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Lean Production Design with Waste and Method Analysis of VALSAT for Assembly Process of Four Wheel Vehicle Components

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Abstract:- In general the purpose of a manufacturing industry is to produce economical goods in order to obtain profits and be able to meet customer needs on time. With the increase in sales projections and significant customer demand, an analysis needs to be made regarding the company's ability to carry out the production process. Therefore, one of the determining factors in order to be able to compete in the industrial world today is to implement lean production, namely through an operating management system approach by eliminating operational processes that are not needed to achieve effective and efficient productivity. Ineffective and efficient production processes can cause production to be hampered such as the accumulation of raw materials and intermediate goods (WIP) on the production floor. The application of lean production is expected to be able to reduce production costs, increase output produced, and production lead time to be shorter.

Keywords:- *Lean Production, Lead Time.*

I. INTRODUCTION

In general the purpose of a manufacturing industry is to produce goods economically in order to obtain profits and be able to meet customer needs on time. In addition, the manufacturing industry hopes that the production process can take place continuously and develop so that the survival of the company can be guaranteed. Now companies are also required to be more competitive so they are able to compete to win the existing market. One step to realize this is through the development of operational systems and waste by eliminating any unnecessary processes.

With the increase in sales projections and customer demand that continues to be significant, it is necessary to make an analysis related to the company's ability to carry out the production process. Therefore, one of the determining factors in order to be able to compete in the industrial world is by implementing lean production, namely through an operational management system approach by eliminating operational processes that are not needed to achieve effective and efficient productivity.

Ineffective and efficient production processes can lead to non-current production, such as the accumulation of raw materials and semi-finished goods (WIP) on the production floor called bottlenecks. Bottlenecks can be caused by an imbalance in the time of each process on the production floor where there is a process that takes a very long time. The reason is because the management system in managing resources is less efficient. For that factors that influence in each process must always be evaluated whether it can still be said to be relevant to the conditions of the business being run or need to be improved (kodradidkk, 2008).

From the application of lean production can be expected to reduce production costs, increase the output produced, and lead to shorter production time (Hawien, 2008). In the concept of lean production activities are divided into activities that are value added, not value added and activities that are important but do not add value to production (Hines&Rich, 1997).

II. THE ORETICAL BASIS

- *Production system*

Production in a factory organization is the deepest, specific and different core of functional fields such as finance, personnel, and others (Vincent Gaspersz, 2002).
Lean manufacturing is a method adapted from the production system of a leading automotive company, Toyota. In their book they mention that in implementing lean, 5 main principles are needed, namely:

- *Define value precisely*
- Determine what happens to value from the customer's point of view
- *Identify the entire value stream*
- Identify all stages needed to design, order and produce goods into the entire value stream to look for non-value adding activity.
- *Value-creating steps flow*
- Create value flow, that is, all activities that provide added value are arranged into an unbroken stream (*continuous*).
- *Design and provide what the customer wants only when customer wants it* (*pull*)
- Knowing the important activities that are used to make what is used by the customer.
- *Pursue perfaction*

- Improvements are carried out continuously so that the waste that occurs can be completely eliminated from the existing process.

- *Lean Concept*

The lean concept is a continuous effort to eliminate waste or waste and increase the value added of goods or services to give customer value (Vincent Gaspersz 2007). This basic concept can be applied to manufacturing or service companies, because basically the concept of efficiency will always be a target to be achieved by the company. The Lean concept fully speaks of waste elimination. Waste can be defined as all non-value-added work activities in the process of transforming inputs into output throughout the value stream.

The aim of the lean concept is to make continuous improvements to the weste that occur with the aim of increasing customer value. APICS Dictionary (in Vincent Gaspersz, 2007) defines that lean concepts are a business philosophy that aims to minimize the use of resources in a variety of corporate activities. In the lean concept, we focus on identifying and eliminating activities that are deemed unnecessary (non-value added activity) in the entire system in the company so that the process flow becomes effective, efficient, and productivity will increase.

