CHAPTER 3

RESEARCH METHODOLOGY

This chapter simplifies about the methodology used to accomplish this research. The methodology is started from defining problem, literature review, research objective, data collection, processing data by using FMEA method, analysis the result, and conclusion.

3.1. Research Methodology Step

Research step on this research started by identifying problem as this is problem solving research. Then, literature review is elaborated to find previous research which has the same parameters with this research. Next is collecting data regarding with the problem. As the problem in this research are finding root-cause/failures that comes from design and process of part ID Plate. Between those two causes design and process the collecting data should find in real observation. Furthermore, the observation is divided into five more steps. First is taking a picture of product. Second is brainstorming of product assembly and subassembly. Third is finding product and component function which find the picture and find the purposes of each part and component. Fourth is finding the production process which is passed by ID Plate. And the last is finding mensuration/standard of product of ID Plate. The author will be sizing all parts and components. In the observation, there will be actions done not only just taking a picture or measuring the part but also comparing the SOP with the real action. Moreover deep interview is done including observation activity, so that the researcher should ask deep to supervisor or the important person in PT.HIM. Later on is processing data by using FMEA method that are divided into four steps determine potential failures, the effects, the causes, calculating Risk Priority Number (RPN), prioritize RPN number, take an action by recommendation which should perform, and recalculating RPN value after implementing. The final step is making conclusion and suggestion for future research. The detailed description of research methodology is shown by flowchart in **Figure 3.1**

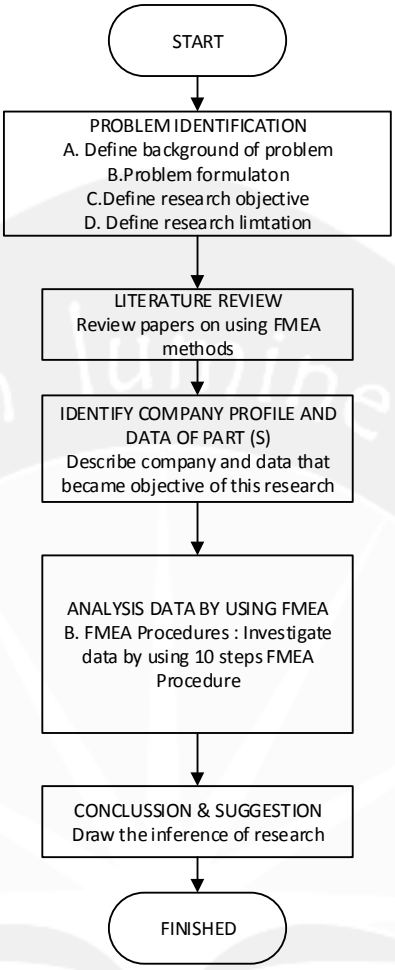

Figure 3.1. Research Methodology

3.2. Problem Identification

The research step describes problem identification which is the first step before the whole process of methodology. Problem identification consists of problem formulation definition of research objective and definition of research scope and limitation.

The problem was established by Supervisor of Quality Assurance in PT. HIM. Their project was about finding out the root-cause of ID Plate problem by using FMEA. Therefore this project continues of their project that not finish yet. This research also used the same method as the previous research which is Failure Mode and Effect Analysis. Problem identification was discussed in Chapter 1 of this research.

3.3. Literature Review

After understanding the current situation and problem appeared in system, the next step is doing literature review. This step is used to find regulation related to this research and previous research based on its similar case. In this section, the purpose is reviewing papers on using FMEA. After reviewing, it obtain regulation and many exemplification to involve FMEA. Literature review and theoretical background is presented in Chapter 2 of this research.

3.4. Identify Company Profile and Data of Part(s)

After finishing in reviewing literature review and continue in compose theoretical background, the next action is searching and taking the data. The data needed was gathered by having interview with management team especially to Quality Assurance Department. Not only interview but also observe each part and component of ID Plate were conducted. The information needed is the company's policy related to take a whole processing data of ID Plate. So, it sustain identify company profile first and the data. It is presented in Chapter 4 of this research.

