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Case Study

Analysis of the Production Loss of the Automotive Company PT DNIA Using Value Stream Mapping and Overall Resources Effectiveness

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ABSTRACT

The purpose of the study case was to analyze the losses that occur in automotive companies on PT DNIA. The results are used to refer to the company in carrying out efficiencies at its plant. The efficiency is a necessity for companies to be able to compete in the highly competitive automotive market. Research by direct observation of the actual condition of the factory by analyzing the value stream mapping and overall resources effectiveness, based on the results of the analysis brainstorming to determine the root of the problem and come up with ideas for improvement by considering costs and benefits. The results of case studies can increase in productivity of 19% and a decrease in the lead time of 28%.

Keywords: [Lean, Balance delay, Overall resources effectiveness, value stream mapping]

INTRODUCTION

The automotive industry in Indonesia has increased in the last 20 years. In Indonesia the growth in car production has increased quite high, in 2003 to 2015 there has been an increase of more than 250%, the increase in production must be supported by an effective and efficient automotive production system. As a result, competition in the automotive industry in the world, especially in Indonesia, forced the company to carry out three primary objectives of lean manufactures, namely a short production period, low production costs, and high quality. Production loss analysis that occurs in the production system must be prioritized so that immediate repairs can be made.

In 2019 the company has targeted a reduction in production time (lead time) by 30%, the productivity of 15% and an increase in quality by targeting a maximum of 5 pcs claim products to customers. Looking at the company's internal data related to the production lead time in Figure 1, there are several production loss times; an example can be taken for H products, the time when the lead time planning is 62.5 hours in the production system while the actual reaches 96.17 hours. Measurement and analysis of loss lead time can use Value Stream Mapping to measure value-added and not value-added so that it can identify waste.

Quantitative Analysis of Overall Equipment Effectiveness (OEE) metrics, which are part of Total Productive Maintenance (TPM) can help companies in identifying waste (loss). There are six biggest wastes as parameters for improvement through the identification of OEE. As time goes on, the development of OEE continues to change, as that of Garza-rayes (2014) [1] who formulates measures of effectiveness becomes Overall Resource Effectiveness (ORE). A more comprehensive ORE measurement, not only measuring Availability (A), Performance (P) and

Quality (Q) but also in other cases, such as labor and production facilities.

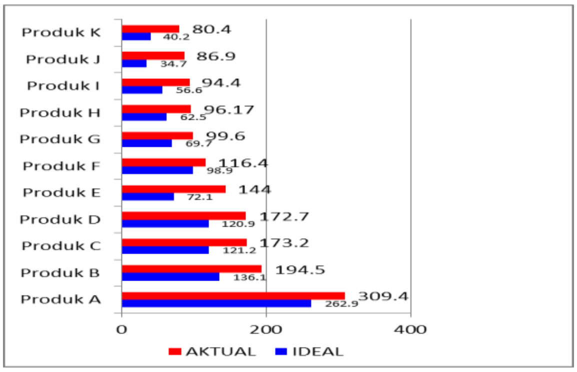

Figure 1. Production lead time of each product

LITERATURE REVIEW

Lean Manufacture

Womack et al. (1990) [2] mentions that there is potential if implementing a lean manufacturing system can make: half the employee's performance in the factory, half the production space, half the production equipment investment, half the technical effort, half the time in product development.

To be able to reduce this waste Womack and Jones (1996) [3] summarize the stages in making improvements with lean manufacture: determining the flow of values, identifying the flow of values, making steps in the flow of values, promoting the pull system, performing process perfection. The focus of lean manufacturing is to reduce waste, balance the flow in the process (value stream), reduce cycle time and increase productivity.

