UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EVALUATION OF MANUFACTURING PROCESS CHOICE USING ANALYTICAL HIERARCHY PROCESS (AHP) METHOD

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

by

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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 Management) (Hons.). The member of the supervisory is as follow:

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ABSTRAK

Projek ini bertujuan untuk mengkaji kriteria utama dan sub-kriteria bagi proses pemesinan dalam industri di samping mencadangkan satu rangka kerja bagi pemilihan proses dalam proses pemesinan. Ini adalah kerana masalah ini yang sering berlaku dalam industri yang sukar membuat keputusan untuk pilihan proses. Dari rujukan kajian sebelum ini, matlamat ini boleh dicapai dengan pelaksanaan kaedah Proses Analisis Hierarki (AHP) yang mana kaedah ini boleh membantu dalam menyiasat kriteria yang menggambarkan struktur hierarki. Dari struktur hierarki, alternatif akan ditakrifkan untuk menyelesaikan masalah tersebut. Selain itu, kaedah ini juga dapat menyelesaikan masalah yang boleh digunakan sebagai alat dalam membuat keputusan. Oleh itu, projek ini akan mengkaji kaedah AHP. Mengenai data yang terlibat, ia akan dikumpulkan oleh pengedaran soal selidik yang mana soal selidik tersebut mengandungi 16 soalan yang berkaitan dengan kaedah ini. Responden yang terlibat adalah di antara orang-orang industri yang mengendalikan proses pemesinan. Kemudian, data yang dikumpul akan dipindahkan ke perisian bernama Minitab untuk memeriksa kesahihan hasil dari soal selidik berdasarkan nilai Cronbach. Tetapi, perisian Excel juga akan digunakan untuk mendapatkan penyelesaian bagi kaedah AHP yang mana kaedah matrik didefinisikan. Dari analisis data, ia akan menunjukkan sama ada kriteria utama dan sub-kriteria boleh ditakrifkan atau tidak. Kemudian, hasilnya juga boleh membantu dalam membentuk rangka kerja.

ABSTRACT

This project aim to investigate the main criteria and sub-criteria for machining process in an industry and to suggest a framework for process choice in machining process. This is because of problem happens in industry which is difficult in making decision for process choice. From the reference of previous study, this aim can be achieved by implementation of Analytical Hierarchy Process (AHP) method which is AHP method can help in investigating the criteria by illustrating the hierarchy structure. From the hierarchy structure, alternatives will be defined to solve the problem. Besides, this method can also solve the problem which is used as a tool in decision making. Therefore, this project study on AHP method. About the data involves, it had collected by distribution of questionnaire which the questionnaire contain 16 questions related to this method. The respondents that involved are among the industry people that handling machining process. Then, the data collected will be transferred to statistical software named Minitab to check the reliability of questionnaire from the result of Cronbach's value. Finally, the Excel software will be used in getting the solution for AHP method. From the analyzing of data, it will show whether the main and sub-criteria can be determined or not. Then, the result will be used in helping for developing of framework.

DEDICATION

Dedicated to my beloved parents, siblings, lecturers and all friends.

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LIST OF ABBREVIATIONS SYMBOLS AND NOMENCLATURES

AHP	- Analytical Hierarchy Process
CIM	- Computer Integrated Manufacturing
DM	- Decision Making
EWMA	- Exponentially Weighted Moving Average
LP	- Linear Programming
MCDM	- Multi-criteria decision-making
TVP	- Total Value of Purchasing

CHAPTER 1

INTRODUCTION

This chapter describes introduction, project background, problem statements, objectives and scope of project. The title for this project is "Evaluation of Manufacturing Process Choices using Analytical Hierarchy Process (AHP) method". Therefore, this project will focus on AHP method.

1.1 Project background

Analytical Hierarchy Process (AHP) method is a method that used in solving problem to make an effective decision. This method has been widely used as a multi-criteria decision making tool in industry as it is simple to use and understand (Chan., 2003). Usually, this method used to choose the best process in enhancing the productivity in an industry. The basic idea behind AHP method is to convert subjective assessments of relative importance into a set of overall scores and weights (Dodgson et al., 2000).

The main reasons behind the wide applicability of AHP method is its simplicity, since it does not involve cumbersome Mathematics then the relative ease with which it handles multiple criteria, its great flexibility that being able to effectively deal with both qualitative and quantitative data and the ease of understanding (Ho et al., 2009 and Kahraman et al., 2003).

This method not only applied in Manufacturing industry(Ozgen et al., 2008; Tahiri et al., 2008; Asamoah et al., 2012; Ramanathan., 2013 and Verma et al., 2013) but there are variety of industries apply this method which it has been applied in General electronics

industry(Chen et al., 2007; Gencer et al., 2007; Lee et al., 2009; Yang et al., 2008 and Wu et al., 2009) , in Home appliances industry(Sevkli et al., 2003 and Zaim et al., 2003; Demirtas et al., 2008; Sevkli et al., 2008; Kilincci et al., 2012),in Automotive/tyre industry (Noaul Haq et al,.2006), in Semiconductor industry (Ebi et al., 2003; Bottani et al., 2005), in Telecommunication industry (Onut., 2008), in Logistic industry (Buyukozkan et al., 2008) and in Commercial tools industry (Schoenherr et al., 2008).

