

Optimization of Supplier Selection Using Fuzzy Analytical Hierarchy Process - State of Art Study

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ABSTRACT:In recent years supplier selection and order allocation as an important part of supply chain management are facing challenges and difficulties. Our project objective is select suitable supplier in optimal way to reduce difficulties in Supplier selection process. Our Proposed FAHP (Fuzzy Analytical Hierarchy Process) method is capable of optimizing the supplier selection by assigning weights of supplier in terms of both qualitative and quantitative criteria and identified optimal supplier.

KEYWORDS: Supplier Selection, Strategic Supplier, Optimization method, multi-criterion, AHP approach.

I. INTRODUCTION

The companies in apparel industry are divided into three market segments based on their competitive strategy: cost advantage, speed, and brand equity. The key to success for the second market segment is providing customers with the most fashionable clothes in the shortest time. In addition, apparel prices are not too high in this mid-end market [1].

A. Fast Fashion

The fashion industry has changed greatly due to the recent success of fast fashion retailers. Over the past decade, new firms have emerged in this industry which have exhibited continuous growth and became the market leaders. For example, in the first quarter of 2008, the Inditex group from Spain, owner of the Zara chain, overtook Gap as the world's biggest clothing retailer [2]. H&M from Sweden is also recognized as a leading player in this industry. Fast fashion, a relatively new business strategy, can be briefly summarized as "cutting-edge fashion at an affordable price" for Zara [3], or similarly as "fashion and quality at the best price" for H&M [4]. The assortment of fast fashion retailers successfully mixes two categories of products including basic items and fashion items. Hence, their supply chains are a combination of an efficient supply chain, which is applied for the basic items, and a responsive supply chain, used for fashion items [5]. In this study, our focus is only on the supply chain of fashion items. It is necessary to have a responsive supply chain for fashion items in order to bring the products quickly to the stores as needed, since such products are perishable and their demand is highly volatile and uncertain. This means a flexible production system is required to minimize the lead time, even at a higher cost. Therefore, the design-to-store time, including raw materials, production and distribution, should be minimized. Companies such as Zara and H&M have successfully cut down design and production lead times from months to just a few weeks, applying a flexible supply chain. They consistently introduce new products on a regular, weekly basis [5]. Fashion items, in particular, have a very short life cycle, since they are routinely substituted by trendier ones. As a result, every year, a fast fashion firm offers a much larger variety of products in comparison with a traditional retailer.

In summary, high volatility, low predictability, short product life cycle, and tremendous product variety are some of the characteristics of products in the fashion industry [1]. Our aim in this research is to study the effect of product variety on the supply chain performance of this industry.

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B. Product Variety

Among several definitions available in the literature, the present study considers the definition of product variety as the number of different versions of a product offered by a firm at a single point in time [6]. According to product characteristics, there are different drivers for product variety such as form (size, shape, and structure), feature (options provided), and style (color, appearance) [7]. Product variety directly affects several departments in a firm such as, for example, marketing, logistics and manufacturing. Increasing product variety in style, size, package, function, etc., can result in improved customer satisfaction, higher market share and enhanced competitiveness [7]. Product variety also affects consumer purchase behavior and welfare. The needs and desires of heterogeneously distributed consumers are better satisfied by higher product variety. In addition, consumers can enjoy a diversity of options through “variety seeking” behavior, which satisfies intellectual curiosity [8]. Thus, increasing product variety enhances consumer welfare [9]. In contrast, a reduction in variety has an adverse impact on both purchase quantity and shopping frequency [10]. On the other hand, increasing availability of product variety also changes consumer behavior, requiring, for example, better product choice selection strategies, and in the long run creating much more sophisticated and savvy customer [11]. Increasing variety has impact on logistics operations and costs as well. Variety induces different indirect costs that are difficult to capture, and are often neglected when making the decision about introducing variety [12]. Raw material costs, work-in-process (WIP), finished goods, and post-sales service inventories, and logistics costs are some examples of costs arising from increased variety. The inventory of finished goods and work-in-process for a firm offering more variants is higher than a firm with lower product variety due to the uncertainty in forecasting demands [13]. It is more challenging to ensure operational efficiency when the variety level is increasing [14, 15]. A broader product line can result in higher costs, essentially because of increases in overhead expenses [16], material costs and labor costs [17]. In particular, the impact of product variety on cost is considerably higher than that suggested by the risk-pooling literature for perfectly flexible manufacturing processes when setup times are significant [18]. Most of the times, the objectives of marketing and manufacturing are contradictory [19]. Although increasing product variety might lead to increased sales, it has its disadvantages so that it might not be economically viable. Thus, a challenge faced by companies is to maintain the competitive price and quality while offering variety in order to satisfy customer's needs and wants. The net impact of product variety on supply chain performance is uncertain when considering both the positive impact of variety on sales and the negative impact of the increased inventory and out-of-stock due to high product variety. The determination depends on the trade-off between these positive and negative effects. Thus, in this research, we study both types of impacts, simultaneously. The literature review reveals that previous research incidentally studied the impact of product variety on business functions and mostly focused on the impact of product variety on individual functional areas [20]. Therefore, the main contribution of this paper is in simultaneously capturing the impacts of variety in product demand and cost outcomes. Integrating marketing factors (demand) and operational factors (costs) within a company is an important, and at the same time challenging issue. This paper presents a model based on system dynamics (SD) methodology to gain structural insight into the effect of product variety on the performance of a fast fashion supply chain. The subject of analysis here is a (simplified) supply chain with a single manufacturer and a single retailer. We first investigate the performance of supply chain when the effect of product variety on the lead time is ignored. Then, we analyze the effect of product variety when it impacts the lead time. Although, many industries are under pressure for higher variety and faster delivery [21, 22], distinct recognition of the leadtime-variety trade-off can rarely be found in the literature. We demonstrate that disregarding the effect of product variety on lead time can lead to poor decisions and can lead companies to offer product variety that is higher than economically feasible. This paper is divided into 5 sections. Section 2 explains the model including structure, characteristics and assumptions. Section 3 discusses the model validation process. Section 4 provides the results obtained from the simulation analysis on the supply chain performance. Finally, section 5 comprises the concluding remarks and the limitations.

