

Waste Reduction In Barwon Dining Chair Production Process Using The Failure Mode And Effect Analysis (FMEA) Method on CV. Valasindo Sentra Usaha

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Abstract: The furniture industry has a vital role in economic growth in Indonesia by one of the activities that are international trade. During the last year, the export value of the furniture industry has increased. It can make an increase of industrial competition in the global market. Therefore, production efficiency needs to be improved under the four pillars that affect global market competitiveness. This study focuses on the Barwon Dining Chair sub-product because it has the most and constant demand with an average demand is 57 units per month while the company experiences delay until 88% with an average delay of 14 days. Determination of Value Added (VA), Non-Value Added (NVA), and Necessary Non-Value Added are used to describe the current Value Stream Mapping (VSM) as an explanation of the production process flow. Failure and Effect Analysis (FMEA) is used to identify a system with the risk of failure and its consequences by giving values from severity, occurrence, and detectability and generating the largest number of RPN assembly stations at 45. The improvements are warehouse rack design and the box at the assembly station, reducing the time to approximately 2 minutes.

Keywords: Lean manufacturing; Value stream mapping (VSM); Pareto diagram; Failure and effect analysis (FMEA)

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INTRODUCTION

The furniture industry is one industry that has an important role in Indonesia's economic growth. The activities carried out by the furniture industry are not only national trade but also international trade including export and import activities. Based on the data from Badan Pusat Statistik (BPS, 2019), the value of furniture industry exports

increased by 4.63% from January 2018 to January 2019. The increase in export value is accompanied by increasing competition in the furniture industry in the global market. Competitors from the Indonesian furniture industry come from China, Mexico, Poland, Malaysia, Thailand, the Philippines, Brazil, and other countries ([International Trade Centre, 2004](#)). According to Indonesian Furniture and Handicraft Association ([Asosiasi Mebel dan Kerajinan Indonesia, 2015](#)), four pillars determine the competitiveness of Indonesian furniture exports, they are raw materials, production processes, design and innovation, and marketing. Regarding the pillars of the production process, one of the influencing factors is the efficiency of the production process. Therefore, to win the competition from these countries, the Indonesian furniture industry must make improvements starting from company performance, product quality, product prices, and on-time deliveries.

CV. Valasindo Sentra Usaha is one of the furniture industries located on Jalan Raya Solo-Purwodadi Km 8.5, Mundu, Selokaton, Gondangrejo, Karanganyar Regency, Central Java. The products include chair furniture, shelves, beds, sofas, and tables. The company is oriented towards export activities to several companies abroad, such as Singapore, Malaysia, Taiwan, Sweden, Mexico, Australia, and the United States. The export activity requires companies to continuously improve performance, production, and service to consumers so that companies can compete in the global market. Some export products produced by CV. Valasindo Sentra Usaha includes Dupuis, Globe West, Teak Scan, Eco Outdoor, Mass Studio, and Fiber. Products that are often ordered among the six products are Eco Outdoor and Scan Teak.

This study focused on Eco Outdoor products because Eco Outdoor products have a constant demand. Eco Outdoor products have several sub-products, including Jan Juc, AYR, Bronte, Nullica, Lennox, Lennox Special Order, Barwon, Zuma, Mill, Turon, Claybourne, Nomah, Albany, Waratah, and Marsden. The sub-product with the most and constant demand for the past year is Barwon Dining Chair, with an average monthly demand is 57 units. Therefore, this study focuses on the sub-product Barwon Dining Chair. The large and constant demand should also be followed by optimal company performance. However, based on the past year's data, these sub-products often delay until 88%, with an average delay of 14 days. If these conditions continued, consumers would trust in the performance of the CV. Valasindo Sentra Usaha will decrease. This delay in shipping because of waste in the production process at CV. Valasindo Sentra Usaha. Therefore, further research is needed to identify the causal factors of waste production time, which results in delays in shipping which are included in the seven waste concepts.

