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A decision method for supplier selection in multi-service outsourcing

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ABSTRACT

Although supplier selection in multi-service outsourcing is a very important decision problem, research concerning this issue is still relatively scarce. This paper proposes a decision method for selecting a pool of suppliers for the provision of different service process/product elements. It pioneers the use of collaborative utility between partner firms for supplier selection. A multi-objective model is built to select desired suppliers. This model is proved to be NP-hard, so we develop a multi-objective algorithm based on Tabu search for solving it. We then use an example to show the applicability of the proposed model and algorithm. Extensive computational experiments are also conducted to further test the performance of the proposed algorithm.

1. Introduction

In today's global service outsourcing arena, increasing numbers of firms adopt multi-service outsourcing; that is, they combine service process/product elements (SPEs) from multiple providers (Levina and Su, 2008). For example, Chinamobile provides M-zone business services, including music online, mobile purse, color ring and mobile news, through service providers (SPs). Multi-service outsourcing has become an important business approach since it can significantly decrease service price, shorten waiting time, improve customer satisfaction and enhance the firm's core competence (McCarthy and Anagnostou, 2004; Antelo and Bru, 2010). As for the process of multi-service outsourcing, a service process/product disaggregation is first conducted to pinpoint the SPEs that need to be outsourced. SPEs imply sub-services or products that combine to form a whole service process/product. A pool of appropriate suppliers is then selected for providing specific SPEs (Stratman, 2008). The outsourcing firm selects the most appropriate suppliers by considering service price, waiting time or service capacity, and builds long-term and profitable relationships with them (Wang and Yang, 2009; Qi, 2011). Supplier selection, orienting long-term collaborative relationships in multi-service outsourcing, is a very important decision problem (Lee, 2009; Nordin, 2008; Levina and Su, 2008; Bustinza et al., 2010).

As for multi-service outsourcing, the collaboration between the outsourcing firm and the potential suppliers as well as between the potential suppliers (partner firms for conciseness, hereafter) is an important underlying factor for the development of long-term collaborative relationships, which has been of particular interest (Lee, 2009; Büyüközkan et al., 2009). The outsourcing firm develops mutually beneficial relationships with their key suppliers so that the suppliers are more willing to invest in skills or technologies that are specific to it (McCutcheon and Stuart, 2000). An outsourcing firm and its suppliers may broaden their contact and share business or technology information. Suppliers may expand their roles to provide related supports beyond traditional outsourcing transactions, such as participating in the outsourcing firm's research and development (R&D) activities or providing technology supports and training by virtue of their areas of expertise (McCutcheon and Stuart, 2000; Guo et al., 2010). Suppliers may share their service facilities or processes with each other to exploit pooling benefits (Allon and Federgruen, 2009). Particularly, suppliers in service industries need more collaboration than those in manufacturing industries because they perform different activities consecutively in a whole service process and in order to impress customers consistently, they have to employ compatible interface management. Indeed, collaborative utility between partners has gained an increasing attention in some latest research on collaborative organizations, such as alliances (Ding and Liang, 2005; Emden et al., 2006), bilateral collaboration innovation networks (Cowan et al., 2007), interfirm collaboration networks (Schilling and Phelps, 2007), virtual network organizations (Lavrač et al., 2007), and teams (Fan et al., 2009; Feng et al., 2010a, b). The collaborative utility between partner firms is a valuable input for decision-making. Thus, it is necessary to consider the collaborative utility between partner firms for supplier selection in multi-service outsourcing.

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In the last two decades, various decision-making methods have been proposed to tackle the problem of supplier evaluation and selection; please refer to a recent review by Ho et al. (2010). However, the vast majority of the published works deal with supplier selection in manufacturing industries and few of them address such a problem in service industries. And usually the individual utility of a single supplier is considered, such as financial stability, business track record, technical expertise, market knowledge and managerial experience (Büyüközkan et al., 2008), while the collaborative utility between pairwise suppliers is seldom involved. Moreover, the criteria (or objectives) focused in service supplier selection differ from those for manufacturing supplier selection. Revenue, cost or the number of suppliers is usually considered in manufacturing supplier selection. However, service price and waiting time are the two most important and irreplaceable objectives for supplier selection in multi-service outsourcing (Allon and Federgruen, 2009). Finally, unlike part or product purchasing, service outsourcing is ordinarily conducted by a long-term contract, not by repeated orders. The outsourcing cost does not contain ordering, transportation, inspection and storage costs. Therefore, the existing decision methods cannot be directly used to solve the problem of supplier selection in multi-service outsourcing. Clearly, there is a need for a straightforward and routine decision method for solving the multi-service outsourcing problem.

