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Strategic Approach in Multi-Criteria Decision Making

A Practical Guide for Complex Scenarios

 Springer

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Preface and Road Map

Book Structure

The book is divided into three fundamentals parts, as follows:

First Part: History of MCDM and How It Is Performed

It includes Chaps. 1 and 2 and tries to answer the following questions:

What is a MCDM process?

Which are its constituent elements?

How is it done at present?

It concludes examining the deficiencies of the MCDM process.

Second Part: What Should Be Done in the MCDM Process?

It includes Chaps. 3, 4 and 5 and tries to answer the following question:

How can it be done?

It gives rational suggestions to correct deficiencies pointed out in the first part.

Third Part: Proposes SIMUS as a Strategic Procedure to Tackle Real-World Scenarios

It includes Chaps. 6, 7, 8, 9, 10, 11, and 12.

The SIMUS method is introduced as a practical tool that can give answers to concerns expressed in the first two parts of the book.

The authors believe that clarifying concepts with examples helps their comprehension. For that reason, the book proposes many real-world cases, some simple and others quite complicated. That is, a concept, a technique, is clarified with very simple problems; however, once that it has been explained, complex and actual scenarios are proposed, which is the main purpose of Chap. 12.

What do Elon Musk, Albert Einstein, Nicola Tesla and Madame Curie have in common?

They all show that it is OK to be unconventional. Separateness had helped the innovators be independent thinkers, freeing them to break the rules and ignore the assumptions that constraint others.

Melissa A. Schilling

Introduction

The decision-making process is a human activity in which the human being, as the decision-maker, can hardly escape the influence of multiple circumstances that, in the end, give shape to what will become the winning decision.

With the aim of reaching this *winning decision*, *Multicriteria Decision-Making* (MCDM) has become one of the most important and fastest growing subfields of Operations Research and Management Science. It started in the Second World War with the contribution of Kantorovich and continued with the modern MCDM, under the influences of the utility theory in the first instance and multiple objective mathematical programming as a second stream of influence. There is plenty of literature that examines and analyses the MCDM timeline as a discipline. Recently, we can find in Köksalan, Wallenius and Zionts (2011) a profuse and extremely talented explanation of the discipline evolution over time.

Although there is a clear advancement in the MCDM field with the incorporation of new methods, the discipline that analyses MCDM processes has evolved in a way that might indicate that the roots of its own existence have been forgotten, by not considering some critical aspects that are key in the correct interpretation of a scenario, and regardless which method is used. The authors of this book observe that under the comfortable ‘umbrella’ of continuity, there is an incessant number of MCDM methods that are not restricted by any kind of normative or protocol to guide them, nor to assure the quality of the assessment.

As a result of the above, the authors want to put in evidence an old claim of many scholars in MCDM who are worried that, for a same problem, MCDM methods deliver different results, an anomaly that is known as the ‘decision-making paradox’. Although this only represents a technical problem that, of course, deserves attention, other elemental question arises like: ‘Are all existing MCDM methods valid to solve all kind of problems?’ Unfortunately, there isn’t any procedure currently in the MCDM field to guide the DM in this quandary.

We wonder whether it is possible to decommission or discontinue this current pattern, by proposing as an alternative a structured decision process more in line with actual requirements of MCDM scenarios and especially with reality, some sort of a framework within which the MCDM techniques have to be applied. Our motivation

for this book derives from this point, in the sense that current MCDM methods seem to be more concerned with the mathematics behind their application than from an accurate application of the MCDM principia as a discipline.

Therefore, the objective of this book is twofold: first, to highlight the need for a larger debate on some critical issues regarding the application of MCDM methods, and second, to provide the reader a strategic, practical and structured guide to deal with multiple and complex scenarios. To address these significant issues, the book proposes an innovative procedure.

Keeping in mind the previous objectives, these authors will not go further in this direction of current MCDM process. Instead, our line of reasoning focuses on the immobility that affects the discipline regarding some structural aspects. Supporting our argument, it is worth mentioning Zeleny (2011), who wisely summarized the mood of many scholars working and applying MCDM methods when referring to the current sense of the discipline: 'It is certainly acceptable and desirable to do the same things better and more efficiently. It is surely more innovative and more promising to do things differently, but it is very proper and energizing to also try doing different things, at least sometimes'.

Consequently, we believe that it is necessary to innovate, to look for new ways to solve the same problems differently and more efficiently.

In this respect, just as almost everyone could agree with this introductory paragraph, it is highly probable that all scholars of MCDM would also agree with the fact that, at present, the essence of these methods is governed by mathematical procedures and subjective assumptions, the latter being something inherent to the human being, and by ignoring many aspects that are present in a scenario.

We will come back to this critical point later on. Instead, our main concern is rooted in the origins of the structural pillars that give coverage to one assumption that, in many cases, is taken for granted. It refers to the supposed rational reasoning of the decision-maker (DM) in the process of defining criteria and weighing them in order to select alternatives or scenarios, which later can provoke other problems such as the above-mentioned. If the MCDM process is supposed to provide support to the DM and avoid subjectivity, then it is worth providing the DM with techniques or methods that keep away, as far as possible, the possibility of introducing value judgements that may not represent reality.

We are not saying that the MCDM process is based only on good data and on a mathematical procedure and then leaving the DM in a secondary role. This book considers the DM as the most important element of the MCDM process and aims to put the DM where she/he is most needed, in time and in form. In the authors' opinion, the DM is most needed at the end of the process, examining results, analysing consequences that the best alternative must generate and providing stakeholders with a wide spectrum of different possibilities, and especially risks, that may jeopardize the best selection due to subjective assumptions and uncertain data.