Lean manufacturing learns about the workflow started from product design until consumers accept the product without any returns caused by defects or waste ([Muhsin et al., 2018](#)). Lean manufacturing is a management philosophy derived from the Toyota Production System (TPS) that focuses on eliminating seven wastes to increase customer satisfaction ([Ariani, 2004](#)). Implementing lean manufacturing in the furniture industry is used to reduce waste on the production floor, which results in late delivery ([Suhardi et al., 2016](#)). Based on the research conducted by [Alfiansyah & Kurniati \(2018\)](#), the steps taken in Lean Manufacturing are to identify all waste and the root of the problem then make improvements to the design of the production process. The concept can be applied in the CV. Valasindo Sentra Usaha to reduce the delay in delivering Barwon Dining Chair sub-products, such as the research conducted by [Siregar & Ayu \(2018\)](#) that

implement Lean to overcome delays in shipping milk products. The factors that cause delays are included in the Seven Waste Concept identified in the theory of the Toyota Production System. The theory identifies the types of Seven Waste in the manufacturing or service processes, namely overproduction, waiting, transportation, excess process, inventory, motion, and defects. Based on the previous research by Harish & Selvam (2015), reducing waste that occurs in the production process begins with understanding the types of waste and the causes of waste because each waste has a different solution.

Based on the research of Chen & Meng (2010), a company needs to implement lean production with value stream mapping (VSM) to identify the overall flow of the supply chain. VSM shows the flow of information needed to plan and meet customer demand. VSM consists of cycle time, inventory held, changeover times, and staffing to eliminate existing waste (Wilson, 2010). Besides, this research also applied methods to identify and understand the potential causes and effects of a failure, assess the risk of failure, and carry out corrective actions called the Failure Mode and Effects Analysis (FMEA) method (Carlson, 2014). Parsana & Patel (2014), research provides an effective tool used to solve quality problems in the manufacturing process by applying the FMEA method to reduce losses for companies in terms of time and cost. Thus, the application of this method is expected to minimize the risk of failure that will arise during the production process.

METHOD

This research begins with a literature review of several journals and field studies at CV. Valasindo Sentra Usaha with direct observation and interviewing workers on the production floor. Data collection is used to obtain primary and secondary data. The data are obtained from observation on the production floor, take pictures and videos with cameras, interview, fill the waste-weighting questionnaire with employees, and discuss with related parties in the CV. Valasindo Sentra Usaha. Data retrieval with videos is done with a sample of 30 times (Suhardi *et al.*, 2019). The sample testing of uniformity and data adequacy proceed with determining activities included in Value-Added activities, Non-Value Added activities, and Necessary Non-Value Added activities that are used as inputs for the current VSM. The determination of activities is carried out by brainstorming with the company.

Station determination is done by using a Pareto diagram with the input of standard time data included in non-value added activities during the production process from the construction station to the packaging station. The determination of stations with Pareto diagrams gives the results of NVA stations with the largest is assembly station. The dominant waste identifies the station for repairs. Waste identification is carried out by giving questionnaires to the relevant parties in the selected station (Intifada & Witantyo, 2012) and processing the questionnaire results using the Borda method (Setiawan, 2017).

Failure and Effect Analysis (FMEA) is a technique used to analyze risk by identifying systems/facilities/tools that can fail and the effects of failures (Gasperz, 2002). Proposed improvements are given based on the analysis results using FMEA with the highest qualification of the RPN on each selected workstation. Improvements are made at selected stations in the form of warehouse rack design and VSM futures

depiction box used for the implementation of the proposed plan that had been given to optimizing the production process of the Barwon Dining Chair sub-product.

RESULTS AND DISCUSSION

Current VSM:

VSM Current is a description of the production process from beginning to end, consisting of material and information flow in a company (Gasperz, 2002).