II. OVERVIEW OF SUPPLIER SELECTION

In today's competitive environment, companies are trying to attain the goals of low cost, high quality, flexibility and more customer satisfaction. So they should know that for a company to remain competitive it is crucial to work with its supply chain partners. Traditionally supply chain management is the integration of key business

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processes from end user to original supplier, different features and attributes will be showed. Finally in provides products, service and information that add value for customers. Therefore it is very important for all companies to have long relationship with few reliable suppliers. Also in manufacturing industries, the cost of raw materials and components comprise the major portion of product's final cost, sometimes it can equal up to 70% product cost. In this situation purchasing department can play a key role in cost reduction. The success of a company is highly depended on selection of proper suppliers and it is critical task to achieving the different objectives of the supply chain.

A. Supply chain

The term "supply chain" used here to define the stages through which construction resources (material, equipment, personnel) entirely proceed from supply points to the constructions site. Supply chain in construction s more concerned with the planning and directing discrete quantities of materials to the construction site where the object is assembled from incoming materials

B. Supplier Selection Methods

The main purpose of this study is to extend and update them. It is very crucial to know which methods are most used by firms because it can have a very important influence on the selection results. So we should find out the models used for many years and well known.

C. Identifying potential suppliers

To survive in the intensely competitive global economy, it is often critically important to not only develop existing suppliers but also to discover new suppliers. This section outlines the process of finding viable new suppliers. First briefly motivates why a buyer might wish to find new suppliers and explains why identifying suppliers is only part of the challenge — the buyer must also be cognizant of the need to ensure such suppliers are qualified. Supplier qualification screening processes are discussed. Because identifying and qualifying potential suppliers can be time-consuming and costly, buyers often develop a long-term supply base consisting of qualified suppliers.

D. Importance of new suppliers

Several factors make new suppliers important. First, there may exist new suppliers that are superior in some way to a firm's existing suppliers. For example, a new supplier may have developed a novel production technology or streamlined process which allows it to significantly reduce its production costs relative to pre dominates production technology or processes. Or, a new supplier may have a structural cost advantage over existing suppliers, for example, due to low labour costs or favourable import/export regulations in its home country. Second, existing suppliers may go out of business, or their costs may be increasing. Third, the buyer may need additional suppliers simply to drive competition, reduce supply disruption risks, or meet other business objectives such as supplier diversity .In recognition of these reasons, buyers and their internal customers may be obliged by company policy to locate a minimum number of viable, potential suppliers for every product or service procured.

E. Reasons for supplier qualification screening

Finding a viable new supplier is challenging mainly due to the need to verify the supplier's ability to meet the buyer's myriad requirements .Supplier non-performance on even the most basic level, and for the simplest commodity, can have dire consequences for the buyer.

F. Multi Attribute Decision Making (MADM) Techniques:

A vendor selection problem usually involves more than one criterion and these criteria often conflict with each other. So MADM techniques such as Analytic hierarchy process (AHP), Analytic network process (ANP), TOPSIS and Multi attribute utility technique (MAUT) are implemented to solve the problem.

