UNIVERSITI PUTRA MALAYSIA

AN ANALYTIC HIERARCHY PROCESS APPROACH FOR SUPPLIER EVALUATION AND SELECTION IN A STEEL MANUFACTURING COMPANY

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By

FARZAD TAHRIRI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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DEDICATION

To my dear parents, that I owe them each moment of my life, particularly my dear sister Farnaz for her affectionate caring

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman : Ir.Mohd Rasid. Osman, M.sc.

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Supplier selection is a complex problem involving qualitative and quantitative multi-criteria. A trade-off between these tangible and intangible factors is essential in selecting the best supplier. This problem initiated when there are limitations in the capacity in which the managers are compelled to decide about two issues: which suppliers are the best and how much should be purchased from each selected supplier.

Varieties of approaches have been applied, in the form of mixed integers, goal, and multi-objective programming to solve this problem. This approaches, being mathematical that have vital problems in considering qualitative factors. These study apply questionnaires to identify and adopt the important criteria for supplier selection based on related studies by Dickson (1966), Weber (1991) and Zhang's (2003).

In this work both tangible and intangible factors in choosing the best suppliers through analytical hierarchy process (AHP) were incorporated into Saaty's (1980) proposed method. AHP process makes it possible to place the optimum order

quantities among the selected suppliers, so that the total value of purchasing (TVP) becomes maximum. The Saaty's (1980) analytical hierarchy process (AHP) which is used in this case study can be useful in involving several decision makers with different conflicting objectives to arrive at a consensus decision. The main contribution of the study was identification of the important criteria for supplier selection process. The criteria found were Trust between key men, followed by net price and re-win percentage. Second contribution or findings was development of a multi-criteria decision model for evaluation and selection which is used for supplier selection in ABC steel company. Finally, the developed model is tested on four supplier selection problems. The results show the models are able to assist decision-makers to examine the strengths and weaknesses of supplier selection by comparing them with appropriate criteria, sub-criteria and sub sub-criteria. Further more, the systematic effect of this process, can reduce the time taken to select a supplier.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENDEKATAN "ANALYTIC HIERARCHY PROCESS"BAGI PENILAIAN DAN PEMILIHAN PEMBEKAL DALAM SYARIKAT PEMBUATAN KELULI

Oleh

FARZAD TAHRIRI

Disember 2007

Pengerusi : Ir.Mohd Rasid. Osman M.sc.

Fakulti : Kejuruteraan

Pemilihan pembekal merupakan suatu masalah kompleks yang membabitkan pelbagai kriteria-kriteria kualitatif dan kuantitatif. Pertukaran antara faktor nyata dan tidak nyata adalah perkara penting dalam pemilihan pembekal yang terbaik. Masalah ini menjadi rumit apabila terdapat perbezaan di dalam kapasiti di mana pengurus terpaksa memilih di antara dua permasalahan; pembekal yang terbaik dan berapa banyak yang harus dibeli dari pembekal yang dipilih.

Pelbagai pendekatan telah diaplikasikan, dalam bentuk integer campuran, matlamat dan pelbagai objektif program untuk menyelesaikan permasalahan ini. Pendekatan ini menjadikan matematik mempunyai permasalahan penting dalam mempertimbangkan faktor kualitatif. Kajian ini menggunakan soal-selidik untuk mengenalpasti dan mengambil kriteria yang penting bagi pemilihan pembekal berdasarkan kajian yang telah dilakukan oleh Dickson (1966), Weber (1991) and Zhang's (2003).Teknik-teknik ini berunsurkan matematik dan mempunyai masalah

dalam faktor kualitatif. Untuk memilih faktor nyata dan tidak nyata dalam pemilihan pembekal yang terbaik, integrasi Saaty's (1980) "Analytical Hierarchy Process" (AHP) dicadangkan. Proses ini membolehkan kuantiti pesanan yang optimum boleh dibuat di antara pembekal yang dipilih. Oleh itu, nilai belian keseluruhan ("Total Value of Purchasing (TVP)") boleh dimaksimakan.