In this paper, we propose a model and algorithm, which pioneer the use of collaborative utility between partner firms, for supplier selection in multi-service outsourcing. A multi-objective 0–1 programming model involving three objectives, collaborative utility, service outsourcing cost and service waiting time, is built for selecting a pool of desired suppliers for the provision of different SPEs. To solve this multi-objective model, we develop a multi-objective algorithm based on Tabu search (TS). We then use an example to show the applicability and necessity of the suggested model and algorithm. In addition, extensive computational experiments are conducted to show the efficiency and effectiveness of the algorithm.

The organization of this paper is as follows. In Section 2, the literature on supplier selection is reviewed. In particular, the existing mathematical programming models for supplier selection are listed. Section 3 builds a model for supplier selection for the provision of different SPEs in multi-service outsourcing. Section 4 develops a multi-objective algorithm based on TS for solving this model. An example and computational experiments are reported in Section 5 to show the effectiveness of the proposed model and algorithm. Section 6 contains some conclusions and suggests future work.

2. Literature review

So far, research on supplier selection in multi-service outsourcing is limited, so the broad and indirect literature on supplier selection is reviewed.

Supplier selection is one of the most widely researched areas in purchasing with methodologies ranging from conceptual to empirical and modeling streams. A series of literature surveys have been made to summarize the criteria and decision methods involved in papers starting from the mid-1960s. See, for example, surveys provided by Moore and Fearon (1973), Kingsman (1986), Holt (1998), De Boer et al. (2001), Aissaoui et al. (2007) and Ho et al. (2010). According to recent research work of Wang and Yang (2009), the quantitative decision methods for solving the supplier selection problem can be classified into three categories: (1) multi-attribute decision-making, (2) mathematical programming models and (3) intelligent approaches. Furthermore, in the latest literature survey by Ho et al. (2010), the mathematical programming models are grouped into the following five categories: (1) linear programming, (2) integer linear programming, (3) integer non-linear programming, (4) goal programming and (5) multi-objective programming. Table 1 summarizes the optimization models for supplier selection involved in the literature published since 2000.

3. Model for supplier selection in multi-service outsourcing

In this section, we formulate a mathematical model for supplier selection in multi-service outsourcing. First, notations used for problem description are defined. Then, a multi-objective 0–1 programming model for supplier selection considering collaborative utility, outsourcing cost and waiting time is built.

Table 1
Research on mathematical programming models for supplier selection.

Model	Objective function	Constraint	Author
Linear programming	Max (overall performance) Min (overall performance)	Productivity score based on the best measures, efficiency score of each vendor	Talluri and Narasimhan (2003)
	Max (overall performance)	Attribute weights	Ng (2008)
	Max (total value of purchasing)	Demand, quality, budgeting and suppliers' capacity	Guneri et al. (2009)
Integer linear programming	Min (number of suppliers)	Efficiency of suppliers, amount order from vendor, buyer's demand requirement, capacity of vendor, and minimum order quantity requirement of vendor	Talluri (2002)
	Max (revenue)	Purchasing demand in meaningful purchasing unit, supplier's potential system constraints and purchaser's policy constraints, number of suppliers, minimization of the supplier number and changing cost	Hong et al. (2005)
	Min (purchasing cost)	Order quantity, quality rate, late delivery rate and number of suppliers	Choi and Chang (2006)
Integer non-linear programming	Min (total annual purchasing cost)	Vendor's capacity, buyer's demand and purchased volume	Ghodsypour and O'Brien (2001)
Goal programming	Min (annual product cost)	Quality of castings purchased, delivery reliability of castings purchased, capacities of each supplier and demand	Karpak et al. (2001)
Multi-objective programming	Min (cost, scrap ratios, tardy-delivery fraction)	Purchasing budget, buyer's demand, inventory capacity and supplier's capacity	Gao and Tang (2003)
	Min (price, lead-time, quality)	Vendor's maximum capacity, product demand, maximum number of vendors and price discounts	Wadhwa and Ravindran (2007)