Benefits of the Lean Concept:
- High quality products,
- Low production costs,
- High work spirit,
- Work area is neat and clean,
- The production process is very fast and efficient,
- Communication within the company runs effectively,
- Low iventory amount
- Employees who always improve their knowledge and skills, and
- The company has a high business advantage.

- *Waste*

Waste is an activity that absorbs or wastes resources such as expenditure or extra time but does not add any value to the activity. Eliminating waste is a basic principle of the Lean Manufacturing concept. The concept of waste elimination can be taught to each member of the organization so that it can be effective and work efficiency can be improved.

Fig 1:- Seven Waste

- *Overproduction*

Waste that occurs due to excess production, both in the form of finished goods and WIP (semi-finished goods), but there is no demand from customers.

- *Inventory*

Waste which happened because of the amount of finished goods, finished goods, and excessive raw materials at all stages of production.

- *Defect*

Waste which occurs because of poor quality or defects so that repairs are needed. This will cause additional costs in the form of labor costs, components used in repairs, and other costs.

- *Transportation*

Waste that occurs because of the unnecessary movement of workers or machines and does not provide added value to the product which has an impact on the excess mileage in the process of transferring the products produced and raw materials needed.

- *Motion*

Waste that occurs due to unnecessary movement of workers or machines and does not provide added value to the product. For example moving material / goods from one place to another that is higher or far from the reach of workers.

- *Waiting*

When a person or machine does not do work, the status is called waiting. Waiting for bias is due to an unbalanced process so that there are workers and machines that have to wait to do the work. There is damage to the engine, supply of components that are late, loss of work equipment, or waiting for certain decisions or information.

- *Overprocessing*

Not all processes provide added value for products produced against customers. The process that does not provide added value is a wasteful or excessive process. For example, repeated inspection processes and approval processes that must pass through many people.

- *Seven Waste Relationship*

In searching for seven wastes carried out by distributing questionnaires. The questionnaire consists of 31 types, because there are 31 waste relations developed by Rawabdeh (2005).

- *Waste Relationship Matrix (WRM)*

Waste Relationship Matrix (WRM) used to analyze the measurement criteria of the relationship between waste / waste. Each row in this matrix shows the effect of each waste on the other six wastes, while each column in this matrix shows that it is influenced by other waste. The diagonal of the

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matrix shows the highest relationship value randomly, each type of waste has a large relationship with itself.

- *Waste Relation Value*

Creating waste Relationship Value is obtained by converting letters in the WRM table with numbers by reference, A=10, E=8, I=6, O=4, U=2, X=0 (Rawwabdeh 2005).

- *Waste Assessment Questionnaire (WAQ)*

Waste Assessment Questionnaire (WAQ) created to identify and allocate waste that occurs in the production line (Rawabdeh, 2005). The WAQ questionnaire consists of several different questions, this questionnaire is known for the purpose of allocating waste. These questions constitute a condition activity or behavior that can produce a certain waste. Some questions are marked with the words "from" which means that the question presented by a type of waste can trigger or cause other types of waste to emerge, while the question marked "To" which means explaining each type of waste that can occur due to other types of waste .

- *Value Stream Mapping (VSM)*

VSM is a tool from lean manufacturing that originally came from the Toyota production system (TPS) known as "material and information flow mapping" (WPI, 2007). Russell and Shook (1999) define the concept of VSM as a powerful tool that can not only define processes but also can be a guide in making improvements. Even farther. Jones and Womack (2000) state that the VSM concept is a process of visually mapping the flow of information and material that aims to prepare better methods and performance in a future state map proposal. From this tool, information about the flow of information and physical in the system can be obtained.

- *Value Stream Analysis Tools (VALSAT)*

VALSAT is a tool developed by Hines & Rich 1997 to facilitate understanding of existing value streams and make it easier to make improvements regarding the waste contained in the value stream. VALSAT is an approach used by weighting waste-waste, then from the weighting tool selection is done by using a matrix.

- *Process Activity Mapping (PAM)*

Process Activity Mapping is a tool for defining processes in detail using symbols that represent operations, transport, inspection, storage and delay activities.

- *Supply Chain Response Matrix (SCRM)*

This tool is a simple diagram that attempts to describe the chain, namely cumulative lead time in the distribution of a company both its suppliers and downstream retailers.

