RELIABILITY STUDY ON AUTOMOTIVE COMPONENT USING DESIGN FAILURE MODE AND EFFECT ANALYSIS

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I hereby declare that this report entitled **“**Reliability study on automotive component using Design Failure Mode and Effect Analysis” is the result of my own research except as cited in the references.

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Date	:	…….....

This thesis is dedicated to my parents, Aminuddin bin Hussain and Che Puteh bt Mansor, sisters, Nurul Rozaida bt Zainal Abidin and other family members who provide a loving, caring, encouraging, and supportive atmosphere. These are characteristic that contribute to the environment that is always needed to achieve the goals a heads.

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ABSTRACT

Final year project is a course or program that is scheduled during 7th and 8th Semester for every University Teknikal Malaysia Melaka (UTeM) Bachelor students. This Project Report consist a report of critical part of radiator fan and Quality Control Technique for 2 semesters. Failure Mode and Effects Analysis (FMEA) is a methodology designed to identify potential failure modes for a product or process. For the first month of project, student understood the critical of automotive component and selects one which is very critical part because it relate with safety of customer. While for the next remaining months, student will be learning the quality control technique which is FMEA method. This Report will present the project that was done by student and most of the project is related with critical part of radiator fan and FMEA method. This report will provide information about what are the steps to use FMEA method which is DFMEA (Design Failure Modes and Effect Analysis) and steps use this FMEA method for apply on the critical part of radiator to decrease the failure. Hopefully, by undergoing the final year project, the product will be improved by using the FMEA method.

ABSTRAK

Tahun terakhir projek ini adalah suatu kursus atau program yang dijadualkan semester 7 dan 8 untuk setiap pelajar UTeM Bachelor. Laporan Projek ini terdiri bahagian penting daripada radiator kipas dan Teknik Pengendalian Mutu selama tempoh 2 semester. Failure Mode and Effect Analysis (FMEA) adalah suatu metodologi yang direka untuk mengenalpasti mod kegagalan berpotensi untuk sebuah produk atau muat. Untuk bulan pertama projek adalah memahami komponen otomotif kritis dan memilih satu yang merupakan bahagian yang sangat penting kerana berkaitan keselamatan konsumen. Pada bulan berikutnya, akan belajar teknik kawalan mutu yang merupakan kaedah FMEA. Laporan ini akan menyajikan projek sebahagian besar adalah berkaitan dengan bahagian penting daripada radiator kipas dan kaedah FMEA. Laporan ini akan memberikan maklumat tentang apa langkah-langkah untuk menggunakan kaedah FMEA yang DFMEA (Design Failure Modes & Effect Analysis) dan langkah-langkah menggunakan kaedah FMEA ini berlaku pada radiator bahagian penting untuk mengurangkan kegagalan. Mudah-mudahan, dengan melakukan projek tahun terkini, produk akan dipertingkatkan dengan menggunakan kaedah FMEA.

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Chapter 1

1.0 Introduction

This project is about the reliability of an automotive component with use a quantities technique such as Failure Mode Effect Analysis (FMEA). By using the quality control technique, it will identify how the product or process will fail and how to eliminate or reduce risk of failure.

1.1 Background

At present, there are various ways that can be used to help the engineers to improve the quality of a product for their company product such as seven quality control tool, six sigma, new seven quality control tool and other. The tool that will be use to analysis a critical part of the radiator fan is Quality Control Technique with FMEA method. The objective of this project is to identify ways of the product or process can fail and eliminate or reduce risk of failure. The company must know the critical part of the radiator fan which relates with the reliability of long term used the car.

From the previous history, the critical part was from radiator fan which were the reliability of radiator fan cannot be used for a long time at several types of car for this company automotive. From the experience in the analysis done by using the FMEA method, which are know the function of the system radiator fan. Every part of radiator fan mostly has the probability to fail by many causes. Therefore, as the Quality Engineer, that should be analyzing the failure using the history data gathered

from the customer's feedback. From the data gathered, the quality engineer can detect the failure and effect to the radiator fan system. Thus, they reduce the reliability of failure and effect for the radiator fan.

