

# SUPPLIER SELECTION FOR AGILE SUPPLY CHAIN

BY

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## **ABSTRACT**

This research examines the selection of suppliers as they are one of the most main important elements of any supply chain. Due to the importance, different aspects of supply chain types and possible mathematical methods have been addressed to select suppliers under predetermined factors and criteria which are followed by all suppliers. A weighted linear model was proposed to solve the problem of supplier selection inspired by multi-criteria decision making. DEA consists of a programmable mathematical approach that enables to evaluate the efficiency and performance of decision-making units successfully with identical inputs and outputs. Considering that different suppliers are available to the company, the manager should make a decision as to who is the best supplier based on their valuations and considered several criteria. Based on the comparison, the main factors can be considered to examine the resulting changes in the findings through the DEA model. The priority of measures can be changed by swapping their order to consider different importance sequences. Recently, organizations are moving towards a reduction in the number of suppliers since it is difficult to manage a large number of them. The reason for this research lies in the development of an evaluation and selection model for suppliers, which is effective and comprehensive. Improving the efficiency and effectiveness of public supply chains processes is an essential part of an organization's ability to compete effectively. Therefore, the main objective of this research is to plan and develop a system to solve problems of selection of suppliers. The model created here is application particular for a manufacturing company. Research is therefore required to distinguish general models that are applicable for various organization types. The utilization of the show strategies likewise needs a lot of research as it might get complex with objectives more than one.

## خلاصة البحث

يبحث هذا البحث في اختيار الموردين وذلك من أهم العناصر الرئيسية لأي سلسلة توريد. ونظراً لتلك الأهمية ، فقد تم تناول الجوانب المختلفة لأنواع سلاسل التوريد والأساليب الرياضية الممكنة لاختيار الموردين بموجب عوامل ومعايير محددة مسبقاً يتبعها جميع الموردين. تم اقتراح نموذج خطي موزون لحل مشكلة اختيار الموردين مستوحاة من إحدى طرق صنع القرار متعدد المعايير. يتكون تحليل البيانات الداخلية من منهج رياضي قابل للبرمجة يتيح لمستخدميه تقييم كفاءة وأداء وحدات صنع القرار (الموردين) بنجاح مع مدخلات ومخرجات متناسبة (العوامل و المعايير). وبالأخذ في الاعتبار إلى أن الموردين المختلفون متاحون للشركة ، و عليه يتبقى على المدير إتخاذ قرار بشأن من هو أفضل مورد على أساس تقييمهم بالنظر إلى العديد من المعايير. استناداً إلى المقارنة ، يمكن النظر في العوامل الرئيسية لدراسة التغيرات الناتجة في النتائج من خلال نموذج تحليل البيانات الداخلية. و يمكن تغيير أولوية المقاييس من خلال تبديل ترتيبها للنظر في تسلسلات الأهمية المختلفة لتلك العوامل و المعايير. في الآونة الأخيرة ، تتحرك الشركات نحو تخفيض عدد الموردين ، حيث يصعب عليها التعامل مع عدد كبير منها. يكمن سبب هذا البحث في تطوير نموذج للتقييم والاختيار من بين الموردين بشكل فعال وشامل. يعتبر تحسين كفاءة وفعالية عمليات سلاسل التوريد العامة جزءاً أساسياً من قدرة المؤسسة على التنافس بفعالية. ولذلك ، فإن الهدف الرئيسي من هذا البحث هو تخطيط وتطوير نظام لحل مشاكل اختيار الموردين. النموذج الذي تم تطويره هنا هو تطبيق خاص بشركة تصنيع. لذلك فإن البحث مطلوب للتمييز بين النماذج العامة التي تنطبق على أنواع المنظمات المختلفة. وبالمثل ، فإن استخدام استراتيجيات العرض يحتاج إلى الكثير من البحث لأنه قد يصبح معقداً مع أكثر من هدف واحد.

## APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science (Manufacturing Engineering).

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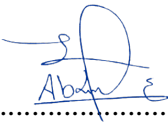
This dissertation was submitted to the Kulliyah of Engineering and is accepted as a fulfilment of the requirement for the degree of Master of Science (Manufacturing Engineering).