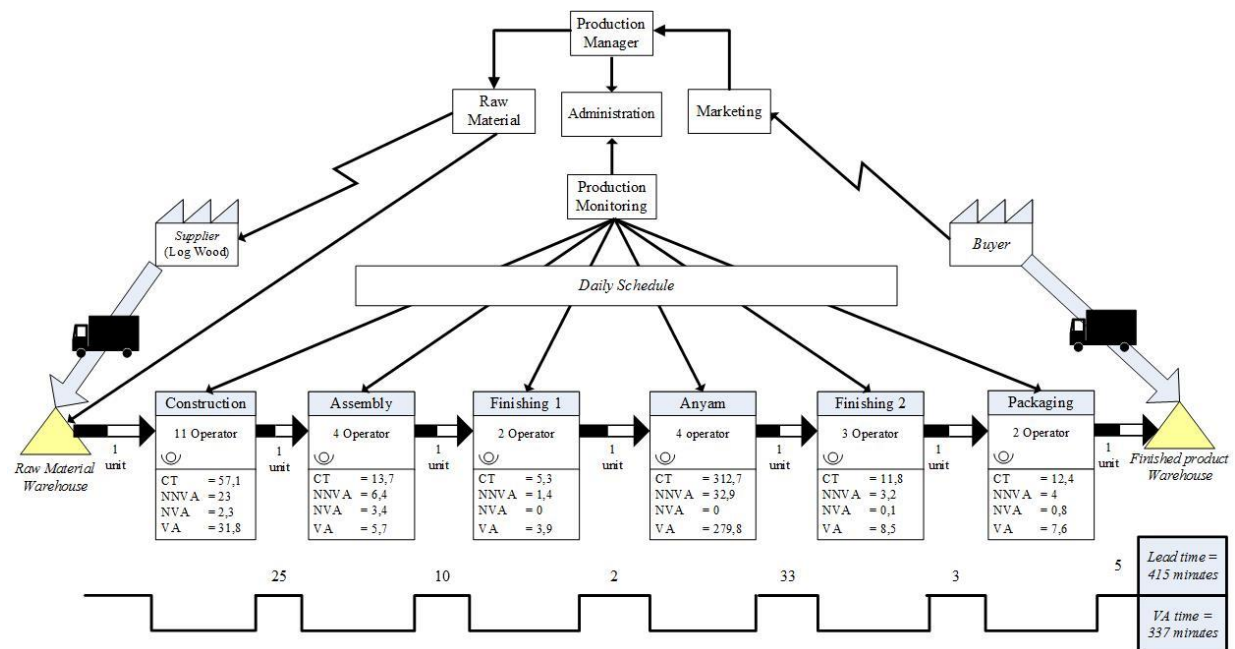


Figure 1. Current VSM

The Barwon Dining Chair production process starts from the construction, assembly, finishing 1, weaving, finishing 2, and ends at the packaging station.

Production: 1 unit

Total cycle time: 415 minutes

Total value-added time: 337 minutes

Current VSM shows that the time of the activities with non-value-added (NVA) and necessary but non-value-added (NNVA) is still large enough. Therefore, it is necessary to reduce production time. Activities that need to be reduced are NVA activities (Eswaramurthi & Mohanram, 2013).

Current VSM shows that the time of the activities with non-value-added (NVA) and necessary but non-value-added (NNVA) is still large enough. Therefore, efforts are needed to reduce production time. Activities that need to be immediately reduced are NVA activities (Eswaramurthi & Mohanram, 2013). The amount of NVA is done by processing data with a Pareto diagram to determine the selected station. Based on Figure 2, the chosen station is the assembly station.

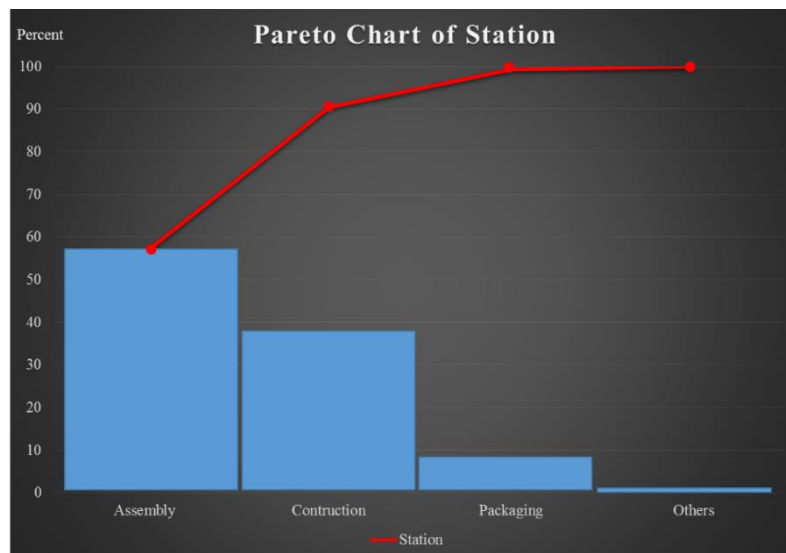


Figure 2. Pareto Chart of NVA

Based on Figure 2, processing NVA data with the largest NVA is obtained at the Assembly station. To find out the type of waste in the station: the weighting of the waste type is carried out at the station related to the questionnaires to parties related to the station. Borda method is used to process data from questionnaires distributed with the results shown in table 2 for assembly stations. Borda method is chosen for decision making from the professional results of each decision-maker (Arliana & Soebroto, 2018).