1.1.1 Part of radiator fan

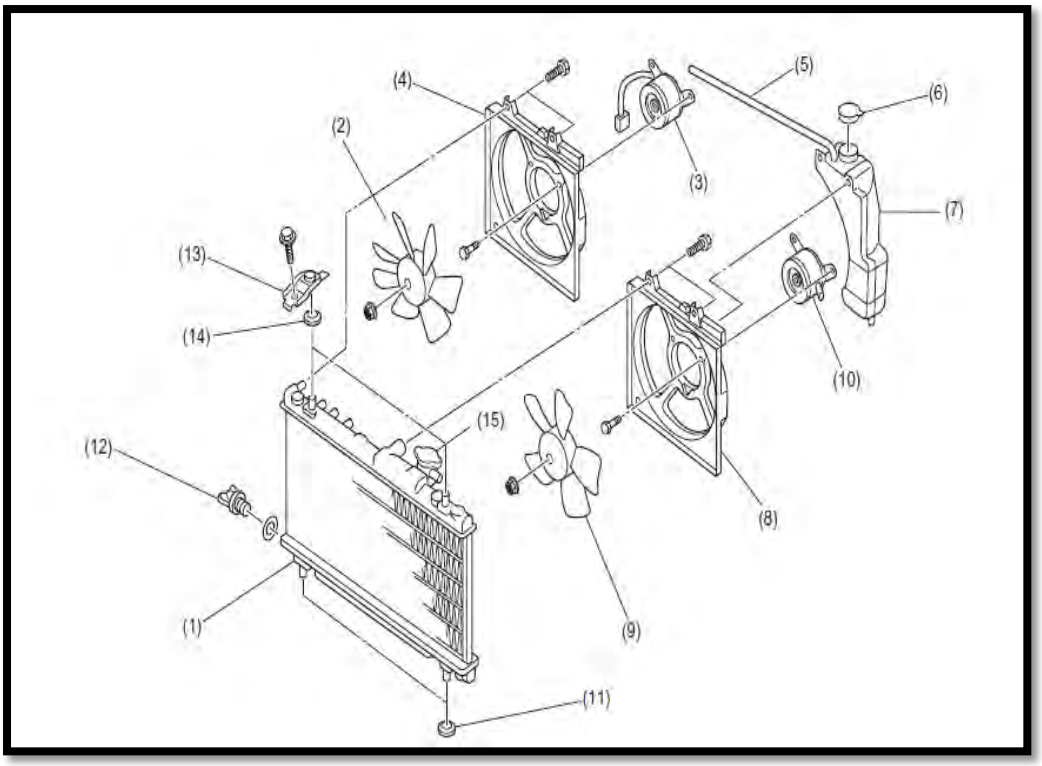


Figure 1: Component exploded for radiator

(1) Radiator
(2) Radiator sub fan (models with A/C)
(3) Radiator sub fan motor (models with A/C)
(4) Radiator sub fan shroud (models with A/C)
(5) Overflow hose
(6) Reservoir tank cap
(7) Reservoir tank
(8) Radiator main fan shroud
(9) Radiator main fan
(10) Radiator main fan motor
(11) Lower cushion
(12) Drain plug
(13) Upper bracket
(14) Upper cushion
(15) Radiator cap

A/C: Air conditioning system

(M. Jordan, 2003)

1.1.2 Quality Control Technique with FMEA method

FMEA is the prefix of Potential Failure Mode & Effect Analysis. It should probably be PFMEA. However, due to the industry wide common terms of DFMEA for Design FMEA and PFMEA for Process FMEA, it was preferred to identity "Potential Failure Mode & Effects Analysis" as "FMEA" to avoid any possible confusion. FMEA is not only a tool to identity potential failures. It is a technical tool to direct the practitioner to focus on prime scopes to design a product, a system or project. Besides that, the manufacturing sector of industries, its are focusing approach can also apply on service industries. For example, banking transaction, highway or bridge maintenance, port operations, equipment maintenance & service parts planning, military operations and security services, just to name a few (J.Jason,1999).

