ABSTRACT

IDENTIFICATION OF CAUSES OF DEFECT IN THE PRODUCT SANITARY NAPKIN BY USING FAULT TREE ANALYSIS (FTA) METHOD IN SOFTNESS INDONESIA INDAH, PT – SURABAYA

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Rapid growth of product and services have changed the customers in their way of transaction with the company in this globalization era which access to the informations had become easier. Competition situation today does not give the slightest opportunity for companies to do wrong. The company have to be really satisfying customers and find out creative way in fulfilling the demand of the customers exceed their expectations.

PT Softness Indonesia Indah is a company that produce sanitary napkin and had never been done such a quality control towards the company's main product which often receive many complaints from customers due to many defects occur

The main purpose of this study is to identify the product defects and the root problems which caused the failure. Those will be analized using a probability in order to be able to do the production management. Fault Tree Analisys method will be used in this study because the ability to analyse the failure and find out the root cause. Evaluation will be done using cut set method to be more aware of disability formations events.

The results of the study is the largest defect be less thick pressed as the main cause. In a sampling of products with a time of 8 hours / day for 3 months of initial production, the probability of occurrence of defects was 0,15 %. Second is the glue that off the track, with a probability of 0,12 %. Third is weigth of pulp is not in appropriate dose, with probability of 0,09%. And the fourth is less normal folding with probability of 0,09%.
Keywords : Fault Tree Analysis, Cut Set, Quality, Probability
Kata Kunci : *Fault Tree Analysis, Cut Set, Kualitas, Probabilitas.*

Research Background
Latar Belakang

Rapid growth of product and services have changed the customers in their way of transaction with the company in this globalization era which access to the informations had become easier. Any single failure is not allowed for the company in today's competitive situation. The company should very satisfy the customers and find out creative way in fulfilling the demand of the customers beyond their wishes.

PT. Softness Indonesia Indah is a manufacturing industry company which produce sanitary napkin for women. To produce high quality product, PT Softness Indonesia should do a quality control by identifying the flaw as the first step to reduce the process' fault as much as possible because although just minor flaw will reduce the quality of the product.

Defects which often occurs in the production of sanitary napkin in PT Softness Indonesia Indah must be overcome in order to obtain the maximum result. The maximum using of raw materials will impact to the desired result.

PT. Softness Indonesia Indah do some serious efforts in order to reduce error as much as possible that may occur in production process by analizing the product defects regularly. During the production process, the production is the party which often have errors that cause defects.

Fault Tree Analysis method can be used as the identifier of the product defects based on logic gate in determining the causes of the defects, such as defects in Pulp, Silicon Paper, Non Wofen Oter and Polymer Elementer Laminated Tissue.

Formulation of Problems

Based on the background that had been explain previously, the problem of the company can be formulated as follows :

"How to identify the causes of defects in sanitary napkin product in the PT Softness Indonesia Indah?"

The aim of the study

The aim of research conducted at PT Softness Indonesia Indah is to determine cause of the greatest defects in the production of sanitary napkin and provide improvement suggestions based on the defects probability value.

Review of the Literature

Quality Management

One of the concepts allows the company to emphasis the principles of quality management is through the production process or operational approach. Services will be achieved more efficiently when the values enter the relationship between activity and the process is well managed as an integrated system, the process is changing the values entered on the organization or company. The system is designed for quality control and improvement of values that simply covers all the work or activities of any organizations or company that consists of various processes within the organization's activities. (Wahyu, 2002)

The quality control of each product has a number of elements which together describe the suitability of its consumer. According to Montgomery (1998) there are several types of these parameters which usually called as quality characteristics. Those characteristics are as follows:

1. Physical: Length, weight, voltage, viscosity
2. Senses: taste, appeareance, color
3. Orientation: time, reliability (reliable), maintainable, treatable

Quality control is the activity of engineering and management, which with the activity we can measure the characteristics of products quality, compare it with specifications or requirements and take appropriate remedial action when there is a difference between the actual appeareance with the standard.

Quality control within a company is the most important part in supporting the sustainability of a company. Benefits that can be gained from management of quality control are:

Efficiency and Productivity level

Reduce lost in the process of work done such as reducing or eliminating unreproductive time.

