



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**REMANUFACTURING ANALYSIS BY USING FAILURE MODE
AND EFFECTS ANALYSIS (FMEA) FOR ENGINE BLOCK**

This report submitted in accordance with requirement of the Universiti Teknikal
Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering
(Design)(Hons.)

by

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I hereby, declared this report entitled “Remanufacturing Analysis by using Failure Mode and Effects Analysis (FMEA) for Engine Block” is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) with Honours. The member of the supervisory committee is as follow:

.....

(Principal Supervisor)

ABSTRACT

Over this recent year, a growing population that increase the economic development, capacity of landfills and critical environmental impact are gaining the importance role of remanufacturing activities. Moreover, many durable products are disposed in landfills at the end of their useful lives without undergoing by any recovery process that affect the landfill space has been decreasing in all over the world including by our country. Remanufacturing is the process by which used products are returned to their new state with minimum waste and expenditure on materials and energy. This study is to learn and analyze the concept of remanufacturing practice in automotive sector. Malaysians have been generated wastes at a manufacturing sector especially in the automotive sector. On top of that, the conventional remanufacturing systems that have been constructed in Malaysia are not widely marketed and lack of practical applications. This study provides a remanufacturing analysis for improvement to the automotive sectors on engine block. Furthermore, this study presents the information based on the discussion of Failure Mode and Effects Analysis (FMEA) to encourage the implementation of remanufacturing activities. By making the remanufacturing activities possible to implement efficiently, manufacturer may decrease their production costs, decrease refuse and landfill materials, and increase their quality management.

ABSTRAK

Beberapa tahun kebelakangan ini, perkembangan penduduk yang semakin meningkatkan pembangunan ekonomi, kapasiti tapak pelupusan dan kesan persekitaran yang telah meningkatkan peranan penting aktiviti pembuatan semula. Selain itu, banyak barangan dan produk lama dilupuskan di tapak pelupusan di akhir hayat penggunaannya tanpa menjalani sebarang proses pemulihan telah membawa kesan ruang tapak pelupusan telah berkurangan di seluruh dunia termasuk negara kita. Perkilangan semula adalah proses di mana produk yang digunakan dikembalikan kepada keadaan asal dengan pembaziran yang minimum terhadap perbelanjaan ke atas bahan-bahan dan tenaga. Kajian ini adalah untuk belajar dan menganalisis konsep amalan perkilangan semula dalam sektor automotif. Malaysia kini dijana dengan bahan buangan di sektor pembuatan terutama dalam sektor automotif. Oleh sebab yang demikian, sistem pembuatan semula konvensional yang telah dibina di Malaysia, namun tidak dipasarkan secara meluas dan kekurangan aplikasi praktikal. Kajian ini menyediakan analisis perkilangan semula untuk penambahbaikan kepada sektor automotif pada blok enjin. Tambahan pula, kajian ini membentangkan maklumat berdasarkan perbincangan Analisis Mod Kegagalan dan Kesan (FMEA) bagi menggalakkan pelaksanaan aktiviti-aktiviti perkilangan semula. Dengan membuat aktiviti-aktiviti perkilangan semula mungkin untuk dilaksanakan dengan cekap, pengilang boleh mengurangkan kos pengeluaran mereka, mengurangkan tapak pelupusan sampah sarap dan bahan-bahan, dan meningkatkan pengurusan kualiti.

DEDICATION

Specially dedicated to my beloved father Hashim Bin Said and my mother Aslina Binti Osman who are very caring, understanding, patient and supporting. Thanks for everything to my supervisor, Mr. Baharudin Bin Abu Bakar for his constructive guidance, encouragement and patient in fulfilling our aspiration in completing this research. I also would like to express my sincere thanks to my co. supervisor, Mr. Tajul Ariffin bin Abdullah for his kindness, helpfulness and sharing do to me.

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LIST OF ABBREVIATIONS

CFC – Chlorofluorocarbon

CNC - Computer Numerical Controlled

DET - Detectability

EPA - Environment Protection Agency

FMEA - Failure Mode and Effects Analysis

MTI - Motor Teknologi and Industri Sdn. Bhd.

MRO - Maintenance Repair and Overhaul

OCC - Occurrence

OEM - Original Equipment Manufacturer

PSM - Projek Sarjana Muda

REP - Repairability

RPN - Risk Priority Number

SEV - Severity

CHAPTER 1

INTRODUCTION

1.1 Introduction

Product waste is becoming a major causes in our life due to critical environment impact and landfill space. In order to reduce waste into landfill, durable product can be remanufactured. Remanufacturing is an industrial practice which can be summarized as a series of manufacturing steps acting in an end of life part or product in order to return it to like new or better performance, with a warranty to match (Parker, 2007). It is such as a process for used product becomes a new product with form by necessary operation such as disassembly, cleaning, and replacement.

Remanufacturing activities apply to a various industries that include automotive industries, electrical and electronic industries and many more as the most important to offer gaining of benefits and growth potential to the industries. Realizing the potential for profitable remanufacturing, many independent businesses have emerged to exploit specific remanufacturing opportunities (Galbreth and Joseph, 2005).

