

Research article

Implementation of Lead Time Improvement in the Cutting Production Process using Clustering Data Mining and Lean Manufacturing

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Abstract.

In steel companies, there are some processes in the production such as cutting, machining and heat treatment. The production process begins with cutting process and then machining process and the last one is the heat treatment process. It becomes a background that gives the challenge and needs continuous improvement on all aspects, mainly in the cutting process. The research is conducted at one of steel companies located in Pulogadung Industrial Estate. The purpose of the research is to know the factors which cause process lead time cannot be achieved. The methods used are clustering data mining and lean manufacturing. Clustering method can be used to focus on big data and find out clusters or the same pattern. Those clusters are processed with Weka software and using K-means algorithm. Improvement ideas will be implemented to the formed clusters using lean manufacturing such as Single Minute Exchange of Dies (SMED) which have been mapped through value stream mapping, 5S, and Kanban beforehand. The materials' dimension on the production process is affecting the cutting process lead time. The thicker material diameters will need a longer time to process. With the methods used, lead time of cutting process increased from 3449 minutes to 2165 minutes (3 days to be 2 days). Meanwhile if the "SMED" activities are implemented, the cutting process lead time increased from 187 minutes to 136 minutes.

Keywords: Clustering; SMED; Lean Manufacturing; Process Lead Time; Value Stream Mapping

1. Introduction

In steel companies, there are some processes in the production such as cutting, machining and heat treatment. The production process begins with cutting process and then machining process and the last one is the heat treatment process. In a steel company where the research is done, cutting production unit is the main process within existing 3 production processes. Based on customer demand and also production result data, cutting production is the highest compared to the machining and heat treatment.

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Particularly for the cutting production, in this company there is a standard of the process lead time which is 2 days. However, in reality, it reaches 3 – 6 days.

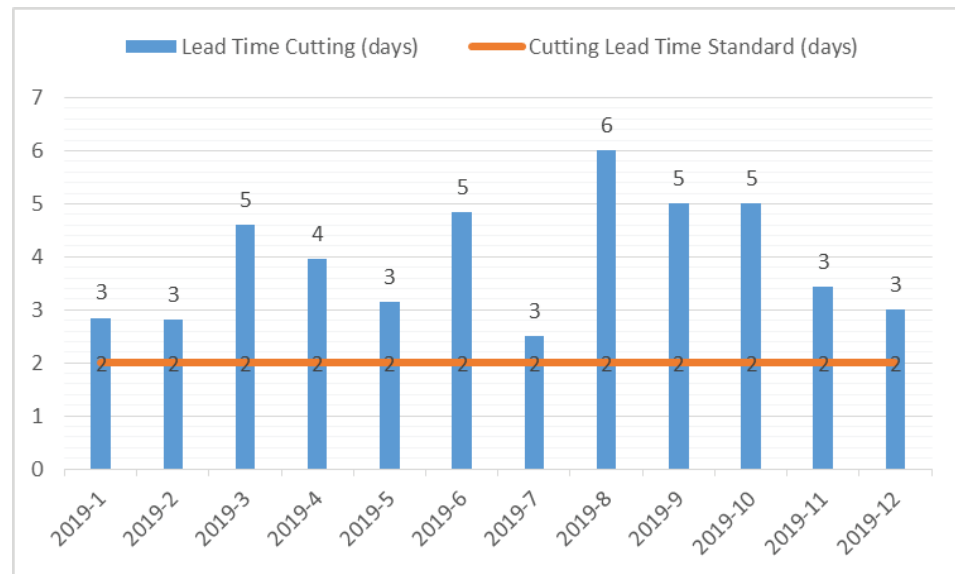


Figure 1: Lead Time Cutting.

In order to analyze precisely, the data that has been collected needs to be categorized based on its similarity. The object will be grouped to be 1 or more clusters so that those objects in the same cluster will have high similarities to each other (1). Generally, in the manufacturing industry, Lean manufacturing philosophy has to be started with the perfect understanding of the production process as well as material and information flow (2)(3). The lean manufacturing concept is implemented in the automotive industry, Ford Motor in Taiwan to have an improvement on quality and cost aspects (4) (5) (6). In the automotive industry, particularly on the assembly field, lean manufacturing implementation starts with 5S, Value Stream Mapping, Kanban and Single Minute Exchange of Dies (7) (8) (9) (10) (11).

