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PROCESS CONTROL OF SACK PRODUCTION USING *FAILURE MODE EFFECT* ANALYSIS (FMEA) AND *FAULT TREE ANALYSIS* (FTA) METHODS

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ABSTRACT

Work station. This study is a type of case study. The data collection technique used is to collect defective product data at each observation and documentation station. The data analysis technique used in this study is (1) collecting information about the number of defective products. (2) Processing the data to find out which sector has the most potential to cause product damage. (3) Analyzing the processed data using the FAILURE Mode Effect Analysis (FMEA) and Fault Tree Analysis (FTA) methods. The results of the study prove that FAILURE Mode Effect Analysis (FMEA) and Fault Tree Analysis (FTA) determine the SOD and RPN values derived from determining potential failure modes. This was obtained through field studies by looking directly at each work station that was a failure factor. in the production process, looking directly at the production process data for 1 month, then making a weighting table, Occurrence.

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1. Introduction

In the current era of globalization, there have been various changes in almost all aspects, such as economic, political, socio-cultural, technological, legal and other aspects. The changes that occur are macro and micro. The manufacturing environment as a part of the economic aspect also experiences the same thing. Various new trends in the manufacturing environment have an impact on quality. (Hermansyah et al., 2021) . Product quality also depends heavily on the process, people, and the system as a whole. Quality control is no longer sufficient to be carried out only with a product inspection model, but is able to analyze and find the root of the problem that often arises at each production process station, and is able to analyze from both human and machine aspects, problems that arise at each work arrangement will cause many losses to both consumers and most of them have an impact on the company, for example, if the production process is defective due to machine or human factors, of course the product will decrease in quality, and must be reprocessed, then the company will experience a loss of production time, material losses and financial losses and the company's image becomes less good in the eyes of consumers, because of the re-production process, consumers also

have to wait longer for the ordered product, of course this will cause consumers to think twice about re-ordering products to the company, therefore the company must have the right tools or methods to analyze and overcome the emergence of various problems that occur in the production process at each work station .

Companies must also always make continuous improvements *in* every department in order to be able to compete in the era of globalization, especially in the production line. A very vital line in a company. The production line contains various things that must always be improved in terms of productivity, including equipment and machines that support the production process. Improvement efforts in the manufacturing world, in terms of equipment and machinery, are by increasing the utilization of existing equipment as optimally as possible. The utilization of existing equipment in the average manufacturing industry is half of the actual machine capacity.

PT. Murni Mapan Makmur is one of the company manufacturing the biggest in java the east engaged in the plastic . Products produced by the company There is a number of type product that is sacks , tarpaulins and ropes . Even though the company This ber PT order job type . Murni Mapan Makmur has consumer remain and for term length capable build branch , This company is also committed For still guard quality from its products to remain become choice First for its customers .

The production units at PT. Murni Mapan Makmur are divided become a number of part in accordance with the products they produce . Amount production each unit is different in accordance with magnitude order of each product . Sack unit have income more products big from product other because of order The largest in PT. Murni Mapan Makmur is product sacks . But in the sack unit also often happen disability products that exceed from provision company that is not enough from 2 tons or 0.075% of the product sack , so that result in the decline quality goods and its decline profit company . Products the sack that experienced disabled product all can processed return However That will cause swelling cost operational production process .

2. Review Literature

The materials in this study are the criteria that are considered by the author as potential failures of each work station which result in defective products in each process .

A. Quality

Quality can be defined as the degree of satisfaction, perfection or suitability for its intended use, which acts as a link between consumer desires and the products produced by the producer. Quality in other words is the entirety of the features or characteristics and characteristics of a product or service that can provide satisfaction in the use and needs of customers. So that quality has 3 characteristics, namely suitability or suitability for use, suitability defined by consumers, and the level of loss given to consumers. Definition of quality according to several other opinions. According to WW. Scherheubach, Quality is determined by customers, because customers want products/services that are in accordance with their needs and expectations for a certain price level that indicates the value of the product. According to (Azar et al., 2015) , Quality is a condition where it is related to service products, people, processes and environments that meet or exceed what is expected.

B. FTA (*Fault Tree Analysis*)

Fault Tree Analysis (FTA) is a techniques used in identify risk yes play a role to the accumulation a failure , This method done with a top - down approach , which begins with assumption failure from incident peak (top event) then detailing causes a top event until a failure root cause. Fault tree analysis identifies connection between factor causes and displayed in form tree error . Definition quality according to a number of another opinion . According to (Heubach, 1903) , Quality That determined by the customer , because customer want appropriate product / service with his needs and expectations to a level price

certain that indicate mark from product said . According to (Dagun, 2000) , Quality is a condition where it is related with product services , people, processes and environments that meet or exceed what to expect .

