PROPOSED OPTIMAL REPLACEMENT TIME CRITICAL COMPONENTS IN THE CRITICAL MACHINE PT. X PADALARANG WEST BANDUNG

Ahmad Miftahul Falah dan I. Made Aryantha A
Study Program Teknik Industri, Indonesian Computer University, Bandung
Jl. Dipatiukur No. 112-116 40132, Telp (022) 2504119, Fax (022) 2533754

ABSTRAK

Manufacturing companies compete by increasing productivity, the machine as one of the important factors in boost productivity should be kept by the company. Like humans, the machine also has a form of life of the longer service life used to be diminishing its performance. Demi menajaga engine performance in order to remain in the desired state, the necessary action in the form of maintenance performed regularly. Especially for machine krits or critical components on a machine that is considered critical.

Failure Mode Effect and Criticality Analysis (FMECA) can be used for machine mengetehaui critical or critical components on a machine that is considered critical. Other Opera- contained on a worksheet FMECA is the effect of damage to the component, the value of badness level (severity), the value of the frequency of damage (occurance), the probability of damage (determinants) and the level of priority treatment (Risk Priority Number). Care measures and grades the level of priority to be a reference to a proposal made improvements based reimbursement models based on the lifetime (Age Replacement). Based on the model Age Replacement, will be known when the optimum replacement of components with optimum cost anyway.

Worksheet FMECA made indicate that there are two critical components contained in two different critical machines, namely printing machines umbrella gear components and components pillow block machine mixer. The optimum replacement time based on the model Age Replacement gained 17.57 hours with a replacement cost of Rp. 21018.35 umbrella gear components for printing machines and 26.42 hours with a replacement cost of Rp. 14316.83 for pillow block mixer machine components.

Kata Kunci: FMECA, *Age Replacement*, *Maintenance*.

I. Literature

A. *Maintenance*

1. Definition of Maintenance

Maintenance is an activity or activities in order to maintain the condition of the engine in order to remain excellent and dependable as the engine to function under the previous conditions. The condition where the machine is maintained properly requires planning and scheduling in accordance with the act of care by taking into account the supporting functions and minimizing the costs incurred. Maintenance activities in fact often experienced problems because of the assumption of the company itself, in which care activities considered as activities that waste time and costs menhabiskan. But basically the maintenance activities will greatly assist the company in maintaining engine performance. Costs incurred by companies when handling after their kerusakanpun much more expensive when compared to scheduled maintenance activity. It will feel when they exercise of maintenance activities.

Maintenance activities also includes several measures aimed at maintaining the condition of the engine in order to remain in the desired condition. Care has a very close relationship with damage prevention measures (preventive) and damage repair measures (corrective). Such measures include:

1. Inspection

Ie actions aimed against the system or machine to determine whether the system is in the desired condition.

2. Service

Ie actions aimed to maintain the condition of a system that is usually set on the manual use of the system.

3. Replacement

That action is deemed faulty component replacement or does not meet the desired conditions. The replacement action may be performed suddenly or with a prevention plan in advance.

4. Repair

That minor corrective actions undertaken in the event of damage
small.

5. Overhaul

That is a massive change action that is usually done at the end of a certain period.

2. Purpose of Maintenance

The presumption of the companies that ignore the importance of the treatment will be felt when the engine had suffered severe damage and lead to disruption of production activities. Machines used in the production scheduling typically has been made in such a way in order to fill orders and keep the productivity of the company. All the plans that have been made will be interrupted when an engine breakdown and cause substantial losses. This can be avoided with the activities of care, because the maintenance activity has the following objectives:

1. Enables the achievement of product quality and customer satisfaction through the adjustment, waiters and proper operation of the equipment.

2. Prevents damage when the engine is operating.
3. Maximizing the useful life of the system.
4. Maintain equipment properly so that the machine or equipment is always in condition remains ready for operation.
5. Minimize the total production costs which are directly linked to service and repair.
6. Minimize the frequency and strength of disturbances to the process
operation.
7. Maximize production and sources of existing systems.
8. Prepare personnel, facilities and methods to be able to do maintenance tasks.

3. Maintenance Policy

Maintenance activities are generally classified into two major groups, namely damage prevention measures (preventive) and damage repair measures (corrective). More clearly in respect of maintenance actions are as follows:

1. Prevention (preventive maintenance)

Preventive maintenance action is a maintenance activity has been planned in a certain period of time to maintain engine performance and minimize the cost out. Preventive care also serves to prevent damage, locate the cause of the damage, minimizing the reduction in the level of reliability and finds hidden damage.

