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Analysis of Quality Improvement of Wood Powder Raw Materials at CV. NKM Using FMEA and FTA Methods

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ABSTRACT

CV. NKM is a supplier company that takes manufacturing plant waste in the form of sawdust, especially waste from merbau wood, sent to factories whose main raw material is sawdust such as pallet factories, briquettes, etc. In every process there are defects such as powder mixed with other sizes, smelly and moldy powder, and wet powder. In every process there are defects such as powder mixed with other sizes, smelly and moldy powder, and wet powder. These defects are due to human factors, tools/machines, storage, etc. So this research was conducted using the FMEA (Failure Mode and Effect) method used to determine the severity, occurrence, and detection levels, so that the highest RPN value of 576 was obtained, namely powder mixed with other sizes and FTA produced basic events from the highest RPN value, namely lack of rest hours, lack of supervision, and lack of routine control. After the results are known, an improvement proposal will be given for the highest RPN value, namely providing sufficient hours of rest and enforcing routine control of the tool/machine.

INTRODUCTION

CV. NKM is a supplier company that takes manufacturing factory waste in the form of wood powder, especially waste from merbau wood, from various factories and then sends it directly to factories whose main raw materials require wood powder such as pallet factories, briquettes, etc. In every wood powder process there are defects in the product such as powder mixed with other sizes, smelly and moldy powder, and wet powder. In every wood powder process there are defects in the product such as powder mixed with other sizes, smelly and moldy powder, and wet powder. These defects are due to human factors, tools/machines, storage, etc. In the industrial world at this time is very rapidly growing as well as competition in local and international markets, as a result companies must prepare products with the best quality (Romadhoni et al., 2022). Companies that can prepare their products well are guaranteed to continue to exist in the massive industrial world like now (Aiman & Nuruddin, 2023). Suppliers cover all aspects related to providing various needs that support business and production operations, including raw materials, components, and services (Falah et al., 2023). Suppliers can also be defined as companies that supply, supply or provide raw materials or raw goods to other companies for production needs (Wicaksono & Yuamita, 2022).

Raw materials are raw materials that have not been processed and will be processed into finished goods as the main result of the company concerned (Anwar et al., 2023). In terms of raw material procurement, the success of the company depends on efforts to find and select raw

materials that will be used in the production process carefully (Hardianto & Nuriyanto, 2023). The quality of raw materials that have been tested for quality so that they can be used as the main ingredient in the production process in order to produce high quality and useful finished products (Isma'il & Andesta, 2023). The definition of raw material quality varies depending on each person's perspective (Hakim & Al-Faritsy, 2024). However, it can be concluded that the quality of raw materials is the main and most important orientation in a company engaged in suppliers in carrying out its business activities, because the quality of these raw materials can directly affect the finished product produced by the producer company (Haryono & Sumiati, 2023).

Therefore CV. NKM needs to improve the source of the defect by identifying it first. From the problems found in wood powder products, it is necessary to identify problems to minimize defects in wood powder products. FMEA and FTA are suitable methods for identifying these problems, because they can improve the quality of wood powder by looking for problems to the grass roots. FMEA (failure mode and effect analysis) is a method for detecting a failure mode with systematic and data collection table assistance for analysis (Wardana & Widiasih, 2023). In addition, FMEA is also used for the identification process to prevent failures that can create defects in products (Chairunnisa & Priyandari, 2023). FTA (Fault Tree Analysis) is a method used to identify the causes of failure in the production process (Ridwan et al., 2023). The use of FMEA and FTA methods aims to determine the highest RPN value of the cause of failure and provide suggestions for improvement based on the highest RPN value and the results of the FTA chart.

RESEARCH METHODS

Failure Mode and Effect (FMEA)

A process designed to find and prevent as many failures as possible (Al Karim & Sari, 2023). FMEA is used to find the source and root of quality problems (Soejanto & Ekawati, 2024). This analysis is to determine the source of certain defects in equipment, supplies, processes, and raw materials used and to establish preventive measures to prevent these defects from recurring. In its identification, FMEA produces an RPN (Risk Priority Number) value which intends to determine the value that has the highest potential for failure (Rahman & Nasrudin, 2023).