1. Suppress cost and save money
2. Maintain the sales continue to increase so that the profit can be gained
3. Increase the realibility of the products
4. Keep the high performance of employers
5. Reduce the complaints from customers
6. Oriented on customer needs

In quality control, there are three types of quality in manufacturing business operations, they are:

1. Design quality
   It is the degree to which a product able to provide the customers with two or more products despite having the same function can give different degrees of satisfaction because of differences in design quality
2. Quality of conformance
   Associated with the specification and standardization of products and criteria agreed upon the standards. Generally, the conformity quality includes three kinds of control, they are: prevention of defect, prevention and analysis, and corrective action
3. Appeareance quality
   Improvement of design quality and the quality of conformance will improve the appeareance of product. If the design quality is low to the adjustment of specification, it will affect the overall appeareance.

***Fault Tree Analysis* (FTA)**

Fault Tree Analysis is an engineering of design reliability of a design system which based on the awareness of the effect of system failures, which called as 'top event'. In this analysis, it is described that Fault Tree Analysis is emphasis more on "Top-down approach" that is because this analysis starts from the top level and pass it down. The starting point of this analysis is identification of failure mode at the top level of a system.

Russell and Taylor (Jurnal:2000) mention that Fault Tree Analysis is a visual method that analyse the interconnected product defects. It is called as Defect Tree or Fault Tree because of the analytical

tools are assembled into a diagram that shows the defects of the product practically. The Defect Tree or quality failure would further recommend alternative solutions to fix or overcome the defects or not qualified that may occur in products. With its way, then fault tree is intended to show the analysis pattern of causal of the product failure as usually found in fishbone diagram. Because fault tree also show the causal of product defects, then fault tree is also called as Failure Mode and Effects Analysis (FMEA). Since it also presents the impact of defects that occur in products and recommend alternative solutions to overcome the defects, Fault Tree Analysis can also be used as the tool to maintain the process to avoid the product failure.

The fault tree principles according to (Villemeur, 1992) that can lead in conducting the analysis are:

1. Identifying any various possible combinations lead to undesired events
2. Presenting such a combination of structured graphic

Some of basic concepts that must be known and understood in order to analyze the events through the fault tree diagram (fault tree analysis) according to (Villemeur, 1992) are

1. Undesired top event
   The center of Fault Tree Analysis is called as undesired event. This event brings the top event and the analysis is aimed to gain all the causes. Frequently, this event is a disaster, but it can be the system failure or the disability of the company (economic aspect)
   In order to make the analysis easier, the undesired event must be defined correctly. Indeed, if the event is way too specific, the analysis would be able to find the major failure on the basic elements of the system, therefore it is recommended to find the initial risk of the undesired event. This events are usually have been characterized according to the system missions
2. Logic Gate Presentation
   The events connected by logic gates based on the consequences of the cause of good relations, as shown in figure 2.4

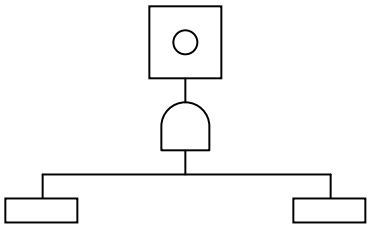

Figure 2.4 *AND Gate example*
Source: P. L. Clemens, (2002)

3. Failure Explanation (Cause of the failure)
   Failure can be divided into two classes according to the causes (Clemen, 2002), they are:
   1. Failure or major cause
      Failure causes the an unwanted event or top event
   2. Failure or secondary cause
      Failure causes the primary failure that will be analyzed further to become the most basic event that cause the unwanted event.
   3. Basic Event
      The analysis of the event is continued until the basic event is found. Therefore, the events should be found carefully since the margin of the analysis is reached.

