



UNIVERSITI PUTRA MALAYSIA

**EFFECT OF INTERDEPENDENCY AMONG SUPPLIER SELECTION
CRITERIA ON SUPPLIER SELECTION IN THE AUTOMOTIVE
INDUSTRY**

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**EFFECT OF INTERDEPENDENCY AMONG SUPPLIER SELECTION
CRITERIA ON SUPPLIER SELECTION IN THE AUTOMOTIVE INDUSTRY**

By

MOHAMMADNAVID KASIRIAN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfillment of the Requirement for the Degree of Master of Science**

April 2009



DEDICATION

To my dear parents, who were incredibly supportive of me on every single decision
I have made in my whole life



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: Assoc. Prof. Rosnah Binti Mohd Yusuff, PhD

Faculty: Engineering

Most organizations prefer to outsource their activities which are not cost-efficient. The proper supplier selection requires all criteria to be clearly identified and investigated. Previous studies indicate that interdependencies exist among the criteria of supplier selection, and this may have an effect on the rankings of suppliers. In this study, six criteria for supplier selection (Cost, Quality, Delivery Reliability, Flexibility and Responsiveness, Professionalism, and Long-Term Relationship) were identified through literature and the interdependencies among them were investigated. A questionnaire was developed to identify weights for the criteria and sub-criteria of supplier selection and to identify the interdependencies among them. One set of this questionnaire was sent to three companies (two in Malaysia and one in Iran) related to automotive industry. Five expert decision makers in each Malaysian company answered the questionnaire and six in Iran.

The supplier selection evaluation was done under two conditions, with and without considering interdependencies. An Analytic Hierarchy Process (AHP) method was used



when the criteria were assumed independent. For interdependencies, Analytic Network Process (ANP) and a hybrid Modified TOPSIS (Technique for Order Performance by Similarity to Ideal Solution) were used. A trial version of Super Decisions 1.6.0 software was used to develop all the three methods. The optimal ordering quantity was then determined by means of a multi-objective decision making (MODM) technique named Preemptive Goal Programming (PGP) aimed to maximize the Total Value of Purchasing (TVP) and to minimize the Total Cost of Purchasing (TCP) using a trial version of Win QSB 1.0 as a linear programming software. Findings from the model show that by considering the interdependencies, the optimal ordering quantities have been changed. Based on this fact, in all three companies the hybrid Modified TOPSIS is more effective than ANP and AHP methods. The results for PROTON show that the hybrid Modified TOPSIS had the optimal TVP of 2,542 units, while the values for AHP and ANP were 1,609 and 1,515 units respectively. However, all three methods present the TCP value of 306,575 US Dollars. This trend was also seen in the other two companies.

The results showed that interdependencies existed among the criteria and they influence the decision of supplier selection. The study was conducted for one particular product. Similar methods can be used to identify the best supplier selection with other products and other manufacturing industries.



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

**KESAN SALING BERGANTUNGAN ANTARA KRITERIA PEMILIHAN
PEMBEKAL PADA PEMILIHAN PEMBEKAL
DALAM INDUSTRI AUTOMOTIF**

Oleh

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Kebanyakan organisasi lebih suka mendapatkan perkhidmatan pembekal luar kepada aktiviti-aktiviti mereka jika ianya menjimatkan. Oleh yang demikian semua kriteria pemilihan pembekal perlu di kenalpasti dan di pertimbangkan. Kajian menunjukkan wujud saling pergantungan di antara kriteria pemilihan pembekal dan ianya juga mungkin memberikan kesan terhadap status pembekal tersebut. Dalam kajian ini, enam kriteria untuk memilih pembekal (kos, kualiti, keboleharapan, kianjalan, tahap sambutan, professionalisma dan hubungan jangka panjang) dikenalpasti melalui literatur dan kebergantungan antara kriteria disiasat. Soal selidik telah digunakan untuk mengenalpasti tahap kepentingan kriteria dan sub-kriteria di dalam pemilihan pembekal dan saling pergantungan antara mereka. Satu set borang soal selidik telah di hantar kepada tiga syarikat (dua di Malaysia dan satu di Iran) berkaitan dengan industri

automobil. Lima pakar dari setiap syarikat yang terlibat dengan pembekal telah memberi maklum balas di Malaysia dan enam di Iran.