Grouping is divided based preventive maintenance tasks, where each task is as follows:

a. *Time Direct Maintenance*

Tugas yang pertama adalah kegiatan perawatan berdasarkan variabel waktu (*time direct*). Kebijakan yang ditetapkan untuk tugas ini adalah *periodic maintenance* dan *on condition maintenance*. *Periodic maintenance* adalah kegiatan yang dilakukan secara terjadwal dengan interval waktu tertentu. Faktor yang mempengaruhi *periodic maintenance* adalah sebagai berikut:

- Both economic factors
  Policy research is done because faced with a comparatively unit cost when compared to the risks covered and the cost is greater when components or units are damaged in case of negligence.

• The safety factor

Development policy is no longer based on the replacement value of the rupiah, but faced with the situation if not done eating human lives are at stake because it is closely linked to security and human safety.

On condition maintenance treatment is carried out by operator policies treatments. Activities undertaken in these conditions is cleaning, inspection and lubricant.

b. Conditon Based Maintenance

Condition Based Maintenance is preventive maintenance carried out in accordance with the conditions that took place in which the time variable is not precisely known. Policy in accordance with the state is predictive maintenance. Predictive maintenance is a maintenance activity carried out by checking and maintaining the time the treatment has been truly require restoration to its original level. This is done by monitoring the operating conditions of the equipment based on the data and information.

c. Failure Finding

Failure finding a precaution which is done by checking the function of the hidden (hidden function) on a periodic basis to ensure that when a component will be damaged.

d. Run To Failure

This activity is called also no maintenance schedule in which the activities of these treatments do not make an effort to anticipate the damage. An apparatus or machines allowed work to be damaged then do maintenance repairs. This activity is performed if there is no effective prevention activities that can be done, action percegahan too expensive or impact of failure has no effect.

2. Corrective Maintenance

Activity maintenance repair a maintenance action after the occurrence of damage or malfunction on the machine. Actions that can be taken is in the form of replacement parts (coorective replacement), a small improvement (repair) and major repairs (overhaul). As has already been mentioned that this maintenance activity performed after the crash, then any activity undertaken can not be predicted and are not scheduled replacement.

4. Types of Maintenance Measures

Grouping types of treatment divided by the level of treatment, the period of implementation, funding support and implementation. More details are discussed as follows:

1. Based on Level of Maintenance

Determining the level of care is basically guided by the scope / weight of work that includes complexity, all kinds of support and time needed for implementation. Three levels of care system, namely:

a. Maintenance Level Light

A preventive measure undertaken to maintain the system in a state ready for operation in a systematic manner and provide periodic inspection, detection and early prevention. Using maintenance support equipment and personnel with the ability to taste that does not require a high degree of specialization. The activities included setting up a system servicing, minor repairs.

b. Medium Level of Maintenance

Corrective nature, undertaken to restore and recover the system in a state ready to provide repairs for the damage that has resulted in decreased levels of reliability. To carry out such work is supported with equipment and workshop facilities are quite complete. Activities include:

- Periodic Inspection / periodically to the system.
- Inspections are limited to the components of the system
- Repairs are limited to the parts, assemblies, sub-assemblies and components.
- Modification of material as determined in accordance with the ability of workshops.
- Repairing and testing machines.
- Creation / production equipment / parts.
- Test and calibration / measurement.
- Prevention and control of corrosion.

c. Maintenance Level Weight

Restorative is implemented on a system that requires a major overhaul or a complete development which includes assembling, making spare parts, modification, testing and reclamation as appropriate. Maintenance heavy level includes extensive and for intensive work on a system. This includes working to recover back, repair complex that requires complete disassembly, repair, reassembling, testing and prevention support equipment and facilities complete the work and skill levels high enough personnel as well as a relatively long time. Maintenance is done at the level of heavy weight. Weight maintenance purposes is to ensure the integrity of the system structure and function of the system by conducting in-depth examination of the items / sub-items and part of the framework of certain systems at predefined intervals.

2. The exercise is based Period

a. Scheduled maintenance

Maintenance which has had a schedule in certain period to conduct an examination of the machine or system, this treatment is still being done either there or not there is damage to the machine.Scheduled maintenance, Maintenance which has had a schedule in

3. Based Support Funds

a. Programmatic (Planned Maintenance): The treatment has had program of its own, and therefore these treatments have technicians, equipment and budget of its own to make improvements.

b. Not programmed (Unplanned maintenance): do not have a budget to perform maintenance on the machine or system is damaged, then the cost comes from an unexpected budget.

