THE GREEN SUPPLIER SELECTION AND ORDER ALLOCATION IN THE SUPPLY CHAIN UNDER STOCHASTIC CONDITIONS

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Dedicated to…

My beloved parents; Hassan and Manijeh whose show me the path and support me in every momonet of my life

My cherished brother and sister

You are in my heart forever

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ABSTRACT

The complexity of the competitive marketing in recent decades has forced the firms, industrial groups and researchers to have more attention towards the supply chain. The supply chain is a network that changes the raw materials to the finished products by passing them through the linked entities. This network consists of suppliers, industrial groups, warehouses, distribution centers, and retailers. Suppliers as a part of a supply chain play a functional role in this network. Since preserving the environment has been a paramount criterion for researchers in recent years, considering the green environment factors in the supply chain could be more favorable. This study was conducted to select the best suppliers among the existing suppliers, and allocate an appropriate order quantity to each of them. The input data have an uncertainty and fuzziness in the real problem, and this study considered this fact in the different levels of supplier selection. Firstly, this study defined the cost, lead time and green environment factors as the qualitative factors, and used fuzzy analytic hierarchy process (FAHP) to weigh each of the existed supplier regarding these criteria. Secondly, a mathematical multi-objective nonlinear model formed with three different objective functions under the stochastic conditions including the demand quantity and the demand timing. Total cost of purchasing, total value of purchasing, and supplier flexibility were considered in this mathematical model as the objective functions, simultaneously. The genetic algorithm was utilized to solve this mathematical method using MATLAB software. Finally, the best suppliers and their optimum order quantity ratio was obtained, and the optimum purchasing fitness function was calculated.

ABSTRAK

Selari dengan perkembangan bidang permasaran yang begitu kompetatif semenjak beberapa dekad muttakhir ini, ia telah menarik minat dunia industri dan para penyelidik untuk menjuruskan fokus kearah bidang ventaian bekalan dengan lebih serius. Ventaian bekalan adalah rangkaian proses yang bermula dari bekalan bahan mentah hingga sesuatu produk siap sepenuhnya. Rantaian ini melalui beberapa bahagian dan proses yang saling berkaitan antara satu sama lain. Secara asasnya rantain ini terdiri daripada pembekal-pembekal, kumpulan industri, gudang-gudang, pusat pengagihan dan para peruncit. Dalam rantaian ventaian bekalan ini, pembekal memainkan peranan fungsi yang terbesar. Pada masa yang sama, beberapa tahun kebelakangan ini isu kelestarian alam sekitar telah menjadi parameter yang penting dalam kalangan penyelidik, selaras dengan itu mengabungkan idea kelestarian alam sekitar sebagai salah satu kriteria Supply chain adalah releven. Kajian ini dengan itu dijalan untuk menentukan pembekal yang terbaik antara kumpulan pembekal pembekal yang ada. Hal ini membolehkan kuantiti pesanan dapat diagihkan antara para pembekal secara tepat. Pada dasarnya, input mengandungi unsur ketidakpastian dan kekaburan , dengan itu, kajian ini turut mengambil kira kriteria tersebut dalam menentukan pemilihan pembekal pada tahap/ peringkat yang berbeza-beza. Pada peringkat pertama, kos, masa menunggu dan kelestrian alam sekitar didefinasikan sebagai element kualitatif dan dianalsis menggunakan (FAHP) bagi menilai kecederungan setiap pembekal terhadap kriteria-kriteria tersebut. Seterusnya, model matematik multi-objektif tidak linear dibentuk. Model ini dibina berdasarkan tiga fungsi objektif stokastik termasuk kuantiti permintaan dan peruntukan masa. Dalam pada masa yang sama nilai kos keseluruhan pembelian, nilai pembelian keseluruhan dan tolak ansur atau kefleksibelan pembekal yang terlibat turut diambil kira sebagai fungsi objektif model ini. Algorthma genetik menggunakan perisian MATLAB diguna pakai untuk menganalisi model yang telah dibina. Hasil dari analisis model ini, pembekal pembekal yang terbaik dapat dikenalpasti dan kuantiti optimum pesanan bagi setiap pembekal seterusnya fungsi bagi kesesuaian nilai optimum pembelian (dari pembekal terbabit) dapat dikira.

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LIST OF ABBREVIATIONS

SCM	Supply Chain Management
SC	Supply Chain
GSC	Green Supply Chain
DEA	Data Envelopment Analysis
AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
GP	Goal Programming
GA	Genetic Algorithm
FAHP	Fuzzy Analytic Hierarchy Process
MODM	Multi-Objective Decision Making
NLP	Non-Linear Programming
MONLP	Multi-Objective Non-Linear Programming
TCP	Total Cost of Purchasing
TVP	Total Value of Purchasing
EDQRP	Expected Demand Quantity Reduction Penalty
EDTRP	Expected Demand Timing Reduction Penalty
EMS	Environment Managing System
TOPSIS	Technique for Order Performance by Similarity

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter introduces this research purpose and scope. The aim of this study was to develop a multi-objective model under stochastic parameters for green supplier selection and order allocation. Moreover, it presents the nonlinear programming model to select optimum suppliers by using a Genetic Algorithm technique. This chapter discusses about background of study, the problems in this study, objectives, scope of study and significance of this research.

