FMEA tool to analysis of blow molding machine damage

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Abstract. Machine performance in industry has a vital role in the production floor. The machine operates smoothly will support the achievement of production targets. One sector produces packaging products made based on plastic experiencing a failure production process due to the frequent stopping of the Blow Molding Machine. Fishbone diagram and Failure Mode and Effect Analysis (FMEA) is used to find information about the factors cause the Blow Molding Machine to stop. Fishbone diagram is used to determine the factors cause the failure of the Blow Molding Machine in running the production process. FMEA is used to identify the factors causing loss and determine the priority level of risk based on the RPN value. The mold damage factor has the highest RPN value. Mold failure is most significant cause of Blow Molding Machine stops operating. The mold is damaged when stored in the spare part warehouse due to crushed by a material made of metal. Mold is stored in an unsuitable location. Analysis using a fishbone diagram to determine the root of the problem handled.

1. Introduction
Companies are always required to produce products on time, according to consumer demand. Achieving production targets is highly dependent on the production of smooth flow. The slick production on the factory floor is significant and must always be maintained. But there are many elements cause the production process hampered. The machine’s effectiveness in production is one of the most significant factors supporting the smooth production flow [1]. The breakdown is a condition in which machines or work equipment cannot be used due to damage to spare parts, usage of machine components, etc. [2]. Machines or work equipment cannot operate normally, or machine stops operationally in sudden conditions. If a machine or production equipment experiences a breakdown, it will fail to produce a product. The most vital thing is that if the machine cannot function, the production process will not run.

Failure of production facilities (machines / work) to support the smooth operation of the shop floor needs to be handled immediately so that production targets can be achieved [3]. The failure of production facilities caused by many factors. Damage of production facilities can be caused by unplanned maintenance system problems [4]. The basic perception of maintenance systems is to repair damaged equipment. Thus, maintenance activities are limited to reactive tasks for repairing or replacing damaged components [5].

A more recent view of system maintenance defines all activities aim to maintain and return an item to a physical state necessary to achieve a production function [6]. A sound maintenance system will have an impact on the availability of production facilities are ready to use. The maintenance function must be able to ensure the availability of production facilities to produce products at the expected quantity and quality levels [7].

Failure Mode and Effect Analysis (FMEA) is a structured procedure to identify and prevent as failure mode possibilities. The failure mode is a part of a process that may fail to meet specifications, resulted by defects or non-conformities impact the customer if it is not prevented or corrected [8]. FMEA is a quality improvement and risk assessment tool widely used in the manufacturing industry. This tool combines human knowledge and experience to (1) identify known or potential failure modes
of a product or process, (2) evaluate product or process failures and their effects, (3) help engineers to initiate corrective or preventive action, and (4) eliminate or reduce the possibility of loss [9].

This paper describes an activity to find the factors cause the stop of the Blow Molding Machine in a plastic packaging industry. The Blow Molding Machine to finish working because the Blow Molding Machine mold is not ready to use. Efforts are being made to focus on increasing the effectiveness of the Blow Molding Machine by reducing breakdown times. Many factors cause a device to finish using. The machine to finish using is not only due to a lousy maintenance system but also occur because the operator's awareness is still low in maintaining machine cleanliness, detecting early signs of damage. This paper will describe the efforts to identify the leading causes of Blow Molding Machines to stop finish using and determine which reasons have the most significant impact on machine failure. Fishbone Diagram and Failure Mode and Effect Analysis analyzes the factors causing the Blow Molding Machine failure to operate.

2. Methodology
This research was conducted in a company that produces plastic packaging products. The research subject observed is a Blow Molding Machine that cannot be used due to the damage of blow molding. The research begins by making observations to find the problems that occur. Then find the root cause of the problem with a fishbone diagram. The root causes and sub-clauses, resulting in imperfection problems can be grouped into categories such as Human, Machine, Material and, Method and Environment [10]. Then find the root cause that has the most significant impact on the stop working of the Blow Molding Machine with Failure Mode and Effect Analysis (FMEA).

The analysis was carried out by collecting information about the possible causes the stop working of the Blow Molding Machine. Brainstorming techniques were used to collect information about the grounds of the Blow Molding Machine stopped working. Brainstorming is a form of discussion to gather ideas, opinions, information, and knowledge and experiences from all participants [11]. The statement obtained from the team is described in the Fishbone Diagram [10]. Fishbone Diagram is a tool used to describe the root cause of a pain systematically [12]. Fishbone Diagram is also used to identify and analyze the failure of a process and to find possible causes of a problem [13].