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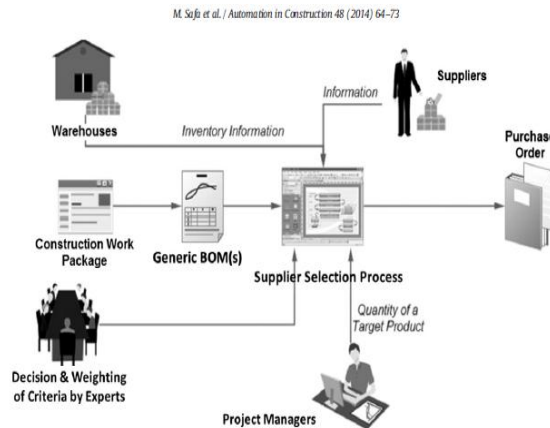


FIG.1.1 Supplier Evaluation flow chart

G. Indications of supplier quality.

The buyer might require that suppliers have ISO 9000 certification (or similar), indicating that the supplier has policies, procedures, documentation, and training in place to ensure continuous adherence to quality standards. However, in some cases the certification documents can be misleading and/or easily forged. To actually see if an adequate level of quality is achievable, the buyer may have to look deeply into the supplier’s organization to ensure the supplier is capable and competent to meet the buyer’s specifications.

H. Financial status checks.

The buyer may use published supplier rating to determine the supplier’s financial status and likely financial viability in the short to medium term. For example, if the supplier has recently assumed significant debt, this may raise red flags about the possibility the supplier will declare bankruptcy before fulfilling its obligations to the buyer.

III.METHODOLOGY

Methodology is the flow of work carried throughout the project. The work process for the proposed project is shown in the flow diagram as follows.

A. Major steps of supplier selection

- Step 1 - Identification of the need for a specific product
- Step 2 - Identify key sourcing requirements and criteria
- Step 3 - Determine sourcing strategy
- Step 4 - Identify potential supply sources
- Step 5 - Limit suppliers in selection pool
- Step 6 - Determine method for final selection
- Step 7 - Select suppliers and reach agreement

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B. Critical success factors for supplier selection

- Quality of materials
- Quantity of materials
- Price of materials
- Availability of materials
- Delivery service
- Technical capability
- Financial strength
- Reputation
- Management and Organization
- Other factors

C. Multi attribute decision making

Multi-criteria decision making methods are gaining importance for selection of best suited alternative among the available alternatives. Decision makers in the construction industry frequently face the problem of assessing a wide range of alternative options, and selecting one based on a set of conflicting criteria. MCDM methods are based on aggregating function representing “closeness to ideal”. In this paper the six multi-criteria decision-making methods including Simple Additive Weighting (SAW) Method, Weighted Product Method (WPM), Analytical Hierarchy Process (AHP), TOPSIS, VIKOR and PROMETHEE are compared for one specimen problem.

C. Simple Additive Weighting (SAW) Method

This is also called the weighted sum method. It is the simplest and still the widest used MADM method. In this method, each attribute is given a weight and the sum of all weights must be 1. Each alternative is assessed with regard to every attribute. The overall or composite performance score of an alternative is given by the equation.

$$P_i = \sum_{j=1}^M W_j M_{ij}$$

Previously it was argued that SAW method should be used only when the decision attributes can be expressed in identical units of measure. However, if all the elements of the decision table are normalized, then SAW can be used for any type and any number of the next-least important attribute is chosen, more points are assigned to it, and so on, to reflect their relative importance. The final weights are obtained by normalizing the sum of the points to one. Edwards et al proposed a simple method to assess weights for each attribute to reflect its relative importance to the decision. For a start, the attributes are ranked in order of importance and 10 points are assigned to the least important attribute. Then, the next-least important attribute is chosen, more points are assigned to it, and so on to reflect their relative importance. The final weights are obtained by normalizing the sum of the points to one.

D. Weighted Product method (WPM)

This method is similar to Simple Additive method. The main difference is that, instead of addition in the model, there is multiplication. The normalized values are calculated as explained under the SAW method. Each normalized value of an alternative with respect to an attribute, i.e. $(m)_{ij}$ normal is raised to the power of the relative weight of corresponding attribute. The alternative with the highest P_i value is considered the best alternative.

E. Analytical Hierarchy Process (AHP)

One of the most popular analytical techniques for complex decision-making problems is the analytical hierarchy process. Saaty developed AHP, which decomposes a decision-making problem into a system of hierarchies of objectives, attributes and alternatives. An AHP hierarchy can have as many levels as needed to fully characterize a

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particular decision situation. A number of functional characteristics make AHP a useful methodology. These include the ability to handle decision situations involving subjective judgments, multiple decision makers and the ability to provide measures of consistency of preference. Designed to reflect the way people actually think, AHP continues to be the most highly regarded and widely used decision-making method. AHP can efficiently deal with tangible as well as non-tangible attributes, especially where the subjective judgments of different individuals constitute an important part of the decision process.