.....  
Sany Izan Ihsan  
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## DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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*This dissertation is dedicated to Mum*

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## LIST OF ABBREVIATIONS

AC	Adaptive Control
ACA	Affordable Care Act
AHP	Analytical Hierarchical Process
ALC	Adaptive Logistics Controller
ANP	Analytic Network Process
ASCM	Adaptive Supply Chain Management
BOCR	Benefits, Opportunities, Costs and Risks concept
CAS	Complex Adaptive System
CBR	Case-Based-Reasoning
DEA	Data Envelopment Analysis
DEMATEL	Decision Making Trial and Evaluation Laboratory
DMU	Decision Making Unit
FL	Fuzzy Logic
GP	Goal Programming
IT	Information Technologies
JIT	Just In Time
LP	Linear Programming
MAMD	Multi-Attribute Decision Modelling
MAUT	Multiple Attribute Utility Theory
MCDM	Multi Criteria Decision Making
MOLP	Multi-Objective Linear Programming
PGP	Preemptive Goal Programming
PID	Proportional Integral Derivative
RFID	Radio Frequency Identification
SAP	Systems, Applications and Products
SC	Supply Chain
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference
SUR	Set Up Reduction
TOPSIS	Technique for the Order Performance by Similarity to Ideal Solution
VE	Virtual Environment
VPI	Vendor Performance Index
WIP	Work In Progress

# **CHAPTER ONE**

## **INTRODUCTION**

### **1.1 GENERAL OVERVIEW**

Agile supply chains need to be highly flexible in order to reconfigure quickly in response to changes in their environment. An effective supplier selection process is essential for this. The focus on competitive supply chains and extended enterprises requires the adoption of agile supply chain practices demanding their suppliers to have agile attributes. Quantitative and qualitative factors are used to assess and select appropriate suppliers to fit within an organisation's agility practices (Lihui Wang & Lenny Koh, (2010)). Various supplier selection methods as observed in the literature have been classified in to a number of broader categories. Figure 1.1 presents various supplier selection methods as will be discussed in the literature (Om Pal et al. (2013)).

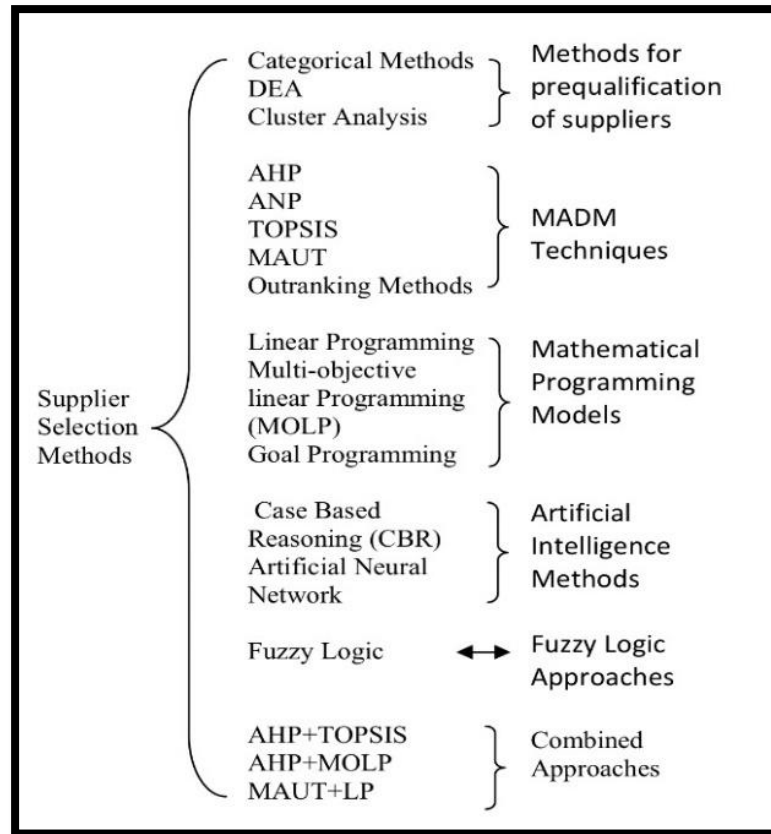


Figure 1.1 Various Supplier Selection Methods (Om Pal et al. (2013)).

