Supplier Selection and Order Allocation Scenarios in Supply Chain: A Review

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Abstract

In these days, firms have to focus on their core capabilities and employ suppliers to outsource for upgrading their competitive advantages in business activities. So, supplier selection and order allocation should be of great importance in supply chain management. This study aims to review the literatures on supplier selection and order allocation scenarios. Thirteen journal articles published between 2008 and 2012 have been surveyed for this purpose. The articles are analysed to summarize the existing criteria and methods to be relevant to different types of industries for supplier selection and order allocation problems. In addition, some discussions on criteria and methods are done and presented in this paper. Finally, suggestions for future researches are proposed for academics and decision makers.

Keywords

Supplier Selection; Order Allocation; Supply Chain Management

Introduction

Successful supply chain management requires an effective and efficient sourcing strategy to eliminate the uncertainties in both supply and demand. Sourcing decisions are more critical than ever, since with the increase of the purchasing costs in the overall costs, the purchasing function and the purchasing decisions have gained a considerable importance at each firm. On average, a typical manufacturing compa ny spends 60% of its total turnover in purchasing materials, goods and services acquired from external suppliers (Bayrak, Celebi, and Taşkin 2007). Thus purchasing decisions have significant effects on lowe ring costs and increasing profits. Purchasing processes are analysed in two stages: first of which is the selecti on of suppliers formally by filtering them through an evaluation process that includes both qualitative and quantitative measures, and the other is the order allocation where the order amounts for each supplier are determined (Erdem and Göçen 2012).

There are some journal articles reviewing the literature regarding supplier selection and order allocation scenarios-separately or together (Weber, Current, and Benton 1991, Holt 1998, Degraeve, Labro, and Roodhooft 2000, de Boer, Labro, and Morlacchi 2001, Ho, Xu, and Dey 2010, Aissaoui, Haouari, and Hassini 2007) (Minner 2003) Since these articles review the literature up to 2008, this paper extends them through a literature review on the sample of international journal articles between 2008 and 2012 with the focus on the both supplier selection and order allocation problems. This paper intends to identify three issues including the existing criteria and methods, the most popular criteria and methods, and applications of the methods in industry.

Criteria and Methods for Supplier Selection and Order Allocation Problems

Supplier selection is the process by which a group or large number of suppliers' performances and abilities are reviewed, evaluated, and chosen to become a part of the company's supply chain. Basically, there are two kinds of supplier selection as multiple sourcing and single sourcing. In single sourcing, one supplier can satisfy all the buyer's needs and the management needs to make only one decision. Although, in principle, the selected supplier is the best, the best is always cunning. Whereas in multiple sourcing as no supplier can satisfy all the buyer's requirements, more than one supplier has to be selected (Guneri, Yucel, and Ayyildiz 2009). Therefore, in multiple sourcing environments, the order allocation decision must be considered in addition to supplier selection decision. A wide range of criteria and methods have been applied in supplier selection and order allocation problems in literature. In this section, a sample of supplier selection and order allocation papers in recent years are chosen to analyse and summarize the

existing criteria and methods to be relevant to different types of industries for supplier selection and order allocation problems. Also, in some papers, hypothetical cases have been applied to show the feasibility and applicability of the methods. This information is shown in Table 1 and Table 2.

TABLE 1 SUPPLIER SELECTION IN DIFFERENT INDUSTRIES

Author	Method	Evaluation and Selection Criteria/Application
Ting and Cho (2008)	AHP, Multi-Objective Linear Programming	Product price, transportation costs, ordering costs, defect and scrap ratio, product rejection ratio, quality system, delivery time-days, delivery quantity shortage, response to change, length of order time, respond to inquiries, co-design production, supply contracts, assets and debts, income and earnings, cash flow/ Motherboard manufacturer
Kokangul and Susuz (2009)	AHP, Integer Non-Linear Programming, Integer Non-Linear Goal Programming	Price performance, delivery performance, collaboration and developing performance, quality/ Automotive manufacturing
Aktar Demartis Ustun and (2008)	ANP, Mixed Integer Programming ANP, Mixed Integer Programming	Low defect rate, process capability, on-time delivery, process flexibility, response to changes, consistency, mutual trust & ease of communication, support to design process, break in line, measurement & assessment cost, customer complaints, order delays, inability to meet further requirements(BOCR)/ The plastic part of a refrigerator plant
Kirytopoulos et al. (2010)	ANP, Multi-Objective Mathematical Programming	Value-added services (additional offers), flexibility, problem solving, ease of communication, reputation, financial status, production facility and capacity, advertising, product specification, supplier's certification, relationships, preference, production delays, delivery delays, low quality of delivered products, wrong quantity/items/ pharmaceutical company
Lin et al. (2010)	ANP, TOPSIS, Linear Programming	Material cost, assembly cost, transportation cost, management cost, negotiation cost, yield rate, reliability, innovation, repair ability, research and development, attitude, communication, response speed, degree of communication, use of technology, accuracy, lead time, location, credibility, capability/ Motherboard manufacturer
Sanayei et al. (2008)	Multi Attribute Utility Theory, Linear Programming	Damage free orders, on time orders, lead time, return product velocity, order increase/decrease flexibility, revise flexibility, total cost, payment terms, quality system certification, company size, reputation/ Automobile manufacturer
Erdem and Gosen (2012)	AHP, Goal programming Algorithm	Cost(unit purchase price, terms of payment, cost reduction projects); Quality(perfect order fulfillment, after sales service, application of quality standards, corrective & preventive action system, improvement efforts in tech & quality); Logistics(on time delivery, order lead time, delivery conditions & packaging standard, flexibility of transport, geographic distance); Technology(allocated capacity, flexibility of capacity, flexibility of technology, involvement in new product development)/ White goods manufacturer