Risk Priority Number (RPN)

Systematic results of the seriousness of the effect (Severity), the likelihood of the cause of the failure associated with the effect (Occurrence), and the ability to detect the failure before it occurs (Detection) (Yuamita & Fatkhurohman, 2023). From the RPN value in the FMEA identification process, there are severity (S), occurrence (O), detection (O) obtained from distributing questionnaires to related actors, which will produce an RPN value that aims to evaluate activities that can cause disability (Wibowo & Pratiwi, 2023). From these three parameters, the RPN calculation is carried out with the formula, as follows :

$$RPN = S \times O \times D \quad (1)$$

Description :
S = Severity Rate
O = Occurrence Rate
D = Detection Rate

Severity

Used to determine the impact criteria that arise due to a failure. The following is the severity value :

Table 1. Severity

Description	Severity	Rating
Impacts that are at risk from system failure	At risk	10
Faults in the system cause serious impact	Serious	9
System does not work	Very high	8
The system works but is unable to operate optimally	High	7
The system can still work safely but has a decrease in performance	Medium	6
Performance decreases gradually	Low	5
Minimal impact on system performance	Very low	4
Slight impact on system performance	Small impact	3
Insignificant impact on system performance	Very small impact	2
No effect on the product	No impact	1

Occurrence

These are causes that have the potential to cause failure in a process. The following is the occurrence value :

Table 2. Occurrence

Description	Occurrence	Rating
Frequent failure	Very high	10-9
Failure continuously	High	8-7
Failure is very rare	Medium	6-4
Very few failures	Low	3-2
Almost no failures	No impact	1

Detection

An anticipation or control of failures that occur to minimize the potential for these failures to occur. The following is the detection value :

Table 3. Detection

Description	Detection	Rating
Inspections are unable to identify potential failure causes and failure modes.	Uncertain	10
Inspection has a very small probability of being able to identify potential failure causes and failure modes.	Very small	9
Inspection has a small probability of being able to identify potential failure causes and failure modes.	Small	8
Inspection has a very low probability of being able to identify potential failure causes and failure modes.	Very low	7
Inspection has a low probability of identifying potential causes of failure and failure modes.	Low	6
Inspections have a medium probability of identifying potential failure causes and failure modes.	Medium	5
Inspections have a medium to high probability of identifying potential causes of failure and failure modes.	Medium and above	4
Inspections have a high probability of identifying potential causes of failure and failure modes.	High	3
Inspections have a very high probability of finding out potential failure causes and failure modes.	Very high	2
Inspections will always be aware of potential failure factors and failure modes.	Almost certain	1

Fault Tree Analysis (FTA)

A method for finding risk factors that cause failure. This method uses a top-down approach (Soejanto et al., 2023). It starts from the failure assumption of the peak event, then explains the reason for the peak event to the source of the failure. Fault tree analysis identifies the relationship between causal factors and shows them in the form of a fault tree (Dzikri et al., 2024). One way that can be used to investigate the primary source of failure or error. The following are symbols of fault tree analysis :

Table 4. Fault Tree Analysis Symbol

Symbol	Term	Description
	Basic event	The basic event of an unexpected deviation from normal in a component of a system.
	Top event	A desired event at the top level that indicates a failure that will be investigated further.
	Logic event AND	Indicates an AND function, this function is used to indicate the output event will occur if all inputs occur.
	Logic event OR	Indicates an OR function, this function is used to indicate an output failure that occurs because there are one or more two failure events in the inputs
	Conditioning event	A special condition applied to a logic gate when a certain condition is met.
	Undeveloped event	Events that do not develop do not need to be searched for their causes, as they are not sufficiently related.
	External event	Indicates an event that is expected to occur and is not included in the failure event.
	Transferred event	Continued description of a different event located on another page.

RESULTS AND DISCUSSION

Data Collection

In collecting data on wood powder defects, interviews and observations are carried out at CV. NKM and the data will be entered into a check sheet to make it easier to identify product defects.

Check Sheet

Check sheets are useful instruments for data collection and analysis. The data is presented in the form of a table containing information about data in the form of defective product data, the number of products produced, and so on. The wood powder defect table data is as follows :

Table 5. Wood Powder Defect Check Sheet

Year	Period	Production Quantity	Type of Disability			Total Defect Products
			Powder Mixed With Other Sizes (Kg)	Odor and Moldy Powder (Kg)	Wet Powder (Kg)	
	February	52750	2160	760	2375	5295
	March	35000	5000	750	350	6100
	April	40000	2550	800	600	3950
	May	40500	3500	720	455	4675
	June	35500	3560	420	360	4340
2024	July	36550	4230	600	340	5170
	August	40000	4500	780	450	5730
	September	50000	1200	1425	3580	6205
	October	49500	1260	1260	2650	5170
	November	49600	1230	1300	2760	5290
	December	49750	2010	1260	3260	6530
2025	January	52600	2150	800	3520	6470
Total		531750	33350	10875	20700	64925
Average		44313	2779	906	1725	5410

(Source : CV. NKM)

From the check sheet data in table 5 above presents data on the number and types of defects that occurred during February to December 2024 and January 2025, on the defect of powder mixed with other sizes, an average amount of 2779 kg was obtained, odor and moldy powder obtained an average amount of 906 kg, and wet powder obtained an average amount of 1725 kg. This data will be used as the basis for the process of identifying the causes of product defects.

