



**Faculty of Mechanical and Manufacturing Engineering
Technology**

**MANUFACTURING SELECTION FOR NATURAL FIBRE
COMPOSITE AUTOMOTIVE COMPONENT**

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**Bachelor of Manufacturing Engineering Technology (Process and Technology) with
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**MANUFACTURING SELECTION FOR NATURAL FIBRE COMPOSITE
AUTOMOTIVE COMPONENT**

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DEDICATION

I dedicate this project to my beloved mother and father for always being there for me.

ABSTRACT

Manufacturing process selection is a process of determining the most appropriate process to fabricate the automotive door panel. The early consideration of manufacturing process in the product development is important in concurrent engineering to achieve a reduction in product development time, production cost, and quality defects. However, there are several factors involved in the step of selection manufacturing process such as the desired properties, size and shape of resultant composites, processing characteristic of raw material, the production speed and the manufacturing cost need the consideration. This study focuses to select the suitable manufacturing process for natural fiber composite of the door panel by compute the process selection according to the product design specification. Determining the right manufacturing process was performed based on fuzzy analytic hierarchy process (FAHP) with extent analysis and analytic hierarchy process concepts. The AHP and FAHP with extent analysis can be obtained from crisp number and triangular fuzzy comparison matrix, meanwhile, the extent analysis in this method is referred to the consideration of the extent to which an object satisfies the objective. The results show that Injection Molding is the best selection of manufacturing process, as in AHP and FAHP with extent analysis method, to fabricate automotive door panel by considering all the criteria and sub-criteria. Lastly, the result from both methods were compared and it is showed that the similar priority ranking in AHP and FAHP with extent analysis data.

ABSTRAK

Kaedah pemilihan proses pembuatan ialah salah satu aspek dalam menentukan proses yang sesuai digunakan untuk mencipta panel pintu kereta. Pertimbangan awal proses pembuatan dalam pembangunan produk adalah penting untuk bidang kejuruteraan bagi mencapai penurunan dalam masa pembangunan produk, kos pengeluaran dan kecacatan mutu. Walaubagaimanapun, terdapat beberapa faktor yang terlibat dalam proses pemilihan pembuatan seperti saiz dan bentuk komposit yang digunakan, proses bahan mentah, dan kos pengeluaran yang harus dipertimbangkan. Oleh itu, kajian ini dilakukan bertujuan bagi memilih proses pembuatan yang sesuai untuk mencipta panel pintu kereta menggunakan komposit serat asli dengan mengambil kira spesifikasi reka bentuk produk. Kaedah FAHP with extent analysis dan Analysis Hierarchy Process (AHP) diaplikasikan untuk mengenal pasti proses yang sesuai digunakan untuk proses pembuatan. Kaedah ini dapat diperolehi daripada perbandingan matriks dan extent analysis yang berkait rapat dengan matlamat kajian. Proses pembuatan optimum harus ditentukan berdasarkan keperluan reka bentuk dan faktor yang mempengaruhi proses pemilihan. Kemudian, analisis kepekaan dijalankan bagi menguji kestabilan susunan prioriti dan kesan daripada faktor yang berbeza dalam menentukan pilihan keputusan terbaik. Injection molding adalah proses pembuatan yang dipilih berdasarkan kriteria dengan menggunakan kaedah AHP dan FAHP with extent analysis.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In this chapter, the background study of manufacturing process selection for natural fiber reinforced polymer composite in the door panel is discussed. The problem identification of the project was identified. Then, the objective and scope of the project were stated based on problem statement to solve the problem occurred. Moreover, the expected result from this project is also discussed based on the scope requirement. The thesis structure of the project is constructed to shows the process flow of each chapter in this report.

1.1 Background Study

Natural fiber is the sourced of fiber that can be obtained from plant or animal. In other words, natural fiber reinforces polymer composites are a composites material consisting of a polymer matrix embedded with high-strength natural fibers. Taj, Munawar, and Khan (2014) claimed that the composites are materials that comprise strong load carrying material embedded in the weaker material while, reinforcement provides strength and rigidity, and helping to support a structural load. The concept of using naturally derived fibers from the plant as reinforcement in composite structure has been successfully utilized and variety of material can be selected to enhance stiffness, strength and impact resistance by the material (Fuqua, Huo, and Ulven, 2012).