4. Based on Place of Maintenance

To carry out maintenance activities necessary to have a place of care tailored to a wide or workload facing and equipped with devices that meet certain requirements, are expensive, so pendayagunaannya needs to be done effectively and efficiently.

Therefore, to prevent duplication of capabilities, the centralized equipment placement in care units suitable places and kinds of treatments performed. It aims to facilitate appropriate action policy that applies when there is interference.

5. Influential Elements on Care

Implementation of maintenance activity on a system or machine, includes two important elements, namely the time and cost. More details are as follows:

1. The time element in Maintenance Activity

A time element associated maintenance activity is used as well in the overall production activities, such as:

a. Up Time

The time at which the machine is functioning properly and is used by the system to perform activities.

b. Delay Time

The time at which the machine is functioning properly but is not used by the system.

c. *Down Time*

The time at which the machine can not be used because of the disruption that occurred , this time can be divided into:

- Down time due to the preventive replacement
  - Time Demolotion
  - When preparing componen
  - Installation Time
- *Down time* due to the replacement of faulty
  - Time to bring the equipment to the workshop
  - Time Discover Damage
  - Time waits replacement parts
  - Time component mounting
  - Testing Tme

2. Elements in the Activity Cost Care

The cost of the maintenance activities include:

a. Direct Cost
- The cost of labor maintenance
- The cost of purchase of replacement component

b. Undireect Cost
- The cost of production workers who are unemployed
- The cost of depreciation of machinery
- The cost due to lost profits
- The cost of depreciation of equipment maintenance
- The cost of administration

6. Costs in Nursing

There are three main groups that influence the calculation of the mathematical model for maintenance scheduling , ie the distribution interval damages , costs and expenses due to damage inspection activities . More details are as follows :

1. Distribution Time Lapse Damage

Distribution interval of damage used to obtain the value of possible damage to an interval of time (function failure) and possible values of all operating machinery until a certain time (reliability function) . One thing that is obtained from the distribution interval of the damage is the behavior of the system (machine) from a state to another . This is helpful in the selection of treatment and labor policies and influence the expectations of long- cycle damages.

2. Costs due to damage

The cost of damage is the cost of the maintenance activities out suddenly , as in the implementation, in accordance with the damage that simply can not be predicted in advance . As a result of the emergence of the damage sudden or unpredictable greatly affects all production activities because the machine can not be used when dilangsungkannya perwatan activities . It will interfere with the production scheduling of the machine in question as well as other machines , even affects all production activities

The cost of damage will trigger the emergence of other costs , such as :

a. The cost of repairing the damage

While the occurrence of the damage and performed corrective actions , actually there are three kinds of costs that arise as a result of the damage, namely labor costs maintenance (repair) , the cost of material and equipment depreciation costs.

b. The cost of idle due to damage

Consists of labor costs that are unemployed due to damage plus loss of profits for the damage (Opportunity Cost).

3. Cost of Care Inspection Activities

The cost of maintenance activity inspection is part of the cost of preventive care policy . Where the costs that arise in inspection activities charged to the labor costs of care.

7. Treatment Rule

The rule is the benchmark treatment in carrying out maintenance activities , ie as a material to conduct an initial analysis of the machine or system to be treated. The standards include a benchmark of what is meant by engine maintenance , the feasibility of the system , and operational capabilities of system readiness (Availability) , system reliability (Reliability) and resource use . More details are as follows:

1. Maintenance System

Care is the activities undertaken to ensure that the system is always ready for immediate use (Serviceable) or revert back to the state system in ready to use .

2. Eligibility System

Feasibility terancang system is the ability of a system to perform its function safely and within the limits specified operating conditions , determined by the amount of configuration, construction standards , performance specifications and technical specifications.

3. Operational capability

Operational capabilities are the capabilities of the machine / system to perform a variety of operations in accordance with the expected or required.

4. Availability

Availability is a ready state of a machine / equipment in both the number (quantity) and quality according to the needs that are used to carry out the operation process . Availability (availability) can be used to assess the success or effectiveness of maintenance activities that have been performed .

5. Realiability

Reliability is the possibility of a system or apparatus capable of carrying out missions or functions in certain conditions without failure .

6. Use of Resources

Efficiency criteria closely related to the use of resources as efficiently as possible , so that any maintenance activities that do not create a positive impact both on the readiness of the system and the operational readiness of the inefficient should be avoided or reduced to a minimum .