TABLE 2 SUPPLIER SELECTION IN HYPOTHETICAL CASES

Author	Method	Evaluation and Selection Criteria
Ebrahim et al. (2009)	AHP, Multi-Objective Linear Programming, Scatter Search Algorithm	Length of guarantee period, available services during guarantee period, needed training for use of production(S), length of the relation period, importance of relations, level of mutual satisfaction during relations, technological level, level of information technology, capital of the supplier, flexibility in manufacturing, capability of getting in touch by buyer, available information about supplier
Li and Zabinsky(2009)	Mixed Integer Programming	Quality, delivery, cost(transaction and inventory)
Wu et al. (2009)	ANP, Mixed Integer Programming	Management quality, technical quality, operational quality, fixed cost, variable cost
Che and Wang (2008)	Mathematical Programming, Genetic Algorithm	Cost, on time delivery, quality
Basnet and Weintraub (2009)	Mixed Integer Programming, Genetic Algorithm	Cost, quality, delivery
Sawik (2010)	Mixed Integer Programming	Price, quality, on time delivery
(Mafakheri et al., 2011)	AHP, Dynamic Programming Approach	Price performance (average time interval of price validity, price increasing trend, sending cost analysis, pay time, penalty for delayed payment, financial stability); Delivery performance (consistency in meeting delivery deadlines, order fill rate, flexibility in meeting customer needs, perfect delivery rate, labelling); Environmental performance, Quality (the number of rejected items at entry level quality control, the number of rejected deliveries at entry level quality control, the number of rejected items at the process quality control, the number of rejected deliveries at the process quality control, the number of rejected items from warranty, the number of rejected safety items)

Li and Zabinsky (2009) suggested a two-stage stochastic programming model and a chance-constrained programming model to identify the best suppliers and to assign order quantities in business

volume-discount environments. Both models were formulated on a mixed integer program. The uncertainties for demand and supplier capacity were considered with a probability distribution in the models (Li and Zabinsky 2009).

Sawik (2010) presented mixed integer programming models for single or multi-objective supplier selection cases in non-discount or discount environment to determine the optimal allocation of orders for the approved suppliers. Risk constraints associated with uncertain quality and reliability of supplies were considered in this model (Sawik 2010).

Ting and Cho (2008) applied AHP to choose a set of candidate suppliers. Subsequently, a multi objective linear programming model was constructed to determine the optimum order quantity allocation to the candidate suppliers (Ting and Cho 2008).

Ebrahim et al. (2009) introduced the multi objective linear integer programming model for supplier selection and order lot sizing in consideration of various kinds of discount in the single item purchasing problem. AHP was utilized to obtain a total weight for each supplier. Because of the complexity of the model, a scatter search algorithm and a branch and bound algorithm were applied to solve the model and the results of two algorithms were compared (Ebrahim, Razmi, and Haleh 2009).

Kokangul and Susuz (2009) applied AHP to make a trade offs between criteria and to determine the score of suppliers in the supplier selection problem. The obtained scores were considered as coefficients of an objective function in a multi-objective non-linear integer programming model to allocate order quantities under quantity discounts (Kokangul and Susuz 2009).

Aktar Demirtas and Ustun (2009) integrated ANP and multi objective mixed integer linear programming models to select the appropriate suppliers and determine the order quantities in the multi-period lot sizing condition. Furthermore, Achimedean goal programming model was applied to solve the model (Aktar Demirtas and Ustun 2009).

Wu et al. (2009) integrated analytic network process (ANP) and multi-objective mixed integer program ming to select appropriate supplier in consideration of bundling strategy. The weighted scores of suppliers were derived from ANP model and these scores were used as coefficients of an objective function in a mathematical model to assign order quantities to each supplier (Wu et al. 2009).

