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MULTICRITERIA DECISION ANALYSIS: STATE OF THE ART SURVEYS

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Ana Krstic*

Faculty of Economics, University of Kragujevac, Kragujevac, The Republic of Serbia

Multicriteria analysis and its methods have developed very rapidly in the last few decades. Basically, multicriteria analysis deals with solving unstructured management problems and, in practical terms, facilitates making an optimal decision. In order to make a good decision, however, it is necessary to specify possible alternatives by defining appropriate criteria. Multicriteria analysis belongs to the decision-making field, where the following meet: economics, mathematics, statistics, psychology, sociology, organizational theory, philosophy, information technology and other sciences.

In a monograph entitled: Multicriteria Decision Analysis: State of the Art Surveys, the editors Salvatore Greco (a professor at the University of Catania, Italy), Matthias Ehrgott (a professor at the University of Lancaster, UK) and Jose Figueira (the University of Lisbon, Portugal) enable us to gain an insight into the decision-making area, which is very useful for many areas of research, and as such has led to the rapid and continuous development of the multicriteria analysis applied in solving the most complex problems. The purpose of the book is to cover the latest and the most interesting concepts of multicriteria analysis, and also show the link between the theoretical and methodological development of a problem and its practical applications. The book is easily and comprehensively written so that beside researchers working in this field, it is also intended for the students interested in the field of multicriteria analysis and its methods. It consists of eight parts and each part is organized into several sections. Forty-nine authors recognized in the field of multicriteria analyisis took part in the creation of this monograph.

In the first part of the book, entitled An *Overview of MCDA Techniques Today* (pp. 3-18), which consists of one authorial article, multicriteria analysis is shown to be not only a set of theories, methodologies and techniques, but also a means providing a specific perspective for solving the problem of decision-making. Multicriteria Decision Analysis (MCDA) is the crucial aspect of any research study because it fundamentally considers all of the possibilities of solving a research problem. In this section,

* *Correspondence to*: A. Krstic, Faculty of Economics, University of Kragujevac, Dj. Pucara 3, 34000 Kragujevac, The Republic of Serbia; e-mail: anakrstic@kg.ac.rs

"pretheoretical" MCDA assumptions are discussed and a detailed overview of this area is given. In addition to making many important theoretical contributions, the key concepts that have been accepted throughout the MCDA community are also subjected to consideration.

The second part of the book, entitled *Foundations of MCDA* (pp. 27-60), focuses on the main problem of multicriteria analysis, which is the presentation of preferences. In two authorial articles, a very rich field of research is shown, which is important to the researchers interested in the theoretical aspects of the MCDA. Also, this section may be interesting to the readers who apply multicriteria analysis in practice. In order to adopt a particular model, it is necessary to know which conditions the preferences should satisfy. An overview of preferential modeling is presented, starting with classical results, only to later address the questions related to fuzzy and neoclassical logic. On the other hand, the axiomatic basis of different models is discussed so as to aggregate preferences for multiple criteria.

The third part of the book is entitled *Outranking Methods* (pp. 133-260) and describes the ELECTRE and PROMETHEE methods. The three chapters provide a detailed overview of the basic concepts and characteristics of these methods. The authors describe the application of these methods in research and the recommend pieces of the software used in the selection of the best alternative. In addition to the ELECTRE and PROMETHEE methods, many other interesting MCDA methods are based on a pairwise comparison. At the end of this paper, a literature review is presented, inclusive of other outranking methods.

Multiattribute Utility and Value Theories is the title of the fourth part of the book (pp. 265-438), and consists of four authorial articles. This MCDA approach tries to assign a utility value to each action. This utility is a real number representing the preferability of the considered action. A utility is very often a sum of the marginal utilities that each criterion assigns to the considered action. One chapter is dedicated to the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP), created by Tomas Satty. The analytic hierarchy process is one of the best known methods of the expert analysis of scenarios and decision-making by consistently evaluating the hierarchies that consist of goals, criteria, and alternatives. Enabling the capturing and quantification of intangible criteria, the AHP is a problem-solving framework and a systematic procedure for presenting the elements of any problem, which is applied in a huge number of areas, such as decision-making and conflict resolution. On the other hand, the influences and interactions that exist between elements and clusters, which can be internal (between cluster elements) and external (between clusters) are the essence of the Analytic Network Process. This in fact indicates that, in this method, it is not necessary to clearly define the levels of the hierarchy, and that there is a network consisting of elements and influences instead. This section also explores the Measuring Attractiveness by a Categorical-Based Evaluation Technique (MACBETH). It is the MCDA approach that only requires qualitative judgements about the differences between the values of the attractiveness of one action over another action so as to help an individual or a group to quantify the relative preferability of different actions.