B. Damage Distribution Function

Determination of distribution functions between failures , directly focused on the Weibull distribution . Because the calculations can meet some periods of the damage. The following. Here are more details on the Weibull distribution

1. Distribution Weibull

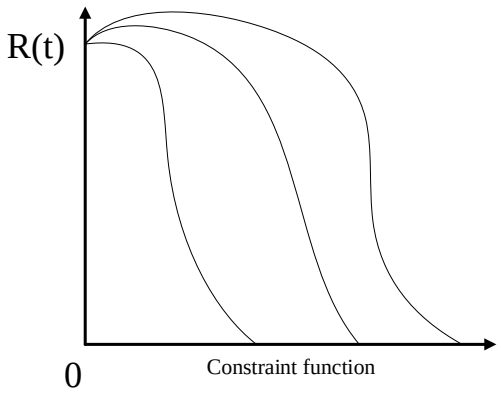
Distribution is the most numerous and most often used to analyze the damage that occurs in a component . This is because this distribution may satisfy some periods of the damage, which is in the initial period , the normal period and the period of wear . Distirbusi has a parameter called β emblem . The rate of damage depends on the distribution of these parameters . Damage rate decreased when β < 1 , the rate constant damage if β = 1 and the rate of damage increase if β > 1 .

The function of distribution Weibull is:

1. function Reliability
Has the following equation :

$$R(t) = exp\left[-\left(\frac{t}{\alpha}\right)^{\beta}\right]$$

Weibul reliability at distribution function can be described using curves , can be seen in Figure 1 .



Gambar 1. Curve of Constraint Function Weibul

2. Damage rate function
Has the following equation:

$$r(t) = \frac{f(t)}{R(t)} = \frac{\beta}{\alpha}\left(\frac{t}{\alpha}\right)^{\beta-1}$$

The function of the rate of decay can be described using the Weibull distribution curve , as shown in Figure 2 .

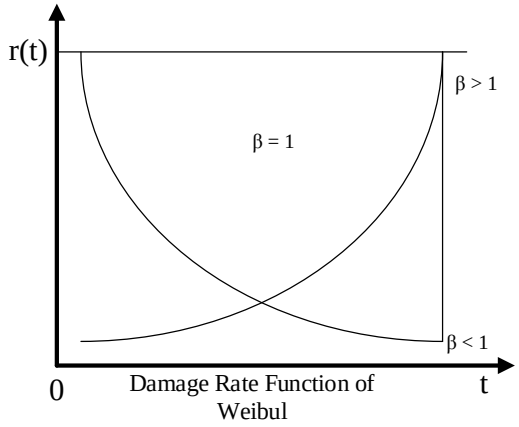


Figure 2. Damage Rate Function of Weibul

3. Density Function Damage
Has the following equation:

$$f(t) = \frac{\beta}{\alpha}\left(\frac{t}{\alpha}\right)^{\beta-1} \; exp\left[-\left(\frac{t}{\alpha}\right)^{\beta}\right], \text{ for } t > 0$$

Damage density function can be described using the curve , as shown in Figure 3 .

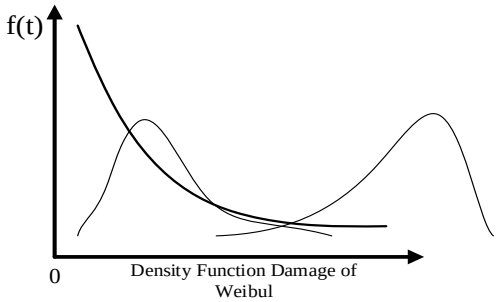


Figure 3. Density Function Damage of Weibul

4. Cumulative Distrusi function
Has the following equation:

$$F(t) = 1 - exp\left[-\left(\frac{t}{\alpha}\right)^{\beta}\right]$$

The cumulative distribution function can be described using a curve , as shown in Figure 4 .

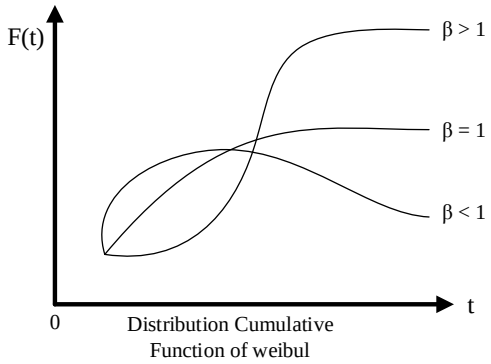


Figure 4. Distribution Cumulative function of Weibul

C. Component Replacement Model Based on Age

The strategy of the model based on the time interval is performed preventive replacement if the component has mencapati a certain umut (tp) . But if these components were damaged before the age is reached , then the replacement will be performed . The equation of this model are as follows :

$$C(tp) = \frac{Expectation\ Replacement\ Cost\ of\ one\ cycle}{Long\ Expected\ Cycle}$$

$$long\ Expected\ Cycle = (Long\ Cycle\ 1 \times Probabylity\ Cycle\ 1) + (Long\ Cycle\ 2 \times Probability\ Cycle\ 2)$$

$$C(tp) = \frac{Cp.R(tp)+Cf.(1-R(tp))}{(tp+Tp).R(tp)+\int_0^{tp} t.f(t)dt+Tf.[1-R(tp)]}$$