Treasury ISO 8402 terms and Indonesian National Standard Series (SNI 19-8402-1991) Quality is overall features and characteristics product or services whose capabilities can satisfying needs , whether stated in a way firm and disguised . The term need , is interpreted as specifications listed in contract and the criteria that must be met defined moreover before . There are several expert who develops draft about quality including W. Edward Deming with PDCA concept and 14 Points, Philip B. Crosby with the concept of Zero Defect and 14 Steps Plan. Joseph M Juran with draft Trilogo Quality (planning , control and improvement) quality) and Genichi Taguchi with draft *Quality by Design* (Kaufmann & Gupta, 1988) . Quality is very closely the relationship with satisfaction customer , thing This Because with quality appropriate product / service with need consumer so consumer will feel satisfied so that arise loyalty customer to products / services issued by a organization . Loyalty customer the will ensure product / service can received by consumers who are very helpful to sustainability a activity business from A organization . Quality need a process of continuous improvement continuous that can measured , good individually , organizationally , and for purposes performance national . Support management , employees , and government For repair quality is important in compete in a way effective in the global market . Improvements quality more from a business strategy , but a not quite enough answer personal , part from inheritance cultural , and is source important pride national .

Fault Tree Analysis (FTA) is a techniques used in identify risk yes play a role to the accumulation a failure , This method done with a top - down approach , which begins with assumption failure from incident peak (top event) then detailing causes a top event until a failure root cause. Fault tree analysis identifies connection between factor causes and displayed in form tree error . Analysis tree fault tree analysis is one of the methods that can used For analyze root reason accident Work or failure work . Fault Tree Analysis using symbols.

Table 1.1 Symbols in *Fault Tree Analysis*

Symbol	Term	Term
	Basic Event	Incident base from deviation that is not expected from a normal state of a component from a system
	Top Event	The incident that required at the top level which shows failure until will examined more further
	Logic Event AND	Show AND function , function This used For show output event will appear If all input occurs
	Logic Event OR	Show OR function , function This used For show output failure occurred Because there is One or more than two incidents failure in input
	Conditioning Event	Condition specifically applied to gates logic when fulfil a condition certain
	Undeveloped Event	Condition specifically applied to gates logic when fulfil a condition certain
	External events	Show expected event appear or not including in failure incident
	Transferred event	Description advanced incident different that is on another page

Source : Data processing

C. **FMEA *(Failure Mode and Effect Analysis)***

(Moubray, 2001) in his book entitled reliability centered maintenance II (RCM II), FMEA *(Failure Mode and Effect Analysis)* is defined as a method used to identify the causes and effects of a failure. The method is implemented in the hope of reducing the level of defects in the output. Defects in products do not only occur in the final process but can also occur at the beginning or during the production process. Through the failure modes and effect analysis (FMEA) method, it is hoped that each form of failure in the production process can be identified. By identifying each form of failure, corrective steps can be taken later to be applied in anticipating product defects.

In general In general , the FMEA concept is defined as A techniques that identify three thing , namely (Stamatis, 2003) :

1. Reason potential failure from system , design products , and processes during cycle his life .
2. Effect from failure the .
3. Criticality level effect failure to function system , design products , and processes.

Benefits and Uses of FMEA Method

1. Increase quality , reliability and safety product .
2. Help increase satisfaction customer .
3. Increase image good and power competition company .
4. Estimating acts and documents that can reduce risk . (Bayou & De Korvin, 2008)
5. Do prevention before problem happen .
6. Identification of potential failure modes against product / process.
7. Evaluate effect from a potential failure for customers.
8. Save time and costs because the solution is systematic and targeted. Identify failure modes and the severity of their effects.

D. *Fuzzy Analytical Hierarchy Process*

a. Shipping . Criteria Delivery includes 4 sub- criteria , namely accuracy time delivery , conformity number and specifications of parts sent , completeness document shipping , and capacity delivery .

a. Price. Price criteria includes 3 sub criteria , namely competitive price , details price and *payment terms*

a. Ability production . Criteria Ability production includes 5 sub -criteria , namely the required lead time , capability in fulfil change of order, diversity products , *minimum order quantity,* and capacity production

a. Service . Criteria Service includes 3 sub- criteria , namely responsiveness to orders received , average time replacement of claim parts, and responsive in repair .

a. Characteristics *supplier,* Criteria Characteristics *supplier* includes 5 sub- criteria , namely stability financial , location geography , reputation , *negotiability,* and professionalism .

For an unknown population size (*infinite population*), the sampling method used is a *non-probability sampling technique* , namely *purposive sampling* where the sample is selected non-randomly and subjectively. The sample taken in this study was 30 respondents.