On the basis of the literature review, it has been observed that the basic criteria typically utilized for selecting the suppliers are pricing structure, delivery, product quality, and service etc. While most buyers still consider cost to be their primary concern, few more interactive and interdependent selection criteria are increasingly being used by the manufacturers. The various important criteria for the supplier selection as observed from the literature review (Om Pal et al. (2013)) are shown in Figure 1.2:

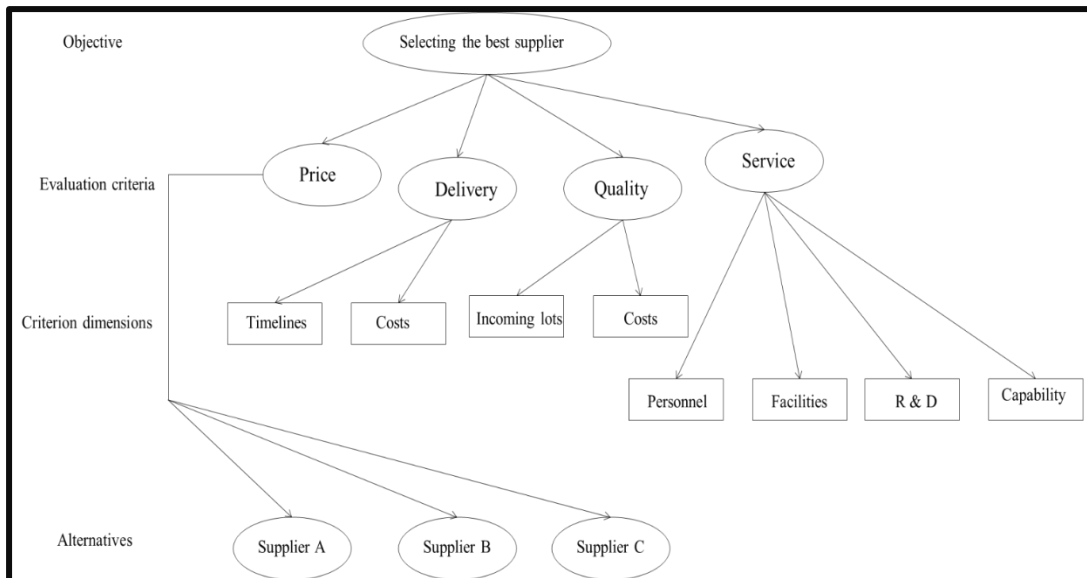


Figure 1.2 An illustrative decision hierarchy for supplier selection (Om Pal et al. (2013)).

## 1.2 PROBLEM STATEMENT AND SIGNIFICANCE

Selection of supplier plays a vital role in effective supply chain management. The supply chain management is a strategic weapon to build up and enhance sustainable competitive advantage by cost reduction without compromising customer satisfaction. Moreover, the ability to understand the environment pressures that drive the supply chain management and clearly note the barriers and implement solutions or bridges enable supply chain performance to maintain competitive advantage. The main goal and important aspect of supply chain is leveraging the expertise, experience, skills and capabilities of the supply chain planning who comprise this competitive network. A supply chain has to be an agile and flexible to meet the changing demand of the customers. A supply chain which is agile will meet the suppliers' need in agile way thus helps to provide the customers' needs in given delivery lead time. Thus agile supply chain will benefit shipper and customers to fulfill the objectives of manufacturer and customers. Thus, issue of selection of supplier is very complex and significant. Potential supplier helps in fulfilling the strategic objectives of the



manufacturer. The present research targets to establish the simple and effective methodology to select the supplier for the given requirement of manufacturer and according to different criteria such as price, quality, delivery, technical capability and financial position.

This research will be very helpful for the managers, decision makers, practitioners and researchers associated with the supplier selection and related activities.

### **1.3 RESEARCH OBJECTIVES**

This study seeks to achieve a set of objectives, which are follows: For such purpose, a research proposal is presented as:

- To analysis and assess the available methodology in supplier to provide a research platform to researchers.
- To develop a conceptual framework in Supplier Selection for Agile Supply Chain.
- To assess the available criteria and their importance to prioritize them and select them for the selection of supplier for the given manufacturing requirement.
- To develop a model to help the manufacturers in deciding the best supplier for the manufacturing requirements.
- To validate the developed model using real case study.

### **1.4 RESEARCH METHODOLOGY**

The research methodology is the skeleton of the procedure whereby the entire research can be built and achieved. This research examines the problem of supplier selection

for a manufacturing company based on different criteria. This research relies upon the inductive approach where many previous studies are dealt with, research and literature that dealt with continuity and responsibility of quantitative and qualitative criteria which are utilized to evaluate and select suitable suppliers to fit within an organisation's agility practices. The obtained model can designate request amounts between the candidate suppliers that can choose the most appropriate and least number of suppliers to accomplish maximum efficiency.