Saaty's (1980) "Analytical Hierarchy Process" (AHP) yang digunakan dalam kajian ini boleh dijadikan sebagai pendekatan berguna membabitkan pelbagai pembuat keputusan dengan pelbagai objektif yang rumit untuk mendapatkan keputusan yang tepat. Sumbangam utama penyelidikan ini adalah mengenalpasti criteria utama proses pemilihan pembekal. Kriteria utama adalah kepercayaan diantara penguasa bertangungjawab, di ikuti harga tawaran, dan peratusan peluang. Sumbangan kedua adalah pemilihan multi-kriteria pemilihan model untuk ABC syarikat keluli. Akhiranya, model yang telah dibangunkan di uji dan keputusan dapat membantu pihak pengurusan memilih pembekal. Dalam kajian ini, kaedah "AHP" digunakan untuk perkembangan suatu model keputusan untuk mengenalpasti ciri-ciri yang paling penting bagi pemilihan pembekal dan pemilihan pembekal yang sesuai dalam syarikat pembuatan keluli. Tambahan lagi, kesan efektif dari proses ini boleh mengurangkan masa untuk pemilihan pembekal.

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I also thank all other faculty members who somehow helped me prepare this assignment.

Last but not least, I would like to express my gratitude to my beloved parents, with their guidance, supports, love and encouragement; I had overcome most problems in my life.

I certify that an Examination Committee has met on 31st December 2007 to conduct the final examination of Farzad Tahriri on his Master of Science thesis entitled "An Analytical Hierarchy Process Approach for Supplier Evaluation and Selection in a Steel Manufacturing Company" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the degree of Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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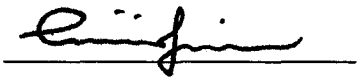

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

FARZAD TAHRIRI

Date: 24/January/2008

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LIST OF ABBREVIATIONS / GLOSSARY OF TERMS

ABC	Activity Based Costing
AMT	Advanced Manufacturing Technology
AHP	Analytical Hierarchy Process
ANN	Artificial Neural Network
CR	Consistency Ratio
CVS	Convenience Store
CRM	Cost Ratio Method
DSA	Differences Sensitivity Analysis
EC	Expert Choice
GSA	Gradient Sensitivity Analysis
JIT	Just In Time
LGP	Linear Goal Programming
LP	Linear Programming
MAS	Multi-media Authorizing System
MAUT	Multiple Attribute Utility Theory
MCDM	Multiple Criteria Decision Making
PSA	Performance Sensitivity Analysis
PCA	Principal Component Analysis
SS	Supplier Selection
SCM	Supply Chain Management
TCT	Time Compression Technologies
TCO	Total Cost of Ownership

TVP	Total Value of Purchasing
VPA	Vendor Profile Analysis
VAHP	Voting AHP
2D-SA	2D-plot Sensitivity Analysis

CHAPTER 1

INTRODUCTION

1.1 Introduction

In today's highly competitive environment, an effective supplier selection process is very important to the success of any manufacturing organization (Liu et al., 2005). Supplier selection is one of the most critical activities of purchasing management which has gained great importance in the supply chain management. It also functions as factors used in globalization, increased value added in supply, and accelerated technological change (Bello, 2003).

A supply chain is coordination between a manufacturer and suppliers which is typically a difficult and important link in the channel of distribution involved in the manufacturing of a product from the procurement of raw materials to the distribution of the final products to the customer (Chen Tung et al., 2006). Purchasing commands a significant position in most organizations since purchased parts, components, and supplies typically represent 40 to 60 percent of the sales of its end products (Ballow, 1999).

Selecting the right supplier is always a difficult task for the purchasing manager (Liu et al., 2005). Purchasing involves buying the raw materials, supplies, and components for the organization. The activities associated with it include selecting and qualifying suppliers, rating supplier performance, negotiating contracts, comparing price, quality and service, sourcing goods and service, timing purchases, selling terms of sale, evaluating the value received, predicting price, service, and

sometimes demand changes, specifying the form in which goods are to be received, etc. (Bello, 2003).

Based on the information, as purchasing is quite vital for the manufacturer, seeking the right supplier is utterly significant for the company. Suppliers have varied strengths and weaknesses which require careful assessment by the purchasers before ranking can be given to them (Liu et al., 2005).

