UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF QUALITY CRITERIA FOR SUPPLIER SELECTION

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By

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

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Abstract of Thesis Presented to the Senate of University Putra Malaysia in Fulfilment of the Requirement for the Degree of Master of Science

Development of Quality Criteria for Supplier Selection

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In supply chain management, supplier selection is one of the most important components of production and logistics management for many companies. Selecting the right suppliers based on high quality and reliability will significantly reduce purchasing costs and other costs related to purchasing indirectly. Consequently, the selection of a wrong supplier could be enough to upset the companies' functional and operational position.

There are many criteria in order to assess supplier such as quality, delivery, performance and price. Quality is the ongoing process of producing and sustaining relationship by assessing, anticipating and fulfilling stated and implied needs. The methods for assessing the quality of products for suppliers can be divided to qualitative methods such as continuous improvement programs, certifications, technical and design level, and quality for customer and quantitative methods such as yield rate, process capability indices, reliability and rate of rejects. Since each method can evaluate just one aspect of an organization and cannot evaluate the whole production process, they are not suitable to assess the product's quality of supplier

selection process. Therefore to address this problem, this study aims to define a real cost-based objective function for assessing suppliers.

In order to form the objective function of the model, three main criteria, quality, price and transportation cost were selected. In this method each of quality costs, price and transportation costs were used as parameters. Revised Taguchi loss function was used to assess the quality of products whereas were used a simple linear programming (LP) model and SOLVER software were used to determine the parameters.

There are other loss functions such as inverted normal loss function, asymmetric inverted normal loss function, and revised inverted normal loss function. The concepts of them are the same and based on loss, but their formulas and applications are different. This model was also developed by other loss functions. Data were taken from an Iranian Plastic Company and proved that it is workable and beneficial. Finally, a sensitivity analysis was conducted in order to compare the usage of different loss functions.

The proposed model has some advantages such as simpler operations research model, integration of quality cost, purchasing cost and transportation cost and better estimation of quality compared with old methods such as rate of rejects.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
Sebagai memenuhi keperluan untuk ijazah sarjana sains

Pembangunan Kriteria Kualiti untuk Pemilihan Pembekal

Oleh

AGHDAS NAIMI SADIGH
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Pengerusi: Norzima Binti Zulkifli, PhD

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Dalam pengurusan rangkaian bekalan, pemilihan pembekal adalah salah satu komponen utama pengeluaran dan pengurusan logistik bagi kebanyakan syarikat. Memilih pembekal yang tepat disebabkan kualitin yang tinggi dan membawa kepercayaan akan mengurangkan kos pembelian dan kos berkaitan secara tidak langsung. Sebaliknya, pemilihan pembekal yang salah cukup mengecewakan fungsi dan kedudukan operasi syarikat.

Kaedah untuk mendapatkan pembekal yang berkualiti boleh dibahagikan kepada kaedah kualitatif seperti program peningkatan berterusan, pensijilan, kedudukan teknikal dan rekabentuk, kualiti untuk pelanggan dan kaedah kuantitatif seperti kadar penghasilan, proses indeks kebolehan, keyakinan dan kadar penolakan. Memandangkan setiap kaedah dapat menilai hanya satu aspek organisasi dan tidak boleh menilai proses pengeluaran secara keseluruhan, ianya tidak sesuai untuk kualiti proses pemilihan pembekal. Untuk menangani masalah ini, kajian ini bertujuan memperinci kos berkaitan sebenar fungsi objektif dalam pemilihan pembekal.

Untuk membentuk fungsi objektif bagi model, tiga kriteria utama iaitu kualiti, harga dan kos pengangkutan dipilih. Dalam kaedah ini sebarang kos berkaitan kualiti, harga dan kos pengangkutan digunakan sebagai parameter. Kaedah semakan fungsi kerugian Taguchi digunakan untuk mendapatkan pembekal yang berkualiti manakala model pengaturcaraan lelurus mudah (LP) dan juga perisian SOLVER digunakan untuk menentukan paramaternya. Model ini juga diuji dalam fungsi kerugian seperti "fungsi kerugian biasa terbalik, fungsi kerugian biasa terbalik asimetris dan semakan fungsi kerugian biasa terbalik dan mereka memberikan keputusan yang sama. Beberapa sampel data sebenar juga telah diambil dari syarikat Iran dan terbukti ianya berkesan dan memberi kebaikan. Akhir sekali, analisis sensitif dibuat untuk membandingkan kegunaan di dalam fungsi kerugian yang berbeza.

Model dicadangkan adalah model terbaru menggunakan fungsi kerugian dan terbukti mempunyai kebaikan seperti model kajian operasi yang lebih ringkas, integrasi dengan fungsi kualiti, kos pembelian dan kos pengangkutan, jangkaan yang lebih baik bagi perbandingan kualiti dengan kriteria lama seperti kadar penolakan.