Penilaian terhadap pemilihan pembekal dilakukan menggunakan dua keadaan, iaitu dengan dan tanpa pertimbangan saling pergantungan. Kaedah “Analytic Hierarchy Process” (AHP) diguna apabila kriteria dianggap sebagai bebas. Manakala untuk saling pergantungan, “Analytic Network Process” (ANP) dan “hybrid Modified TOPSIS” (Technique for Order Performance by Similarity to Ideal Solution) pula digunakan. Ketiga-tiga kaedah dibangunkan menggunakan perisian “Super Decisions” versi percubaan 1.6.0. Kuantiti tempahan optimum telah ditentukan dengan teknik membuat keputusan pelbagai-objektif (“Multi-Objective Decision Making (MODM)”) dinamakan “Preemptive Goal Programming” (PGP). PGP mensasarkan untuk memaksimumkan nilai perolehan keseluruhan (“Total Value of Purchasing (TVP)”) dan meminimumkan harga perolehan keseluruhan (“Total Cost of Purchasing (TCP)”) menggunakan perisian aturcara lurus versi percubaan “Win QSB 1.0”. Hasil daripada model menunjukkan pertimbangan terhadap saling pergantungan telah mengubah kuantiti optimum tempahan. Berdasar fakta ini untuk ketiga-tiga syarikat, kaedah modifikasi TOPSIS adalah lebih berkesan daripada ANP dan AHP. Keputusan dari syarikat Proton menunjukkan nilai optimum “hybrid Modified TOPSIS” untuk, TVP ialah 2,542 unit, manakala nilai bagi AHP dan ANP masing-masing ialah 1,609 dan 1,515 unit. Ketiga-tiga kaedah ini menunjukkan nilai TCP yang sama, iaitu 306,575 dolar Amerika. Kecenderungan ini juga dapat dilihat dari dua syarikat lain.

Keputusan ini menunjukkan bahawa saling pergantungan wujud antara kriteria dan ini mempengaruhi keputusan pemilihan pembekal. Kajian ini hanya dilakukan berdasarkan

satu produk sahaja. Kaedah yang hampir sama juga boleh digunakan bagi mengenalpasti pemilihan pembekal yang terbaik bagi produk lain di dalam industri pengilangan.



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I certify that an Examination Committee met on **9 of April 2009** to conduct the final examination of **MohammadNavid Kasirian** on his philosophy of Master thesis entitled “**Effect of interdependency among supplier selection criteria on supplier selection in the automotive industry**” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree.

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DECLARATION

I 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.

MOHAMMADNAVID KASIRIAN

Date:



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LIST OF ABBREVIATIONS / GLOSSARY OF TERMS

AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
BOCR	Benefit, Opportunities, Costs and Risks
CR	Consistency Ratio
CST	Cost
DLR	Delivery Reliability
DM	Decision Maker
FLX	Flexibility and Responsiveness
GP	Goal Programming
IGP	Integer Linear Goal Programming
LHS	Left Hand Side
LTR	Long-Term Relationship
MADM	Multiple Attribute Decision Making
MCDM	Multiple Criteria Decision Making
MODM	Multiple Objective Decision Making
NGP	Non-preemptive Goal Programming
NIS	Negative Ideal Solution
OEM	Original Equipment Manufacturing
PGP	Preemptive Goal Programming
PIS	Positive Ideal Solution
PRF	Professionalism



QLT	Quality
QSB	Quantitative System for Business
RHS	Right Hand Side
SCC	Supply Chain Council
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference
TCP	Total Cost of Purchasing
TOPSIS	Technique for Order Performance by Similarity to Ideal Solution
TVP	Total Value of Purchasing



CHAPTER 1

INTRODUCTION

1.1 Introduction

In many large industries most of the activities which are not cost efficient to the companies are outsourced (Wadhwa and Ravindran, 2007). Operative functions of the organizations traditionally have been marketing, planning, production, purchasing, finance, etc. These functions are integrated by a strategy called “Supply Chain” which helps organizations creating a general plan to satisfy the service policy. This chain is exposed to a competition environment which supports companies maintain the lowest possible cost level. A supply chain could be referred to as a network of departments, which involves manufacturing of a product from the stage of raw materials to the final products distributed to the customer (Noorul Hagh and Kannan, 2006).

