Soft Computing Based on an Interval Type-2 Fuzzy Decision Model for Project-Critical Path Selection Problem

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ABSTRACT

This article describes how project managers are faced with the conflicting criteria to make their decisions. In many real-world conditions, it may be difficult to get certain information about activities attributes, including time, cost, risk, and quality. In this case, interval type-2 fuzzy sets (IT2FSs) which consider more uncertainty than type-1 fuzzy sets (T1FSs) are used. In this article, a new group multi-criteria analysis model is expressed based on new compromise solution and relative preference relation (RPR) concept under IT2FSs environment. Also, a new version of the evaluation on distance from average solution (EDAS) method is introduced to specify the weight of each expert under IT2FSs. Furthermore, the RPR is more reasonable than the defuzzification approach. In fact, the RPR not only can provide preference degree between two fuzzy numbers but also can keep some information. Finally, an application from literature is adopted and solved to demonstrate the applicability of proposed method.

KEYWORDS
Compromise Solution Method, EDAS Method, Interval Type 2 Fuzzy Sets (IT2FSs), Multi-Criteria Decision Making, Project-Critical Path Selection Problems, Relative Preference Relation (RPR)

1. INTRODUCTION

Multi-criteria decision-making method plays a crucial role in project management problems. In recent years, many extended MCDM methods have been applied to these problems (Gitinavard et al., 2016b; Lin et al., 2016). VIKOR method is categorized as one of the multi-criteria decision-making techniques which use for ranking of the alternatives and specified the solution, called compromise, that is the nearest to the ideal. Liu et al. (2015) presented an approach for failure mode and effects analysis by means of fuzzy VIKOR method. Opricovic and Miloradov (2016) expressed an MCDM method based on VIKOR for selection of municipal waste treatment system. Lin et al. (2016) introduced a method for improving project risk management by VIKOR, DANP, and DEMATEL methods.

The critical path selection problem was considered as an MCDM problem for the first time of the literature by Zammori et al. (2009). They considered efficient criteria such as duration variability, costs, shared resources, risk of major design revisions and external risks. Then, Amiri and golozari (2011) obtained the critical path project by time, cost, quality, and risk criteria. Moreover, Cristobal (2012) presented a PROMETHE method for specifying the critical path of the project by using the time, cost, quality and safety criteria. Finally, Mehlawat and Gupta (2016) introduced an MCDM method based on the strength and weakness concepts by means of time, cost, risk, and quality criteria.

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In this paper, a set of efficient criteria, such as time, cost, risk, and quality criteria, are considered to determine the critical path of the project in real-world situations.

In group decision-making problem, determining the weight of decision makers (DMs) is an important issue. In order to specify weights of DMs, many studies were recently done. Yue (2011) developed the TOPSIS method for determining weights of the DMs based on the closeness to the ideal average solution concept. Moreover, Gitinavard et al. (2016a) introduced an extended method for specifying the weight of each DM. One of the new MCDM method in recent years is an evaluation based on distance from average solution (EDAS) method. EDAS method was applied in many MCDM problems. This method was presented by Keshavarz Ghorabaee et al. (2015) for multi-criteria inventory classifications. Peng and Liu (2017) introduced a decision-making method based on the EDAS method. Keshavaz Ghorabaee et al. (2017) developed the EDAS method under IT2FSs for multi-criteria group decision making. In this paper, to use advantages of EDAS method, it is applied to determine weights of the DMs for the first time in the literature.

In the classical MCDM approaches, ratings and weights of the criteria are known precisely. In other words, the problem is considered under certain environment. While in real-projects, the decision environment is not certain; it has vagueness and ambiguity (Mousavi et al., 2015). To address uncertainty, evaluation ratings and criteria weights in fuzzy MCDM (FMCDM) problems are expressed by imprecision and vagueness. Furthermore, experts and DMs can utilize linguistic variables by their knowledge and experience. With this approach, they can provide more realistic and reasonable judgments and feelings. Sanaye et al. (2010) used fuzzy VIKOR to supplier selection by group decision-making process. Shemshadi et al. (2011) presented a fuzzy VIKOR method to supplier selection based on entropy measure for objective weights. Yücenur and Demirle (2012) expressed an extension of VIKOR method under a fuzzy environment for group decision process to insurance company selection problem. Vahdani et al. (2010) developed an interval-valued fuzzy VIKOR (IVF-VIKOR) to solve MCDM problems in which the performance rating values as well as the weights of criteria are linguistics terms which could be taken in interval-valued fuzzy numbers (IVFNs).

T1FS are fuzzy sets with crisp membership grades in the interval [0, 1] which consequently cannot completely support various types of uncertainty, appearing in linguistic explanations of numerical quantities or in the subjectively explained judgments of experts. In many situations, it is difficult for experts to dedicate a crisp membership in the interval [0,1]. Thus, representing membership in a set with a degree of membership instead of classical all or none membership has been more feasible. In T2FSs, unlike T1FS, each element has membership value represented by fuzzy set in [0, 1] instead of a crisp number in [0, 1]. Furthermore, IT2FSs are three-dimensional and their membership function is specified by a fuzzy set on the interval [0, 1] and described by both primary and secondary memberships to prepare more degrees of flexibility (Balin and Baraçlı, 2017). The theory of IT2FSs provides an intuitive and computationally practical way of addressing uncertain and incomplete information in decision-making fields. In fact, the IT2FSs are more powerful than T1FSs in coping with the uncertainty (Mohagheghi et al., 2017b). Nevertheless, with considering the great uncertainty of real-world projects, a new soft computing decision model for tackling the uncertainty in this paper is developed under IT2FSs.

The IT2FSs have been used successfully for many project management problems (e.g., Lin et al., 2016; Mohagheghi et al., 2017a). Kiliç and Kaya (2015) presented a model for investment project evaluation under IT2FSs. Mohagheghi et al. (2017c) examined the project cash flow by a new IT2FSs model in construction industry environment. Mohagheghi et al. (2017b) introduced a mathematical modeling approach for technology-project portfolio selection under IT2F-environments. Nevertheless, with considering the great uncertainty of real-world projects, a new soft computing decision model for tackling the uncertainty is developed under IT2FSs in this paper. Many cases of fuzzy MCDM requires the defuzzification for the final ranking of alternatives.

As matter of fact, the defuzzification causes loss of fuzzy messages. Fuzzy preference relation is a new approach to resolve tie above because it satisfies a total ordering relation on fuzzy numbers.
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