Product Quality Improvement by Using the Waste Assessment Model and Kipling Method

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Abstract. This study aims to identify waste, calculate the value of waste that occurs and provide suggestions for improvement to reduce waste. VSM describes the production flow and waste information that occurs, while WAM is the method used to calculate the waste assessment. Proposed improvements to reduce waste that has occurred using the Kipling Method. There are 6 types of waste that occurs. Waste assessment results that have been sorted in the production process are defect, motion, overproduction, transportation, waiting and process. This sequence is based on the largest weight to the smallest weight. For improvement proposals are prioritized for the type of waste with the highest rating weighting, namely defects. This shows that the defect is the type of waste that most influences the production process, making it easier to explore the cause of the problem and the advice that will be given to reduce the defects that occur. The company should make a visual form of the defect category so that the implementation of the recommendations for improvement can be applied and the operator can find out the true form of disability. It is expected that the proposed improvements can reduce the number of defects and meet the production targets achieved.

1. Introduction
Waste can be interpreted as something that does not add value to the product both in terms of cost, inventory, scrap, regulation and rework. Waste can be identified by using the WAM and Kipling methods, where the results will be used as a reference for improvements made by the company. Waste threatens the performance of the company so that reducing waste that occurs during the production process makes the company more competitive and efficient. Every company may know the level of performance in order to know the extent to which the effectiveness and efficiency of the production system is being carried out, so as to produce a quality product and in accordance with what consumers want. Improving product quality will certainly provide assurance to consumers that the company is able to provide the best service in meeting consumer demand. In the manufacturing, industry waste is one problem that often occurs both naturally and caused by the operator during the production process. There is waste that cannot be seen clearly, and it does not add value to the product, this is worse if it is not realized [1-4].

Waste that often happens to companies is to wait and product defects that are produced, especially for product X. The waste that occurs causes the amount of production that is not reached and production time becomes longer. The problem that is often experienced by manufacturing companies is how to make products with good quality, fast, cheap, so that productivity and product quality increase [5]. Directing to a good and right supply management system, this situation makes the company less responsive and can cause loss of consumers. Waste that occurs during the production process can be
known by making Value stream mapping (VSM), which shows the flow of material and information clearly and making a flow map can explain how the machines, tools, raw materials operate [6-9]. To find out the percentage weights of each type of waste using the Waste Assessment Model (WAM). In the production process of product X in the company where the research is, there is a waste that occurs and causes the amount of daily production is not reached and the production time requires a long time.

In research by Rawabdeh, WAM is used to calculate the value of waste that occurs in the work area [1]. For this reason, the aim of this study is to improve product quality through WAM by knowing the weight of the type of waste and the impact on other wastes, then the greatest weight will be made recommendations for improvement using the Kipling method analysis. Using the Kipling method analysis, it is hoped that the objectives of the company will be more targeted, so that work activities will be more organized, and easier to conduct evaluations [10].

2. Method
This research analyzed the type of waste that occurred, and the impact caused. The stages of this research are conducting observations in the company to find out current production conditions to identify problems that occur. The purpose of the study was made as an answer to the identification of the problem and as a basis for the results to be obtained from the study.

This research uses descriptive method with exposure using VSM, which shows the flow of material and information clearly and makes a flow map to explain how the machines, tools, raw materials operate [7]. The next process is to find out the percentage weights of each type of waste using WAM, which consists of two stages. The first stage is the Waste Relationship Matrix (WRM), making a waste relations matrix and the second stage is the Waste Assessment Questionnaire (WAQ) and filling out the waste assessment questionnaire. WAM results obtained will be made recommendations for improvement using the Kipling method analysis, commonly known as 5W + 1H (What, Why, Where, When, Who, + How). 5W + 1H are question words commonly used in identifying problems that occur and remedial actions to be taken [6].

3. Results and Discussion
Based on the VSM product image, it shows the information flow of the product order process to the company to the delivery of the product to consumers. In addition, VSM also shows that there were 6 processes that occur in the products made. These processes were the inspection of raw materials for 30 seconds per product, the cutting process with the time required for 2 seconds per product, the blanking process in which the results of raw materials will be cut into product specifications with the time required for 2 seconds, the repair process is a process additionally if there was a remaining cut with a required time of 2 seconds, the process of bending the raw material with a time required of 5 seconds, and the final process is a final inspection with a time required of 5 seconds. Based on the six processes, the time needed to flow one unit of product during the production process and the overall cycle time was 52 seconds. VSM images can be seen in Figure 1.