3. Methodology

Study This used method FMEA *(Failure Mode and Effect Analysis),* and FTA
The steps and stages of the method process are as follows:

1. Identifying Failure Modes Potential

   The failure mode process is the reason why a part is rejected. A part can be rejected because the characteristics of a part are not within the engineering specifications. Part characteristics are the characteristics of the part such as size, shape, location, orientation, texture, hardness, appearance, layers, and others. In general, the failure mode process can be categorized as follows:

   a) Manufacturing : dimensions (outside tolerance), visual..
   b) Assembly : relationship , missing part
   c) Acceptance / Inspection : whether a part is rejected , when accepted .
   d) Testing / Inspection : accept bad parts , reject good parts . (Kossoudji & Dresser, 1992)

2. Identifying Effect Failure Potential

   Effect from a failure is consequence from failure mode which will be noticed or experienced during surgery Next , the consequences operation , next process according to process flow, or by the customer last . (Kossoudji & Dresser, 1992)

   Customer in PFMEA analysis includes :

   a) Down stream user / Next user, namely the next process according to process flow.
   b) Severity is step First For analyze risk count how much big impact / intensity incident influence process *output* . Severity (S) is quantification how much Serious conditions caused by If happen the failure that the result mentioned in Failure Effect . According to level seriousness , severity rated on a scale of 1 to 10.
   c) Ultimate customer, namely the final customer .
   d) operator safety, namely operator safety , both operators in the factory manufacturer or in the factory assembly vehicles.Machine /equipment, namely effect to machine or equipment others , for example, to become fast worn out or easy damaged .

3. Determining *Severity* Value

   Severity is the first step to analyze risk , namely calculating how much impact/intensity the event affects the process *output* . *Severity* (S) is a quantification of how serious the conditions are if a failure occurs, the consequences of which are stated in the Failure Effect. According to the level of seriousness, severity is assessed on a scale of 1 to 10.

TABLE 3.1 Determining the *Severity value*

Rating	Criteria
1	*(Negligible Severity)* Influence bad that can ignored . We don't need think about that consequence This will impact on quality product . Consumer Possible No will pay attention disability This .
2 **3**	*(Mild Severity)* Influence mild bad . The consequences will nature light . Consumer No will feel decline quality .

4 **5** **6**	*(Moderate Severity)* Influence moderate bad . Consumers will feel decline quality . However Still within tolerance limits .
7 **8**	*(High Severity)* Influence high bad . Consumers will feel decline quality beyond tolerance limits .
9 **10**	*(Potential Severity)* Influence very high bad . The resulting effects are very influential to quality other . consumer No will accept it .

4. Determine mark *Occurrence*

Occurrence is the likelihood that the cause will occur and result in a form of failure during the useful life of the product. Associated with current controls. . Occurrence (O) The degree of likelihood of failure occurring. Shown in 10 levels (1,2,...,10) from almost never occurring (1) to most likely or difficult to avoid (10).

TABLE 3.2 Determining *Occurrence Value*

Degree	**Based on frequency incident**	**Rating**
Remote	0.01 per 1000 items	1
Low	0.1 per 1000 items 0.5 per 1000 items	2 3
Moderate	1 per 1000 item 2 per 1000 item 5 per 1000 item	4 5 6
High	10 per 1000 item 20 per 1000 item	7 8
Very High	50 per 1000 item 100 per 1000 item	9 10

5. Menentukan nilai *Detection*

Detection is a measurement of the ability to control or control failures that can occur. Detection (D) Indicates the level of possibility of escaping the cause of failure from the installed control. The level is also from 1-10, where the number 1 indicates the possibility of passing the control (definitely detected) is very small, and 10 indicates the possibility of escaping the control (not detected) is very large.

TABLE 3.3 Determining *Detection Values*

Rating	**Criteria**	**Frequency**
1	Prevention methods are very effective . There is no chance reason Possible appear	0.01 per 1000 items
2 3	Possibility reason occurs very low .	0.1 per 1000 items 0.5 per 1000 items
4 5 6	Possibility cause happen nature moderate . Prevention methods sometimes allow reason That happen .	1 per 1000 items 2 per 1000 items 5 per 1000 items
7 8	Possibility reason happen Still high . Prevention methods not enough effective . Cause Still repetitive return .	10 per 1000 items 20 per 1000 items
9 10	Possibility reason happen still very high . Prevention methods not enough effective . Cause Still repetitive return .	50 per 1000 items r 1000 items

6. Determine *Risk Priority Number*

RPN or *Risk Priority Number* , which is a number that states the priority scale for quality risks used as a guide in carrying out planning actions. RPN is the result of multiplying severity, occurrence and detection. RPN = S x O x D …(1)

7. Problem solving using Fault Tree Analysis can be done with the following stages:
   a) Determining the minimum cut set means determining the basic event as the root cause of the problem of the cause of defects that occur in the tuna canning process.
   b) Change logic tree error become equality Boolean Algebra .
   c) Reduce Boolean equations into simple models .
   d) Do analysis qualitative on Fault tree
   e) Do analysis quantitative .