Managing constrains in line process

Karjewski et al. (2016) [4] conveyed that process balancing is to place workplaces on the system to be able to increase process output with the smallest number of workplaces, to be able to produce goods more efficiently. In balancing the process, the 1st stages must know the work element (a small activity in the activity) to be able to produce an existing product

In analyzing constraints in balancing the process, several parameters must be analyzed to obtain weaknesses from the process. So that loss can be seen in the production line can be more efficient, Table 1 explains in more detail related to the analysis used in this research

Table 1: Margin specifications

Analysis	Equations	Remark
Cycle Time	$c = \frac{1}{r}$	c: *cycle time* r: *output.*
Theoretical	$TM = \frac{\sum_{:} t}{c}$	$\sum_{:} t$: Total Time
Idle Time	$= nc - \sum_{:} t$	n: *number of stations*
Efficiency (%)	$\frac{\sum_{:} t}{nc}(100)$	
Balance Delay (%)	100- *efficiency*	

Value Stream Mapping

Value Stream Mapping (VSM) delivered by Rusell and Taylor (2011) [5] in his operation management mentions that VSM is a tool used to analyze process flow so that it can eliminate loss, a VSM can show in detail the material flow, operational parameter information flow (lead time, cycle time, process time, setup time), number of employees, overall process efficiency etc. VSM has special symbols in its creation both from the mapping of the current situation and mapping future conditions. Figure 2 below shows an example of VSM on automotive

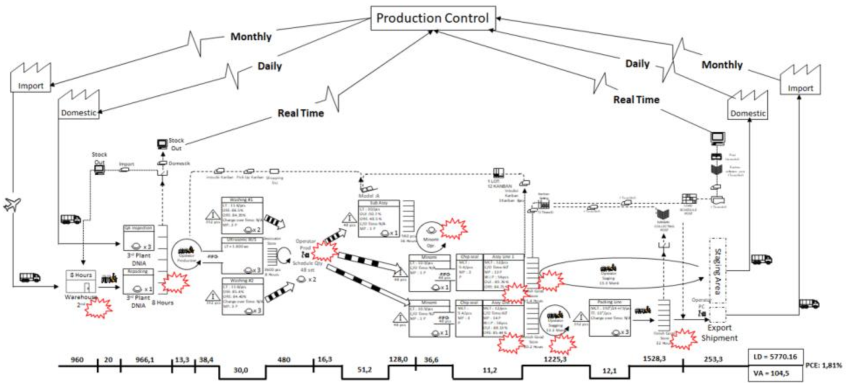

Figure 2. Value Stream Mapping.

Overall Equipment Effectiveness (OEE)

Nakajima (1988) [6] determines Overall Equipment Effectiveness as a measure to evaluate how effective production equipment is, by identifying losses that occur during production, either directly or indirectly. Nakajima (1988) [6] has defined six big losses:

1. Damage to production equipment (breakdown machine), resulting in loss of production time.
2. Set up / adjust the time at the beginning of production, the production runs and when production is finished in accordance with the requirements of the product.
3. Idling and small stops when production.
4. Reduced speed due to differences in speed determined by actual speed.
5. Reduction in production results when production begins until production begins to stabilize.
6. The product is defective or reworked due to nonstandard quality.

Overall Line Effectiveness (OLE)

In one manufacturing unit, it consists of various types of production lines based on market demand, customer needs and technical capabilities available in the company. This is evidenced by the system model "Product Line Manufacture" or an assembly line, where the product must move sequentially with the engine layout according to the route of manufacture of the product.

If depicted in losses according to Nakajima, the six largest losses in quantitative OLE metrics can be generated in Figure 3

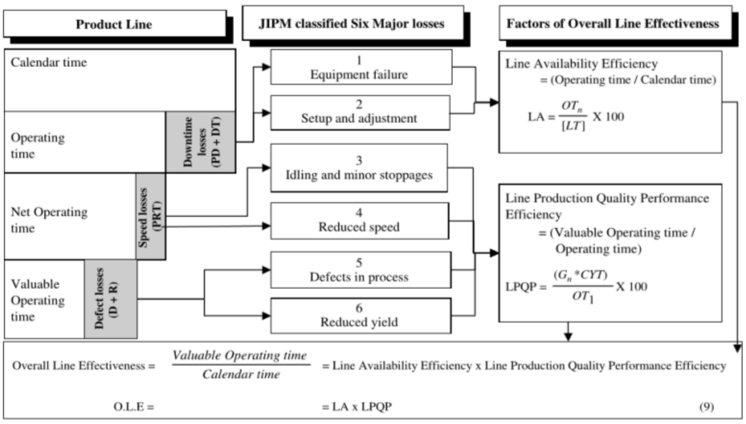

Figure 3. Overall line Effectiveness.