In this sense, the book propositions are, in part, based on Henig and Buchanan (1996) view of what a good decision-making process is meant to be and how to model any problem to clearly distinguish between what is objective and

subjective. If we are able to make a clear-cut distinction, then it will be easier to keep the DM away from introducing unnecessary subjectivity and value judgments in the process, beyond where it is completely impossible to avoid it. In this sense, we want to make ours the principle of Buchanan et al. (1998): 'be objective wherever possible'.

Two main concepts have been explained so far, but not enough highlighted:

1. It was said that this book is mainly strategic and that MCDM process had to provide techniques to the DM. Based on these concepts, a question arises: Must the DM provide useful and strategic information to stakeholders? The answer to this obvious question is one of the principal contributions of this book and probably its largest strategic value. This work delivers a free software for modelling complex scenarios which incorporates an innovative sensitivity analysis (SA) that to the authors' knowledge never has been developed. The output of this SA gives strategic answers to the decision-making process.
2. Related to these complex scenarios, this book does not provide the reader with a procedure, as the typical manual that explains, step by step, what to do to solve a problem; instead, it describes what should be done to tackle some classical problems and to consider reality which is, in essence, a complex scenario. This is the main and perhaps more important pillar of the book, and it is performed by building a frame of reference for the description of the problem and its alternatives, as objective as possible.

The book acknowledges that decision-making is in a large extent a subjective affaire. It recognizes that it is very necessary because the different mathematical methods are only tools and not designed to give solutions, but it does support and help the DM, who can use this tool to make a rational and documented decision. The word 'documented' is key, since acting on results, the DM has a solid base on which he bases his decisions. This is why we think that the DM has a crucial role at the end of the process, not at the beginning, as is normal nowadays.

Linked to this, it cannot be lost in sight the fact that a problem is surrounded by a series of elements and collateral elements that the DM cannot leave aside when modelling reality, as well as the reality of the problem. Consequently, we want to bring up again the need to address scenarios in their full complexity, considering the circumstances and the collateral elements it is composed of. This book, with practical foundations, provides the reader with a template as a guidance to reflect, as much as possible, complex scenarios, and this is one point that we understand is missing in the present-day MCDM modelling.

Bottom line, this book highlights the idea of a systemic representation of the problem if the aim is to keep it as close to reality as possible. As it was mentioned above, obtaining different solutions to the same problem is an uneasiness for many MCDM scholars since its reasons have not been thoroughly explained or understood, let alone solved, although it is revealed on many occasions. Sometimes, different solutions are due to considering different types of weights for criteria, or by ignoring interrelations between criteria, or by parcelling out a problem. The latter refers to partitioning a problem or scenario for an easier analysis. With respect to

this point, we align with Triantaphyllou (2001) when he compares results when partitioning a problem, versus when solving it as a whole, especially when analysing rank reversal.

All these drawbacks of the MCDM process at present moment are analysed in this book, presenting what we believe is more important and proposing a procedure to avoid them.

This book could be classified as a practical guide because certain concepts or situations are explained in a simple way and those explanations are accompanied by numerous examples to be able to support them, but additionally it aims to work with a new paradigm in MCDM.

The book is clearly structured in three different parts. The first part is devoted to exploring the history and development of the discipline and the way it is performed nowadays. It specifically involves Chaps. 1 and 2. Included in this part, the book highlights those drawbacks and problems that scholars have identified in the different MCDM methods and techniques. As indicated above, the motivation to raise this aspect is to provoke the necessary debate on the validity of the theoretical pillars that sustain the discipline, considering the generalized absence of representing reality.

The second part of the book includes Chaps. 3, 4, and 5 with the intention of answering an important question: What should be done to assure a quality MCDM process? The purpose is to offer a theoretical response to the drawbacks identified in the first part.

Finally, the third part encompasses Chaps. 6, 7, 8, 9, 10, 11, and 12 which introduces and explains in simple language and by using graphic aids, the Linear Programming concept and the SIMUS method, based on Linear Programming, as the new toolkit that is suggested to deal with MCDM process. Chapter 8, analyses and wholly exemplifies a new procedure for sensitivity analysis, which is always of the utmost importance in decision-making. As in most parts of the book, the explained procedure is innovative and based on sound mathematical principles. It provides examples that sustain what was said above about the kind of information that stakeholders need.

Chapter 9 is devoted to group decision-making using SIMUS. An actual and complex example is provided together with a simulation of debate amongst members of the group. The system is based in a progressive analysis of the scenario by sequentially addressing each objective, considering potential changes and examining their applicability or not, measured by quantified values.

Chapter 10 tackles a very important aspect; it is related with selecting the best strategy and using the very well-known SWOT (Strengths, Weakness, Opportunities and Threats) technique. It is exemplified by a complex and actual scenario, and the result quantitatively selects the best strategy, and in so doing, it is a step forward, since SWOT finishes by determining the SWOT matrix of strategies, but not selecting the best one.

Chapter 11 analyses the reasons for the lack of agreement amongst results from different methods and proposes the use of a proxy method which would determine the closest solution to the proxy.

Chapter 12 addresses six complex, practical and actual cases on six different fields such as the construction industry, government policies, hydroelectric projects, upgrading villages' infrastructure, urban development in a large city and 'fabricating' the best road between an airport and the downtown of a city. Its purpose is to demonstrate that complex scenarios can be modelled and solved adequately following a structured procedure such as the one we propose.

Finally, in the Appendix, the theory of Linear Programming is explained in tabular format for easy comprehension. It is completed with a very important issue, since it demonstrates through eight different examples that SIMUS is not subject to rank reversal.

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¹These references correspond to authors mentioned in the text. However, there are also publications than are not mentioned in the text but that have been added for the reader to access more information about this Chapter; they are identified with (*).

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