2. Literature Review

Cluster is a group or collection of data's object which is similar one to another in a same cluster and differs to the object in a different cluster (12). The object will be grouped to be one or more clusters so that the objects which are in the same cluster will have high similarities one to another. K-means algorithm is a non-hierarchy method, which initially takes some parts of population components to make it an initial main cluster. On this step cluster center is randomly chosen from the bunch of data population (13). Cluster center position will be calculated again until all data component is categorized

into each of cluster center and eventually will be formed new cluster center position. Euclidean is the range of each object x_a and x_b which are measured using “i” variable = 1...n, which can be depicted to be equation 1 (12) (13):

$$d(x_a, x_b) = \sum_{i=1}^n (x_{a,i} - x_{b,i})^2 \quad (1)$$

Lean manufacturing is a philosophy that is used to reduce the waste which happened due to over-production. It includes the waste of waiting time, transportation usage, inventory, over-process, over-motion, and defect products (14) (15) (16). Value Stream Mapping (VSM) is one of the lean manufacturing tools or methods that has pictures from all activities (named value added and non-value added) (17) (18). It is needed to carry the products or services to the customers (19). One of the methods that has purpose to reduce the amendment time by eliminating the existing waste is Single Minute Exchange of Dies (SMED). This can be detected by amendment time measurement (20). On SMED there are two types of main activities which can be classified to be internal and external activity (21).

3. Methodology

Data collection with literature review in advance and observation is done with writing notes and summarize all activities list from the process in the beginning which is from these departments order fulfillment, supply chain until delivery. To find out the value added and non-value added activities, we can create the flow of each process in a form of current value stream mapping. From that flow, each process is being recorded from the daily production report and does a direct observation in the production line so that the data is taken according to the reality in the field.

4. Result and Discussion

This research is using Weka Software and data mining which would use clustering along with K-means algorithm to result clusters which have the same pattern and data.

In the cluster 0 areas, it can be seen that the total time of cutting is within a range of 0-390 minutes, meanwhile in cluster 1 is in the range of time 0-195 minutes. Data processing is by using the clustering method with K-means algorithm. From that process, based on the data groups, it focuses in the cluster 0 compared to the cluster 1. It can be seen in the cluster 0 with the time range of cutting more than 181 minutes and on