Tushar (2015) study the fiber reinforced polymer matrix that considered can be functioned in numerous applications because of the good properties and superior advantage of natural fiber over synthetic fibers in term of low density, low cost, availability, recyclability, and biodegradability. The growing of natural fiber polymer composite is an increase in various sectors of engineering fields (Mohammed, Ansari, Pua, Jawaaid, and Islam, 2015). The characteristic of natural fiber which is lightweight and low-cost makes it becomes potential material in numerous automotive interiors and exterior (Holbery and Houston, 2006).

Mohammed et al., (2015) also state that the natural fiber reinforced polymer composite has become important in different types of automotive applications by many automotive companies such as German auto company, Proton company, and Cambridge industry. The characteristic of natural fiber as lower price, weight reduction, recycling, and marketing incentives make it is adopted in automotive components (Faruk, Bledzki, Fink, and Sain, 2014). The trend of produce automobile industry with the low-weight material will enhance the application potential of natural fiber composites eventually leading to the ultimate vision of cars that grow on the tree (Zah, Hischier, Leao, and Braum, 2007).

Generally, the traditional manufacturing technique is applied to fabricated the natural fiber plastic composites. The technique includes resin transfer molding (RTM), vacuum infusion, compression molding, direct extrusion, hot pressing, compounding and injection molding. However, there are several factors that influence the processing of natural fiber composites such as fiber type, fiber content, fiber orientation, and moisture content of fiber.

Manufacturing process selection is a process of determining the most appropriate process to fabricated the automotive door panel. There are several manufacturing processes involved in fabricated automotive door panel which is injection molding (IM), structural

reaction injection molding (SRIM), thermoforming, prepreg development and compression molding (CM). However, there are several factors involved in the procedures of selecting manufacturing process.

The factors that involved in the selection of manufacturing process is the parameter of the product design specification required. Then, by applying the appropriate selection tool, the method will assist in the selection process to determining the most suitable manufacturing process. For this study, the selection tool of Analytic Hierarchy Process (AHP) and Fuzzy AHP with extent analysis methods are apply to determine and to compare the differences on the selection of manufacturing process. The final decision on suitable manufacturing process selection will be proceed based on the requirement of product specification.

1.2 Problem Statement

The early consideration of manufacturing process in the product development process is important in concurrent engineering to achieve a reduction in product development time, production costs, and quality defects (Hambali, Sapuan, Ismail, and Nukman, 2009). The error occurred in the manufacturing process is one of the factors effects on the incorrect selection of manufacturing process. This is due to the transformation of material to the final shape product require appropriate manufacturing process to avoid causing any defect (Ho et al., 2012). Some of the critical issues also happened and will damage the fiber during a manufacturing process is the main causes of the reduction of the strength of the composites.

Other than that, the manufacturing process selection is performed to assists the designer engineer to select the suitable process required. This is to avoid the designer to redesign the product because of the lateness identify the constraints imposed by a

manufacturing process. Thus, the consideration in selection manufacturing process is important to improve the efficiency of manufacturing products. At the early stages, the determination of suitable process is important to avoid the penalty cost of making changes become higher (Hambali et al., 2009).

The selection of manufacturing process is a critical task due to considering various factors. These factors include the desired properties, size, and shape of resultant composites, a raw material used, production speed and cost of manufacturing that need to take into consideration in the selection of right manufacturing process (Ho et al., 2012). Basically, the decision of choosing the manufacturing selection is assisted by applying the appropriate selection method. The selection method using Analytic Hierarchy Process (AHP) Fuzzy Analytic Hierarchy Process (FAHP) were applied to assist manufacturing engineer in determining the most suitable manufacturing process for this research.

1.3 Objectives

The objectives of conduct these studies are:

1. To study the characteristics of manufacturing process for natural fiber composites in automotive door panels.
2. To synthesize the process selection of manufacturing process for automotive door panel using Analytic Hierarchy Process (AHP) and Fuzzy AHP (FAHP) with extent analysis.
3. To select the suitable manufacturing process for natural fiber composite of the door panel.