Weight calculation of waste overproduction at the assembly station is shown below:

$$Weight = \sum (Rank \times Weight \text{ of rank})$$

$$Weight = (0 \times 0) + (1 \times 4) + (2 \times 0) + (3 \times 1) + (4 \times 0) + (5 \times 0)$$

$$Weight = 7$$

Percentage calculation of waste overproduction at the assembly station is shown below :

$$Percentage = \frac{\text{weight of waste overproduction}}{\text{total weight of waste}}$$

$$Percentage = \frac{7}{77} \times 100\%$$

$$Percentage = 9\%$$

Table 1. Processing of Waste Questionnaire at Assembly Station

Waste	Rank						Weighting	Percentage
	1	2	3	4	5	6		
Overproduction	0	1	2	3	4	5	7	9
Defects	0	0	1	1	3	0	17	22
Inventory	0	2	0	3	0	0	11	14
Overprocessing	0	4	0	1	0	0	7	9
Transportation	0	2	1	2	0	0	10	13

Waiting	0	2	1	0	1	1	13	17
Motion	0	1	1	3	0	0	12	16

Based on the weighting results, the waste results obtained from assembly stations are waste defects with a percentage of 22%. Thus, it is necessary to identify the causes of failure that result in waste defects using the FMEA method (Puspitasari & Martanto, 2014). FMEA is a method used to find out the causes of waste and determine the critical level of waste, which is shown in the form of calculation of Risk Priority Number. RPN is obtained by multiplying the rating from Severity, Occurrence, and Detection. The value of Severity, Occurrence and Detection is based on discussions with parties at assembly stations. The RPN value from the waste defect of the assembly station is shown in table 2 based on Ratri *et al.*, (2018) and Ririh *et al.*, (2018).

Example of RPN Calculation on Man Factor with failure mode of Operator is incorrect when he took a part is shown below:

$$RPN = Severity \times Occurance Value \times Detectibility Value$$

$$RPN = 5 \times 9 \times 1$$

$$RPN = 45$$

Table 2. The Value of RPN Waste Defect

No	Factor of Failure	Failure	Failure Mode	Severity Value	Occurrence Value	Recommended action	Detectability Value	RPN
1	Man	The size is not suitable during the assembly process	The operator is incorrect when he took a part	5	9	Improvement of warehouse system with box and label design per product components	1	45
			The operator has less skilled	1	3	Training for operators	2	6
2	Environment	Mixed Components	Warehouse is mess	4	7	Improvement design of warehouse system	1	28

3	Method	The steps of work are unclear	There is no SOP for making the product	3	6	Make SOP's product making	2	36
4	Machine	Misuse mall	The mall is not organized	1	2	Make a mal's store	2	4

Based on table 3, the largest RPN value at the assembly station is caused by the man factor, and the failure is the size that is not suitable during the assembly process. The failure mode is the operator who is incorrect when he took part from components warehouse with the RPN value of 45, severity value of 5, and occurrence value of 9. The recommended action in table 2 is an improvement warehouse system with box and label design per product components with a detectability value of 1.

Recommended action

Recommended action for the waste defect at the assembly station is the design of the warehouse rack and product box according to table 2. The visualization design of the recommended action is shown in figure 3 to figure 6 which consists of the warehouse rack and box design with dimension and information card (label) on the box per product component. The following is an explanation of the recommended action:



Figure 3. Warehouse Design

These are explanations in determining the dimensions of the proposed improvement given:

1. Box

The box is used to facilitate operators in transferring and storing the Barwon Dining Chair sub-product. Besides, the box is used to avoid mixing between product components with the box image shown in figure 4. The inside of the box has a length of 900 mm, which refers to the longest component size, namely the rear leg component with a component length of 884 mm. The inside of the box has a height of 450 mm, which refers to the thickest component size, namely the rear leg component with a component thickness of 30 mm so that in one stack is arranged ± 15 components. While

the inside of the box has a width of 600 mm, which refers to the widest component size multiplied by 2 for the right and left parts 464 mm so that it still has an allowance of 126 mm. The right and left sides have a hole to make it easier for the operator to lift the box with a size 150 mm, which refers to the hand width anthropometry of 15.17 with the 95th percentile.

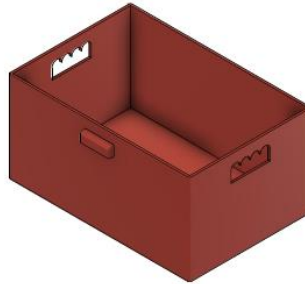


Figure 4. Box Design

2. Label

This label serves to make it easier for operators to find components and reduce errors in retrieving components according to the results of the weighting of VA, NVA, and NNVA. The following is a breakdown of the proposed label to solve problems at the assembly station (Noerfajr & Suliantoro 2016).