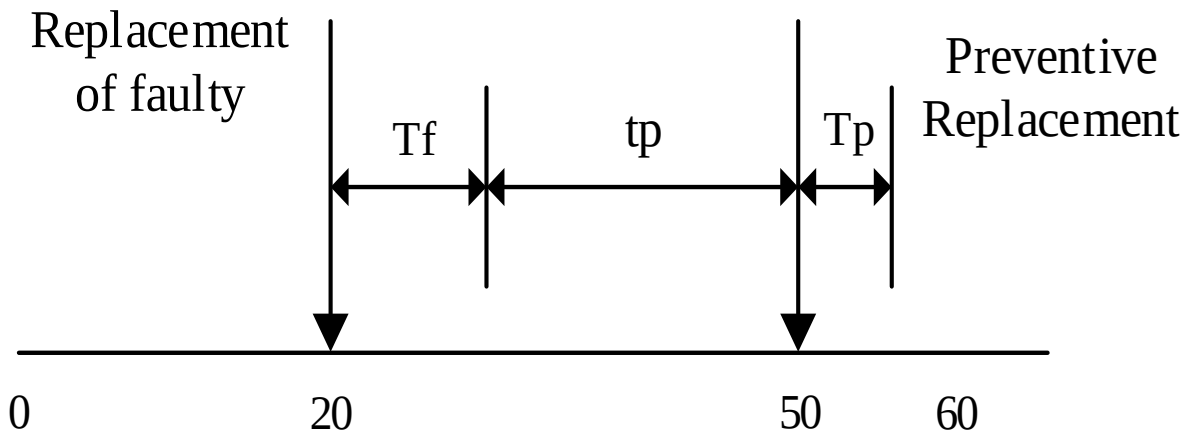
This model can be described as follows :

D. Design Analysis and Evaluation Component

The process of making the maintenance schedule needs to be well planned and analysis in order to manufacture the maintenance schedule for a targeted system . The process can be evaluated further analysis results are to be effective and efficient to apply. One meotde that can be used for process analysis and evaluation is Failure Mode Effects and Criticality Analysis (FMECA) , a clearer view of FMECA is as follows .

1. *Failure Mode Effect and Criticality Analysis* (FMECA)

This type of damage , effects and criticality analysis (FMECA) is a systematic design techniques to identify and invest potentially system (product / process) is bad , is in line with the methodology for testing steps in which the system damage can occur . Potential effects of system performance and security of the damage and other serious effects . FMECA is composed of two different analyzes , the type of damage and impact analysis (FMEA) , all of which extended to analyze the type of critical damage , called criticality analysis (CA) . Above another real advantage from the action identifiers or change of eliminating or reducing the chance of damage .



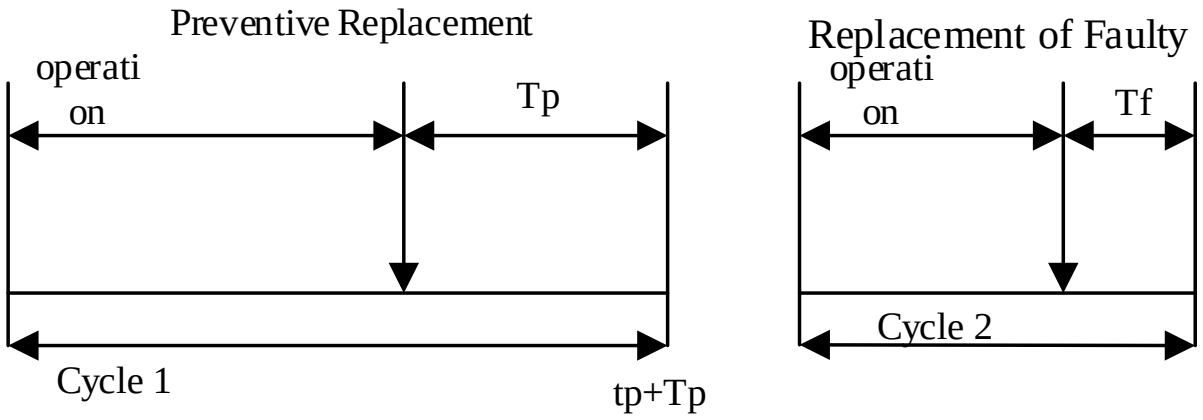


Figure 5. Components Replacement Model Based on Age

FMECA also improve the knowledge of the system and improve supplies into the expected behavior , the output of FMECA done at the right time from the invaluable input to improve the cost effective preventive maintenance program and the work focused on the control plan .

