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An Implementation of Failure Mode and Effect Analysis (FMEA) in a Fibre Industry for Loss Reduction

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***Abstract* – This paper gives the report of the FMEA methodology in the fibre industry. This used as a tool to ensure the product quality, operational performance of the manufacture cycle. In fibre industry cellulose sheet is the main raw material, it impacts directly to cost and quality of the fibre produced. The rejection and losses of the raw material being identified by applying the failure mode and effect analysis (FMEA). The FMEA is formed by identifying the risk priority number in the biggest and smallest one. The data is collected by the interviews and group discussions. This study allows the decision maker to take actions for mitigate the failure in the fibre industry.**

Keywords – FMEA, fibre industry, decision maker, risk priority number, cellulose sheet.

1. Introduction

Every industry's main objective is to reduce losses and getting profit. With the rapid increase of industries in the market the competitive environment developed. This development pushes the industries to reduce their losses or try eliminate the waste as minimum as possible and implement the strategies and innovative methods to which the waste could minimize. In fibre industry, cellulose sheet is the main raw material in the manufacturing process of fibre (staple fibre). The cellulose pulp is processed by hard wood with the help of chemical like sodium hydroxide, Sulphur dioxide etc. [4]. Failure mode and effect analysis (FMEA) method used to analyze and identify the probabilistic failure modes of the particular process [1].

Based on the background of the industry we conducted research aiming to find the dominant cause of failure in the quality and quantity of cellulose sheet by using FMEA. The output of the study as able to judge the most dominate factor as the cause of losses in the cellulose sheet. Then, offered improvement suggestions to eliminate the cellulose sheet losses in the industry.

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2. Literature Review

Failure mode and effect analysis (FMEA) is a procedure to prevent and detect as many as failure modes. FMEA helps to find the root causes of quality issues [2]. A failure mode includes failure of design, conditions beyond the limits or changes in the product that disrupts the function of production line. FMEA can be done by evaluating the potential failure of the product or eliminate the chance of failure by recording the observation [3]. The following steps are identified for implementing the process of FMEA [5].

a. Functions of business process
b. Potential failures modes
c. Potential failures effects
d. Causes of failure
e. Modes of detection
f. Calculate the rating of severity, occurrence, detection and RPN (Risk Priority Number)
g. Rectification in industry

To calculate the value of severity, occurrence and detections as follows [6][7].

1. Severity value:
   Severity value calculates how much impact or intensity of the incident will affect to the final outcome in the process because one failure mode subsequently affects another activity. The impact factor on the rating scale ranges from 1 to 10 shown in table 1.
2. Occurrence value:
   Occurrence is the possibility that the cause of the failure occurs and the failure during the running process of

industry. To identify the value occurrence, look at the table 2.

3. Detection value:

Detection functions as a preventing potential failure during the process of research and reduce the failure level in the industry. Detection rate can be seen in table 3.

Representation	Scale	Example
None	1	No effect on quality
Very small	2	Cellulose sheet quality not change
small	3	Little change in quality
Very low	4	Cellulose sheet small impaired
Low	5	Dissatisfaction on the quality of cellulose sheet
Moderate	6	Failure cause trouble
High	7	Cellulose sheet quality unsatisfactory
Very high	8	Cellulose sheet quality very unsatisfactory
Hazardous alarm	9	Potential failure cause bad effect on cellulose sheet
Hazardous no alarm	10	Failure mode effect is fatal to the quality of cellulose sheet

Table 1. Severity Value

Representation	Scale	Example
Never	1	No history of failure
Rarely	2	Failure is rare
Very little	3	Possibility of failure is very little
Little	4	Cellulose sheet suffered minor irritancy
Low	5	Some of the possible failure
Moderate	6	Possibility of failure occurs
Quite High	7	Possibility of failure is high enough
High	8	High number of failures
Very high	9	Extremely high possibility of failure
Almost certain	10	Failure is almost certain

Table 2. Occurrence Value

Representation	Scale	Example
Almost certain	1	Definitely detect
Very high	2	Almost detect
High	3	Greater chances of detect
Moderate high	4	May detect high enough
Moderate	5	May detect moderate
Low	6	May detect low
Very low	7	Possessed very low opportunities to detect
Distant	8	Possessed very little opportunities to detect
Very Distant	9	May not detect
Impossible	10	Certainly not detects

