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A fuzzy inhomogenous multiattribute group decision making approach to solve outsourcing provider selection problems

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ABSTRACT

Considering various situations and characteristics of supply chain management, we regard the outsourcing provider selection as a type of fuzzy inhomogenous multiattribute group decision making (MAGDM) problems with fuzzy alternatives' comparisons and incomplete weight information. Hereby we focus on developing a new fuzzy linear programming method for solving such MAGDM problems. In this method, the decision makers' preferences are given through pair-wise alternatives' comparisons with fuzzy truth degrees represented as trapezoidal fuzzy numbers (TrFNs). Intuitionistic fuzzy sets, TrFNs, intervals and real numbers are used to express the inhomogenous decision information. Under the condition that the fuzzy positive ideal solution (PIS) and fuzzy negative ideal solution (NIS) are known, the fuzzy consistency and inconsistency indices are defined on the basis of the relative closeness degrees and expressed with TrFNs. The attribute weights are estimated through constructing a new fuzzy linear programming model, which is solved by the developed method of fuzzy linear programming with TrFNs. Through solving the constructed linear goal programming model, we obtain the collective comprehensive relative closeness degrees of alternatives to the fuzzy PIS, which are used to rank the alternatives. The effectiveness of the proposed method is verified with an example of IT outsourcing provider selection.
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1. Introduction

In global business environment, many companies are looking forward to outsourcing. They entrust some jobs to external providers. Through proper outsourcing, they can deliver goods to consumers in time and hereby reduce operating costs, increase their focus on internal resources and core activities, and sustain competitive advantages [1]. Information technology (IT, or information system (IS)) outsourcing is a common outsourcing activity for many organizations [2]. Generally, the process of IT outsourcing may be divided into seven phases, involving: (1) IT demand, application status and performance evaluation of department; (2) development and programming of IT; (3) outsourcing strategies; (4) design contract object; (5) select outsourcing providers; (6) contract negotiation, implement and supervise; (7) project approval. The process of IT outsourcing is illustrated with Fig. 1.

It is very important that companies scientifically select appropriate outsourcing providers to increase the success rate of outsourcing. Selecting outsourcing providers in the fifth phase is a classical problem of decision making in supply chain management. Usually there are many attributes to be considered between different alternatives. Due to the complexity, fuzziness and uncertainty inherent in the evaluated attributes, selecting appropriate outsourcing providers is a difficult task. There are a number of frameworks in the literature offering guidelines and prescriptions on the outsourcing decision. Most of early researchers commonly utilized the transaction cost theory to illustrate outsourcing decisions. However, in recent years, strategy aspects related to core competency, risk analysis and organizational flexibility have becoming important. As a result, this trend has led researchers and industries to become more interesting in multi-criteria decision making (MCDM) or multi-attribute decision making (MADM) methods for outsourcing.

1.1. Review for decision methods of selecting outsourcing providers

Lin et al. [3] proposed a hybrid MCDM method for outsourcing vendor selection through combining a case study of a semiconductor company in Taiwan. Combining a decision making trial and evaluation laboratory (DEMATEL) with the analytical network

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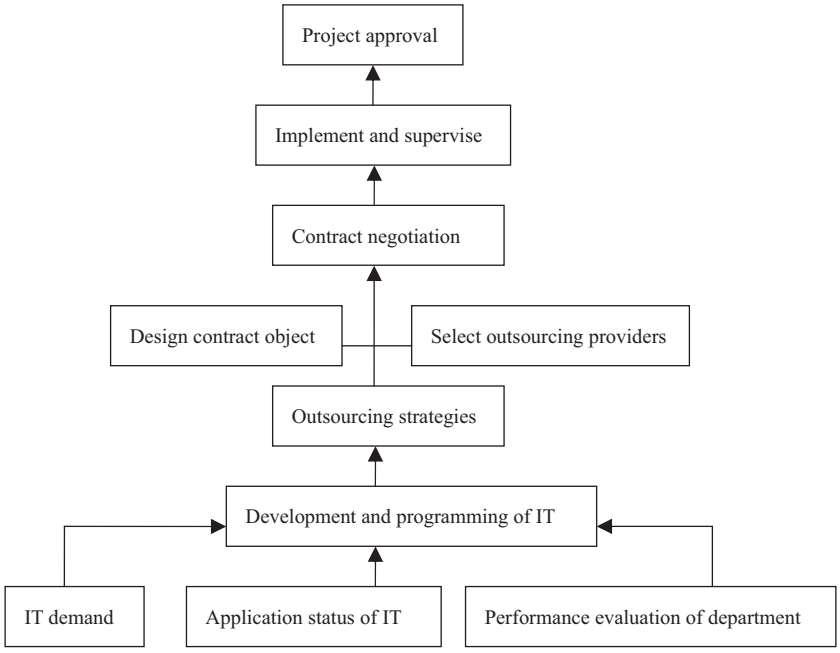