AHP method was proposed by Thomas L. Saaty in 1980, which is able to solve the multiple criteria decision making (MCDM) problems. AHP utilize three principles to solve problems (Aydogan., 2011; Podvezko., 2009; Sivilevicius., 2011). The three principles are:

1) Structure of the hierarchy,

2) The matrix of pair wise comparison ratios, and

3) The method for calculating weights.

Saaty (1980) proposed four basic steps to deal with the AHP problems:

1) Modelling- It involves the construction of a hierarchy at different levels of criteria, sub-criteria and alternatives.

2) Valuation- Based on a 1 to 9 ratio-scale measure, the decision making (DM) provide judgments over paired comparisons of objectives at each level of the hierarchy.

3) Prioritization- Using prioritization methods to derive local priorities of the objectives at each level of the hierarchy.

4) Synthesis- Using aggregation procedures (such as the weighted arithmetic average and the geometric mean) to synthesize the local priorities into global priorities of the alternative.

Its philosophy is based on the intention to provide a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions. It is based on Mathematics and Psychology.

AHP method requires the establishment of a hierarchy of criteria which is important to achieve the goal of the decision problem. The hierarchy structure includes main and sub-criteria and alternative with the purpose. Actually, the aim of creating a hierarchy is to get reflection the relationship between the purpose of the comparison and the result that desired to obtain.

The study for this project is focused on the making decision in choosing a process in an industry by using AHP method.

1.2 Problem statement

In a manufacturing industry, there always become a problem in choosing the best machining process among processes. This is because of no specific method used in decision making. Besides, the machining process (milling, turning, grinding) cannot be selected easily because of their own advantages. To increase the productivity, there are many criteria that must be considered for several times likes lead time of supply, part critically, availability, stock-out penalty costs, ordering cost, scarcity, durability, substitutability, reparability etc. (Flores & Whybark., 1986, 1987; Zhou & Fan., 2007). Furthermore, the time constraint in an industry cause the problem happens. Therefore, to make a decision in choosing which process is the best, AHP method can be used as a tool in decision making. AHP method can also be used as to achieve the industry's goal in making decision for choosing the best process. Excel software can be used to give a reasonable answer which is ranking for each calculated process.

1.3 Objectives

The objectives of this project are:

i. To investigate the main criteria and sub-criteria for selecting the machining process in industry.
ii. To establish alternative of process choice and develop a framework for decision making in machining process.
iii. To propose the framework in choosing machining process to related industry.

1.4 Project scope

To achieve the objectives of project, software named Minitab and Excel were used to help in ranking the multi-criteria of the machining processes that focus on the manufacturing industry. One of machining process will be chosen as the best process after the ranking was done based on the main criteria and sub-criteria of the process. Then, a data was collected by distributing the questionnaire based on main criteria and sub-criteria of machining processes. After the data was collected, it was transferred into the both of software where the methodology in collecting of data will be explained detail in Chapter 3. Besides, this software will help the user in making a decision by showing a result after the criteria had been compared. All the steps and result were in the next chapter.

CHAPTER 2

LITERATURE REVIEW

This chapter will provide the review on previous research that is related to this study. There are many previous researches on AHP method which had implemented in various fields. AHP method not only suitable to implement in the industry, but this method can be used as a tool in making decision in various fields.

2.1 Application of AHP Method in Industry

In an industry, there will be numerous types of process. Among them, it must be picked the best one whether a process that has shorter time, a process can decrease waste or the most essential one is a process that can expand a profit. Anyhow, to pick the best process is not a simple job in an association when each one process has its own great criteria. Accordingly, AHP method is a method that can be related as a tool in settling on choice of the best methods.

It has been a standout amongst the most broadly utilized multi-criteria choice making device to model certifiable choice issues. This method considers both unmistakable and impalpable criteria (Erdogmus et al., 2006). AHP method is a process that needs assessment of various criteria and different. While, the option is the best one which originates from the sub-criteria that has great qualities.

Applying the AHP method in spatial multi-criteria choice investigation, as depicted in Malczewski (1999), it includes three noteworthy steps. For the first step, AHP method breaks down the choice issue into a chain of command of crucial components likes objectives and goals, criteria, and sub-criteria. Chiefs then, in the second step, think about these components on a pairwise comparison to gauge the relative essentialness of every component over one another, and make a correlation network of the positions for every various level. In the third step, these grids are consolidated with a specific end goal to structure composite weights speaking to the evaluations of choices concerning the objective.

The preferences of AHP method over other multi criteria routines are its adaptability, instinctive engage the decision makers and its ability to check inconsistencies (Ramanathan., 2001). For the most part, users find the pairwise comparison type of information data clear and helpful.

Moreover, the AHP method has the different playing point that it disintegrates a choice issue into its constituent parts and manufactures pecking orders of criteria. Here, the imperativeness of every component (foundation) gets to be clear (Macharis et al., 2004). The Figure 2.1 below shows the illustrating for structuring of hierarchy in AHP method which every criteria has its sub-criteria that must be chosen for an alternative. While, the alternative is the best one which comes from the sub-criteria that has good characteristics.