According to Ballou (1999) purchasing has a considerable place in most organizations. 40 to 60 percent of the final products’ sales are represented by purchased parts, components, and supplies (Gourdin, 2006). With respect to the huge expenditures on outsourcing, vendors (suppliers) must be selected so that the two major objectives of the purchasing process are met. The total value of purchasing (TVP) should become maximized and the total costs of purchasing (TCP) become minimized (Wang, Huang, and Dismukes, 2004).



Supplier selection is one of the essential steps in supply chain design. Since selecting the right suppliers considerably reduces the purchasing cost and improves competitiveness, the supplier selection process is known as the most significant task of a purchasing department (Saen, 2007).

Achieving an optimal solution in supplier selection is typically difficult since it involves multiple criteria. Traditional techniques in operations research generally consider quantitative measures, while vagueness and uncertainty, which is described by qualitative measures, exists everywhere within the supply chain (Sheu, 2007). Several criteria have been identified for supplier selection, such as the *net price*, *quality*, *delivery*, *capacity* and *communication systems* and *historical supplier performance* (Bello, 2003).

Multi-criteria decision-making (MCDM) techniques are typically utilized to rank potential suppliers of a purchased part. These criteria play a key role in measuring performance of the suppliers and subsequently specifying the optimal ordering amounts to the favorable ones (Wang et al., 2004).

Presented by many researchers (Hua, Gong, and Xu, 2007; Wang et al., 2004; Ghodsypour and O'Brien, 1998) Analytic Hierarchy Process (AHP) is one of the most common techniques to be used in supplier selection. AHP makes trade-off between quantitative and qualitative criteria in pair-wise comparison matrices, generated by decision-makers, and rates the potential suppliers (Wang et al., 2004). Although the efficiency of AHP is undeniable, there is a significant drawback for it which is discussed in the following section.

1.2 Problem statement and significance of the research

The AHP is argued to be more accurate than other rating methods for supplier selection (Ghodsypour and O'Brien 1998). Supposedly, this methodology could be valuable when there is a hierarchical relationship among decision levels (Shyur and Shih, 2006). When making a decision not only the influences from top to bottom or bottom to top but also all the potential influences need to be looked (Saaty, 2004). However, the criteria or elements used to evaluate the alternatives are not always independent, but mostly interrelate with each other. In complex environments an invalid result can be drawn if all these influences are not considered (Carney and Wallnau, 1998). Furthermore, AHP becomes unusable once the number of alternatives and criteria is large. This is because of the fatigue which involves in repetitive assessments by the decision makers (Briand, 1998).

Manufacturing companies still ignore such interdependencies among their decision making criteria. Resulting from the fact that criteria are usually interdependent on each other in the real world, it is not suitable to use traditional approaches. The Analytic Network Process (ANP), an extension of AHP introduced by Saaty (1970), is employed to attain a set of suitable weights for the criteria. Shyur and Shih (2006) proposed a hybrid Modified TOPSIS that incorporates ANP to consider interdependencies of supplier selection criteria.

By means of ANP and the hybrid Modified TOPSIS, interdependencies among decision making criteria are taken into account by which the ordering quantities sent to each alternative supplier might become different. This also causes difference in Total Value

of Purchasing (TVP) and Total Cost of Purchasing (TCP) which are both extremely crucial to the companies (Wang et al., 2004). The resulting priorities from multi-criteria decision making techniques enable the decision makers to take the required actions and invest on the resources. The ANP is a suitable prediction tool which is also capable to represent a variety of competitors and their relative strengths by which they apply their influence in making decisions (Saaty, 2004). This research is carried out to determine whether the effect of considering interdependencies among criteria leads to an improvement in the supplier selection process.

1.3 Objectives

Objectives of this research specifically are:

- i) To identify the inter-dependencies among criteria of supplier selection.
- ii) To develop supplier selection models using multi-attribute decision making (MADM) methods to rank the suppliers.
- iii) To determine the optimal ordering quantity using the priorities established from MADM methods.

Besides, the main aim of this research is to investigate that when using the three MADM techniques among which AHP assumes independency of supplier selection criteria while ANP and the hybrid Modified TOPSIS consider interdependencies among the criteria, which one presents the best TVP and TCP values. As a result, the supplier selection could be performed based on the findings from that particular technique.