However, remanufacturing had stronger representation in the automotive industries. This industrial practice has a relationship with the automotive industries in the world many years ago, for example the United States where since the Second World War and until now considered as the largest remanufacturer in the United States and automotive parts account for the largest civilian sector within the remanufacturing sector (Margarete, 2001).

Relate to the title of this project on *Remanufacturing Analysis by using Failure Mode and Effects Analysis (FMEA) for Engine Block*, it is important that our country to implement this remanufacturing activity. It is can able to bring up the various benefits such as transform our economy of automotive sector at a higher level than at present.

1.2 Problem Statement

In Malaysia, one of the significant remanufacturing commercial activities is the automotive remanufacturing or rebuilt commercial vehicle industry. The industry has evolved in two eras, in 1970s and late 1990s, the periods when the construction sector was booming. The question is how far our country involvement in this remanufacturing activities and is it still active to this day for our automotive industries since despite of its importance in bringing a sustainable development of a country, no detail studies have been conducted on the effectiveness of this practice in Malaysia (Harlina, 2009).

Although remanufacturing has been practiced for many years in many countries throughout the world such as Germany, Spain, Thailand and Indonesia, however, there seems to be no contradiction in the definition of remanufacturing. The standard procedure has also been clearly explained, in which it involves a process of disassembling, cleaning, refurbishing, replacing parts and reassembling a product in such as manner that the part is at least as good or better than new (Harlina, 2009). By this evidence are proved well that Malaysian automotive industries must implement this remanufacturing activity to gain both the environmental and business benefits of remanufacturing. It is important for encourage and driven the remanufacturing activities to gain both the environmental and business benefits.

1.3 Objective

The objectives of this project are related to the remanufacturing activities which are will implement to Malaysian automotive industries such below:

- a) To study the concept of remanufacturing and its operating principles.
- b) To analyze current process of remanufacturing practices in automotive products.
- c) To apply Failure Mode and Effects Analysis (FMEA) approach for remanufacturing of automotive engine block.

1.4 Scope

The scopes for this project are the general information of remanufacturing which it is important and are the one option amongst a number for dealing with end of life products. Besides that, the studies of remanufacturing in automotive industries also are covered in this report, so that the activities can be implemented in our country. The other sectors of industries due to remanufacturing activities are not being covered in detail in this study.

1.5 Report Organization

This report contains five major chapters which are Introduction, Literature Review, Methodology, Discussion and Conclusion.

- a) Chapter 1: Introduction

Chapter 1 will explain on Background, Problem Statement, and Objective of the project, Scope and limitation of the project, Report Organization and Final Year Project Planning Flow Progress.

b) Chapter 2: Literature Review

Chapter 2 will explain in the literature review. The information which is related to the project was studied and summarized. The literature review is based on journal, magazines, conference, books and studies past course

c) Chapter 3: Methodology

Chapter 3 will explain on methodology. This chapter explains and elaborate more on research method, and the process flow on how to conduct the research method. This chapter shows the project flow from beginning until it's finished.

d) Chapter 4: Data Collection

Chapter 4 will explain on data collected by survey and site visit. This chapter elaborates the remanufacturing activities and process procedure during remanufacturing the diesel engine.

e) Chapter 5: Design for Remanufacturing by FMEA

Chapter 5 will elaborate the implement of Failure Mode and Effects Analysis based on the Design for remanufacturing. One of the diesel engine parts is chosen to analyze by the FMEA approach.

f) Chapter 6: Results and Discussion

Chapter 6 will explain the result of analysis and followed by discussion and recommendation of improvement and action had been taken.

g) Chapter 7: Conclusion

Chapter 7 will explain on conclusion and recommendation according to the result of analysis. The recommendation of this study are based on the action taken in FMEA worksheets.

1.6 Final Year Project Planning Flow Process

In order to accomplish the project within the time provided, a Gantt chart is designed to show the schedule of the project. The Gantt chart is very important as a guide that used to monitor the entire project progress.

Table 1.1: PSM 1 Gantt Chart

GANTT CHART FOR PSM 1																	
No.	Task	Week															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Determination on title of the project	■															
2.	Research, study and understand the title	■	■														
3.	Find the information related to the project based on journal, books, conference, and magazine.		■	■	■	■	■	■	■	■							
4.	Discuss with supervisor on Objective, Scope and Problem statement			■	■	■											
5.	Chapter 1 Introduction					■	■	■	■								
6.	Chapter 2 Literature review						■	■	■	■	■						
7.	Chapter 3 Methodology									■	■	■	■				
8.	Review chapter 1,chapter 2 and chapter 3 with Supervisor										■	■	■	■			
9.	Complete the report and submit to supervisor														■		
10.	Preparation of presentation															■	
11.	Presentation of PSM 1																■

