the total production per month to a percentage increase of 80%.

4 Conclusion

Based on the results of data processing and analysis performed, it can be concluded that:

1. Based on the results of the 7 waste questionnaires, there are 3 most dominant wastes in the cireng production process of PT Brexelle Berkah Uniti which is defects, waiting, and excessive transportation.
2. Based on calculations and simulations with the proposed improvements, the total production lead time was reduced by 657.97 seconds or 10.97 minutes from 2426.77 seconds or 40.45 minutes to 1768.80 seconds or 29.48 minutes. Based on VSM, the NVA and NNVA time on FVSM decreased by 648.53 seconds or 10.81 minutes from the activity time on CVSM. Based on the simulation results, an increase in production yields was obtained by 80% after the proposed improvements, which from 4,671,945 pcs per month to 8,429,679 pcs per month. Therefore, it can be concluded that the proposed improvements can minimize production time and increase production results in the cireng production process of PT Brexelle Berkah Uniti using the Lean Manufacturing method.

References

- B. Andersen, T. Fagerhaug, *Root Cause Analysis*, 223 (2006)
- M. Arif, *Pemodelan Sistem*, 195 (2017)
- V. Gaspersz, *Continous Cost Reduction Through Lean-Sigma Approach (Strategi Dramatik Reduksi Biaya dan Pemborosan Menggunakan Pendekatan Lean-Sigma)*, 254 (2006)
- P. Hines, N. Rich, *The Seven Value Stream Mapping Tools*, 17 (1997)
- P. L. King, J. S. King, *Value Stream Mapping for the Process Industries*, 2, 244 (2017)
- S. K. Land, D. B. Smith, J. W. Walz, *Practical Support for Lean Six Sigma Software Process Definition*, 2, 360 (2012)
- T. Ohno, *Toyota Production System: Beyond Large-Scale Production*, (1998)
- S. Santoso, *SSBTTI: SPSS Statistik NonParametrik+CD*, (2006)
- T. Satria, E. Yulawati, *Perancangan Lean Manufacturing dengan Menggunakan Waste Assessment Model (WAM) dan VALSAT untuk Meminimumkan Waste (Studi Kasus: PT. XYZ)*, 7, 1 (2018)
- N. A. Viana, A. E. Nurhidayat, *Analisis Sistem Antrian dalam Meningkatkan Pelayanan Customer Di PT. Optima Kurnia Elok Menggunakan Promodel*, 1, 2 (2019)