III. RESEARCH METHODOLOGY

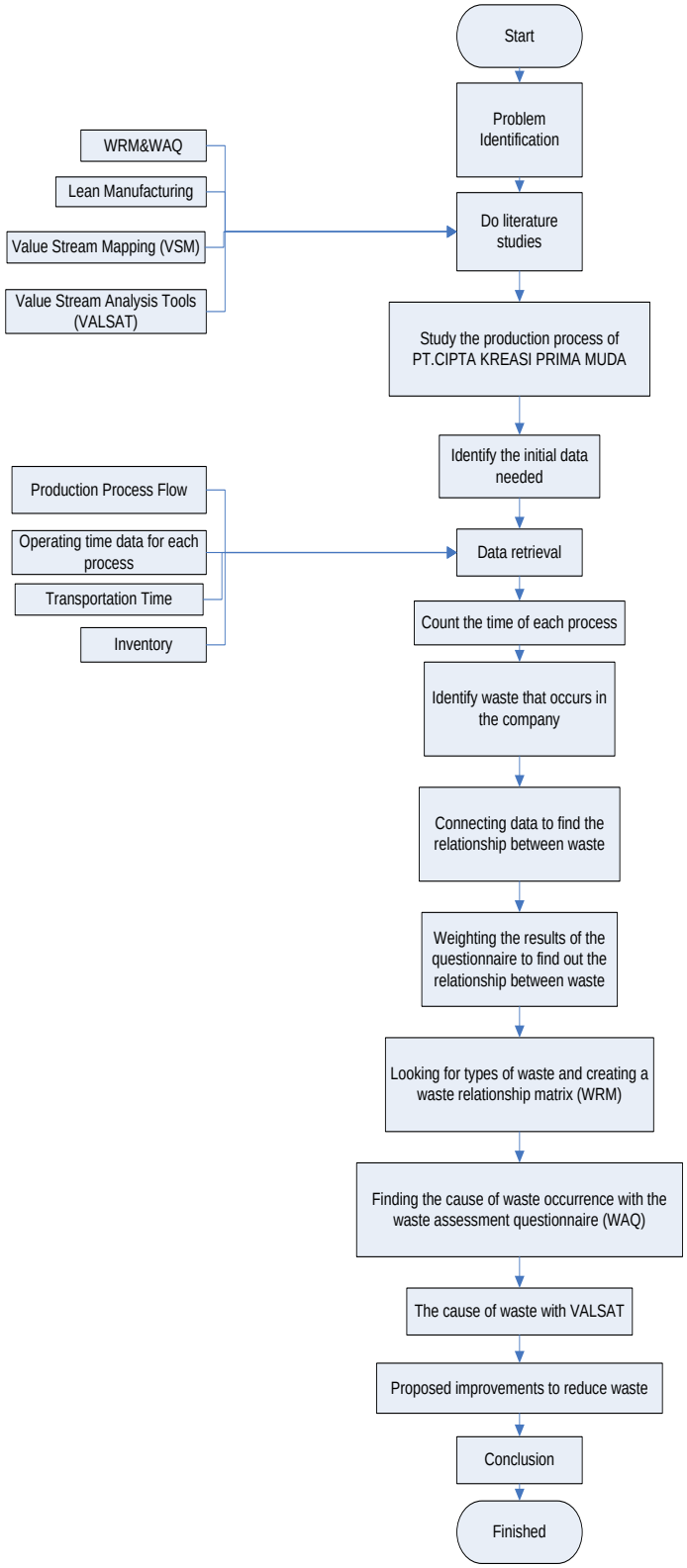

Fig 2:- Stages of Data Collection

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IV. RESEARCH RESULT

- *Total Production Data*

In this study the data collected is in the form of actual production in the assembly parts of four-wheeled vehicles obtained from PT CIPTA KRASI PRIMA MUDA as an example. In graph 4.3 below, it can be seen the number of production of PT. PRIMA MUDA CREATION COPY for the period of January to July 2016