3.5. Analysis Data by Using FMEA

The next stage is a stage in the processing of data by using FMEA that are the result of collecting the data. The analysis is following 10-steps from (Raymond J. Mikulak, 2009). In this processing data using FMEA is to discover and prioritize the potential failure modes, potential effect, potential causes and find current detection by computing them in calculate risk priority number (RPN). The statistical data collection involves approach especially related with the frequency of component and subcomponent failures. FMEA Methodology will be shown in Figure 3.1 and continued to be explained in chapter 5.

3.6.1. Review process and design product (part ID Plate)

In the first step of reviewing process and design. It include collecting data that already describe in research methodology step. From take picture the part ID Plate, determine product assembly and sub-assembly, determine function of each assembly and sub-assembly, determine production process which through by ID Plate part and the last is find mensuration/standard that should perform in assembly line. They will describe in Chapter 4 especially sub 4.1 and 4.2 of this research.

3.6.2. Determine failure mode

Determine failure mode is used to find what issues that most occur. The team must use an evaluation criteria and rating systems even if some changes are necessary in special cases. The best determine controls those that are done during the process of the development projects in the earliest possible time. The methodology is breakdown from 10 steps which became way to solving this research based on (Raymond J. Mikulak, 2009). Failure mode will find in both FMEA process and FMEA design.

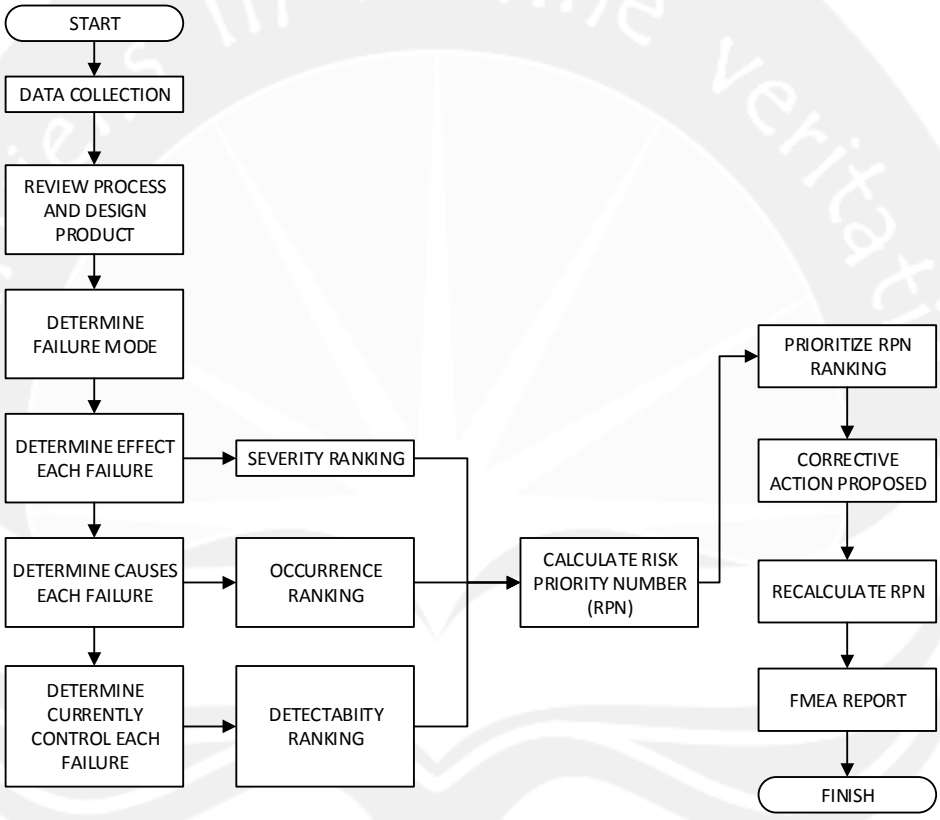

Figure 3.1. FMEA Methodology

3.6.2. Determine the effect of each failure

Severity or deterioration of risk is only considered in its "effect"; reducing the deterioration of risk is only possible through changes in process and how to do activities. There are few quantitative factors for this deterioration of risk that are expressed on a scale of 1 to 10. The ranking severity is shown in Figure 2.5 and Figure 2.6 by the priority order.

