EDITORIAL

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Multi-Criteria Decision-Making: advances in theory and applications—an introduction to the special issue

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Multi-Criteria Decision-Making (MCDM) has become a very fertile and popular branch of the Operational Research/Management Science discipline; in recent years, indeed, many alternative methodologies and paradigms have been developed in this field, with an ever-increasing application to a very diverse set of problem scenarios.

MCDM methods can provide tools for complex planning exercises, in terms of structuring priorities, weighing and selecting alternatives, allocating resources across competing activities. Such methods can also accommodate contexts in which multiple stakeholders are involved, potentially leading to conflictual situations. Applications of MCDM methods have flourished in any scientific field. Given the proliferation of such approaches (and their variants), it is important to have a thorough understanding of their comparative value and usability in different contexts. As such, this special issue contains a collection of methodological and applied papers which provide significant advances to the field of Multi-Criteria Decision-Making.

The special issue has received very strong interest from researchers and practitioners working in the field, also thanks to related sessions that were arranged at the International Symposium on the Analytic Hierarchy Process that was held in London (UK) in August 2016. After several rounds of peer review by two or three reviewers, 14 papers were selected for publication out of 28 submissions, providing a wide range of application contexts and methodologies. A brief overview of each paper is then reported.

Zolfani et al. (2018) proposed an enhancement to the Step-wise Weight Assessment Ratio Analysis (SWARA) procedure for criteria weighting, which is one of the most fundamental issues in any MCDM problem.

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Chu (2018) illustrates an approach for ranking alternatives under fuzzy multiple criteria Decision-Making via an inverse function-based total utility approach, where ratings of alternatives against qualitative criteria as well as importance weights of criteria are assessed in linguistic values represented by fuzzy numbers.

The paper from Sahu et al. (2018) studies the consistency property for incomplete interval-valued intuitionistic multiplicative preference relations. Authors propose a technique which first estimates values for missing entries and then improves them by a local optimisation method. Two examples are presented in order to illustrate applications of the proposed method to group Decision-Making problems.

Xu et al. (2018) propose a new method for dynamic emergency Decision-Making for large-group risk based on Cumulative Prospect Theory. In this approach, authors utilise a preference judgment matrix in order to aggregate the opinions of Decision-Makers related to different event states; then, a clustering method is used to aggregate the preferences of the Decision-Makers and identify different groupings and their weights. Markov chains are then utilised in order to characterise the transition among different states.

Wu et al. (2018) develop a multiattribute Decision-Making method based on single-valued neutrosophic information measures, testing the devised approach on a numerical example concerned with the evaluation of pollution levels in urban areas. Similarly, Ye (2018) introduces several operators for Neutrosophic Cubic Numbers (NCSs, consisting of both an interval neutrosophic set and a single-valued neutrosophic set), including arithmetic and geometric average operators and ranking approaches. The usage of NCSs is then tested on an investment alternative selection problem, in order to demonstrate the application and feasibility of the developed approach.

Besides these methodological contributions, the special issue also contains several papers of a more applied nature.

In particular, Ishizaka et al. (2018) propose an adaptation of the PROMETHEE method for the measurement of productivity. In this contribution, a method for displaying

graphically the results of PROMETHEE productivity analysis is developed, permitting the user to distinguish between four types of actions (efficient, effective, frugal and inefficient actions). To illustrate the use of the method, authors analyse the productivity of British universities.

Pendharkar (2018) proposes a framework combining a genetic algorithm and a Data Envelopment Analysis (DEA) approach for solving the fixed cost allocation problem. The approach allows managers to incorporate different fixed cost allocation sub-objectives for efficient and inefficient Decision-Making units (DMUs) and solves the problem in such a way that the total entropy of resource allocation for efficient DMUs is maximised, while minimising correlation between resource allocation and efficiency scores of inefficient DMUs. The computational study reveals that the proposed solution is very close to the optimal solution.

Jato-Espino et al. (2018) develop a Multi-Criteria decision support model based on the Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to facilitate the selection of wearing courses of highly trafficked roads in European countries, practically evaluating the suitability of different road surface types in different contexts.

Can and Kılıç Delice (2018) propose an approach for determining the most prominent criteria to be taken into account when designing shopping malls. The method used to resolve this problem is based on a Fuzzy DEMATEL approach, which is then combined with a fuzzy multi-objective optimisation process.

Yurdakul and Tansel (2018) introduce an approach for assessing the performance of manufacturing organisations based on an original modification of the fuzzy version of the TOPSIS technique.

Ravichandran et al. (2018) combine the usage of fuzzy hesitant information as an input and a newly developed three-way hesitant fuzzy VIKOR ranking procedure. The practicality of the proposed approach is verified through an empirical example dealing with outsourcing decisions in an automobile factory.

Bongo et al. (2018) apply a conventional DEA model to the measurement of the efficiency of electricity distribution operations in the Philippines. The work is of great practical relevance, as results reveal great inefficiencies in the current operations, also suggesting potential improvements.

Shafiq et al. (2018) contribute to the vast literature in the field of life-time data analysis. Accelerated life-testing models are regarded as the most popular techniques for engineering life-time data analysis, for the sake of modelling life-times of infrastructures and devices under different stress levels. The innovation provided by the authors is the adoption of a fuzzy approach for the representation of life-times, in order to enhance standard statistical tools and generalising some classic parametric and non-parametric procedures.

In closure, the Guest Editors would like to thank all of the authors, the editor-in-chief, the associate editors and all of those who provided peer review. This special issue would not be possible without their valuable time and input.

Also, the Guest Editors would like to dedicate this special issue to the memory of Professor Thomas L. Saaty, a great contributor to the field of MCDM, who stimulated, to a great extent, the interest of Guest Editors in MCDM through his seminal work and thanks to many fruitful interactions at the ISAHP conferences.

Compliance with ethical standards

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