Fig. 1. The process of IT outsourcing.

process (ANP) method, Hsu et al. [4] proposed a novel hybrid model for the selection of an outsourcing provider. Ho et al. [5] integrated the quality function deployment, fuzzy set theory and analytic hierarchy process (AHP) to evaluate and select the optimal third-party logistics service providers. Chen et al. [6] presented the fuzzy preference ranking organization method for enrichment evaluation to evaluate four potential suppliers on seven criteria and four decision makers through using a realistic case study. Chen and Wang [7] developed the fuzzy Vlsekriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method for the strategic decision of optimizing partners' choice in IT outsourcing projects. Fan et al. [8] utilized an extended DEMATEL method to identify risk factors of IT outsourcing with interdependent information. Combining the DEMATEL, ANP with zero-one goal programming, Tsai et al. [9] developed a MCDM method for sourcing strategy mix decision in IT projects. From a policy-maker's perspective, Tjader et al. [10] researched the offshore outsourcing decision making. Buyukozkan and Cifci [11] proposed a novel hybrid MCDM method based on the fuzzy DEMATEL, fuzzy ANP and fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to evaluate green suppliers. Chou et al. [12] developed a fuzzy MCDM method to evaluating IT investments.

The aforementioned methods seem to be effective and applicable for selecting outsourcing providers. Nevertheless, they have three disadvantages. The first is that most of these methods assume that the attribute weights are completely given *a priori*. In many real decision situations, there are some difficulties or challenges for the decision maker (DM) to provide precise and complete preference information due to time pressure, lack of knowledge (or data), and limited expertise about the problem domain. In other words, usually weights are totally unknown or partially known *a priori* [13–15]. The second is that these methods only considered single DM for the process of outsourcing provider selection and ignored the function of group decision making. With ever increasing complexity and business competitiveness, companies often engage more and more DMs (or experts) in participating in making decision to increase the success of outsourcing. Therefore, outsourcing provider selection may be regarded as a type of multiattribute group decision making (MAGDM) problems. The third is that these methods seldom considered the inhomogenous evaluation information. The real-life decision making problems often involve multiple different types/formats of attribute values such as real numbers, intervals, trapezoidal fuzzy numbers (TrFNs), linguistic terms [16] and intuitionistic fuzzy sets (IFSs) [17] due to DMs' knowledge areas, work backgrounds and manners/habits. Consequently, MAGDM problems may include multiple different formats of decision information. Such a type of MAGDM problems is called the inhomogenous MAGDM problems, which have drawn some attention from a spectrum of disciplines [16,18–22]. For instance, ratings of research and development capability of an outsourcing provider can be expressed with IFSs, the product quality and technological level can be assessed by TrFNs, the flexibility and delivery time can be represented by intervals, the assessment of price can be expressed with real numbers. Moreover, it is very difficult for the DMs to accurately give these attribute weights due to various subjective and objective reasons. Thus, the outsourcing provider selection problems belong to a type of inhomogenous MAGDM problems with incomplete weight information.

1.2. The motivation of this paper

To reflect the vague characteristic of human thinking and evaluation, the fuzzy set theory [23] should be incorporated into decision making models [24–29]. TOPSIS [30] and Linear Programming Technique for Multidimensional Analysis of Preference (LINMAP) [31] are two commonly-used decision making methods. TOPSIS is based on the concept that the chosen alternative should have the shortest distance from the positive ideal solution (PIS) and the farthest distance from the negative ideal solution (NIS). However, TOPSIS can only be used to solve the decision making problems with attribute weights completely known *a priori*. If attribute weights are completely unknown or partially/incompletely known, TOPSIS cannot be used. LINMAP is based on pair-wise alternatives' comparisons given by the DM and generates the compromise alternative as the solution which has the shortest distance to the PIS. Nevertheless, LINMAP neglects the importance of the NIS in the decision making process. Integrating the advantages of TOPSIS

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