1.2 Background of Study

With the globalization of the economic market and the development of information technology, many companies consider that a well-designed and implemented supply chain management (SCM) system is an important tool for increasing competitive advantage, which can be achieved by strategic collaboration

with suppliers and service providers. Companies need to work with different suppliers to continue their activities. The success of a supply chain is highly dependent on selection of good suppliers.

Beamon (1998) mentioned that firms fierce competition, global marketing, product shorter life and customers' expectations have forced firms to pay more attention to supply chain. The purpose of these forms is to reduce their cost and improve quality to save their old users and attract new ones, for this purpose they need supply chain. Typically, in supply chains, raw materials procured, and then products produced in factories, shipped to warehouses and distributed to markets or customers. Supply chain consists of suppliers, factories or manufacturing centers, warehouses, distribution center and retailers. Hou and Wie proposed that 70% of product cost is raw materials and component parts, as a result the supplier selection plays a huge role in supply chain success.

Dickson (1966) presented and listed 23 important evaluation criteria for supplier selection. (Wu *et al.*, 2010; Haleh *et al.* (2011); Zhang *et al.*, 2011) and many other researchers studied the supplier selection and presented models which can help industrial groups to choose the best suppliers and allocate quantity orders to each supplier because selecting the right supplier gives firms a competitive edge, reduced cost, improved quality, and reduces their lead time and decreases supply chain's risk.

On the other hand, sustainability has become more and more important factor in supply chain production process so that scientists have more attention paid on environmental sustainability nowadays. Miemczyk *et al.* (2012) provided a structured literature review of sustainability in purchasing and supply management, moving beyond the traditional environmental and social sustainability.

1.3 Problem Statement

Selecting a supplier has a direct effect on final product price and quality; also firms responsibility depends on their supplier lead time. Selecting wrong supplier will increase costs, reduce quality and also increase lead time. These factors are enough to firms losing their customer satisfaction and marketing. Selecting the wrong suppliers can be enough to upset the company's financial and operational position whereas the selection of right suppliers significantly can reduce purchasing costs, improve competitiveness in the market and enhance final customer satisfaction. Therefore, the supplier selection problem has become one of the most important issues for establishing an effective supply chain System.

In several related researches and studies on the supplier selection area, the researchers assume that all their data in their models are clearly and precisely. However, many of the decision making problems in the real world take place in a fuzzy environment. On the other hand, several papers which used a fuzzy environment in their studies used single factor, objective or criteria. Considering one factor in supplier selection will break-down the industrial groups since in today’s competitive market, cost, quality, and lead time should take into account simultaneously.

In recent years, discussion and role about green environment and green supply chain improve between researcher, Society and government. As a result, firms need to improve environmental factors in their product and production process. Implementing green system for firms is impossible without the cooperation of all partners in the supply chain. Hence, selecting good supplier is critical and aims to achieve this purpose. There are few specific studies in the supplier selection area which consider sustainable factors in their mathematical models and all the researchers did this before, assumed that the demands are certain. In realistic models demands are not constant in all the periods and decision making under stochastic demand is more realistic.

Finally, based on Kannan study lack of mathematical model for green supplier selection and order allocation under fuzzy environment and stochastic conditions exists.

1.3.1 Research Questions

The research questions of this study can be stated as follows:

1. What are appropriate criteria and sub criteria and their importance weight for green supplier selection?
2. How to formulate a multi-objective mathematical model for green supplier selection under stochastic parameters?
3. How the optimum order quantity to be allocated to suppliers under green environment can be achieved?

1.4 Objective of the Study

The objectives of this study can be stated as follows:

1. To determine criteria and sub criteria and the importance weight of each criterion and sub criterion
2. To develop a mathematical model for green supplier selection and order allocation
3. From the developed model, determine the optimum order quantity to be allocated to suppliers.

1.5 Scope of the Study

The scopes of this study are as follows:

1. This research covers green supplier selection in the supply chain.
2. The Fuzzy Analytic Hierarchy Process is used for weight to criterion and sub criterion.
3. The multi objective nonlinear programming is used for mathematical model and solves the formulation.
4. The mathematical model considers to Cost, quality, lead time and environmental factors.
5. MATLAB software is used for writing codes and get the results.

1.6 Significant of the Study

Based on what has mentioned in the literature and the problem statement supplier selection is an essential factor in the firm's success. This study provides a mathematical model for the best supplier selection in fuzzy environment and allocates optimum quantity order to each supplier under green environment. Fuzzy environment used in this study makes this model more realistic and Genetic Algorithm that used to solve nonlinear programming give optimum results. The purpose of this model is to reduce cost, improve quality and decrease lead time with considering the green environmental factors. Multi objective programming that used in this study will help managers who may have more than one objective with different priorities.

Cost, lead time and sustainable factors chosen because they have a direct effect on customers' satisfaction, productivity, profit and environmental concerns.

Logical and clever supplier selection is able to promote competitive capability and improve productivity performance.

1.7 Conclusion

This chapter discussed the research foundation. The background presented in this chapter gives sufficient content to understand the intention of the study. In addition, the significance and effect of this study on solving the existing problem has been illustrated in this chapter.

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