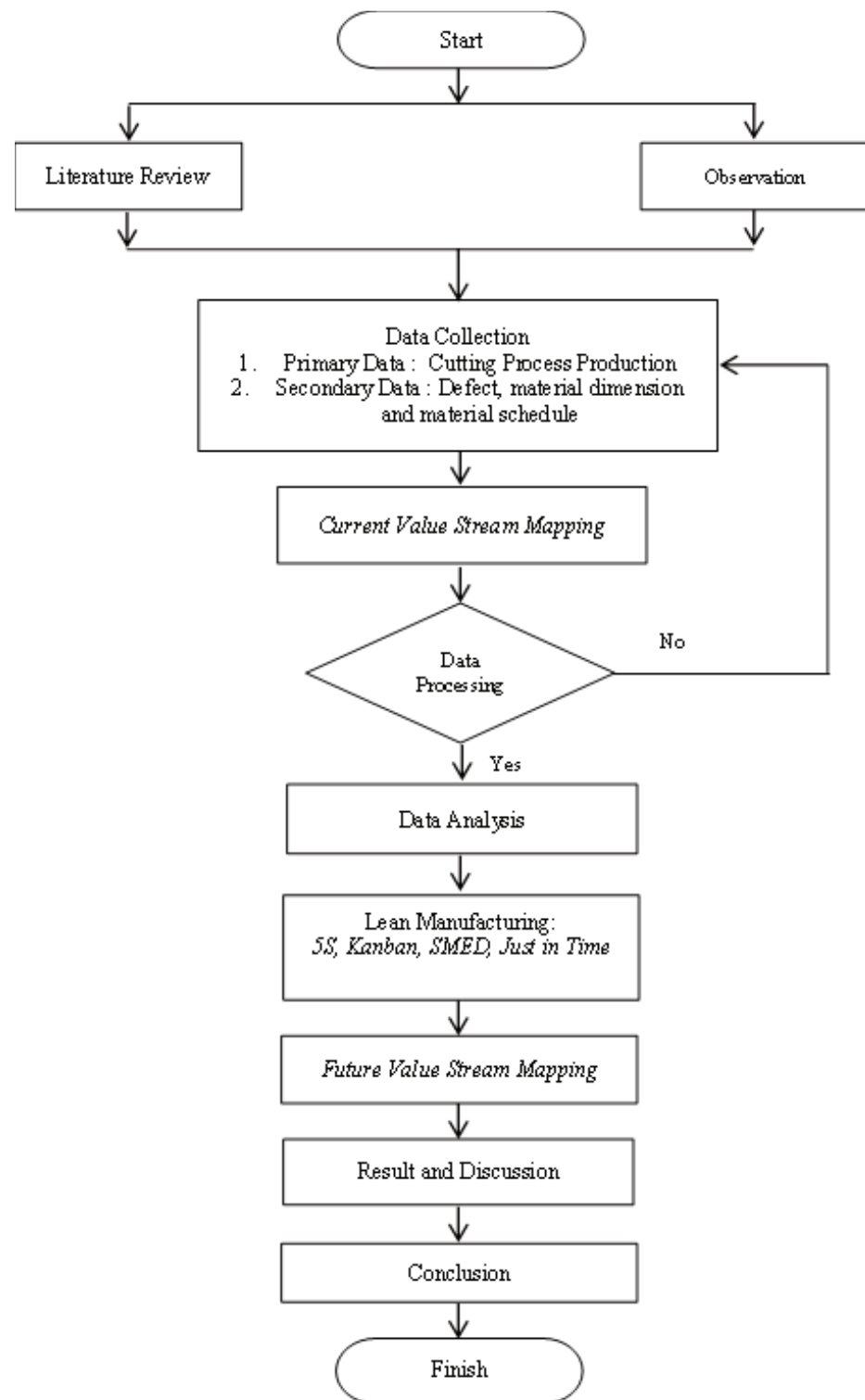


Figure 2: Research Methodology.

the diameter 147 mm if compared to the cluster 0. On the next step, it is to conduct the mapping of process flow in all areas. Process starts with a customer and ends back to the customer again. The order of the process is the customer will give the market



Figure 3: Visualization of cluster 0 and cluster 1.

forecast to the Order Fulfillment (OF) department which will be continued to supply chain to determine the quota which needs to be prepared for each customer. After that the supply chain department will arrange material arrival according to customer needs. If the material needs are ordered completely, the Order Fulfillment (OF) department will distribute the work instruction from the system in a form of Cutting Instruction (CI) to the Warehouse department to take the material which has been prepared by supply chain.

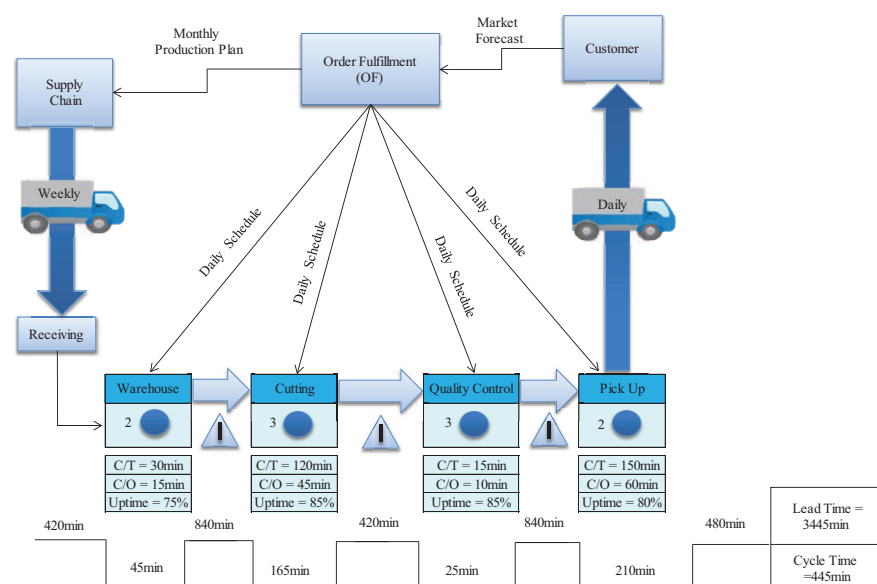


Figure 4: Current Value Stream Mapping.