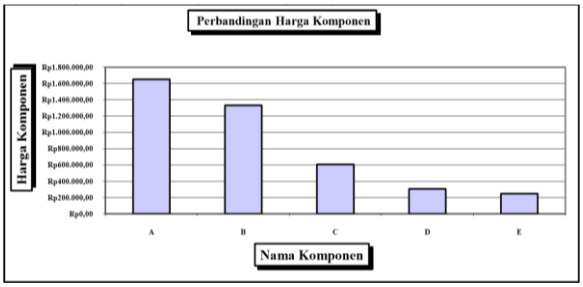
FMECA begins with the conceptual stage and preparation , when the design of the system is analyzed from a functional perspective . To maximize effectiveness , however, the analysis needs to enhance any additional information is available for an analysis , it also reflects all the design changes and their impact on the overall system . Besides, and in addition , gain or benefit more apparent with FMECA , it can make an important contribution to the feasibility study preparation phase system throughout the design and depiction of functional problems .

The steps in implementing FMECA are as follows :

1. Depictions of system requirements (product / process) , for some product or process is very important not only for the purpose of desire but also the unwillingness of the results or output , what should be met by the product / process , eventually those needs will again left a trail needed to identify and customer needs , all the performance and effectiveness of the factors required to meet those objectives .

2. Fulfillment of functional analysis , this involves defining the function system terminology . Functional systems typically use a representative symbol as a functional flow charts . The function of a representative system comes with a set of data flow chart format , such as N - Squared Chart , to slightly improve the system of any characteristics / behavior .

3. Fulfillment allocation needs , this is the rise and fall of a system malfunction measure the need for some functional unity (product / process) in the system functional hierarchy . It's very important to identify the achievement of the performance , effectiveness , input or output , total output , speed and other factors for each functional block .



Fifure 6. Example of Pareto Diagram

Pareto diagram is a diagram in the form of ladder (ladder) which has the function to determine and see the different levels of priority of the various problems to be solved . By using Pareto diagram can be seen where the dominant issue and of course we can determine the priority solution to the problem , the criteria and considerations in determining the Pareto diagram is the frequency of damage , repair costs , the total cost of care and the price of the replaced part .

The function of the Pareto diagram are :

- Demonstrate the main issues are dominant.
- Stating the comparison of each issue to the overall problem .
- Demonstrate the degree of improvement after the corrective actions in a limited area .

- Demonstrate comparison of each issue before and after repair .
- Provide information graphically , where it becomes more efficient and effective and more easily understood , because the priority of a problem will be obvious .
- Facilitate research and look at his achievements before and after the implementation of countermeasures .

4. Identifying the type of damage , in the context of this analysis , the type of damage has the meaning of an element in which the system fails to fulfill its functions . As an example; failed to open or turn on a machine.

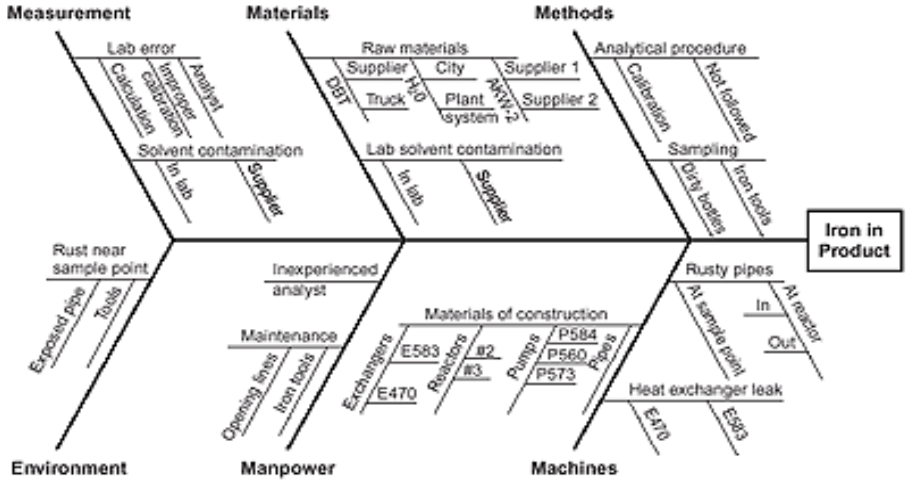
5. Determining the cause of the damage , this analysis involves the entire process or product required to limit the causes of damage in general. FMECA implement compliance group to facilitate the identification of a set of other potential causes . As experience with similar systems have limited more to fulfill the steps in the process of analysis , techniques such as cause and effect diagram ishikawa also known as the fishbone diagram , it could prove highly effective to describe potential causes for any damage.