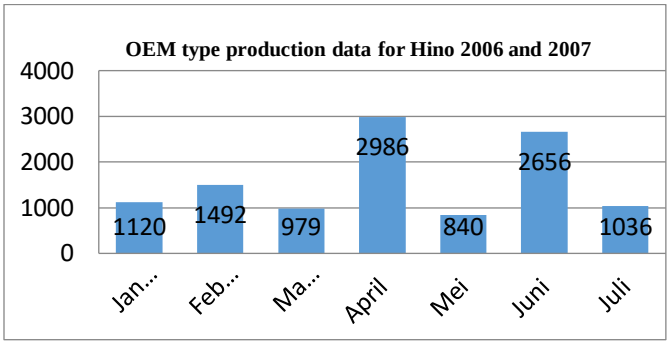

Table 1:- Production Data

- *Seven Waste Relationship*

In searching for seven wastes carried out by distributing questionnaires consisting of 31 types of questions, because there are 31 wastage relationships developed by Rawabdeh (2005).

	Question Type	Question						Score	Relationship Level
		1	2	3	4	5	6		
1	O_I	2	2	0	0	1	0	5	O
2	O_D	2	0	2	2	4	2	12	I
3	O_M	4	2	0	0	2	2	10	I
4	O_T	2	2	2	1	2	2	11	I
5	O_W	0	0	0	0	1	0	1	U
6	I_O	0	0	0	0	1	0	1	U
7	I_D	2	2	2	0	2	0	8	O
8	I_M	0	2	2	1	1	0	6	U
9	I_T	0	1	0	0	1	0	2	U
10	D_O	0	0	0	2	1	0	3	U
11	D_I	0	0	0	0	1	0	1	U
12	D_M	2	2	2	1	2	2	11	I
13	D_T	0	0	0	0	1	0	1	U
14	D_W	4	2	0	0	2	4	12	I
15	M_I	2	0	2	0	1	0	5	O
16	M_D	2	1	2	1	2	2	10	I
17	M_P	2	0	4	1	2	2	11	I
18	M_W	2	0	2	1	1	2	8	O
19	T_O	0	0	0	0	1	0	1	U
20	T_I	0	0	0	0	1	0	1	U
21	T_D	4	2	2	4	1	2	15	E
22	T_M	2	2	4	2	1	4	15	E

Table 2:- Save Waste Relationship

- *Waste Relationship Value*

Next, making Realationship value is obtained by converting letters in the WRM table with numbers with reference, A = 10, E = 8, I = 6, O = 4, U = 2, X = 0 (Rawabdeh 2005). In this waste relationship value, through calculation, we will know the value of each waste percentage for the "from" and "To" types. The following table waste relationship value:

F/T	O	I	D	M	T	P	W	score	%
O	10	4	6	6	6	0	2	34	15.7
I	2	10	4	2	2	0	0	20	9.3
D	2	2	10	6	2	0	6	28	13.0
M	0	4	6	10	0	6	4	30	13.9
T	2	3	8	8	10	0	6	37	17.1
P	4	3	6	10	0	10	8	41	19.0
W	4	6	6	0	0	0	10	26	12.0
Score	24	32	46	42	20	16	36	216	100
%	11.1	14.8	21.3	19.4	9.3	7.4	16.7	100	

Table 3:- Waste Relationship Value

- *Waste Assessment Questionnaire* (WAQ)

Waste Assessment Questionnaire (WAQ) is a concept using a waste assessment questionnaire. This assessment questionnaire consists of 68 questions. This questionnaire is divided into two types of questions, namely "From" and "To". "From" if the waste can affect or produce other waste and "To" if the waste can be influenced or produced by other types of waste.