Similar to other scholars, Kirytopoulos et al. (2010) applied ANP to rate the suppliers and then exploited a multi objective mathematical programming method to assign order quantities. The suppliers were clustered besides ranking in the model (Kirytopoulos et al. 2010).

Lin et al. (2011) combined ANP and TOPSIS models to obtain the weights of suppliers in the ERP environm ent. The final weight of each supplier was considered as a coefficient of the objective function in linear programming model to assign an optimal order quantity to each supplier (Lin, Chen, and Ting 2011).

Che and Wang (2008) developed an optimal mathematical model for multiple products in the supplier selection problem due to common and non-common parts. The model was constructed to allocate suitable order quantities to selected suppliers under the limitation of production capacity. A GA approach was applied to obtain acceptable results for the model (Che and Wang 2008).

Sanayei et al. (2008) applied multi-attribute utility theory to rate the suppliers while considering uncertainty. The obtained rates were then utilized as coefficients for the objective function of the linear programming model to identify the optimal quantities of order allocation (Sanayei et al. 2008).

Erdem and Gocen (2012) implemented AHP model to evaluate the suppliers and based on these evaluations, a mathematical programming model was proposed for order allocation among suppliers (Erdem and Göçen 2012).

Mafakheri et al. (2011) used AHP model to select the appropriate suppliers. Then, a bi-objective mathem atical model was structured to assign orders allocation and a dynamic programming approach was devised to solve the model (Mafakheri, Breton, and Ghoniem 2011).

It is worthy to note that all of the aforementioned supplier selection papers in the sample applied ma thematical programming approaches or their hybrids for supplier selection and order allocation papers.

Critical Discussion on Criteria and Methods

Many criteria have been suggested in the supplier selection decision as seen in Table 1. The most popular criterion is quality, followed by cost/price, delivery on time, service, organization and management, financial situation, flexibility, technological level, production facilities and capacities, relationship, and etc. It is clear

that all of mentioned criteria involved in economic aspects. However, the green issues and environmental aspects have received a lot of attention. So, there is a need to make more concentration on environmental aspects in supplier selection decision besides economic aspects for future research.

Since supplier selection is a multi criteria decision making, this issue can be modelled as a multi-objective programming technique. Usually, one or more than one criterion is considered in objective functions and other criteria are considered as constraints. Besides evaluation and selection criteria, companies are exposed to various constraints in the supplier selection problem which can be formulated as mathematical programming models. Moreover, in multiple sourcing environments, mathematical programming methods are well known because they assist not only the selection of the appropriate suppliers but also determination of the amount of order allocation to selected supplier simultaneously. That is why the integrated mathematical programming is one of the most popular methods for supplier selection and order allocation problems as seen in Table 1 and Table 2.

However, mathematical programming method has some drawbacks as follows. Mathematical Program ming models often fails to consider scaling and subjective weighting issues and have no possibility for the decision makers to apply his or her preference. The weight determination is a challenging task for implementing these models. Moreover, mathematical programming models have no ability to cope with the qualitative criteria.

To overcome the weightless drawback of mathematical programming models, there are some solution methods. As seen in Table 1, AHP technique providing the most functional solution methods in this sample, is a common approach to calculate the relative importance weightings of criteria and sub-criteria owing to its simplicity and flexibility. Based on the above analysis, it is obvious that mathematical programming models are the most prevalent methods for order allocation problem and integrated mathematical programming-AHP method is the most popular hybrid methods for supplier selection and order allocation scenarios.

Conclusion and Suggestions

This study has reviewed a sample of supplier selection and order allocation papers from 2008 to 2012 and has provided valuable insights into existing criteria and methods. The most popular criterion to evaluate suppliers is quality, followed by cost/price, delivery, and so on. In addition, the most popular method for supplier selection and order allocation problems is integrated AHP-Mathematical Programming method.

To pave future researches on criteria, the green issues can be considered in the supplier selection problem and environmental aspects can be added to existing criteria. In addition, after the implementations of existing methods has been analysed in this review article, it is found that the researchers have focused on manufacturing industries. It is worthwhile and essential to apply the methods for supplier selection in service industries and sectors as well.

To improve the existing methods, it can be focused on shortcomings of AHP technique. The AHP technique, a time-consuming model in consideration of a large number of criteria and alternatives (Amin & Zhang, 2012), can compare a very limited number of decision alternatives, usually not more than 15 (Wang, Liu, & Elhag, 2008) due to the utilization of a pair-wise comparison procedure. So, developing on methods which cope with the large number of criteria and alternatives is a hot area for research.

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