### **1.5 SCOPE OF STUDY**

In this research, a review is mentioned for different multi-criteria methods which are reported in the literature for reinforcement the supplier selection process. The review is based on an extensive search in the academic literature. The contributions in a conceptual frame are placed for reviewing the supplier selection methods which are appropriate for small and medium companies. This takes and accommodates the diversity of procurement situations in terms of complexity and importance into account, which finds purchasing practice in the present day and covers the different phases in the supplier selection process.

### **1.6 DISSERTATION OUTLINE**

The dissertation is consisted of five chapters. Chapter One provides a general overview of the research problem and displays the main objectives of the research with a passing illustration for the research methodology and the size of facility which is selected as a case study. Chapter Two grants a detailed view for two headlines in the research, regarding supply chain management and supplier selection as a literature review. Chapter Three presents the research methodology in details by analyzing and

constructing the research model, and mentions the main reasons that lead to the importance of research in the selection of suppliers and supply chain. A theoretical part illustrates the technique of DEA method in evaluating and analyzing data. Chapter Four (case study) discusses the case study in practice, and then analyzing and discussion the obtained results. Conclusions, limitations and possibilities for future research tasks are outlined in Chapter Five.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 GENERAL LITERATURE REVIEW

Supply chain management (SCM) includes all management activities related with flow and transformation of goods from the raw material stage through the end client stage, alongside the management of flow of the related information for accomplishing feasible competitive advantages for production and service-oriented organizations.

Lee & Billingham (1995) realize (SCM) as the combination of all activities occurring among a system of facilities that produce raw materials, transform them into moderate goods and final items, and deliver the final items to clients through a physical distribution networks. Figure 2.1 shows a graphical model of a supply chain.

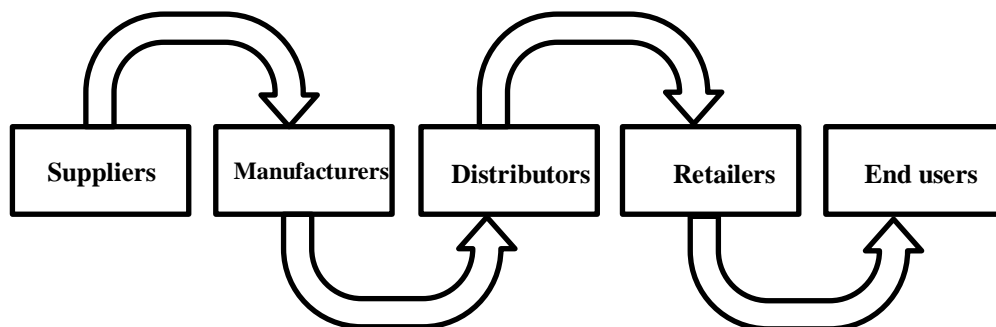


Figure 2.1: Supply chain structure

In the supplier selection arena, there are numerous researches that use different methodologies to solve the problem. One of the most recent studies that has provided a reviewed the literature on application of decision-making techniques in supplier selection is the work of Chai et al. (2013). In this research the literature review has

been investigated from two perspectives: (1) various strategies of supply chain management and (2) various methods used for supplier selection.

The number of factors that one could consider for supplier selection is not only large but also depends on the context (for example strategic or transaction-oriented, etc.), type of the product, nature of the markets, and so on. Since 1960s, supplier selection criteria and supplier's performance have been a focal point of many researchers.

The receptiveness of decision makers to the utilization of formal decision tools in terms of formulation of decision criteria, the qualification of appropriate candidate suppliers and recognition of the requirement for a new supplier are topics that have been argued widely within the literature (De Boer & Van Der Wegen, (2003)).

Few works have considered both agile and lean criteria in an integrated way to model supplier selection problem. Besides, based on the planned framework, different concepts can be used to maintain the competitiveness within the market like different suppliers that are presented with different levels of leanness and agility. Examples of recent studies that have used ANP or DEMATEL for supplier selection problem are Yang & Tzeng (2011), and Buyukozkan & Cifci (2012), but they have not considered the inefficiency of ANP technique in choosing between different alternatives. However, a solution is proposed to this issue by combining DEA and ANP processes.

This research contributes to supplier selection knowledge field in three ways. First, this research features a framework for agile criteria. Secondly, the selection of suppliers is performed in a mean that their leanness and agility is calculated separately. This leads to higher understanding of suppliers' capabilities and provides better managerial insights towards the problem. Thirdly, the proposed methodology

during this research is the first that integrate DEA and agile supply chain in an exceedingly supplier selection context.