F. Technique for Order Preference by Similarity to Identical Solution (TOPSIS)

The TOPSIS method was developed by Hwang and Yoon. This method is based on the concepts that the chosen alternative should have the shortest Euclidean distance from ideal solution and the farthest from negative ideal solution. The ideal solution is a hypothetical solution for which all attribute values corresponds to the maximum attribute values in the database comprising the satisfying solutions; the negative ideal solutions the hypothetical solution for which all attribute values corresponds to the minimum attribute values in the database. TOPSIS thus gives a solution that is not only closest to the hypothetically best, that is also the farthest from hypothetically worst.

G. Compromise Ranking method (VIKOR)

The foundation for compromise solution was established by Yu (1973) and Zeleny (1982) and later advocated by Oprcovic and Tzeng (2002, 2007) and Tzeng et al (2002, 2005). The compromise solution is a feasible solution that is the closest to the identical solution and a compromise means an agreement established by manual concession. (Serafim et al 2012). The compromise solution method is also known as the VIKOR method, was introduced as one applicable technique to implement within MADM. The multiple attribute merit for compromise ranking was developed from the Lp-metric used in the compromise programming method (Zeleny, 1982). VIKOR

is a helpful tool in MADM, particularly in a situation where the decision maker is not able or does not know how to express preference at the beginning of system design

H. Fuzzy Analytical Hierarchy process procedure:

The FAHP is one of the extensive multi-attribute decision making. Fuzzy AHP is an extension of AHP has been developed to solve hierarchical fuzzy problems in the fuzzy AHP procedure, the pair wise comparisons in the judgment matrix are fuzzy numbers that are modified according to the designers focus. The FAHP is based on four stages:

Step 1: Construct of the structuring hierarchy: a problem is decomposed into a hierarchy, this one contains three levels: the overall objective is placed at the topmost level of the hierarchy, the subsequent level presents the decision factors and the alternative solution are located at the bottom level.

Step 2: Construct of the pair wise comparisons: to establish a decision, FAHP builds the pair wise matrix comparison such as:

Elements r_{ij} .

Step 3: Calculating the weights of criterion: the weights of the decision factor i can be calculated by:

Step 4: Calculating the coherence ratio (CR): to test consistency of a pair wise comparison, a consistency ratio.

Step 5: Calculation of the similarity distance

Step 6: Ranking: A set of alternatives can be ranked according to the decreasing order of C_j^*

V. NUMERICAL EXAMPLES

To illustrate the different approaches used to solve the supplier selection problem, we present, in this section a numerical example.

- Number of decision makers $k=4$;

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- Number of criterias to be evaluated $n=4$;

- criteria cost or benefit criteria:

Benefit=1, Cost=2, vector of length n .
i.e.criteria=[1 1 1 2];

- Number of attributes to be ranked $m=6$;

WD1={VH H H H};

WD2={H VH VH H};

WD3={MH H H MH};

WD4={M M MH MH};

WD={WD1;WD2;WD3;WD4};

- Needed linguistic variables for importance weight of each criterion as generalized fuzzy % numbers:

VL=[0 0 0.1 0.2 1]; % Very low

L=[0.1 0.2 0.2 0.3 1]; % Low

ML=[0.2 0.3 0.4 0.5 1]; % Medium low

M=[0.4 0.5 0.5 0.6 1]; % Medium

MH=[0.5 0.6 0.7 0.8 1]; % Medium high

H=[0.7 0.8 0.8 0.9 1]; % High

VH=[0.8 0.9 1.0 1.0 1]; % Very High

- Needed linguistic variables for ratings as fuzzy numbers:

VP=[0,0,1,2, 1]; % Very Poor

P=[1,2,2,3, 1]; % Poor

MP=[2,3,4,5, 1]; % Medium Poor

F=[4,5,5,6, 1]; % Fair

MG=[5,6,7,8, 1]; % Medium Good

G=[7,8,8,9, 1]; % Good

VG=[8,9,10,10,1]; % Very Good

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Our Proposed FAHP (Fuzzy Analytical Hierarchy Process) method is capable of optimizing the supplier selection by assigning weights of supplier in terms of both qualitative and quantitative criteria and identified optimal supplier.

VI. CONCLUSION

Current supply chain management has encountered a series of challenges in the past decade or so due to the fast changing market demand and the trend of globalization. Supply chain is then required to be fast and effective enough to react to the changes of the market. Supplier selection and order allocation is a key process in supply chain management; Due to the increasing importance of this problem, this project is used for improving the accuracy and efficiency of supplier selection and order allocation process. At the same time, this project also aims to generate a meaningful and practical set of criteria for supplier selection by using hybrid Fuzzy Analytical Hierarchy process (FAHP) and Genetic Algorithms (GA) approach. The literatures are collected from different authors, published in the year of 2009 to 2014. From this literatures review, it has been observed that the effective optimization technique for supplier selection is FAHP with GA application. The implementation of this thesis will carried out in Phase II of this project.

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