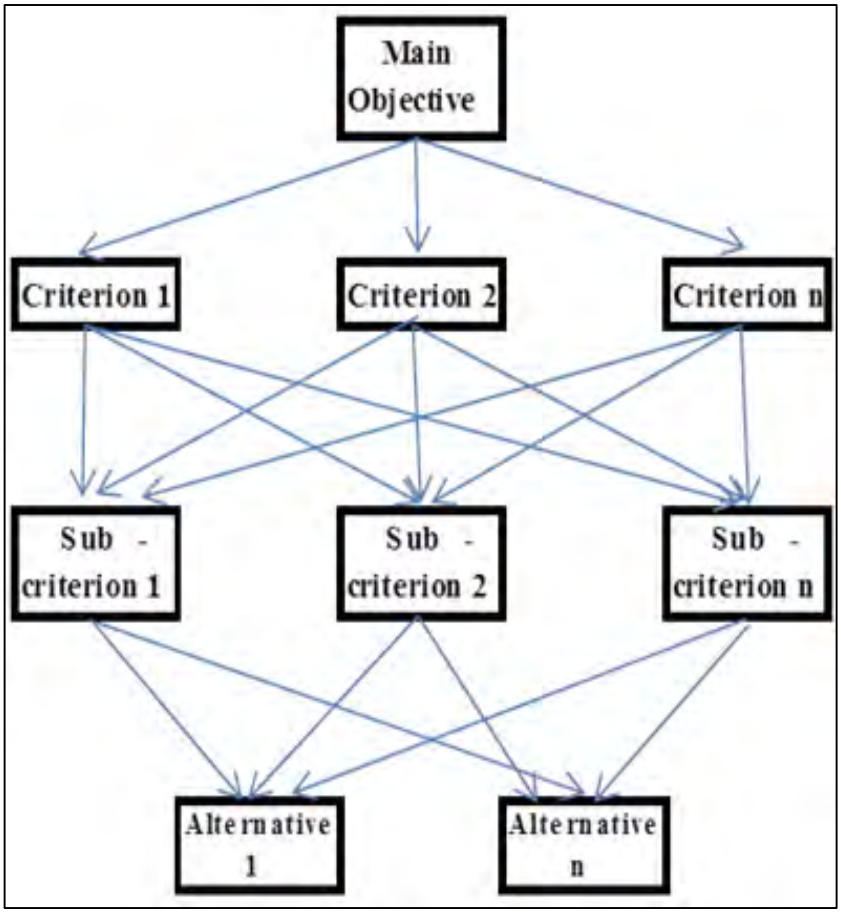

Figure 2.1: Model by Saaty 1980

(Source: http://www.acrwebsite.org)

2.2 Application of AHP Method for Supplier Evaluation and Selection in a Manufacturing Company

In any manufacturing industry, there will be supplier for raw material or unfinished products to process before it produced as a completed item. Yet, a great supplier must be chosen to verify nature of material supplied. As Sarkis et al., (2007) said, "The vitality of supplier determination can be ascribed to its control commitment to a company's capacity to streamline the quality, amount, dependability and cost of acquired merchandise and administrations."

Guller (2008) expressed that AHP method is extremely valuable for decision maker to form the sought choice making criteria and give a rule to focus the level of essentialness of diverse choice making criteria. In addition, it can help in getting the best choice. AHP method is regularly considered as a supplier determination technique on the grounds that it permits decision makers to rank suppliers focused around the relative vitality of the criteria and the suitability of the supplies (Saaty., 1980). In addition, it is a strategy for positioning a few choice plan B and selecting the best one when the chief has various goals, or criteria, on which to base the choice (Taylor., 2010).

In such circumstances, the choice making of obtaining administration can assume a key part in expense diminishment. In today's exceedingly aggressive environment, a powerful supplier determination procedure is critical to the achievement of any manufacturing organization (Liu & Hai., 2005).

In many commercial ventures, the expense of crude materials and segment parts constitutes the fundamental expense of an item, such that sometimes it can represent up to 70% (Ghodsypour & O'brien., 1998). Generally, numerous businesses understand that the push to get items at the right cost, in the right amount, with the right quality at the perfect time from the right source is vital for their survival (Oboulhas et al., 2004). Consequently, an effective supplier determination process needs to be set up and of principal vitality for fruitful store network administration (Sonmez., 2006). At that point, the AHP method is distinguished to support in choice making to intention the supplier determination issue in picking the ideal supplier mix (Yu & Jing., 2004).

Moreover, Ghodsupour and O'brion (1998) observed the clashes between two unmistakable and impalpable variables, in view of AHP method, i.e. subjective and quantitative which so as to pick the best suppliers. They coordinated AHP method and Linear Programming (LP) to consider both unmistakable and immaterial variables in picking the best suppliers which put in the ideal request amounts among them such that by utilizing incorporated AHP method and LP as the Total Value of Purchasing (TVP)