1.4 Project Scope

This research is conducted to identify the suitable manufacturing process for natural fiber in the door panel. The selection of manufacturing process is conducted based on the manufacturing requirement in the concurrent engineering environment. Based on the objectives, the scopes of study are highlighted as follows:

- a) The selection manufacturing process for door panel is based on the composite material used, standard patent and critical issues in the manufacturing process of natural fiber.
- b) The constraint of manufacturing process is developed to set the standard requirement for fabricated automotive door panel.
- c) The Analytic Hierarchy Process (AHP) and Fuzzy Analytic Hierarchy Process (FAHP) with extent analysis technique are used as the decision-making tools to assist in the selecting suitable manufacturing process of particular natural fiber door panel.

1.5 Thesis Structures

Chapter 1:

This chapter introduces the brief idea of the project. It focused on the overview of the project, background study, the problems statement, detailing the objectives and scope, and the expected result outcome from the project.

Chapter 2:

This chapter concentrate on the literature review that will describe all the information that was referred as a reference in order to complete the research project. Generally, literature review consists of facts and theoretical identification from a previous research that provides a guideline for the project to build up.

Chapter 3:

The methodology of the research conducted is discussed in this chapter. The schedule that needs to be completed and the detailed reports of studies that were done to achieve the aim of the project are presented. The methodology is the important aspect of it as the beginning process of planning. If the methodology is not organized only then will encounter the problem involved in the project.

Chapter 4:

This chapter shows the result and discussion of the project. All the data collection and the process involved in selection processes will be discussed in detail. The results will be compared with the objectives outlined in order to arrive at some hypothesis and conclusion.

Chapter 5:

This is the last chapter that proved the success achieved by the objective stated in the earlier chapter. This project can be concluded and explain the detail in this chapter. Other than that, a future recommendation for this project also includes improving this project for the future improvement.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Natural fiber reinforces polymer composites (NFRPC) is a type of composites material consisting of polymer matrix embedded with high-strength natural fibers like jute, oil palm, sisal, kenaf, and flax. According to Mohammed (2015), natural fibers are getting attention from researcher and academician to utilize in polymer composites due to their eco-friendly nature and sustainability. Moreover, natural fibers have possessed unique physical and mechanical properties and also cost-effective processing. This characteristic made them considered as the reinforcing phase of composites.

The potential of natural fibers as the reinforcing phase for polymer composites are important as they are renewable, biodegradable and minimize the effects on the environmental issues. In addition, plenty of different natural fiber has been used in automotive industries such as hemp fiber epoxy, flax fiber polypropylene (PP), and China reed fiber PP due to their low bulk density and lower production cost. Thus, the burgeoning demand for natural fiber reinforces polymer composite has grown the production of high-performance engineering products from the renewable resource.

Generally, traditional manufacturing technique has been designed for conventional fiber-reinforced polymer composites such as compression molding, injection molding and vacuum infusion that are considered to be efficient. However, fabrication of natural fiber is challenging due to their low stability during processing. The requirement of understanding

for the structure and properties of natural fiber which have low thermal stability and low mechanical resistance to shear and compatibility with conventional thermoplastic are needed to achieve success ability in the production (Ho et al., 2012). There is importance correlation in selection material and processing methods to the final properties. Thus, pretreatment of fiber surface is necessary to improve the interfacial interaction between fiber and matrix polymer.

The natural fiber market is expected to be largest till 2016 in automotive industries due to their low weight, lower production cost, and recyclability (Faruk et al., 2014). According to Salit, Jawaid, Yusoff, and Hoque (2015), a remarkable trend of utilizing natural fiber-reinforced can be noticed by the concerning the environmental issues related to the disposal of plastic waste. Moreover, a various product of interior and exterior of the automotive component have been marketed.

In this chapter, the manufacturing process for natural fiber has been discussed based on the stage, requirement, and type of manufacturing. The characteristics of natural fiber have been considered in the selection of processing method. Moreover, the study on the process of manufacturing door panel has been carried out with the reference of the composite material and standard patent for the door panel. On the other hand, the selection tool in selective processing method and the issues related to machining between material and processing method are identified.

2.1 Manufacturing Process for Natural Fiber Reinforce Polymer Composites

A plant fiber is a new generation of reinforcing material that can be classified as seed hair, bast fibers, and leaf fibers (Faruk et al., 2014). Plant fibers have complicated composite cell structures which composed of cellulose microfibrils that reinforce the lignin and