Overall Resources Effectiveness (ORE)

Overall OEE is a performance measurement approach that has been widely used in the industry not only to control and monitor performance but also as an indicator and process driver and performance improvement (Kumar et al. 2004). [7] However, although OEE is still the key to performance measurement and must be supported by several performance factors that are relevant to the operation of the process. For example, efficient use of raw materials, quality and costs, logistics, production systems, and labor.

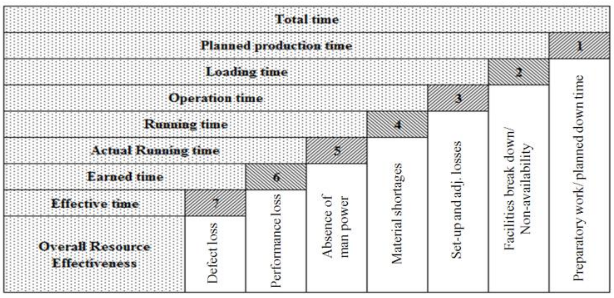

Figure 4. Overall Resources Effectiveness

Garze-reyes (2014) [1] developed ORE, a manufacturing measurement system to provide a more inclusive evaluation of OEE. The main difference between traditional ORE and OEE is the evaluation of overall performance based not only on availability (A), performance (P) and quality (Q) but also in other cases, such as labor and facilities.

Pareto Diagram

The purpose of the Pareto diagram is to determine a vital few or trivial many problems slack et al. (2009). [8] The basic principle in Pareto diagrams is to state that for many events around 80% is caused by 20% of the causes or the so-called Pareto law or 80/20 rule (Hill, 2000). [9] Pareto. The Pareto list is obtained by placing the highest of the number of events/problems in the front and so on. The Pareto approach is used in industry to help organizations identify the most important processes were to be a starting point for improvements to Rohleder and Silver (1997). [10] Pareto analysis effectively helps in managerial decision making.

Fishbone Diagram

The most important aspect of process analysis is connecting all elements of input, methods, and processes. One way to analyze the occurrence of problems in the system is to use a causal diagram that matches what has been delivered by Krajewski et al (2016) in his book Operation Management. Where the main problem in the system is in the "fish head" and the solution is in the last bone in the fish. The application of fishbone diagrams according to Ishikawa (1976) [11] to reveal six potential categories that might cause problems

ANALYSIS

Overall Effectiveness Analysis

Table 2. Overall Line Effectiveness in sub-assembly 1 and assembly 1 has the highest ratio in the calculation of data, but not in Overall Resources Effectiveness, sub-assembly 1 has the lowest calculation of 64.86% with the lowest availability of manpower of 69.8%. In other words, the utilization of employees in the sub-assembly occurs almost half of the minimum time of work (± 20 working days @ 8 hours) set by the company.

Table 2: Result of overall effectiveness

	Wash 1	Wash 2	S/A	Assy 1	Assy 2
OEE	86.65%	85.53%	-	-	-
OLE	-	-	90.73%	90.13%	88.67%
ORE	86.62%	85.51%	64.86%*	89.69%	88.24%

Following the Pareto concept which contains the 80/20 element, you can see the Pareto diagram in Figure 17 and the detailed loss of ORE found in Appendix 6. There is little potential for loss analysis from the Overall Resource effectiveness at performance loss (29.51%), when the operator does not work (for sub-assembly) (21.27%), and engine preparation time (14.44%).

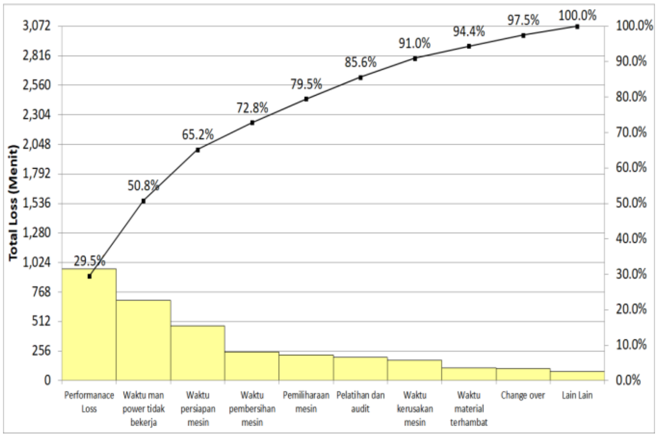

Figure 5. Pareto overall resources effectiveness

Balance delay analysis

Analyze the balance delay in the process of each process. Observers and measurements are carried out in each process, such as assembly line 1, assembly line 2, sub-assembly, washing machine 1, washing machine 2. And to get the overall results, observations and measurements are also carried out on processes that are unified in the assembly line, such as chip seal 1, chip seal 2, minomi 1, minomi 2, transfer 1 and transfer 2. In Appendix 12 the layout of the machine and the position of the operator in performing the work can be seen.