It needs around 420 minutes from supply chain to the warehouse department, then from the warehouse to find out the materials it needs around 30 minutes. There will be a change over time if the actual materials are not available which around 15 minutes. From warehouse to cutting department needs time 840 minutes. In the production process the cutting will be done with the average cycle time is 120 minutes. The operator does self-checking for quality control with the cycle time in 15 minutes. The finished good will go to the delivery department to be created its delivery order and pick up to the transportation with the cycle time 150 minutes. In this steel company, activities in the production department with the low cycle time are really required. In this research, activities done were not only machine's setup but also there were activities when machine operating or turned off.

Activities	Before			After		
	Internal	External	Time (min)	Internal	External	Time (min)
Queue CI from OF	x		15	x		5
Write report CI on book	x		2	x		2
Finding Material based on CI	x		10		x	5
Transfer material to machine	x		7		x	4
Prepare material on machine	x		5		x	2
Setting machine		x	8		x	5
Dimension material setting		x	5		x	5
Cutting process		x	120		x	100
Create of identification numbers	x		5	x		2
Fill report on computer	x		5		x	3
Put on finished good	x		5		x	3
			187			136

Figure 5: Time Saving using SMED.

SMED method has improved the lead time from 187 to be 136 minutes in the production process. Each activity list which initially was an internal changed to the external. The purpose is when the machines are operating in the production; all activities can be sorted and done without waiting the machines are turned off.

In this future value stream mapping, the previous lead time process was 3445 minutes or 2.65 days and it's improving to be 2165 minutes or 1.7 days (22) (23) (24). In this research, each department implements the lean manufacturing method in order to increase lead time cutting process. Activities and shifting process from each department can be categorized as having value added and non-value added, so that using the lean manufacturing method can decrease the waste in each department.

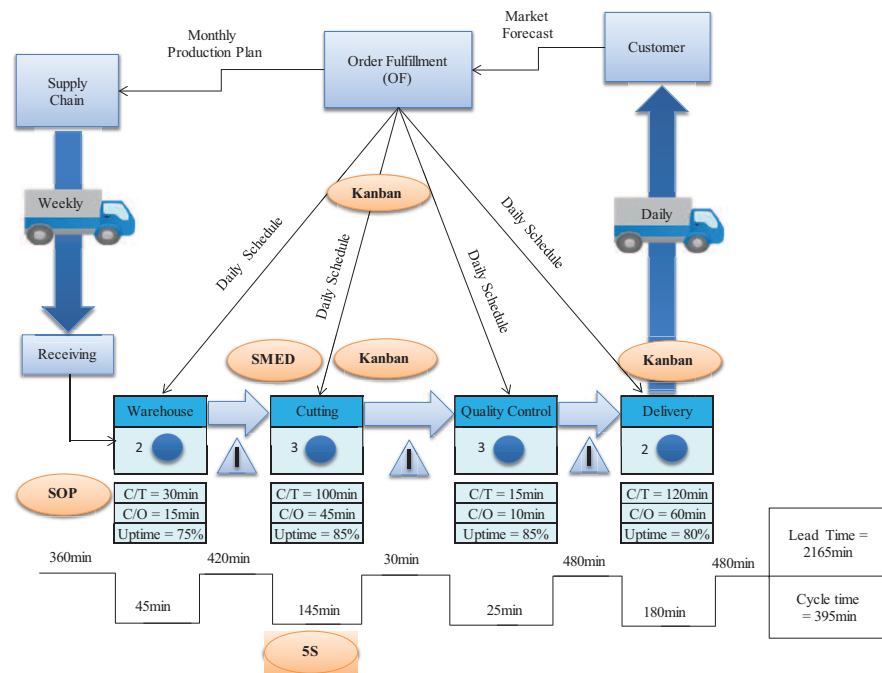


Figure 6: Future Value Stream Mapping.

5. Conclusion

Clustering method with K-means algorithm can be processed using Weka software to result clusters which can be formed to be cluster 0 and cluster 1. Cluster 0 has lower lead time so that it becomes the focus of improvement. Besides, the lean manufacturing method which is SMED and VSM can increase the lead time process which previously was 3445 minutes to be 2165 minutes (3 days to be 2 days).

6. Authors' Contributions

The authors contribute to share an improvement idea that can be implemented in steel companies in Indonesia. The focus is mainly on the improvement of the lead time process, to reduce the waste from all departments.

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