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LIST OF ABBREVIATIONS

SCM	Supply Chain Management
AHP	Analytical Hierarchy Process
ABC	Activity Based Costing
EOQ	Economic Ordering Quantity
VAHP	Voting Analytical Hierarchy Process
ANP	Analytical Network Process
DEA	Data Envelopment Analysis
MOP	Multi Objective Programming
OR	Operations Research
TQM	Total Quality Management
JIT	Just In Time
TCO	Total Cost of Ownership
MAUT	Multi Attribute Utility Theory
SSR	Service Supplier Rating
SUR	Standardized Unit Less Rating
DSS	Decision Support System
AI	Artificial Intelligence
NN	Neural Network
KBS	Knowledge Based System
CBR	Critical Based Reasoning
MAUA	Multi Attribute Utility Analysis
LP	Linier Programming
MLR	Modified Likelihood Ratio
SCPIC	Suppliers Capability and Price Information Chart
TLF	Taguchi Loss Function
RTLF	Revised Taguchi Loss Function
INLF	Inverted normal Loss Function
AINLF	Asymmetric Inverted Normal Loss Function
RINLF	Revised Inverted Normal Loss Function
$\overline{X}_{ij}$	Mean of Sample from Supplier i for Product j
B	Coefficient of Quality Loss Within the Specification Limits
B_j	Coefficient of Quality Loss for Product j
K	Maximum Value of Quality Loss
K_{ij}	Maximum Value of Quality Loss for Product j of i^{th} Supplier

m_{ij}	Ordinary Samples Within L and U
n_{ij}	Sample Size of Product j from i^{th} Supplier
p_{ij}	Price of One Unit of Product j from i^{th} Supplier
Q_j	Quantity of the Demand for Product j
R_{ij}	Rate of Ordinary Products
S_{ij}	Standard Deviation of Sample from Supplier i for Product j
T	Target Value of the Specification
TC	Total Quality Cost
T_i	Target of Process for j^{th} Product of i^{th} Supplier
X_{ij}	Order Quantity for i^{th} Supplier for Product j
Y	Quality Character
z	Number of Items (Products)
u	Number of Items (Suppliers)
L	Starting Point of Ordinary Loss
L_j	Starting Point of Ordinary Loss
U_j	Finishing Point of Ordinary Loss
H_{ij}	Transportation Cost of Product j from i^{th} Supplier
r_{ij}	Rate of Products of Product j from i^{th} Supplier for Right Side in Asymmetric Loss Functions
r'_{ij}	Rate of Products of Product j from i^{th} Supplier for Left Side in Asymmetric Loss Functions
m_{ij}	Sample Size of Product j from i^{th} Supplier for Right Side in Asymmetric Loss Functions
m'_{ij}	Sample Size of Product j from i^{th} Supplier for Left Side in Asymmetric Loss Functions

CHAPTER 1

INTRODUCTION

1.1 Introduction

Supply chain management is defined as the integration of activities to procure materials, transforms them into intermediate goods and final products, and delivers to customers (Heizer and Render, 2001). Therefore, it covers all activities related to transporting goods from the raw materials stage to the end part (customers).

Supply chain management aims to minimize overall costs across the supply chain and to maximize the revenue generated from the customer in cooperation with business partners (Ha and Krishnan, 2007). Thereby, supply chain management has a significant role in decreasing the total costs.

The decision in supply chain management is one of the important topics, because it covers many topics such as location capacity of facilities, inventory policies, order tracking and allocation, and supplier selection (Huang et al., 2002). Among these decisions, supplier selection is one of the most important components of production and logistics management for many companies (Onut et al. 2009). Selecting the right suppliers because of its high quality and reliability will significantly reduce purchasing costs and other costs indirectly related to purchasing. Consequently, selection of wrong suppliers could be enough to upset the companies' functional and operational position (Onut et al. 2009).

There are many criteria such as price, quality and on time delivery, which can affect on selecting the proper supplier. As competition becomes fierce worldwide quality turns to be one of the main factors that will affect directly in a decision for supplier selection (Dickson, 1966). Quality can be assessed by methods categorized in two different groups. The first group, qualitative methods include assessment on certifications, technical design level and continuous improvement programs. The second category, quantitative methods include assessment on rate of rejects, percentage on time shipment, reliability, yield rate, process capability and loss function.

There are some loss functions such as Taguchi loss function, revised Taguchi loss function, inverted normal loss function, asymmetric inverted normal loss function and revised inverted normal loss function. All loss functions can assess the quality of suppliers and have different applications and formulas. In this study, the proposed model is based on revised Taguchi loss function. Because this loss function is bounded. Then, the model was developed by other loss functions.