Besides that, FMEA is a discipline and also a mechanics to help engineers, manager and scientist to think innovatively and focus on the functions of the product. FMEA also was a structured and guided procedure to identity potential failure based on not able to fulfill the intended functions, to identity possible causes by eliminate it and to locate the failure impacts with reduces the effects of the impact (K.Carol, 2005).

FMEA is a discipline by itself. FMEA discipline is a systematic process which identifies potential product related problems either may be caused by mission definition, design intent definition, function definition, design trade-off consideration, product design, product manufacturing, product applications or products service in the field.

Then, FMEA also should be conducted at the early stage of the product cycle. Only when FMEA discipline becomes the tools to direct design efforts, design alternatives, design trade-off (balanced design) and manufacturing process planning, the FMEA benefits can be fully realized. It is fair to say that FMEA should be started as soon as product mission defined. It is also a discipline, a process and a living document. It should always be interacted with product design, process development, sourcing & supplier quality, downstream application and field service (B.Nisbet, 2001).

A qualified FMEA program is a living document of the product life cycle. A Design FMEA should reflect the latest product actions and design level. A process FMEA should reflect the existing, or proposed manufacturing process on the production floor (LP Yeo, 2002).

1.2 Problem Statement

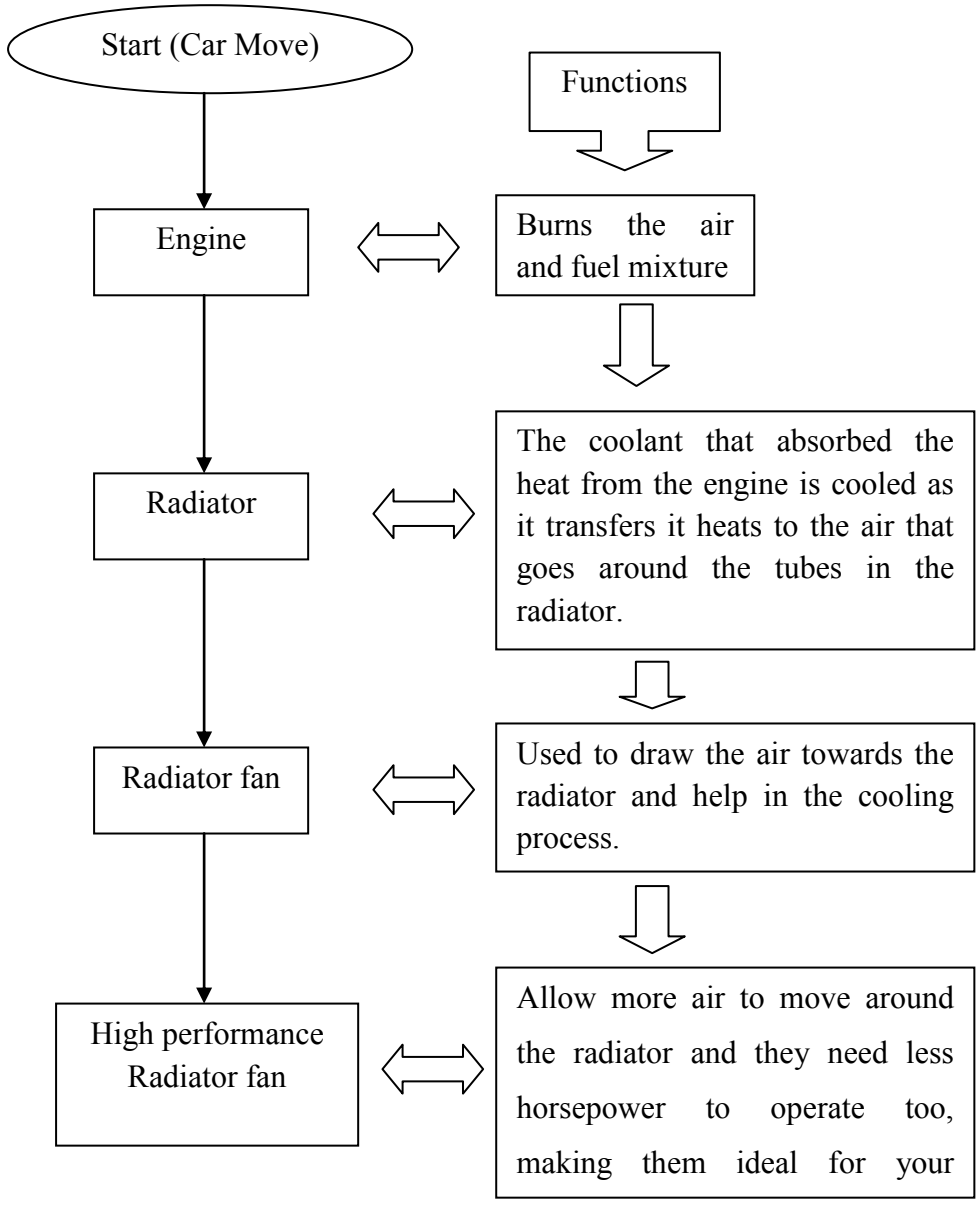
Critical parts of radiator fan have problems with their system when the cars drive for long distances. The critical part of radiator fan problems for the car must be solved to increase confident level of customer to use the car. The radiators fan has many problems with the design. The teams which are participant to handle this problem are Quality Engineer, Process Engineer, Material Engineer, Design Engineer and Product Engineer.