Waste occurs in three running processes. The blanking process produced 2 types of defects namely chipped and nonstandard dimensions. In the repair process, there was a waste of transportation caused by the operator moving back and forth to pick up equipment that is needed in different areas. And in the bending process, there was waste in the form of dent defects and waiting activities caused by the repair process to remove the remaining cuts.

The process of working on WAM, the first stage, WRM is a value in the relationship of seven types of waste. WRM data were in the form of questionnaire results given to the company's production department with a total of six questions per wasteful relationship. The second stage of WAQ is the allocation of waste. WAQ data is the result of a questionnaire completed by the operator of the product under study. The number of questions was 68. Each question was representative of activities that cause waste [1]. Questions consist of two types, namely to and from. This means that the question represents the type of waste caused by other waste. Categories of questions are about machines, people, methods and materials. The two stages of WAM produce the process of identifying waste which is sorted from the percentage of the largest to the smallest waste, which can be seen in the table 1.
The purpose of the Waste assessment model is to find out waste assessment and simplify waste identification [1]. Based on table 1, the type of waste with the highest percentage is defects by 20.77%. For this reason, corrective action is needed so that defects that occur can be minimized or even eliminated. Proposed repairs so that defects that occur can be reduced or even eliminated, the root cause of the emergence of defects must be known in advance. The root causes and proposed corrective actions can be seen in table 2.
| Defect category | Product on floor | Blanking Operator | During the production process | Improvement |
|-----------------|------------------|-------------------|-------------------------------|-------------|
| Chipped         |                  |                   | • Stopper wear               | • Making guidance on how to operate the machine installed in the production process area |
|                 |                  |                   | • Lack of operator ability to operate machines | • Providing training to operators on how to operate machinery |
|                 |                  |                   | Maintenance on the machine is not done routinely | Make regular machine maintenance schedules |
| Nonstandard dimensions | | | | |
| Nonstandard dimensions | | | | |
| Nonstandard dimensions | | | | |
| Dent            |                  |                   | • Placement of material on the stopper is not appropriate | • Making guidance on how to operate the machine installed in the production process area |
|                 |                  |                   | • Firing results from blanking attached to the product | • Providing training to operators on how to operate machinery |
|                 |                  |                   | Maintain cleanliness of the work area by removing the remaining firsing from the blanking process | |

Shown in Table 2, that chipped defects occurred on the production floor carried out by the blanking operator during the production process. This defect was caused by a worn stopper, the operator did not have sufficient expertise in operating the machine [11], and maintenance on the machine was not carried out routinely. The reason can be corrected by making guidelines on how to operate machines installed in the production process area, providing training to operators on how to operate machines, and making regular machine maintenance schedules.

Non-standard dimension defects occurred on the production floor and was carried out by blanking operators during the production process. This defect was caused by the bolts on the engine stopper loose and maintenance on the dies machine was not done routinely. Improvements that can be done is checking the engine components first before the machines are operated and make regular machine maintenance schedules.

Dent defects occurred on the production floor and was carried out by the bending operator during the production process, which was caused by improper placement of the material in the stopper and firing results from the blanking attached to the product. Improvements that can be done are making guidelines for how to operate the machine installed in the production process area, providing training to operators on how to operate the machine [11], and keeping the work area clean by removing the remaining firsing from the blanking process.
4. Conclusion

Based on the calculation of the WAM method shows that the sequence of waste from the largest to the smallest weight is a defect of 22.31%, motion of 16.88%, overproduction of 16.47%, inventory of 15.32%, transportation of 10.68%, waiting of 10.17% and process of 8.17%. Improvement proposals to reduce waste of defects in the production process of the product is to make guidelines for how to operate the machine installed in the production process area and provide training to operators on how to operate the machine and make regular machine maintenance schedules. At the time the machine will be operated, it should be checked on the engine components first before the machines are operated. Maintain cleanliness in the work area by removing the remaining firsing from the blanking process. In order for implementation of improvements to be implemented, the company should make a visual form of the type of defect so that the operator knows the form of disability clearly and add personnel to oversee the performance of the operator.

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