The FMEA process includes three main variables, namely Severity, Occurrence, and Detection [14]. The severity rating shows how profound the effect of a failure model is. Occurrence is the frequency or failure probability and/or causes of failure during a certain period. Detection describes how well process control detects the cause of loss itself after a failure event occurred, but before customers know it. These three variables are evaluated in FMEA [15]. FMEA is conducted to determine the component failure factors and their effect on the overall system function based on the highest Risk Priority Number (RPN) value. The RPN procedure can be obtained by the following formula [16]:

\[ RPN = \text{Severity} \times \text{Occurrence} \times \text{Detection} \]  

(1)

3. Result
3.1. Brainstorming
Brainstorming conducted by ten respondents consists of production managers, production supervisors, maintenance supervisors, supervisors of the equipment warehouse, three production operators on a Blow Molding Machine, two maintenance operators, and one operator of the equipment warehouse. All respondents discussed to analyze the causes of the Blow Molding Machine failure. All respondents expressed their opinions based on observations and experiences during work to conclude the cause of frequent stop working of Blow Molding Machine. All opinions appear that are grouped into 4M and 1E factors, namely: Man, Machine, Method, and Material and Environment. The results of this brainstorming are visualized using the fishbone diagram.
3.2. Cause and Effect Analysis

Cause and effect analysis is illustrated using a fishbone diagram by observing aspects of the man, machine, material, method, and work environment used in the production process. The following are the results of problem analysis using a fishbone diagram.

Figure 1. Cause and Effect Diagram

Based on the figure above, problems in the production process of packaging products made from plastic due to the stop working of the Blow Molding Machine occurred because:

1. Work Environment
   From the aspect of the work environment, there are several conditions such as there is no clear boundary on the storage area, there are materials not needed in the work area, the warehouse conditions, the dirty and dusty spare parts area, and items are not stored according to their place.

2. Material
   The raw material determines the quality of the final product output. From the aspect of raw materials, there are several conditions such as storage not based on the material type and the material quality sometimes is not based on standards [17].

3. Man
   Humans are one of the factors that can cause errors in production. View from the human aspect, there are several conditions such as workers do not work carefully, lack of employee knowledge about the production materials property so that the mold damage, happens.

4. Method
   The work method determines the result of work productivity. View from the aspect of work method, there are several conditions such as no mold maintenance schedule, no mold maintenance SOP, and no standard regulation of how molds are handled when it is stored.

5. Machine and Production Equipment
   View from the aspect of work methods, there are several conditions such as mold damage, and production equipment is not placed in the right place. The number of damage mold because the
storage system is not arranged properly according to the right place. Items placement in warehouses are not based on the mold material property is easy to change shape and experiencing cracks when it is hit by metal materials. The stop working of the Blow Molding Machine is influenced by the readiness of the mold to use.

3.3. Failure Mode and Effect Analysis
After finding the factors are caused by stop working of the Blow Molding Machine, the Failure Mode and Effect Analysis (FMEA) was carried out. FMEA is used to determine the most dominant factor that has the potential to cause the Blow Molding Machine to the stop finish working. Based on FMEA analysis, it is known that the elements are cause damage and their influence on the overall system function can be found so that practical solutions can be found to solve these problems. Table 1 shows the results of the assessment of the factors caused by the Blow Molding Machine to stop finish working using the Failure Mode and Effect Analysis.

| No | Cause Factor                              | RPN |
|----|-------------------------------------------|-----|
| 1. | Mold damage                               | 300 |
| 2. | There is no standard regulation of mold storage | 240 |
| 3. | There is no SOP of mold maintenance       | 240 |
| 4. | There is no schedule of mold maintenance  | 210 |
| 5. | The grouping in storage is not based on the material type | 180 |
| 6. | Lack of knowledge about material properties | 160 |
| 7. | There is no clear boundary of storage place| 160 |
| 8. | There are materials are not needed in the work area | 120 |
| 9. | Workers do not work carefully             | 100 |
| 10.| Mold is not placed in the right place      | 80  |
| 11.| In the spare part area, the warehouse is dirty and dusty | 80  |
| 12.| The quality of raw materials often does not meet standards | 60  |

The RPN (Risk Priority Number) value is the multiplication result of the failure severity level, failure occurrence, and failure detection ability. The RPN shows the priority value of the root problems in the production process which is must be handled immediately. The leading cause the stop is the Blow Molding Machine in the production process due to mold failure. Mold is used to shape liquid plastic into the required packaging form. A damaged mold was made the Blow Molding Machine unusable (breakdown).

Confirmation made to the team to get more in-depth information about mold damage. The factors cause mold damage is closely related to the other factors. Damaged molds are known due to low mold storage systems. Meanwhile, molds are easy crack and easily change shape when it contacts with metal materials. There is no standard regulation regarding to mold storage procedures, mold maintenance, grouping during storage, and cleanliness of storage places that cause the mold damaged. It takes a long time to repair and prepare the mold. So that the Blow Molding Machine stops working in a long time. Efforts, that can be made to minimize the downtime of the Blow Molding Machine are to minimize mold damage by improving the mold storage system.

4. Conclusion
Brainstorming and fishbone diagrams are used to collect information about the loss. The failure is that the Blow Molding Machine cannot run the production process. Failure Mode and Effect Analysis (FMEA) is used to identify factors cause failure and determine risk priority levels based on the RPN value. The results of the collaboration of the brainstorming method, fishbone diagram, and FMEA obtained that a factor that has a high potential for failure (the stop working of Blow Molding Machine). Mold damage is the factor with the highest RPN value of 300. This means that to reduce the
failure of the Blow Molding Machine of stop working, repair and mold control must be carried out so that the damage to the mold is minimal.

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