Critical parts refer to the important parts of the car which are relating with the safety or reliability the part to be used. By use FMEA to modifications to existing design or process and the scope of the FMEA should focus on the modification to design or process, possible interactions due to the modification and field history. There are five critical parts must be choose by follow the priority to customer.

- First, the part must know about consumption to the car if the parts is doesn't have inside the car.
- Second, the part must be give aesthetic value to attract the customer to buy the car.
- Third, the part must be give ergonomic to make sure customer feel easy to use the car.
- Fourth, the material must be easy to fabricate and not expensive.
- Fifth, the part must have good reliability to use for long time.

From the data which are observation from mechanic or expert about the car the data show the radiator fan is a critical part of the car. Therefore, by focusing on performance improvement and customer satisfaction it will make design decisions leads to improved reliability, quality, and safety by using tools called FMEA method.

1.2.1 Flow chart the function of radiator fan when the car is move.



(R.Bosch, 2007)

Figure 2: Flow chart of function the radiator car

1.3 Objectives

The objectives of this problem are:

a) Identified ways the product or process can fail and eliminate or reduce risk of failures.
b) Recommend a solution to selected critical component to eliminate or reduces the failures.

1.4 Scope of Project

The scope of this project is focus on the Failure Mode and Effect Analysis for component automotive. Besides that, research will study and apply the Methodology of Failure Mode and Effect Analysis. Then, select automotive component should be the most critical part with available record history. By using the method of FMEA, the reliability study should be recognized.

1.5 Report Outline

This report is consists of six chapter. Every chapter has different description and elaboration. Then, every chapter also sequence of this project final year.

1.5.1 Chapter 1

Chapter 1 introduces the project including the objectives, scope, and background. In this chapter, it describes what is FMEA and background of Failure Modes and Effect Analysis.

1.5.2 Chapter 2

Chapter 2 describes the literature review on the component of automotive in general, analyzing the potential of failure, and Failure Modes and Effect Analysis (FMEA) method.