The fifth part of the book, entitled *Non-Classical MCDA Approaches* (pp. 445-634), deals with the issue of uncertainty in multicriteria decision-making and explains the fuzzy approach in multicriteria analysis. It is necessary that we should distinguish between internal uncertainties (related to the decision-maker's values and judgements) and external uncertainties (related to the imperfect knowledge concerning the consequences of actions). The four broad approaches to dealing with external uncertainties are discussed, namely: multi-attribute utility theory and some extensions; stochastic dominance concepts, primarily in the context of the pairwise comparisons of alternatives; the use of surrogate risk measures, such as additional decision-making criteria; and the integration of the MCDA and the scenario planning. The fuzzy set approach is applicable to the real problems that occur in a complex environment, where all conflicting logic systems, uncertain and imprecise knowledge and all possible ambiguities must be taken into account. In that sense, preferential modeling requires the use of the specific tools, techniques and concepts that make information accessible. In this perspective, fuzzy set theory has been receiving a lot of attention in the MCDA for a long time. All of these topics are explained by the authors in the five chapters.

The sixth part of the book, entitled *Multiobjective Mathematical Programming* (pp. 641-787), explains that

the classical formulation of an operations research model is based on the maximization or minimization of an objective function which is subject to some constraints. In the first part (out of the four parts) of this chapter, the focus is on the basic concepts of multiobjective programming. Because criteria are generally mutually opposed, a decision is made on which of them should be reduced and which should increase in order to make an optimal decision. An overview of the use of multiobjective programming in combination with fuzzy coefficients is given. Since fuzzy programming has a relatively long history, many approaches related to the different interpretations of fuzzy multiobjective programming have been proposed. The chapter provides a broad overview of the most representative multiple criteria location problems which have been divided into the three classes of continuous, network, and discrete problems.

The seventh part of the book, entitled *Applications* (pp. 799-981), consists of four articles and explains the importance of success and the development of multicriteria analysis for decision-making. The application is very wide because the problems that the MCDA encompasses are numerous and cover different areas. It is clear that to cover all of the fields of the application of the MCDA is impossible. A significant contributions are made in the fields of finance, energy planning, telecommunications and sustainable development. All of these areas require complex, well-structured, flexible decision-making systems with different decision levels and different timeframes. The chapter aims to examine the extent to which the use of multicriteria analysis in these areas has influenced the effectiveness of complex decisions made and their responsiveness to all the requirements of a complex and turbulent environment.

The last, eighth part of the book, entitled: *MCDM Software* (pp. 989-1035), provides an overview of the software support that contributes to the rapid development of multicriteria analysis methods. It is important to keep in mind the fact that software is an important element in the application of MCDA methodologies, which, on the other hand, does not mean that only a good piece of software is sufficient for the correct application of the methodology. Prior to using a piece of software, a good knowledge of the problem and the methodology adoption are needed. In this section, one authorial article provides the reader with the presentation of the known software and the basic information that are to be taken into consideration when assessing the manner in which a particular software package problem should be solved.

Greco, S., Ehrgott, M., Figueira, J. are the authors renowned in the field of multicriteria analysis, its methods and applications. Their impressive biographies and rich experience in this field have contributed to the quality of the book, and the considerations provided are relevant, current and applicable in practice. The most important concepts and methods, and the application of multicriteria analysis in solving research problems are sublimated in one place. In order to make the book even more complete, the other methods based on linear programming that supplement multicriteria methods could be processed. Data Envelopment Analysis (DEA) is one of them, and has recently been in the focus of attention of many authors dealing with contemporary environmental issues.

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Ana Krstic is a teaching assistant at the Faculty of Economics, University of Kragujevac, Republic of Serbia. She teaches the subjects of Operational Research and Financial and Actuarial Mathematics. She is a PhD student at the Faculty of Economics, University of Belgrade. The main area of her scientific research is operational research.