   Minimal cut set is a quantitative analysis using Boolean algebra to simplify or decompose complex and complicated logic circuits into simple logic circuits. Quantitative calculations are calculated based on the probability numbers for each component, where the basic event component will be valued at 0.01, the conditioning event is valued at 0.50 and the undeveloped event is valued at 0.001. The probability value is <1 and> 0, if the probability value of the top event approaches 1 then the undesirable event will be at greater risk of occurring. Conversely, if the probability of the top event approaches 0 then the risk of an undesirable event will be lower.
8. Make improvement proposals based on the results of *Fault Tree Analysis.*

   Identify the main criteria and sub-criteria that will be used to determine quality in the production process.

   Suggested improvements

   Research Variables:
   1. Weaving Process
   2. Whaising Process
   3. Cutting Process
   4. Sewing Process
   5. Packaging

4. Results and Discussion

Based on observations of the sack production process at PT Murni Mantap Makmur, the number of failures was obtained below.

TABLE 4.1 Data on Number of Failures

NO	Process	Amount Product Fail
1	Basic material thread bag	25Units/1000
2	Weaving process	20 Units / 1000
	Ayama rah lusi	20 Units / 1000
	Weaving direction feed	20 Units / 1000
3	Wahishing process	22 Units / 1000
	Mixing chat	22 Units / 1000
4	Cutting process	37 Units / 1000
	Size surface	37 Units / 1000
5	Process sew	36 Units / 1000
	Sew 1 side 2 rows	38 Units / 1000
6	Packaging	
7	Storage	

A. *Fault Tree Analysis* (FTA)

The number of failures in the detection process that exceeds the tolerance set by the company and the failures are in the core process of making sacks, the next step is to create a fault tree *on* the four process functions. Can be seen in the image below.

Figure 4.1 *Fault Tree Analysis* (FTA) of Weaving Process

1. *Fault Tree Analysis* (FTA) Weaving process

Potential causes of product failure are caused by the weaving process which causes the tensile strength of the sack to not be in accordance with the size standards set by the company caused by 2 factors, namely *human error* and *the tools* used. Failure caused by *human error* is caused by the supply of yarn that is not timely in the yarn row, this is caused by operators who experience fatigue and monotonous work and non-conducive work environment factors, namely poor lighting. Another factor that causes failure is *the tools* used such as needles that experience a lot of friction during the production process, causing the yarn to break, this will cause the number of warp and weft threads to decrease in certain parts, in other words the tensile strength of the woven results will decrease and be below the standard set by the company.

2. *Fault tree analisis FTA proses wahising*

Potential causes of product failure caused by the washing process result in decreased color quality after this process which results in faded and changed colors caused by 2 factors, namely *human error* and mixing of dyes for pants outside the dosage. Failure caused by *human error* is caused by decreased concentration of workers or operators caused by boring work behavior and a work environment that is too noisy because workers or operators neglect to add thinner liquid as a mixture of paint which results in reduced color and viscosity of the paint, Another factor is from the machine, namely the transfer roller that drives the sack which is dirty so that the sack that runs in the whaising process is tilted or not symmetrical so that the expected color or logo does not match the order, this also causes the color to not match the expected or the amount of paint that overflows for several meters.

B. *Failure Mode and Effect Analysis* (FMEA)

Failure Mode and Effect Analysis (FMEA) is used to see which part of the process is the most dominant in producing failures in the sack making process. Based on *the Fault Tree Analysis* (FTA) that has been made, the next thing to do is to create an FMEA table that functions to provide weighting for *the Severity, Occurrence,* and *Detection values* based on the potential effects of failure, causes of failure and the process cont

5. Conclusion

Types of catastrophic events that occur in the production process of PT Murni Malang prosperous in products bag there are 4 types defect in between disabled woven , defective wahising,disabled cutting , defect sewing . Occurrence product disabled happens in every station Work

Reason defects that occur in pure PT established prosperous in cause by two things that is from aspect human and machine , from aspect man mostly due to lack of concentration Work so that the decline quality Work matter this is triggered by conditions environment underwork support among them temperature too much room heat, poor lighting , noise too much machine noisy.from aspect machine plumpness happen Because the machine that is experiencing down time start from exhaustion asroll, the needle is too Lots experience friction in a way overload , trailing transfer rollers , and compressor downtime .

Research For to marry SOD and RPN values at the start from determine failure mode This potential is obtained with studies field see how directly in every station Work What only that is a factor of failure in the production process , see secra direct production poses data for 1 month Then to do making a weighting table severity , occurrence, which is considered as a source of problems production process failure , Detection every station work,weighting in action start from value 1 to 10, after done weighting done calculation RPN,value rapan can be obtained from SxOxD value =RPN

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