1.5.3 Chapter 3

Chapter 3 represents the flow chart that will be carried out the whole process of the methodology and project scheme (Gant Chart).

1.5.4 Chapter 4

Chapter 4 represents the steps taken in order to get are valid data. There are some methods to enhance the validity of the data such as fishbone method and checklist for inspect the radiator fan.

1.5.5 Chapter 5

Chapter 5 represents the analysis based on recommendation that have been done. This uses some facts to prove the recommendation can improve and eliminate or reduce the failure.

1.5.6 Chapter 6

Chapter 6 represents the discussion and conclusion of the FMEA technique will improve the component automotive and eliminate or reduce the failure.

1.6 Conclusion

This chapter introduces the project background and the objective of the project. In addition, the problem statement and scope of the study will be clarified in order to limit the range of the project conduct. The following chapters consist of the literature review and knowledge that required while conducting the whole study.

Chapter 2

2.0 Literature Review

At this chapter, learning about the description of FMEA method is an important sub topic because FMEA methods have many types. Also, at this sub topic FMEA will know about potential the failure. Besides that, FMEA can be used at every department production from department design until department process for know the potential failures and effects. Although, FMEA are using in many sector industrial for example in sector automotive and aerospace. Then, FMEA have steps must be follow for use this method.

2.1 What FMEA

The Institute for Healthcare Improvement defines FMEA as "a systematic, proactive method for evaluating a process to identify where and how it may fail and to assess the relative impact of different failures, in order to identify the parts of the process that are most in need of change." (Thomas, 2004 ").

Failure Mode and Effects Analysis (FMEA) is a methodology designed to identify potential failure modes for a product or process, assess the risk associated with those failure modes and prioritize issues for corrective action and identify and carry out corrective actions to address the most serious concerns (Orlando, January 22-25, 2007).

Failure Modes and Effects Analysis is a key design method to help engineers improve quality of ownership. FMEA is an engineering technique used to define, identify, and eliminate known and/or potential failures, problems, and errors from the system, design, or process before they reach the customer (Omdahl, 1992).

A failure mode is essentially an undesired cause-effect chain of events. Once the development teams identify and prioritize failure modes, they can make design decisions leading to improved reliability, quality, and safety (Stamatis, 1995).

Considering the degree of competition between companies in the world, advantages in competition will be won by those companies who focus on performance improvement, customer satisfaction, reducing the costs and increasing the efficiency, and overlay try to purify their organizations and processes. In this way, production strategies and lean thinking can help us to identify and eliminate non value added resources. Besides that, issues like competition, increase in expectations, changes in requirements, and alterations in technology, leads to more responsibility for producers on removing products deficiencies and deviation in processes. Otherwise, companies will lose their market share, due to customer dissatisfaction. In order to do so, today companies use tools called FMEA (S. Fallahian, 2007).

2.2 When FMEA are using

Failure mode and effect analysis is primarily a quality-planning tool. It is useful in developing features and goals for both products and processes, in identifying critical product/process factors and designing countermeasures to potential problems, in establishing controls to prevent process errors, and in prioritizing process subunits to ensure reliability (Age. Q, 2005).

The FMEA is used to allocate goals to the various components within a system. In both the design and cases, the focus of the FMEA is on the failure modes of the components within the system. For a Reliability-Centered Maintenance (RCM)

analysis, the focus is on the functions and the ways and physical mechanisms by which the function can fail (Richard L., 2000).

FMEA technique is applied to analyze the possible failures, in order to raise the safety factor and consequently customer satisfaction. One of the main differences between FMEA and other quality methods is that FMEA is an active method, while other methods are passive when failures occur, other methods define some reactions; but reactions have lots of costs and Failure mode and effects analysis resources. FMEA tries to estimate the potential problems and their risks and then decide upon actions leading to reduce or eliminate this risk (Shekari, 2007).