The steps in the manufacture of fishbone diagram is as follows :

Determine the problem or the quality characteristics to be controlled and fixed in the bone fish head:

a. Determine the problem or the quality characteristics to be controlled and fixed in the bone fish head.
b. write quality characteristics on the right side . Draw arrows at the side left side of the right .
c. Jot down the main factors of the damage to be repaired on the branch arrows, for example; Humans , Machines , Methods , Materials and Environment
d. Jot sub factors that cause damage in detail on each of the branches that form the branches branch .

6. Determine the effect of the damage . Impact of failure often occurs in some ways , the effectiveness and the achievement is not only associated with functional elements , but also the entire system, while performing the FMECA is very important to consider the effects of failure on the next higher level , measuring the functional unity together with the impact on the overall system . At other positions , when analyzing a process , it is important to indicate a failure affecting a process.
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Gambar 7. An Example of a Casual Diagram (*Fishbone)*

7. Assessing the evils of this type of damage . In the context of this analysis is concerned with the effects or serious consequences against this type of damage in general . Identifying the damage detection means, in this context , an orientation process FMECA , referring to the process flow control that can detect the occurrence of a failure or defect . However , when FMECA focused on this design indicates the existence of some kind of design , help, size , reading or verification procedures that will detect the result of the kind of damage potential . In the measurement standard MIL- STD - 1629 A. The purpose of classifying the effects of the damage can be divided into four types of damage , namely :

a. Accident : A damage that can lead to the loss of a private life and damages to a complete system .
b. Critical : The damage that can potentially cause serious injury and significant damage system and loss of functional systems .
c. Marginal : The damage that can lead to loss of personnel , the system destruction and degradation of functional systems
d. Minor : The damage is not sufficient cause losses of personnel or systems , but generating the need for some corrective maintenance

Provision of scale at the level of ugliness can be seen in Table 1 .

8. Assess the frequency of this type of damage , this gives a function or physical components in which a system that is often damaged . This measure is aimed at a frequency of individual types of damage . Basically the number of frequencies to an element of the system should be proportional to the value of the damage. A qualitative approach only recommend specific damage . Table 2 below describes the qualitative ratings to damage, type of damage FMECA , a performance in which an industrial company improve the ranking of frequency of damage on a scale of 1-10 .

Table 1. Scale Level Ugliness

Effect	Criteria: Severity of the Effect	Ranking
Hazardous - without warning	Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation without warning.	10
Hazardous - with warning	Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation with warning.	9
Very High	Vehicle / item inoperable, with loss of primary function.	8
High	Vehicle / item operable, but at reduced level of performance. Customer dissatisfied.	7
Moderate	Vehicle / item operable, but Comfort/Convenience item(s) inoperable. Customer experiences discomfort.	6
Low	Vehicle / item operable, but Comfort/Convenience item(s) operable at reduced level of performance. Customer experiences some dissatisfaction.	5
Very Low	Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by most customers.	4
Minor	Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by average customer.	3
Very Minor	Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by discriminating customer.	2
None	No Effect.	1

Table 2. Frequency Scale Damage

Probability of Failure	Possible Failure Rates	Ranking
Very High: Failure is almost inevitable	>= 1 in 2	10
	1 in 3	9
High: Repeated failures	1 in 8	8
	1 in 20	7
Moderate: Occasional failures	1 in 80	6
	1 in 400	5
	1 in 2,000	4
Low: Relatively few failures	1 in 15,000	3
	1 in 150,000	2
Remote: Failure is unlikely.	<= 1 in 1,500,000	1