   Basic events in the fault tree are as follows:
   1. Events which not required to be developed and the extent of uselessness of the basic event boundary
   2. Events which can not be considered fundamentally but the basic event would not be developed. In this case, the system boundary studied include when identified
   3. Events can not be described or as the basis and the cause of the events have not been developed, but will soon be developed. The analysis consider then temporarily reach the

Fault Tree Analysis Stages

According to Pyzdex, (2002) fault tree have some common stages to achieve optimal results of the analysis down to the roots causes, they are:

1. Define the top event, sometimes also called as the main event. This is the condition failure in the early study.
2. Define the boundary of fault tree analysis
3. Check the system to understand how various elements connected to each other for the top event.
4. Create the fault tree, start from the top event and work downward. Fault tree analysis to identify ways to eliminate events that lead to failure.
5. Prepare the corrective action plan to avoid the failure and probability plan due to the failure as if it happens.

Cut set

Cut set according to Clemens, (2002) is a combination of fault tree former which if all happen will cause the top event occurs.

Calculation in Fault Tree Analysis is used to know the probability value of the top event occuring. To calculate the probability is only required the amount of success and failure of the process, this is indicated in following formula (Clemens. 2002)

$$P_F = \frac{F}{(S+F)}$$

Explanation

S = The amount of success production

F = The amount of failure or defect production

PF = Failure probability

The next step is calculate the probability of each gate, they are:

1. OR Gate, probability of each event or input have addition and substraction.
   2 inputs:
   $P_F = [\ 1 - (1 - P_A)\ (1 - P_B)\ ]$
   $P_F = (P_A + P_B) - (P_A \times P_B)$
   More than 2 inputs:
   $P_F = P_A + P_B + P_c$

2. AND Gate, probability of each input is multiplied.
   In this AND Gate, it does not matter how many inputs it has, the way to calculate is the same, that is multiplying the inputs.

Correction Action

Correction action is used to give suggestion or feedback towards the problems occur. Sometimes, the recommendation is based on the probability values were found after doing calculation for each failure. The greater the probability value, the more significant the failure to get attention for immediate improvement.

Research Methodology

The steps in processing the data on a case study in PT. Softness Indonesia Indah by using the FTA method are as follows:

1. Analysing unwanted events to the root causes which covers primary causes which resulted in a top event and secondary causes that lead to the occurance of the primary causes.
2. Describe those root causes into Fault Tree Diagram which contains the events logic symbols (gate) so that it will form a relationship with one another.
3. Fault Tree Diagram will form the combination of fault tree , so that it requires cut set that are used to evaluate the diagram. This is obtained by drawing a line through the block in

the system to indicate the minimum number of failed blocks that lead to the whole system fails.

4. To find the smallest combination of events required minimal cut sets. Minimal cut sets is the smallest combination of events that lead to the most undesirable event or the smallest potential root causes of failure (peak event or top event).
5. To calculate the probability is only required amount of whole success and failure process, this is indicated in the following formula:

$$P_F = \frac{F}{(S+F)}$$

Explanation

S = The amount of success production
F = The amount of failure or defect production
PF = Failure probability

Next is calculating the probability of each gate, they are:

1. OR Gate, probability of each event or input have addition and substraction.
   2 inputs:
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   $P_F = (P_A + P_B) - (P_A \times P_B)$
   More than 2 inputs:
   $P_F = P_A + P_B + P_c$

2. AND Gate, probability of each input is multiplied.

6. After all the steps above done and everything required is known, the probability of top event will be achieved. The next step is each each probability will be evaluated through a matrix in the minimal cutsets. Cut set matrix will then be calculated After all know it will get the top event probability and for the next stepeach probability is evaluated through a matrix in the minimal cutsets. The probability of cut set matrix will then be calculated using the following formula:

$P_T \approx \sum P_K = (P_1 + P_2) + (P_1 + P_3) + (P_1 + P_3) + (P_3 \times P_4 \times P_5 \times P_6)$

P_T is probability of the top event
P_K is probability of cut set

Identification of Products Failure

In the production process of manufacturing sanitary napkins in PT Softness Indonesia Indah found some discrepancy of product specifications so that products produced in the production process are classified as defective goods. The occurrence of defects in the product that is checked by the quality control department of PT Softness Indonesia Indah during the month of March to May 2010 found that the most often failure events occur are as follows : the weight of pulp is not in appropriate dose, glue that off the track, less normal folding and less thick pressing. For more details can be seen in the following table:

Table 4.1 The data of production result and failure in PT Softness Indonesia Indah during the production month of March - May 2010

No	Month	Amount of success production (pcs)	Amount of defect production (pcs)	Explanation
1.	March	4.304.754	15.241	1.472 pcs of the weight of pulp that is not in appropriate dose
				2.156 pcs of off the track glue
				5.580 pcs of less normal folding
				6.033 pcs of less thick pressing
2.	April	4.468.456	12.544	1.698 pcs of the weight of pulp that is not in appropriate dose
				2.431 pcs of off the track glue

				4.161 pcs of less normal folding
				4.254 pcs of less thick pressing
3.	May	4.653.368	14.092	1.852 pcs of the weight of pulp that is not in appropriate dose
				2.976 pcs of off the track glue
				4.588 pcs of less normal folding
				4.676 pcs of less thick pressing

(Source : Processed Primary Data)

Table 4.2 Calculation result of each type of defect

No	Type of defect	Amount (pcs)
1	The weight of pulp that is not in appropriate dose	5.022
2	Off the track glue	7.563
3	Less normal folding	14.329
4	Less thick pressing	14.963

(Source : Processed Primary Data)

Identification of top event of defect

Based on the data of defect products by the quality control can be found the events of peak of defect or commonly called as top event. The events are as follows:

1. Weight of pulp is not in appropriate dose
2. Glue that off the track
3. Less normal folding
4. Less thick pressing

Table 4.3 Rate of product defect during production month of March to May 2010

No	Type of defect	Amount of defect (pcs)	Defect rate (%)	Amount of comulative defect (pcs)	Rate of comulative defect (%)
1	Weight of pulp is not in appropriate dose	5.022	$\frac{5.022}{41.877} x 100\% = 11,99\%$	5.022	11,99
2	Glue that off the track	7.563	$\frac{7.563}{41.877} x 100\% = 18,06\%$	12.585	30,05
3	Less normal folding	14.329	$\frac{14.329}{41.877} x 100\% = 34,22\%$	26.914	64,27
4	Less thick pressing	14.963	$\frac{14.963}{41.877} x 100\% = 35,73\%$	41.877	100,00
Sum		41.877	100		

(Source : Processed Primary Data)

From the calculation in table 4.3 can be found that when the rate of comulative defect is 100 %, then the amount of comulative defect is 41.877 pcs.

Identification of root causes (basic event) of sanitary napkin defect in each production process

The next step is to identify the root causes that lead to the occurrence of undesirable events, so the observation to the root causes that occur in each production process is made. The explanation of the root causes that lead to the occurrence of undesireable events are as follows:

1. Composition of raw materials are not suitable
   In producing sanitary napkins needed some kind of raw materials that are not produced by the company, and must be booked at other factories. It usually force workers to reduce the amount of production than usual , so the dose does not match those specified by the manufacturer , but use the estimation of such workers .
2. Less experienced operator
   Inexperienced operator due to the operator's own character who hesitate to dig up information from other operators about the working method of the machine at each available workstation. This is because operators are still in training period and not permanent employees.
3. Operators in a hurry
   Operators become in a hurry is usually due to the break time or time is up but the remaining work is still unfinished. So the production process that should be finished being stopped.
4. Less discipline operator
   Operators lack of discipline in obeying the rules during the production process because of their selfishness that are too excessive and undermine all the faults that may occur in a factory environment.
5. Machine trouble
   Machine trouble caused by the age of the machine that old enough so that the operator should set it more carefully before the machine is used.
6. Increasing of production number
   An increasing number of production caused by increasing demand by consumers and distributors that require sanitary napkins.
7. Inappropriate machine setting
   Machine setup that is not appropriate due to the factor of the machine age that is old enough so that the operator must be careful in resetting the machine for earlier production process.
8. Perfunctory arrangement
   Perfunctory arrangement occurred because the operator is tired or low on energy. So that the operator arrange the product perfunctorily on existing machines.
9. Operator substitution
   Substitution occurs when an operator at the specific workstation experiencing shortages of certain operators. So at workstation which require the operator will usually be replaced from the workstation which has more operator available.
10. Unwell operator
    During the production process, the operator suddenly unwell, so the operator will rest on the clinic of the factory and leave the job. It is usually caused by operator is saturated, stressed and tired.