Data Processing

Failure Mode and Effect (FMEA)

In this section, it intends to find out what are the causes of failure in table 5 that cause wood powder defects in CV. NKM. The initial process carried out is the distribution of questionnaires on the causes of disability.

Table 6. Types and Causes of Failure

Failure Type	Failure Cause
Powder Mixed with Other Measures	Human Error
	Dirty separator
Odor and Moldy Powder	Human Error
	Damp Storage
Wet Powder	Human Error
	Improper Storage

The results of distributing questionnaires in table 6 show that each cause of failure will be calculated to determine the highest RPN value, as follows :

Table 7. RPN Calculation Result

Failure Mode	S	Cause of Failure	O	Control	D	RPN Value	Ranking
Powder Mixed with Other Measures	9	Human Error Dirty separator tool/machine	8	Provide adequate rest hours Provide routine maintenance	8	576	1
Odor and Moldy Powder	9	Human Error Damp Storage	7	Performing rechecks Perform storage with low humidity temperature	7	441	2
Wet Powder	8	Human Error Improper Storage	9	Performing re-checking Perform storage in accordance with SOP standards	6	432	3

In table 7 above, it can be seen the RPN value of the S x O x D formula obtained from the value of the questionnaire results with the highest value. The results of the RPN value of powder mixed with other sizes are 576 with rank 1, smelly and moldy powder is 441 with rank 2, and wet powder is 432 with rank 3.

From the results of the RPN value, it has been determined that the highest ranking is the top priority. The proposed improvements to powder defects mixed with other sizes are prioritized because they have a high enough risk followed by smelly and moldy powder, and finally wet powder.

Fault Tree Analysis (FTA)

This process is useful as a root cause stage of each cause of failure from top event - basic event, for future improvement.