Table 1.2: PSM 2 Gantt Chart

GANTT CHART FOR PSM 2																	
No.	Task	Week															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Industrial visit to MTI remanufacturing company	■															
2.	Research and study the remanufacturing approaches due to failure remanufacturing product of MTI company	■	■														
3.	Find the information related to the approach on journal, books, conference, and magazine.		■	■	■	■	■	■	■	■							
4.	Discuss with supervisor on approach and action taken			■	■	■											
5.	Chapter 4 Data collection					■	■	■	■								
6.	Chapter 5 FMEA approach						■	■	■	■	■						
7.	Chapter 6 and chapter 7 Discussion and conclusion									■	■	■	■				
8.	Review all chapter with Supervisor										■	■	■	■			
9.	Complete the report and submit to supervisor														■		
10.	Preparation of presentation															■	
11.	Presentation of PSM 2																■

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A lot of research has been conducted on remanufacturing by today. There are various definitions for remanufacturing. Remanufacturing is an industrial practice which can be summarized as a series of manufacturing steps acting in an end of life part or product in order to return it to like new or better performance and with a warranty to match (Parker, 2007). Remanufacturing also can be summarized in other definition that presented by Walsh (2010) as a returning used product via a manufacturing process to at least its original performance with a warranty that is equivalent or better than that of the newly manufactured product. Remanufacturing have a large relationship with the manufacturing activities which that while the manufacturing process produces new products, the remanufacturing process take a durable product at the end of life and transform them to a like new condition for reuse.

Remanufacturing is generally applied to complex manufactured products that possess material, energy and labor such as in automotive industries, machining industries, electronic industries and many more. Many different types of products can go through remanufacturing process, including auto parts, tires, furniture, laser toner cartridges, computers, and electrical equipment. Basically any product that can be manufactured can also be remanufactured. Often, remanufacturers upgrade the products from old to current performance standards of energy efficiency or productivity. Although remanufacturing has been practiced for many years in many countries throughout the world such as Germany, Spain, Japan, United State and many more, there seems to be no contradiction in the definition of remanufacturing.

The standard procedure has also been clearly explained, in which it involves a process of disassembling, cleaning, refurbishing, replacing parts and reassembling a product in such a manner that the part is at least as good as, or better than, new (Hammond et al., 1998). This was supported by Fargher (2005) which remanufacturing is the only process where used products are brought at least to Original Equipment Manufacturer (OEM) performance specification from the customer's perspective and at the same time, given warranties that are equal to those of equivalent new products.

Today, the authorities force by means of environmental laws that manufacturers reduce the amount of waste generated by their products and also environmental factors put pressure on manufacturers to start waste reduction programs (Erwin et al., 1996). One of the options to reduce waste is to remanufacture, while used products are returned from the market. Upon return, the used products are tested, cleaned, and repaired. Typical for remanufacturing is the product is suitable to be re-sold in the market of new products. This implies that remanufactured products need to satisfy the same quality standards as new products. As mentioned by Steinhilper (1998, p6) "We all know that there is only a certain amount of natural resources on this planet. The closer we get to zero waste, the more future generations will enjoy the same material wealth that we enjoy today".

There are many activities in term that encourage to waste reduction in order to prevent waste from going to landfill sites aside from remanufacturing, this is illustrated in Figure 2.1.

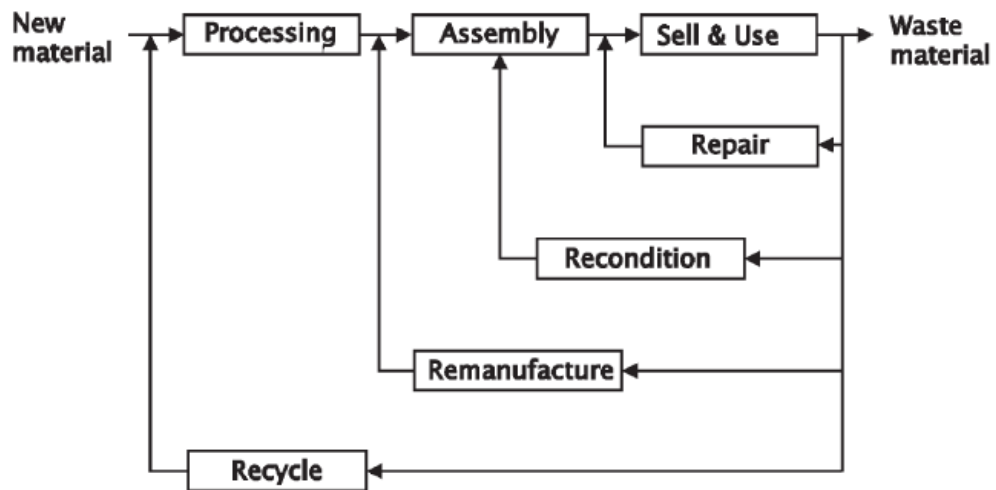


Figure 2.1: Waste Reduction Activities (Parker, 2007,p16)

The Figure 2.1 shows that a new material will be processed and assembled before it going to sell and be used as a product. When the product are reaching to the end life period, the product going to be waste to landfill. With recovery process such as remanufacturing, the product possibly going to landfill are decreased. The another recovery process such as recondition, repair and recycle are also play the important role due to decreasing the time for product enter the waste stream.