During the 1990s, many manufacturers seek to collaborate with their suppliers in order to upgrade their management performance and competitiveness (Chen-Tung et al., 2006). Thus the supplier (vendor) selection process has received considerable attention in the business-management literature due to the key role of supplier's performance on cost, quality, delivery and service in achieving the objectives (Amid et al., 2006).

The overall objective of supplier selection process is to reduce purchase risk, maximize overall value to the purchaser, and build the closeness and long-term relationships between buyers and suppliers, (Monczka et al., 1998) which is effective in helping the company to achieve ' just-in- time' (JIT) production (Li et al., 1997).

The supplier (vendor) selection process would be simple if only one criterion were used in the decision making process. However in many situations, purchasers have to take account of a range of criteria in making their decisions. If several criteria are used then it is necessary to determine how far each criterion influences the decision making process, whether all are to be equally weighted or whether the influence varies accordingly to the type of criteria (Yahya and Kingsman, 1999).

Supplier selection problem has become one of the most important issues for establishing an effective supply chain system. The supplier selection problem in supply chain system is a group decision-making under multiple criteria out of which

quantities criteria has been considered for supplier selection in the previous and existing decision models (Chen-Tung et al., 2006).

As a multiple criteria decision-making (MCDM) problem is affected by several conflicting factors in supplying selection, a purchasing manager must analyze the trade off among the several criteria. MCDM techniques support the decision-makers (DMs) in evaluating a set of alternatives. Depending upon the purchasing situations, criteria have varying importance and there is a need to weigh criteria (Dulmin and Mininno, 2003).

The analytic hierarchy process (AHP) was found widespread application in decision-making problems, involving multiple criteria in systems of many levels (Liu et al., 2005). This method has the ability to structure complex, multi-person, multi-attribute, and multi-period problem hierarchically (Yusuff et al., 2001). The AHP can be very useful in involving several decision-makers with different conflicting objectives to arrive at a consensus decision (Maggie and Tummala, 2001). The AHP method is described in this research to develop decision model to identify the important criteria for supplier selection and selecting the suitable supplier in a steel manufacturing company. The AHP method is identified to assist in decision making to resolve the supplier selection problem in choosing the optimal supplier combination in steel manufacturing company (i.e. supplier (vendor) selection of a telecommunication system) (Yu and Jing, 2004).

1.2 Research problem

The ABC steel company is immensely in need of a new and efficient system of ordering raw materials to handle huge variety of finished products, thus great need for raw materials. ABC has a large number of projects in process and needs to select suitable supplier in highly fluctuated market of raw materials such as: mild steel sheets, stainless steel and UB ($2^{cm}/2^{cm}$). The ABC steel company has around 60 suppliers for different projects and from the other hand they don not have any general model for supplier selection. Selection of the best supplier among this large number of suppliers providing varieties in terms of quality, price and other factors like delivery can be cumbersome and complicated for managers. Based on the above problems a unique and suitable model is needed to facilitate the supplier selection and consequently provide the company with a proper system for raw material ordering.

1.3 Objective of the Study

The objectives of this research are:

(i) To identify the important criteria for supplier selection process based on priority for a steel manufacturing company.

(ii) To develop a multi-criteria decision model for evaluating and selecting suppliers with the use of AHP method for a steel manufacturing company.

(iii) Testing the model and selecting the suitable supplier for a steel manufacturing company.

1.4 Scope of the Study

The scope of this study is to compare the supplier selection process across and within the company by using both qualitative and quantitative approaches. Also, the focal point process in this research is the selection and evaluation of suppliers. The focus study is limited to one particular steel manufacturing company in Malaysia. Hence, the findings from this study are not strong enough to be generalized to all Malaysian steel manufacturing companies; therefore greater care needs to be taken when references are made on the results.

1.5 Importance of Research

In today's competitive market, selecting the best supplier among the vast number of providers with more alternatives is a difficult choice which needs an effective model of selection for decision makers. Currently, companies do not use any special supplier selection model and decision making process is handled quantitatively. The importance of this research is that, the developed model can handle the decision making process which is to be performed by precise computer programming using AHP method which considers both quality and quantity criteria.