Table 3 shows the cycle time and results of balance delay assembly lines 1 and 2. The balance delay produced in this process is 31% for assembly 1 and 30% for assembly 2, which means total loss or idle time for assembly 1 is 41.1 seconds and 35.9 seconds for assembly 2

Table 3: Balance delay assembly line

Proses	*Cycle Time* Assy 1	*Cycle Time* Assy 2
1	11.2	11.6
2	-	-
3	12	12
4	-	-
5	11.5	11.6
6	8.7	11.3
7	9.7	8.9
8	9.7	9.9
9	10.9	10.7
10	7.9	-
11	-	-
12	9.3	8.1
13	8.6	9.5
14	7.1	7.3
Total Operator	11.0	10.0
Total Waktu	90.9	84.1
Bottle neck Cycle time	12.0	12.0
Theoretical Minimum	7.6	7.0
Idle Time	41.1	35.9
Efficiency	69%	70%
Balance Delay	31%	30%

If measurements are taken separately, the problem will only be seen in the assembly line, so the researcher takes measurements by combining a single process unit from the first process of machine washing, product transfer, processing process, chip seal process, and finally assembly line, total loss on balance delay will be seen in Table 13, where there is a loss of 9.17% of the total assembly line unit.

Table 4: Balance delay total

Proses	Assy 1	Assy 2
Washing (sec)	11,6	11,6
Transfer (sec)	10,8	10,8
Minomi (sec)	10,7	10,7
Chip seal (sec)	9,4	9,4
Assembly (sec)	12,0	12,0
Total Station	5,00	5,00
Total Time	54,50	54,50
Bottle neck cycle time	12,00	12,00
Theoretical Minimum	4,54	4,54
Idle Time	5,50	5,50
Efficiency	90,83%	90,83%
Balance Delay	9,17%	9,17%

Based on the lean concept, the focus in managing balance line is the concept of equity, so the presentation process which is a bottleneck must be carried out until the second bottleneck process. And from the side of the chip seal process, which is the lowest cycle time process which means there is a loss of waiting time for the process of the assembly process, it can be seen at 5.5 seconds idle time.

Current state value stream mapping

The result of value stream mapping is process cycle efficiency. The results of the process cycle efficiency in the production process with a ratio of 1.81%. With the biggest loss at the supply level above 90% of the total identified as loss, it can be seen in the Figure 6.

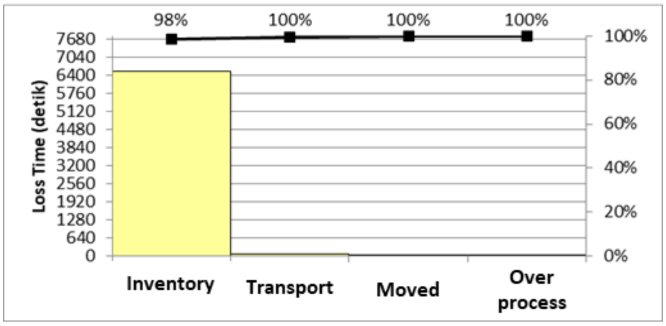

Figure 6. Pareto Loss form analysis VSM

Improvement Item

Every problem will be analyzed by using Fish bone analysis, sample analysis can be seen in Figure 7