1.2 Statement of the Problem

Qualitative and quantitative methods have some weak points. For example, using records quality of customer services may not assure the quality of products they purchased (Boer, 2001). Some organizations used product reliability evaluation to assess the quality. However, reliability method is only useful under fixed environmental conditions and period of time (Adamyan and He, 2002). Process

capability indices also have some limitations in order to evaluate the quality of products. Perakis and Xekalaki (2002) illustrated that process capability indices such as C_p, C_{pk} and C_{pm} do not have a direct relationship with the conformance proportion of the process.

Therefore, this study will look at loss functions as an alternative method to assess quality of suppliers. Since loss functions take into account all samples and have a significant relation with loss, they seem to be appropriate and reliable for evaluating the quality of suppliers. ((Pi and Low (2005)) and (Teeravaraprug (2008)))

1.3 Objectives of Study

Since loss functions consider all data and can determine the cost of bad quality, they are appropriate tools for assessing the suppliers. The purposes of this study are mainly:

- To develop the quality criteria for supplier selection using different loss functions.

- To develop a model for supplier selection based on quality cost, price and transportation cost.

1.4 Scope of Study

As stated, this study is about selecting supplier in supply chain management. In order to select the best supplier, there are many models and methods categorized in two main approaches. The first approach is to select the best single supplier, which can meet all the requirements (single sourcing). The second approach is to select an appropriate combination of suppliers when no single supplier can satisfy all the requirements (Sanayei et al. 2008). As shown in Figure 1.1, this study is related to multiple sourcing. In this problem, some buyers can produce or supply some products and they want to select the best suppliers; such that the total cost of purchasing will be minimized.

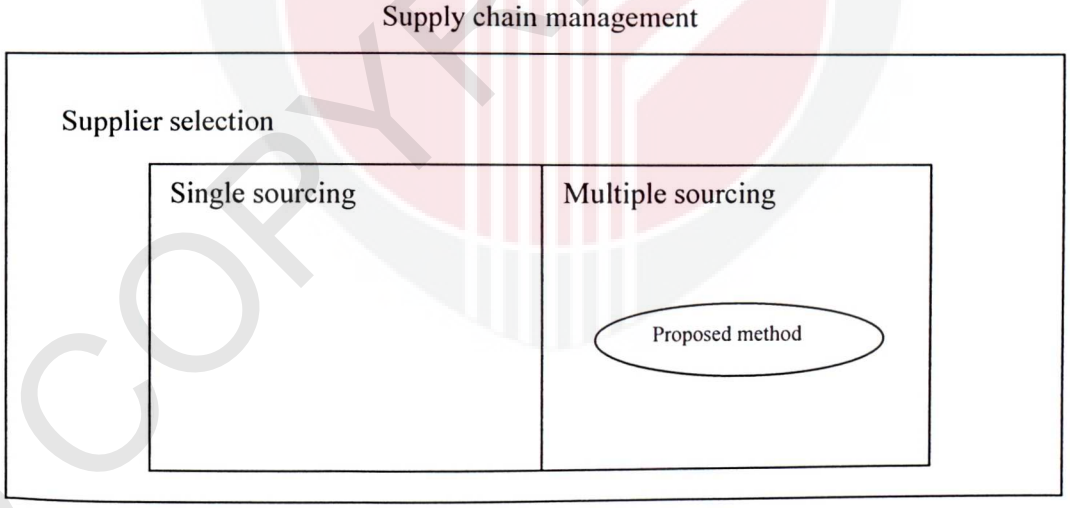

Figure 1.1: Scope of proposed model

As stated in literature review, many supplier selection methods for solving the supplier selection problems were employed so far. These methods divided to three

main categories: rating, mathematical, and hybrid methods. This study uses mathematical methods and among mathematical methods, operations research (linear programming) is employed. Since the proposed model uses a simple linear operation research method, it is applicable for buyers to select the suppliers.

1.5 Organization of Dissertation

Chapter 1 introduces the basic concepts in supply chain management and the importance of decision making in supply chain management for organizations. Then the core problem is stated and the objective of the research is described with intended contribution.

Chapter 2 deals with the literature review in the relevant areas to the research topic. Background of prior work done in supply chain management area and specifically in supplier selection is discussed along with brief review of supply chain operations model and interpretive structural modeling.

Chapter 3 defines the methodology of this study. This chapter distinguishes why and how loss functions are employing for assessing the suppliers. Chapter 4 is dedicated to model development. After defining the concepts of objective function of the proposed model and setting the main criteria of the model, the mathematical formulation is defined. In this chapter, two numerical examples were solved with

SOLVER software package and sensitive analysis was conducted for numerical example 2. Finally, chapter 5 deals with conclusions and recommendations.

1.6. Limitation of Study

There were some limitations to this study. One limitation was the scope of the study. The study focused mainly on the manufacturing industry, and it is not suitable for service sectors. Another limitation is we considered 3 criteria to evaluate the supplier, while in some studies, scholar can consider other criteria.

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