A Machinery FMEA must be started early in the design phase when the equipment and tooling being specified is able to take advantage of revisions in order to derive the desired benefits. Besides that, when information on component parts are available and Critical/Special Characteristics are identified. Normally, Design FMEAs on the products that are being manufactured and Process FMEAs on the steps used during the manufacture will be available (F. Manual, 1996).

2.3 Who use FMEA

Companies who are currently supplying or wishing to supply to the big three car companies in United Stated (ie. Ford, GM, & Chysler), implementation of an FMEA programmed is a prerequisite to be considered an approved vendor. In addition, to achieve QS 9000 certification, FMEA must be adopted in all design and manufacturing activities. In US, studies of safety and emission recall campaigns in the automotive industry have shown that FMEA is essential to prevent litigation liabilities and costly compensation. A fully implemented FMEA programmed is a “living document” and must reflect the latest practices and design requirements (L.Choon, 1996).

The general industry trend to continually improve products and processes whenever possible, using the FMEA as a disciplined technique to identify and help minimize potential concern is as important as ever. Studies of vehicle campaigns have shown

that fully implemented FMEA programs could have prevented many of the campaigns. One of the most important factors for the successful implementation of an FMEA program is timeliness. It is meant to be a "before-the-event" action, not an "after–the-fact" exercise (FMEA, 2007).

The FMEA is a team function and cannot be done on an individual basis. The team must be defined as appropriate for a specific project and cannot serve as the universal or company FMEA team. The knowledge that is required for the specific problem is unique to that problem. Therefore, the makeup of the team must be cross-functional and multi disciplined for each FMEA (T. Key, 2002).

2.4 How to use FMEA

2.4.1 FMEA can be used to develop product or process requirements that minimize the likelihood of those failures. FMEA is also the basis for:

- Evaluate the requirements obtained from the customer or other participants in the design process to ensure that those requirements do not introduce potential failures.
- Identify design characteristics that contribute to failures and design them out of the system or at least minimize the resulting effects.
- Develop methods and procedures to develop and test the product/process to ensure that the failures have been successfully eliminated.
- Track and manage potential risks in the design. Tracking the risks contributes to the development of corporate memory and the success of future products as well.

(Dr.M.Mraz, 2005)

2.4.2 Method of FMEA

The basic process is to take a description of the parts of a system, and list the consequences if each part fails. In most formal systems, the consequences are then evaluated by three criteria and associated risk indices severity (S), likelihood of occurrence (O), and (Note: This is also often known as probability (P) and inability of controls to detect it (D) (Q. Age, 2002).

There is not one single FMEA method. The following ten steps provide a basic approach that can be followed in order to conduct a basic FMEA. An example of a table lamp is used to help illustrate the process. Attachment A provides a sample format for completing an FMEA are step one identify components and associated functions, step two identify failure modes, step three identify effects of the failure modes, step four determine severity of the failure mode, step five identify cause(s) of the failure mode, step six determine probability of occurrence, step seven identify controls, step eight determine effectiveness of current controls, step nine calculate Risk Priority Number (RPN), step ten determine actions to reduce risk of failure mode (A. Steven 1993).

Overviews of the common steps performed in a team-oriented FMEA are FMEA Team Leader performs the preparatory efforts (i.e., collecting the requirements and past similar evaluations, selecting and inviting the team, and preparing the review forms). Besides that, during the FMEA team meeting, the FMEA Team Leader either facilitates the meeting or assigns a person to do the facilitating. Then discuss any customer requirements, select the FMEA evaluation purpose, select the analysis method, select the product baseline, select the customer view, select the failure modes and select the failure effects. Other, assign severity ratings with review RPN values, if applicable. Also discuss actions and responsibilities as applicable, discuss FMEA evaluation updating criteria, and discuss FMEA follow-up meeting needs. Conduct FMEA follow-up meetings, if needed with prepare, review and approve FMEA report. Finally perform the FMEA Project Evaluation (D. Crowe, 2001).