3.6.3. Determine the causes of each failure

Occurrence is the probability emergence of a specific cause or mechanism. In other words, the probability of occurrence specifies that a potential error occurred with what frequency. The probability of occurrence is assessed based on 1 to 10 to achieve this number, survey previous records and documents, check the control processes and labor laws can be helpful. Also, prevention or control of one or several mechanism errors is the only way that can decrease the occurrence of the degree through establishing change in plan or change in design process such as checklist of design, design review, design guidelines and etc. So, only with eliminate or reduce the causes or mechanisms of each hazard can hope to reduce the number of occurrence that the probability scales have shown in Figure 2.9 and Figure 2.10.

3.6.4. Determine currently detection of each failure

After considering the failure mode and its possible causes, the estimate of the probability of the failure actually occurring must be recorded, using all currently identification, and then the probability of occurrence would be ranked on a 1 to 10 scale. The probability that a potential failure will be detected before it reaches the customer should also be estimated based on a scale of 1 to 10. This is called 'detection rate'. In addition after finished find the currently control it should find detection scale by see Figure 2.12 and Figure 2.13.

3.6.5. Calculate RPN ranking

In order to finish the FMEA report the next step is calculated RPN number. FMEA team should multiply Severity (S), Occurrence (O), and Detect (D) after achieving by observation. The calculation of RPN expresses in Equation.1

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

(Equation.1)

RPN value can vary between 1 and 1000 and errors or failures will prioritize according to their numbers. Errors or failures with high risk priority preference to analyze and resource allocation and the team should be focus on errors that have a higher RPN number. RPN is actually a marker for separating acceptable and unacceptable risks for considered system. In fact, errors that have a higher RPN number than attribute is unacceptable and the other called an acceptable risk. However, the fundamental problem of FMEA is that it attempts to quantify risk solely through RPN computation without adequately quantifying the factors that contribute to risk. This point can be a criticism into the accurate of FMEA method. This method focuses on errors that have a high RPN number; while it is

possible that errors with low RPN number have one or two factors (especially the severity and probability) with high value and does not be consider.

3.6.6. Prioritize RPN Ranking

Generally, regardless of the RPN number, should pay special attention to ensure the definition of existing design control or preventive/ corrective actions. To prevent of errors, Precautionary/correction actions should be define through elimination, reduction or control of their causes, if the identified effect of potential errors may be a danger to the ultimate consumer.

3.6.7. Take a corrective action

After priority and identify the important of each errors, the team can advise some solutions to reduce or eliminate identified errors through regular meetings by prioritize RPN value and using Pareto principle. Based on (Vinodh & Santhosh, 2012) ccorrective actions should be performed for the following purposes after determining RPN:

a. Eliminate the base of risk causes
b. Reduce the severity of the error
c. Increase the chance of discovering in the process
d. Increase job satisfaction

3.6.7. Re-calculate RPN after implementing the recomendation action

After finish in the implementing recomendation action, the next step is re-culmination the RPN ranking by find new data observation. Actually according to (Shafiee & Dinmohammadi, 2014) the new calculation of RPN changes in the occurrence and detection if there is any corrective action in inspection or detection process. While, for severity it will change if the effects is for customer. On condition that customer has no complain about 50% have possibility if after perform corrective action the customer who complain lower than 25%. And other example for severity scale. The purpose of re-calculate is to know how much change reducing of failure mode by see RPN value. Not only by RPN it can be fulfil with real observation data.

3.7. Conclusion

The results of the analysis made in the form of a FMEA worksheet. The worksheet elements can be seen in Appendix 2 and 3. Moreover, the discussion will explain in chapter 4 and will describe FMEA boundaries and also FMEA procedure. Both of them only focuses in process and product design. If finished

until calculate RPN it will be prioritize base on their failure modes. Then, after that it will look for corrective action to fixing and reduce the incidents of failure mode and also improve the quality of part ID Plate. Conclusion from this research is the answer of problem statement that ask in the chapter 1.