Figure 5. Detail of Information Card in Every Box

3. Component Shelves

The component shelf is used to store the Barwon Dining Chair components and it has visually shown in Figure 6.

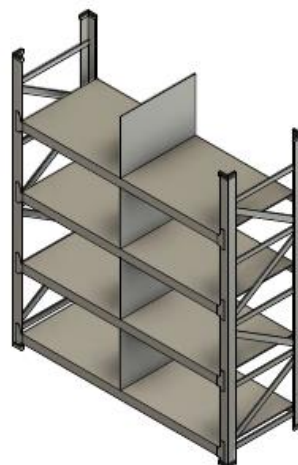
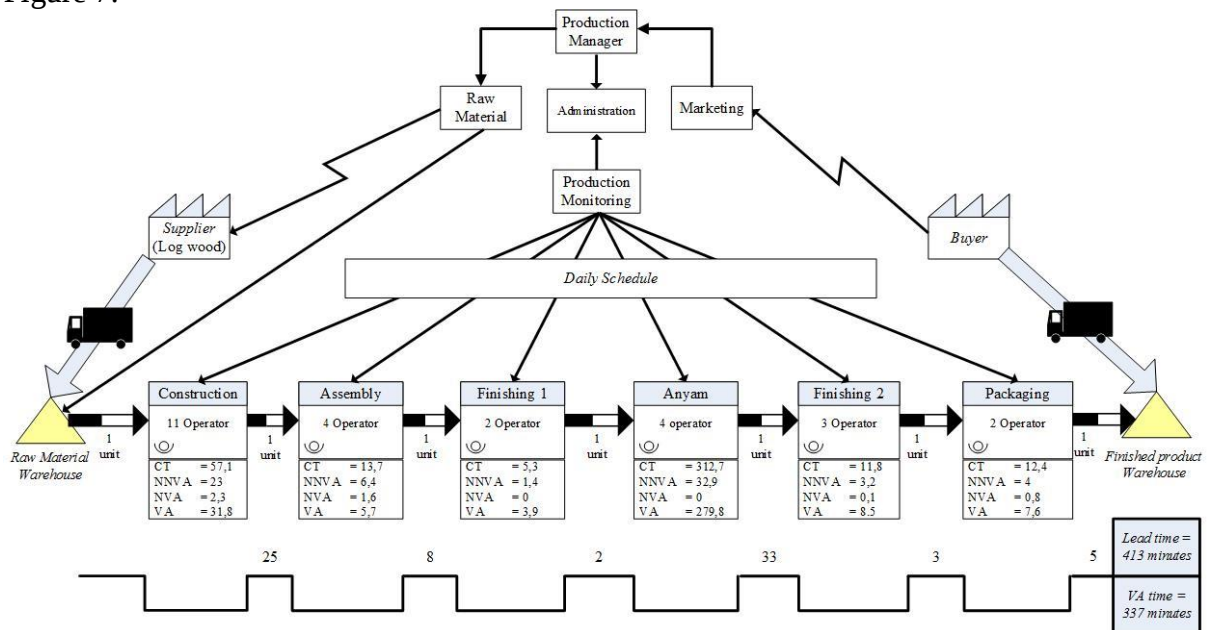


Figure 6. Warehouse Shelf Design

The height dimension of the warehouse shelf is 2300 mm that refers to the anthropometric dimensions of the upward grip in a standing position using the 95th percentile specification 2332 mm so that the shelf height is still in the 95th percentile specification. The dimension of the shelf width is 682 mm that refers to the box width 620 mm.

Future VSM

Future VSM describes the conditions resulting from the improvements that are applied to the current VSM. Future VSM will become a new line in the Barwon Dining Chair production after the wastes are eliminated. Lead-time material from construction station to packaging station becomes faster, which is 413 minutes. Future VSM is shown in Figure 7.



CONCLUSIONS

The production process of Barwon Dining Chair in the CV. Valasindo Sentra Usaha has the dominant type of waste, namely waste defects in assembly stations. The factors of the defect such as the Operator is incorrect when he took a part, the operator has less skilled, there is no SOP for making the product, there is no SOP for operating the machine, the mall is not organized, components are mixed, and the warehouse is a mess. From the causes described by FMEA, the operator who is incorrect when he took a part obtains the largest RPN value of 45. Therefore, it needs improvements. The solutions to this problem are warehouse rack design and the box at the assembly station, which can reduce the time to approximately 2 minutes.

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