Data Processing

After identifying the root causes of defect in the production process at PT Softness Indonesia Indah, the product defect per day during 3 months study will be known.

Table 4.8 Calculation process of root causes (basic event)of defect

No	Root causes	Amount of defect product (F)	Amount of production per day (F + S)	Production defect probability $\left(\frac{F}{(F+S)}\right)$

1	Composition of material are not suitable	68,07	223.844,37	0,000305
2	Less experienced operator	67,74	223.844,04	0,000303
3	Operator in a hurry	72,14	223.848,44	0,000323
4	Less discipline operator	72,17	223.845,14	0,000308
5	Machine trouble	70,07	223.846,37	0,000314
6	Increasing of production number	70,10	223.846,40	0,000306
7	Inappropriate machine setting	75,24	223.851,54	0,000337
8	Perfunctory arrangement	68,12	223.844,42	0,000305
9	Operator substitution	70,02	223.846,32	0,000314
10	Unwell operator	67,12	223.822,90	0,000301

(Source : Processed Primary Data)

Table 4.13 Summary of calculation result of probability for each type of defect

No	Type of defect	Probability value	Rate
1	The weight of pulp that is not in appropriate dose	0,00152	0,15
2	Off the track glue	0,00124	0,12
3	Less normal folding	0,00093	0,09
4	Less thick pressing	0,00092	0,09

(Source : Processed Primary Data)

Analysis Result

From the data that have been processed the probability with minimum structural defects is obtained. After each forms of occurrence of deffect and its cause is identified and analyzed, the results obtained are as follows:

1. The weight of pulp that is not in appropriate dose
   Major cause of disability in the pulp weight dose does not fit due to the ability of the destroyer machine is rotating too slow rotating. This is because the raw material composition does not appropriate and trouble of the machine. Causes of the composition of the raw materials are not suitable due to inexperienced operators, services operators in a hurry and less discipline. While trouble of the machine is caused by the increasing number of production and inappropriate machine settings.
   The calculation result of defect resulting probability value of 0.00093 or 0.09% for 3-month production process.
2. Off the track glue
   The main cause of glue off the track is the hot glue machine temperature have not been hot enough. This is due to machine trouble and the perfunctory arrangement. Things that cause engine trouble could be caused by the composition of the raw materials are not appropriate. While the perfunctory arrangement caused by less discipline operator, inexperienced operator or the operator is in a hurry.
   The calculation result of defect resulting probability value of 0.00124 or 0.12% for 3-month production process.
3. Less normal folding
   Major cause of less normal folding is pres cremping machine is damage in one or both sides of the machine. This is because the operator in a hurry and ignore the setting in machine side. The causes of the operator in a hurry can be caused by substitution of operators, operators are less healthy and less disciplined. While the things that cause the machine settings were not appropriate is the increasing number of production and less experienced operators.
   The calculation result of defect resulting probability value of 0.00092 or 0.09% for 3-month production process.
4. Less thick pressing

Major cause of less thick pressed wapping caused by machine damage. This is due to machine trouble and the perfunctory arrangement. Things that cause the machine trouble was the inappropriate machine settings.
While the things that cause perfunctory arrangement are the operator is less healthy, less experienced operators, substitution of operator, and increasing of production number.
The calculation result of defect resulting probability value of 0.00152 or 0.15% for 3-month production process.

In a probability scale, the incidents of four types of defects are included in 1 in 100 criteria which means events that are very likely to occur, and the sequence of events from the four types of defects that occur most often are:
1. Less thick pressing
Within 3 months of the production process, the probability of defects is 0.00152 or 0.15%.
2. Off the track glue
Within 3 months of the production process, the probability of defects is 0.00124 or 0.12%.
3. The weight of pulp not in appropriate dose
Within 3 months of the production process, the probability of defects is 0.00093 or 0.09%.
4. Less normal folding
Within 3 months of the production process, the probability of defects is 0.00092 or 0.09%.