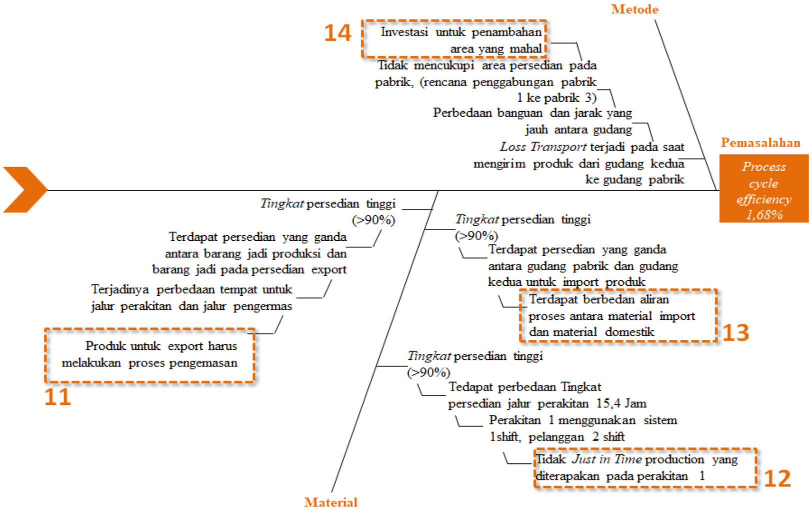

Figure 7. Pareto Loss form analysis VSM

Of the 14 problems based on fishbone analysis summarized with 24 improvement ideas. Not all ideas for improvement are carried out, there are 5 ideas of improvement that are not recommended to be done due to additional costs, long time to apply or large investment without any short-term benefits, thus there are 19 improvement ideas carried out cost and benefit analysis.

The idea of improvement using investment will be an analysis of payback and ROI, with criteria as follows:
1. Payback analysis takes a maximum 2-year improvement idea.
2. Positive ROI.
3. Improvement ideas with the same results, the idea of improvement is taken with the highest ROI.

A total of 9 improvement items will be implemented and will be included in the future state value stream mapping:
1. Improvement 1: Decrease cycle time on process 1 assembly line with Automation
2. Improvement 9: Add a machine timer calendar system for setting the temperature on the washing machine
3. Improvement 11: Make a shift in the sequence working on the process 6-10.
4. Improvement 13: Make a sequence move to work in process 12-14
5. Improvement 14: Change the layout of the washing process.
6. Iimprovement 19: Eliminate the supply of exports in the supply of production by combining the process of processing with the production process.
7. Improvement 20: Make changes to the shift system on assembly line 1 to 2 shifts
8. Iimprovement 21: Making one import and domestic material system at the factory warehouse.
9. Improvement 23: Using one warehouse system (factory warehouse)

RESULT

It can be seen from the results of the future value stream mapping based on 9 ideas of improvement, decreasing production lead-time by 1,615.54 minutes, process cycle efficiency increasing to 2.52%, loss lost, among others, inventory in the second warehouse, shipping process to factory warehouse, material delivery to assembly lines 2 and 1, withdrawals for packaging line requirements, decreases in assembly line availability. The balance delay value in the process decreases with a total loss of 15% for Assembly Line 1 and 13% for assembly line 2. Decreased loss of up to 50%, Balance delay after improvement can be seen in Table 5 and for Value stream before improvement and after improvement can be seen in figure 8 and 9

Table 5: Balance delay assembly line After Improvement

	Before		After	
Proses	Cycle Time Line 1	Cycle Time Line 2	Cycle Time Line 1	Cycle Time Line 2
1	11,2	11,6	11,6	11,6
2	-	-	-	-
3	12	12	11,5	11,5
4	-	-	-	-
5	11,5	11,6	11,5	11,5
6	8,7	11,3	11,3	11,3
7	9,7	8,9	-	-
8	9,7	9,9	11,5	11,5
9	10,9	10,7	11,4	10,7
10	7,9	-	7,9	-
11	-	-	-	-
12	9,3	8,1	11,5	11,5
13	8,6	9,5	-	-
14	7,1	7,3	11,5	11,5
Total station	11,0	10,0	9,0	8,0
Total time	90,9	84,1	88,2	79,6
Cycle time	12,0	12,0	11,5	11,5
Theoretical Minimum	7,6	7,0	7,7	6,9
Idle Time	41,1	35,9	15,3	12,4
Efficiency	69%	70%	85%	87%
Balance Delay	31%	30%	15%	13%

The idea of improvement in Overall Resource Effectiveness influences the readiness ratio, availability of man power and performance efficiency. In Table 6 shows the effect on improvements to ORE, calculations that change estimates if there is a reduction in loss from repair results. An example can be taken of a sub-assembly where if loss to the availability of man power is lost then the ORE is estimated to increase to 90.14%.