De Boer, L., (1998) expressed that to this point the application of outranking strategies in purchasing decisions has not been instructed in purchasing or operations research literature. Authors have shown by suggests of a supplier selection example, that an outranking approach may be very well suited as a decision making tool for primary purchasing decisions.

Weber, C.A, (1991), reviewed, annotated, and classified seventy four connected articles that have appeared since 1966. Specific attention is given to the factors and analytical strategies utilized in the supplier selection method. In response to the increased interest in Just-In-Time (JIT) manufacturing methods, and analysis of JIT's impact on supplier selection is additionally presented. Finally, conclusions and potential fields for future research are presented.

Li & Fung., (2014), proposed a supplier performance measure using the thought of dimensional analysis to obtain an index known as the VPI. Typically the performance criteria employed in supplier performance analysis involve quantitative and qualitative factors. Here a replacement supplier performance measure is planned as another to the VPI. For qualitative factors, a two directional consideration is employed rather than a one directional attitude, which results in mere one score. The fuzzy bag technique is employed to compensate for blindness in human judgment. Then all scores for quantitative and qualitative factors are combined in an intuitive sum of weighted averages known as the SUR.

Weber et al. (2001), described three methods for the selection and negotiation with suppliers who were not selected. Moreover, it describes how in certain conditions two multi criteria analysis tools, multi objective programming and data envelopment

analysis, can be used together for this selection and negotiation method. The paper describes non-cooperative supplier negotiation approaches where the selection of one supplier leads to another being omitted of the solution.

Weber & Desai, (2000), demonstrated the employment of data envelopment analysis (DEA) for measuring supplier performance and efficiency. An algorithmic rule is used for determining points of supplier efficiency on multiple factors. This study then demonstrates how parallel coordinates graphical representation is used to show the efficiency of suppliers on multiple factors, and, in thus doing, visually determine benchmark values on these factors for negotiating with inefficient suppliers.

Maggie & Tummala, (2000), developed an AHP based model and applied it to a real case study to inspect its feasibility in selecting a supplier for a telecommunications system. The utilization of the planned model specifies that it will be applied to enhance the group decision making in selecting a supplier that fulfils consumer specifications. Also, it is found that the decision process is systematic and that using the proposed AHP model will reduce the time taken to select a supplier.

Hill & Nydick, (2002), have shown how AHP can be employed to structure the supplier selection technique. This technique of selection is described, and a detailed, hypothetic example of how AHP may be used also is provided. In conclusion, a framework is presented that any business organization will adapt to suit its specific set of desires.

Liu & Hai, (2011), compared the weighted sum of the selection number of rank vote, after determining the weights in a much selected rank in order to make decision of the total ranking of the suppliers. This investigation presents a unique weighting procedure in place of AHP's paired comparison for selecting suppliers. It provides an easier process than AHP that is called voting analytic hierarchy process; however that

does not lose the systematic attitude of derivation the weights to be used and for scoring the performance of suppliers.

Ellram, (1995), has examined case studies of eleven corporations that utilize total cost of ownership concepts in purchasing. Supported the case study data and also the literature, barriers and advantages related to the whole cost of ownership approach are mentioned. The whole cost of ownership models utilized by the case study corporations are classified by sort as dollar-based or value primary based. The whole cost of ownership models are then further classified by their primary usage: supplier selection or supplier analysis. This cross classification reveals a robust relationship between model sort and model usage.

Elanchezhian, C., (2010), used a flexible technique particularly multi criteria decision making (MCDM) technique that includes the analytical network process (ANP) and technique for order performance by similarity to perfect solution (TOPSIS) technique to select the best supplier. Author established normal software in an appropriate platform such as VB, NET and MS access.

Min, H., (1994), proposes multiple attribute utility theory which might facilitate purchasing professionals to formulate viable sourcing approaches in the changing world marketplace significantly for international supplier selection. Author considered the criteria together with political situations, tariff barriers, cultural and communication barriers, trade regulations and agreements, currency exchange rates, cultural variations, ethical standards, quality standards and so forth.

Sanayei et al. (2008), proposed an integrated method of multi-attribute utility theory (MAUT) and linear programming (LP) for rating and selecting the best suppliers and defining the optimum order quantities among selected ones in order to maximize aggregate additive utility.