Table 3. Probability Scale Damage Unknown

Detection	Criteria: Likelihood of Detection by Design Control	Ranking
Absolute Uncertainty	Design Control will not and/or can not detect a potential cause/mechanism and subsequent failure mode; or there is no Design Control	10
Very Remote	Very remote chance the Design Control will detect a potential cause/mechanism and subsequent failure mode	9
Remote	Remote chance the Design Control will detect a potential cause/mechanism and subsequent failure mode	8
Very Low	Very low chance the Design Control will detect a potential cause/mechanism and subsequent failure mode	7
Low	Low chance the Design Control will detect a potential cause/mechanism and subsequent failure mode	6
Moderate	Moderate chance the Design Control will detect a potential cause/mechanism and subsequent failure mode	5
Moderately High	Moderately high chance the Design Control will detect a potential cause/mechanism and subsequent failure mode	4
High	High chance the Design Control will detect a potential cause/mechanism and subsequent failure mode	3
Very High	Very high chance the Design Control will detect a potential cause/mechanism and subsequent failure mode	2
Almost Certain	Design Control will almost certainly detect a potential cause/mechanism and subsequent failure mode	1

9. Assessing the probability of damage to be detected , it is related to the probability that a design and verification procedures will detect the type of damage potential at the corresponding time in the system. The level of damage damage to this analysis has an orientation towards a specific process in some place that would detect the position and classify the damage before it is sent and processed again to end up in consumers .

10. Analyze the types of critical damage , the object in this step strengthens the information produced until now . In an attempt to make a sketch on other critical aspects in the design of critical systems in the context of this analysis is a function of the frequency of this type of damage , the ugliness and the probability to be detected at a time to block the impact on the measurement system . At this stage used the term Risk Priority

Number (RPN), equation from RPN are as follows:

RPN = (Level Ugliness) x (Frequency Rate) x (Probability of Detection) (2.8)

However , in determining the priority of critical components , the value of the first note is the value level of ugliness , after the value of the frequency of the damage and then the value of the probability of detection . In other words , if the two components have different RPN value , the priority remains the components that have high value level of ugliness .

After determining the priority of each critical component, the component information that has been analyzed is inserted into the table FMECA . Here is an example of a process FMECA of a Critical Component . FMECA worksheet examples can be seen in Table 4 .

Figure 4. Example of *Worksheet* FMECA

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
Front Door L.H.

___ System 1 - Automobile
___ Subsystem 2 - Body Closures
X Component 3 - Front Door L.H.
Design Responsibility Body Engineering
Model Year(s)/Program(s) 199X/Lion 4dr/Wagon
Key Date 3/3/2003
Core Team T. Fender - Car Product Dev., C. Childers - Manufacturing, J. Ford - Assy Ops (Dalton, Fraser, Henley Assembly Plants)

FMEA Number 1234
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Prepared By A. Tate - X6412 - Body Engr
FMEA Date (Orig.) 2/28/2003 (Rev) 3/3/2003

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/Mechanism(s) of Failure	Occur	Current Design Controls	Detec	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results: Actions Taken	Sev	Occ	Det	RPN
3 - Front Door L.H.																
- Ingress to and egress from vehicle. - Occupant protection from weather, noise, and side impact. - Support anchorage for door hardware including mirror, hinges, latch and window regulator. - Provide proper surface for appearance items - paint and soft trim.	Corroded interior lower door panels	Deteriorated life of door leading to: - Unsatisfactory appearance due to rust through paint over time. - Impaired function of interior door hardware.	7		Upper edge of protective wax application specified for inner door panels is too low.	6	Vehicle general durability test veh. T-118 T-109 T-301	7	294	Add laboratory accelerated corrosion testing.	A. Tate Body Engrg - 2/25/2003	Based on test results (Test No. 1481) upper edge spec raised 125 mm.	7	2	2	28
					Insufficient wax thickness specified.	4	Vehicle general durability testing - as above. - Detection	7	196	Add laboratory accelerated corrosion testing.	A. Tate Body Engrg - 3/28/2003	Test results (Test No. 1481) show specified thickness is adequate.	7	2	2	28
										Conduct Design of Experiments (DOE) on wax thickness.	A. Tate Body Engrg - 3/28/2003	DOE shows 25% variation in specified thickness is acceptable.				
					Inappropriate wax formulation specified.	2	Physical and Chem Lab test - Report No. 1265. - Detection	2	28				7	2	2	28
					Entrapped air prevents wax from entering cornerledge access.	5	Design aid investigation with nonfunctioning spray head. - Detection	8	280	Add team evaluation using production spray equipment and specified wax.	Body Engrg & Assy Ops - 3/28/2003	Based on test, addition vent holes will be provided in affected areas.	7	1	3	21
					Wax application plugs door drain holes.	3	Laboratory test using "worst case" wax application and hole size. - Detection	1	21				7	3	1	21
					Insufficient room between panels for spray head access.	4	Drawing evaluation of spray head access. - Detection	4	112	Add team evaluation using design aid buck and spray head.	Body Engrg & Assy Ops - 3/28/2003	Evaluation showed adequate access.	7	1	1	7