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	Jenis Pertanyaan	O	I	D	M	T	P	W
	Man							
1	To Motion	6	2	6	10	8	10	0
2	From Motion	0	4	6	10	0	6	4
3	From Defact	2	2	10	6	2	0	6
4	From Motion	0	4	6	10	0	6	4
5	From Motion	0	4	6	10	0	6	4
6	From Motion	0	4	6	10	0	6	4
7	From Process	4	3	6	10	0	10	8
	Material							
8	To Waiting	2	0	6	4	6	8	10
9	From Waiting	4	6	6	0	0	0	10
10	From transportation	2	3	8	8	10	0	6
60	To Defact	6	4	10	6	8	6	6
61	From Process	4	3	6	10	0	10	8
62	To Transportation	6	2	2	0	10	0	0
63	From Motion	0	4	6	10	0	6	4
64	From Motion	0	4	6	10	0	6	4
65	From Motion	0	4	6	10	0	6	4
66	From Overproduction	10	44	6	6	6	0	2
67	From Process	4	3	6	10	0	10	8
68	From Defact	2	2	10	6	2	0	6
	Total Score	236	254	430	416	232	278	338

Table 4:- Initial Weight obtained from WRM

Calculate the final value of waste factor (yj Final) by entering the influence probability factor between the type of waste (Pj) based on the total "From" and "To" on WRM by multiplying the percentage.

	O	I	D	M	T	P	W
Score (Yj)	0.69	0.78	0.75	0.80	0.70	0.73	0.74
Pj factor	174.90	137.17	276.06	270.06	158.61	140.60	200.62
Final result (Yj Final)	120.97	107.59	207.01	216.48	111.11	103.03	148.92
Final result (%)	11.92	10.60	20.39	21.33	10.95	10.15	14.67
Ranking	4	6	2	1	5	7	3

Table 5:- Results of the WAQ Calculation Table

Untukdapatmemudahkankitamelihatrespresentasidarihasilakhirpersentasesetiap waste makadibuatsebuah diagram sebagaiberikut:

Fig 3:- Graph of Waste Rating

- *Value Stream Analysis Tools* (VALSAT)

The waste assessment model (WAM) concept has obtained the final results in the form of percentages and ranks for each waste.

Waste	Weight	Mapping Tool						
		Process aktivity mapping	Supply Chanin respon se matrix	Production variety finnel	Quality filter mapping	Demand aplicati on mapping	Decisi on plant analysis	Physical struture mapping
Overprouctio n	11.92	11,92	35,75	0	11,92	35,75	35,75	0
Unnecessary Inventory	10.60	31,8	95,39	31,8	0	95,39	31,8	10,6
Defact	20.36	20,39	0	0	183,54	0	0	0
Unnecessary motion	21.33	191,93	21,33	0	0	0	0	0
Transportatio n	10.95	98,51	0	0	0	0	0	10,95
Inapproproate processing	10.15	91,35	0	30,45	10,15	0	10,15	0
Waiting	14.67	132,03	132,03	14,67	0	44,01	44,01	0
Total		577,93	284,5	76,92	205,61	175,15	121,71	21,55
Peringkat		1	2	6	3	4	5	7

Table 6:- Results of the Mapping Tool

Based on the calculation of the results of the VALSAT tools mapping above, the results and rankings can be described in the graph below