Corrective Suggestion (*Correction Action*)

Corrective suggestions that is done using correction action toward the incidents that lead to less thick pressing production defect so that production process will be manageable can be seen in table 4.12 below

Table 4.12 *Correction Action* toward the cause of less thick pressing

Root causes	Probability	Description of Situtation	Correction Action
Trouble of the machine	0,000314	Less awareness of the operator to take care and manage the machine and also the age of the machine that is too old.	It would be better if do some trainings for the employess according to each workstation. Especially for the knowledge of solving the problems that may occur during the production process.
Perfunctory arrangement	0,000299	This is caused by less discipline operator of less instruction from the factory so that it influence the running of production process.	It would be better if PT. Softness Indonesia Indah re-observate the operators or give optimum training for them.
Inappropriate machine setting	0,000337	Machine setting that get less attention from operator and the defect of the machine itself.	PT Softness Indonesia Indah should replace the spareparts of the defect machine and give optimum training for the operator.
Less healthy operator	0,000302	Because of hot weather and the schedule that is decided by the company is too early can cause the employees be in a hurry and don't have enough time to have some breakfast that will influence their health and less awaraness from the company to the operator of production department.	PT Softness Indonesia Indah should re-observe the operator work schedule the company's rules.

Less experienced operator	0,000304	This is because of the company recruit employees based on their high school certificate which don't have good competences and less experienced.	PT Softness Indonesia Indah should do some training for employees according to each workstation. Especially for the knowledge in solving problems that may occur during the production process.
Substitution of Operator	0000314	Beside that the operator is pay less attention in procedure of production process, they also seldom notice the rules of the company.	It is expected that the feasibility of the rules is checked as good as possible and the operator expected to be able to obey it according to the procedure.
Increasing of production number	0,000301	High number of demand from customers cause the perfunctory in processing that cause increasing number of defect.	PT Softness Indonesia Indah should be able to refuse if the demand is too much or recruit more employees and add more machine.

(Source: Processed Primary Data)

Summary and Suggestion

Summary

Based on data processed that have been done in previous chapter, the summary of this study are as follows:

Berdasarkan hasil pengolahan data yang telah dilakukan pada bab sebelumnya penelitian ini berkesimpulan sebagai berikut :

1. Types of defect that often occur in sanitary napkin in production process at PT Softness Indonesia Indah are:
   - Weight that not in appropiate dose caused by destroyer machine that rotating too slow, composition of raw materials are not suitable, trouble of the machine, less experienced operator, operator in a hurry, less discipline operator, increasing of production number and inappropriate machine setting. Within 8 hour/day during 3 months production process, probability of defect is 0,00104 or 0,10%
   - Off the track glue caused by the temperature of hot glue machine that have not been hot enough, trouble of the machine, perfunctory arrangement, composition of raw materials are not suitable, less experienced operator, operator in a hurry and less discipline operator. Within 8 hour/day during 3 months production process, probability of defect is 0,00125 or 0,12%
   - Less normal folding is caused by damage in one or both side of pres cremping machine, operator in a hurry, inappropriate machine setting, substitution of operator, unhealthy operator, less discipline operator, increasing of production number and less experienced operator. Within 8 hour/day during 3 months production process, probability of defect is 0,00093 or 0,09%
   - Less thic pressing is caused by damage in wapping machine, trouble of the machine, perfunctory arrangement, inappropriate machine setting, unhealthy operator, less experienced operator and increasing of production number. Within 8 hour/day during 3 months production process, probability of defect is 0,00152 or 0,15%
2. Corrective suggestion for the company based on Correction Action is done to the type of defect which have highest probability that is less thick pressing. Corrective actions that should be done are PT Softness Indonesia Indah should do some observations to the operator or provide optimum training, observe the work schedule and rules of the company, able to refuse if the demand is too much or recruit more employees, add more machine and replace the spareparts of the damage machine.

Suggestion

After doing the research, so the researcher would like to give some suggestions that may inspired the company:

The company need to do observation and examination regularly followed by providing training for the employees according to each workstation in order to make the employess more creative, expert and discipline in enduring the production process.

Maintenance department need to increase the corrective action both predictive and preventive toward production tools or production machines that connected to machine damage or minimize the tools so that the production process run effectively and efficiently.

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