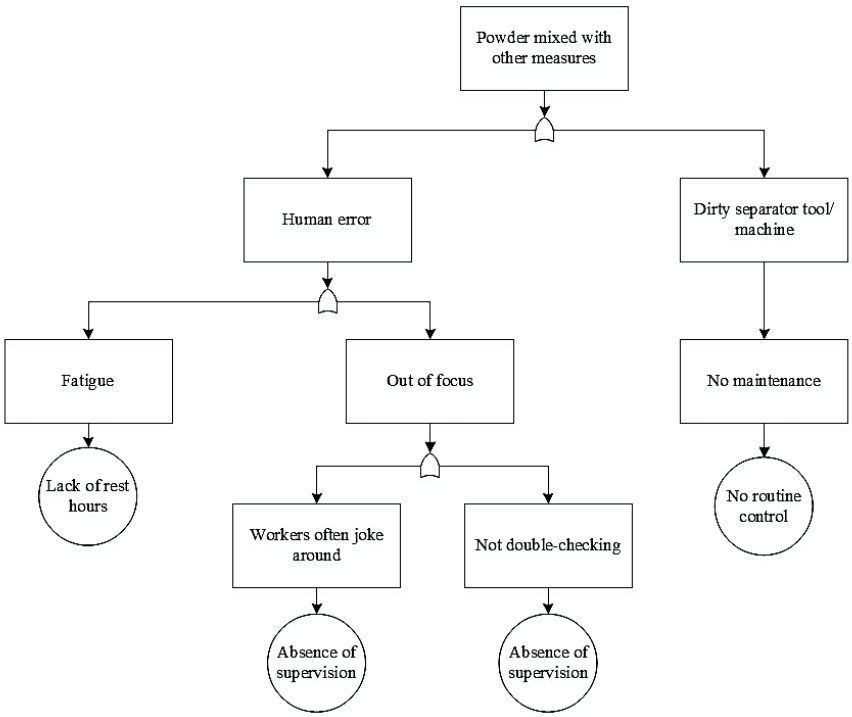

Figure 1. Powder Mixed With Other Measures

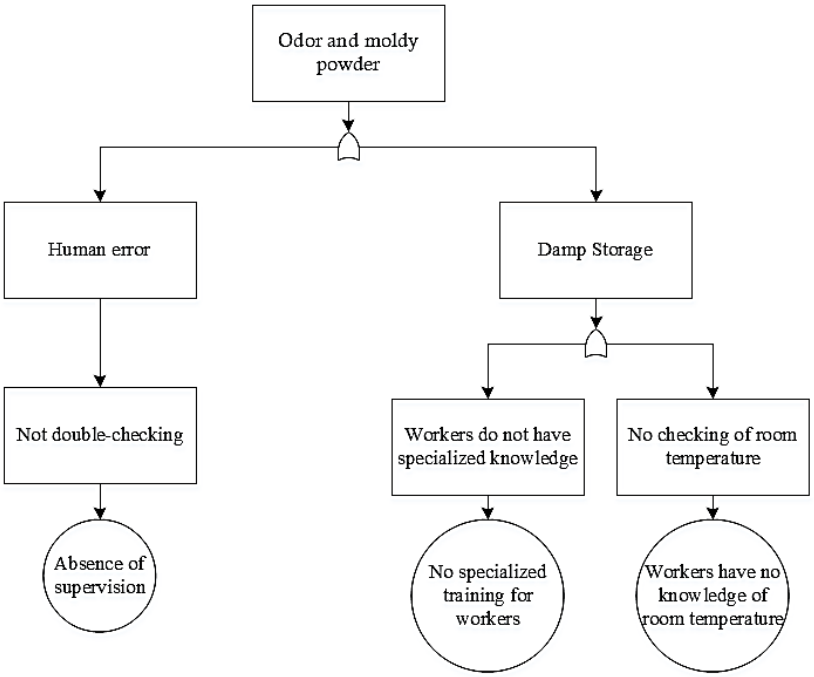

Figure 2. Odor and Moldy Powder

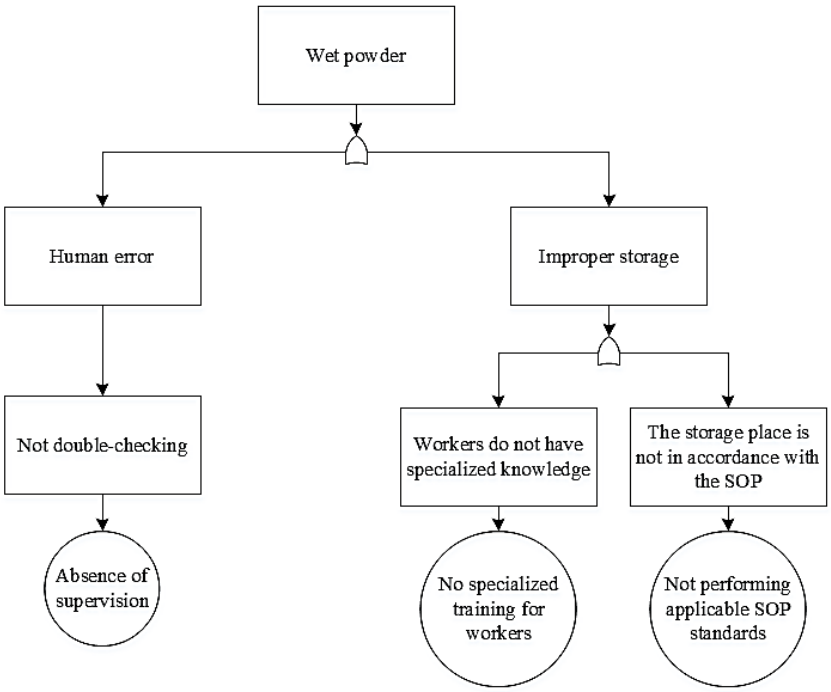

Figure 3. Wet Powder

The results of figures 1, 2, 3 above can be explained, that from powder mixed with other sizes, smelly and moldy powder, and wet powder have root causes or basic events including lack of rest hours, no supervision, no routine control, no special training for workers, workers do not have knowledge of room temperature, and do not carry out applicable SOP standards owned by the company.

Proposed Improvements

After knowing the results of FMEA identification, the highest RPN value, and FTA. Then these results are carried out especially improvement proposals that have the highest RPN value. Proposed improvements, as follows :

Table 8. Proposed Improvements at the Highest RPN

Defect Type	Cause of Failure		Proposed Improvement
Powder Mixed With Other Measures	Human error	Worker fatigue	Provide adequate rest hours
	Dirty separator tool/machine	No maintenance	Perform routine control on tools/machines

From the results of table 8 above, it is known that the proposed improvements from the highest RPN value, namely powder mixed with other sizes for fatigue workers, are to provide adequate rest hours and the absence of maintenance is to impose routine control on the tool / machine. That way CV. NKM can reduce the impact that occurs such as decreased performance, products not according to specifications, reduced product quality, additional costs for machine repairs, and wasted products.

CONCLUSION

The conclusion that can be drawn from the identification process at CV. NKM is that of the 3 defects, namely powder mixed with other sizes, odor and moldy powder, and wet powder, the results of powder mixed with other sizes are obtained with the most average defects. After that, the FMEA identification process is carried out by distributing questionnaires to the objects concerned. The next process is the calculation of finding the RPN value, from the calculation it results in defects in powder mixed with other sizes having the highest RPN value of 576. The next process is FTA identification and produces basic events from the highest RPN value, namely lack of rest hours, lack of supervision, and lack of routine control. After all the identification processes have known the results, an improvement proposal is given for the highest RPN value, namely giving enough hours of rest by giving 30-60 minutes for rest time so that the working time is not too long and enforcing routine control of the tool/machine by checking every time before and after the machine is used if there are worn parts immediately replaced on the machine part.

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