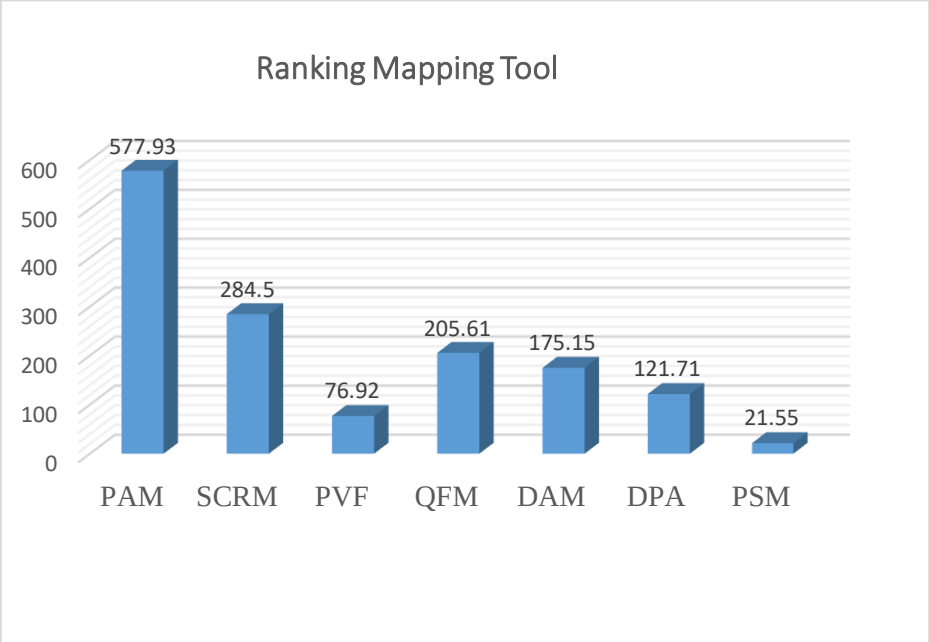

Fig 4:- Ranking Chart of Mapping Tool

- *Supply Chain Response Matrix* (SCRM)

This tool is a simple diagram that attempts to describe the chain, namely cumulative lead time in the distribution of a company both its suppliers and downstream retailers.

	Days Physical stock	Cummalative Days Physical Stock	Lead Time	Cummulative Lead Time
Area PenyimpananBahan Baku	1.041	1.041	0.34	0.34
Area Proses Produksi	1	2.041	0.008	0.348
Area PenyimpananProduksiJadi	1.2	3.241	0.125	0.473
	Total			3.714

Tabel 7:- Days Physical Stockdan Lead Time

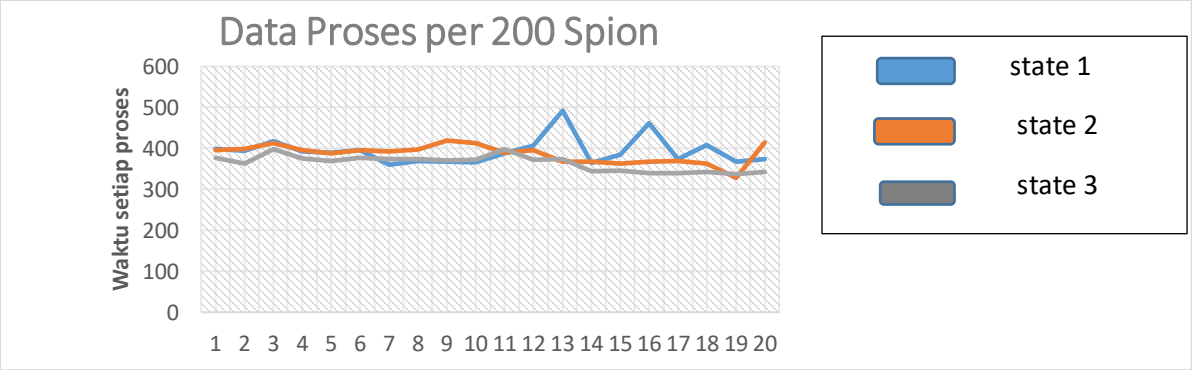

Fig 5:- Production Results Before and After Repair

V. CONCLUSION

A design for the Lean Production System was obtained, with better production process performance by eliminating waste from identification results with analysis. The design can be seen in the Future State Value Stream Mapping.

Based on the results of identification of waste by using the Waste Assessment Model (WAM) method which consists of the Waste Relationship Matrix (WRM) and Waste Assessment Questionnaire (WAQ). It was found that the most influencing the occurrence of other waste is the process of 19% and the most affected waste by other waste is a defect of 21.3%. Then for the final result of Motion in the first rank of 21.33%, Defect is 20.30%. and Waiting with a weight of 14.67%.

Using the VALSAT method in selecting detailed mapping tools, the top three priority tools are as follows:

- Process Activity Mapping (PAM) with a score of 577.93.
- Supply Chain Response Matrix (SCRM) with a score of 284.50.
- Quality Filter Mapping (QFM) with a score of 205.60.

According to the results of the Process Activity Mapping (PAM) mapping tools, it was found that activities that provided added value (VA) were only 0.69% of all activities, then activities that did not provide added value but were still needed at 33.62%, while the most large is an activity that does not provide added value which is equal to 65.69%.

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