Table 3. Detection value

3. Methodology

This study was able to determine the most major activity as the cause of losses of cellulose sheet. Data collection methods that used are interviews, group discussion. Observations are carried out to observe the process of cellulose sheet supply chain activities, orderings process in the industry and the needs of quality of cellulose sheet that must be met up to supplier's specifications of cellulose sheet quality. Its specifications were obtained by quality control department. Follow up with the interviews were conducted to identify the cause of the failure to the losses in the cellulose sheet as well as to get an assessment of the five respondents and group discussion who have been determined. The research process to solve the problem was represented by diagram in figure 1.

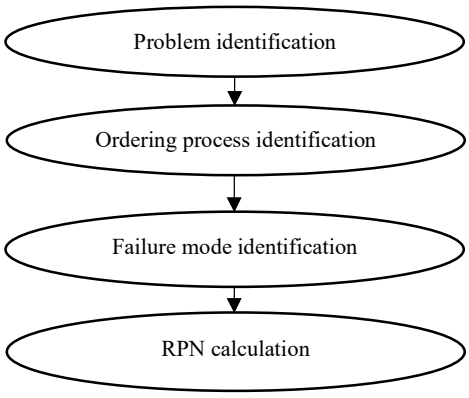

Figure 1. Research Process

4. Results

The identification of failure modes conducted the experts. The researches determine five experts who are from procurement department of the industry. All the five experts will estimate the severity, occurrence and detection of failure modes that are below in the table. After that, the expert will estimate the risk priority number (RPN). This value determines the cause of the most cardinal issues in the cellulose sheet losses. Risk Priority Number (RPN) value is evaluation is carried out with help of interviews and group decision. The results of the evaluation are based on the table below can be seen the 10 different types failure modes of risk priority number (RPN) value and the potential failures are ranked accordingly.

Components	Severity					Occurrence					Detection					RPN					Average RPN	Ranking
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	RPN1	RPN2	RPN3	RPN4	RPN5		
Sheet spoilage	8	5	7	7	8	9	7	8	6	4	6	4	7	7	8	432	140	382	294	256	300.8	**3rd**
Unfavorable quality	9	5	8	4	8	5	7	8	8	4	5	4	5	2	7	225	140	320	64	224	194.6	**5th**
Unloading location	6	6	5	7	7	3	4	5	6	4	4	3	5	4	2	72	72	125	168	56	98.5	**10th**
Wet sheets	7	6	9	8	8	4	5	4	7	4	4	5	2	4	4	112	150	72	224	128	137.5	**7th**
Logistics error	4	6	3	7	8	2	5	3	7	6	6	7	8	7	8	48	210	72	343	384	211.4	**4th**
Sample test	8	7	4	8	5	7	7	2	4	5	4	4	5	3	4	224	196	40	96	100	131.2	**8th**
Human Inspection	7	8	8	6	8	5	4	3	5	5	5	7	6	7	4	175	224	144	210	160	182.6	**6th**
Storage area	9	9	8	7	8	7	8	9	8	8	8	7	5	7	5	504	504	360	392	320	416	**1st**
Drainage stockpiling	9	8	7	8	8	8	7	7	8	6	8	5	6	6	7	576	280	294	384	336	374	**2nd**
Spilling sheets at loading	3	4	3	5	4	5	5	4	7	4	5	5	7	5	4	75	100	84	175	64	99.6	**9th**

Table 4. RPN Calculation

5. Conclusions and recommendations

The failure modes were the dominating cause of losses of cellulose sheet in the industry. The industry's quality map is not so good and storage area or then the test results of the samples show that by the cellulose sheet supplier and the cellulose sheet actually tested are not up to the mark. The inspection activities such as errors in sampling and at the time of delivery due to the wet conditions. Proposed improvements to reduce the failure in the cellulose sheet rate is need to again review by the contract vendor.

The recommendation given by the author for the industry is to give the access to vendor should be selected on the basis of quality of cellulose sheet. For further research, the advice is given to building research to determine the fundamental cause of failure and the risk associated with it. By using quality methods like DMAIC and fuzzy implementation methods of the qualities associated with the identification of failure in the product. The causes of failure of the product to the next step is to continuously improve while expanding the research scope by value engineering.

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