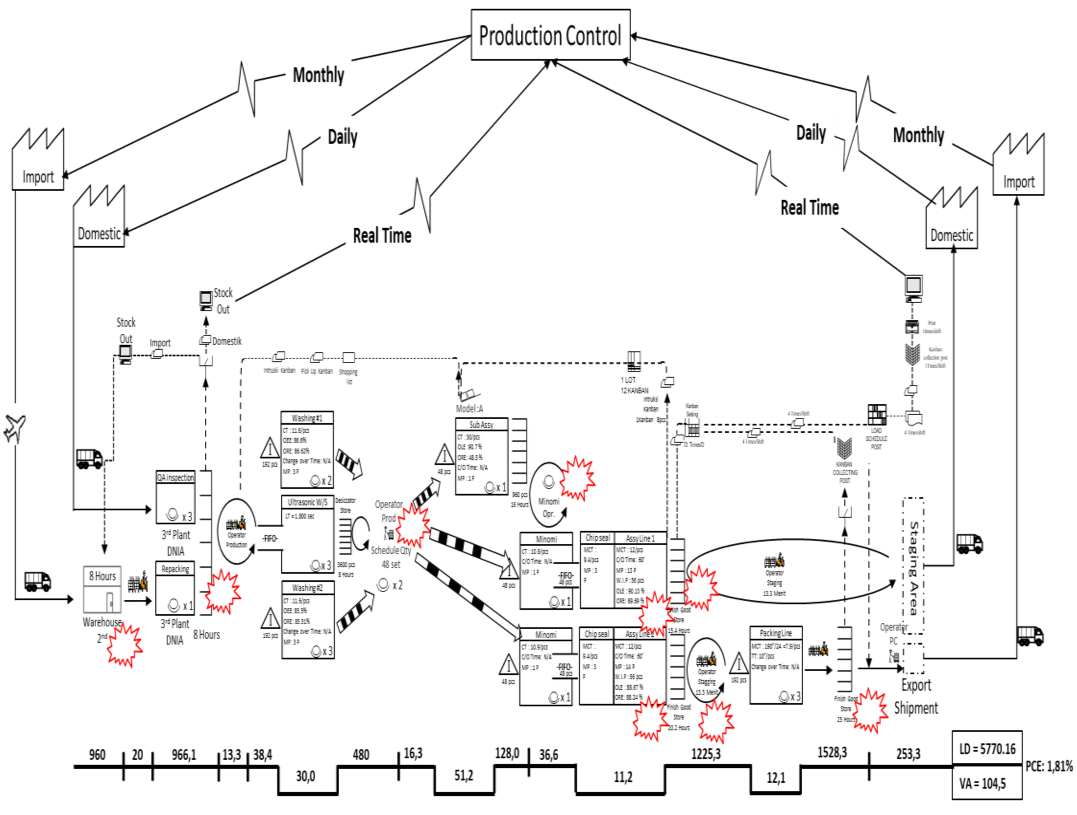

Figure 8. VSM before improvement.

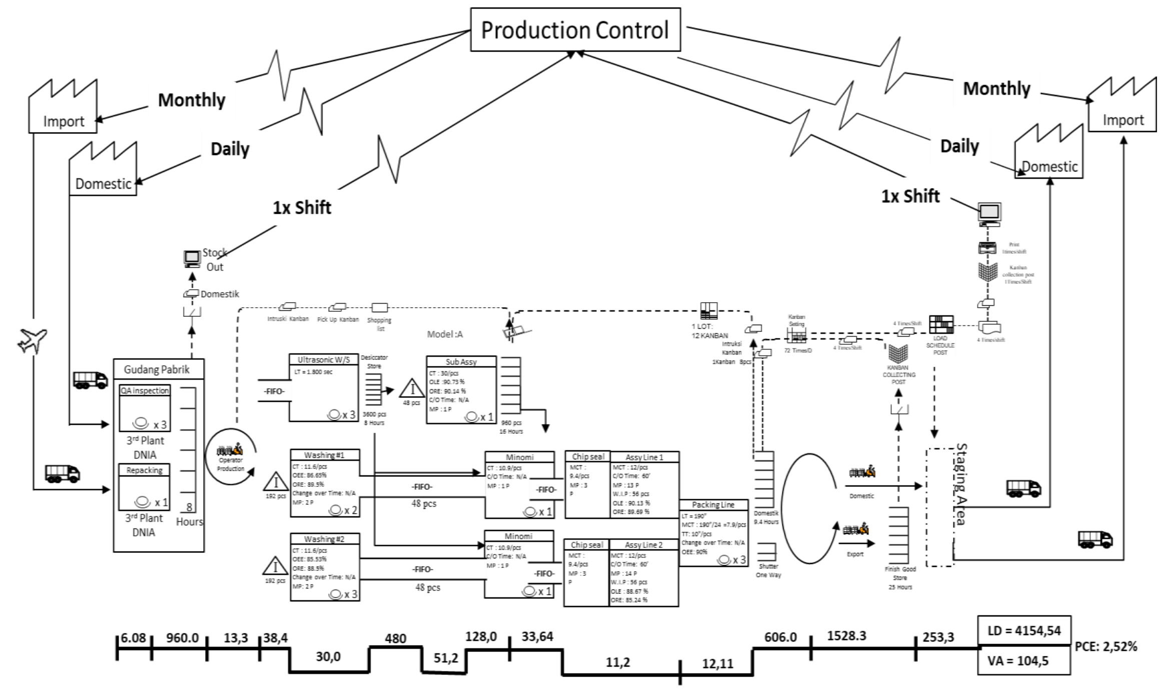

Figure 9. VSM after improvement.

The results of improvement will also have an impact on the company's productivity because it can reduce man sec in the production process as shown in Table 7, assembly line 1 will reduce 16.5% and assembly line 2 will decrease by 19.4%

Table 6: Comparison of ORE after improvement

Item		Wash 1	Wash 2	S/A	Assy 1	Assy 2
ORE	Before	86,62%	85,51%	64,86%	89,69%	88,24%
	After	89,54%	88,46%	90,14%	-	-
Readiness	Before	93,29%	96,28%	93,68%	93,71%	94,62%
	After	**96,13%**	**97,71%**	**91,17%**	-	-
Aviability of Facility	Before	99,81%	99,89%	99,90%	98,83%	97,79%
	After	-	-	**99,86%**	-	
Changover Efficiency	Before	100,00%	100,00%	100,00%	98,74%	98,86%
	After	-	-	-	-	-
Aviability of Material	Before	97,66%	99,62%	100,00%	99,78%	99,75%
	After	-	-	-	-	-
Aviability of Man power	Before	99,81%	99,91%	69,76%	99,81%	99,90%
	After	-	-	**99,66%**	-	-
Performance Efficiency	Before	95,50%	89,40%	99,35%	98,95%	97,27%
	After	**95,80%**	**91,13%**	**99,35%**	-	-
Quality Rate	Before	99,93%	99,93%	100,00%	99,53%	99,52%
	After	-	-	-	-	-

Table 7: Improvement productivity

	Man Power	Cycle time	Man sec	Balance
Before				
Line 2 (2shift)	36	12	216,0	-
Line 1 (1shift)	22	12	264,0	-
After				
Line 2 (2shift)	30	11,6	174,0	19,4%
Line 1 (2 shift)	19	11,6	220,4	16,5%

CONCLUSION

Analysis of loss using the Value Stream Mapping method and the Effectiveness of Overall Resources, looks to be able to repair losses that exist on the production side, in the case study PT DNIA application can cause losses using the results of the application in mapping the flow of future value can reduce production lead time by 1,615 minutes by the balance of delays of 4.21% can be replaced and ORE increases in some production processes such as sub-approval reaching 90.14%. Total improvement was also in the decrease in production MANSEC with the highest decrease in the rehabilitation track 2 of 19.4%. Repairs to the two improvements made improvements and new improvements that will arise by improvements that continue to lead to an increase in the company to make production cuts.

Target companies that want a reduction in waiting time by 30% can only be obtained 28% by analyzing Value Stream Mapping, and Balance Delay. Analysis of the level of completion must be done with a proper calculation by equipping several factors related to the value of the production process downtime, safety stock, fluctuations, and lead time suppliers so that the 2% reduction target can be met. Company targets related to productivity can be met with a total finding of 19.4% and a coordination path 1 of 16.5%, which has exceeded the target set by the company by 13%.

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