Chapter 46
Artificial Intelligence in Stochastic Multiple-Criteria Decision Making

Hanna Sawicka
Poznan University of Technology, Poland

ABSTRACT

This chapter presents the concept of stochastic multiple criteria decision making (MCDM) method to solve complex ranking decision problems. This approach is composed of three main areas of research, i.e. classical MCDM, probability theory and classification method. The most important steps of the idea are characterized and specific features of the applied methods are briefly presented. The application of Electre III combined with probability theory, and Promethee II combined with Bayes classifier are described in details. Two case studies of stochastic multiple criteria decision making are presented. The first one shows the distribution system of electrotechnical products, composed of 24 distribution centers (DC), while the core business of the second one is the production and warehousing of pharmaceutical products. Based on the application of presented stochastic MCDM method, different ways of improvements of these complex systems are proposed and the final i.e. the best paths of changes are recommended.

INTRODUCTION

Nowadays, an integral part of any organization is the application of practical tools and techniques that make changes to products, processes and services resulting in an introduction of something new in a market. Improving continuously operations is essential for a better performance of the organizations. Due to the growing impact of globalization, migration, technological and knowledge revolutions, it brings added value to customers and helps organizations to remain competitive. Many of them are forced to make changes in various areas, such as: technology, infrastructure, human resources etc. Moreover, to meet customers' expectations and needs, companies should also consider organization's manager interests, as well as the supplier's opinions, customers' point of view and the other stakeholders' preferences. It makes the decision situation very complex and the application of decision aiding methods seems crucial.

DOI: 10.4018/978-1-7998-0951-7.ch046

According to Vincke (1992) multiple criteria decision making (MCDM) is a field which aims at giving the decision maker (DM) some tools in order to enable him/her to solve a complex decision problem where several points of view must be taken into account. This methodology concentrates on suggesting "compromise solution", taking into consideration the trade-offs between criteria and the DM's preferences. The above mentioned compromise solution is selected from the family of variants. They are constructed in different ways. In some situations, it is assumed that the variants are exclusive and at least two of them cannot be implemented together. There are also real-world situations where two or more alternatives can be introduced conjointly.

The variants are evaluated by the set of criteria, which should be characterized by the following aspects (Roy, 1985):

- Completeness due to the decision-making aspects of the considered problem.
- Appropriate formation, taking into account the global preferences of the decision maker.
- Non-redundancy, i.e. a situation in which semantic ranges of criteria are not repeated.

Thanks to the criteria it is possible to compare variants, especially when the performances are expressed as deterministic values. However, in some cases the alternatives are modeled e.g. in a simulation tool and their performances are presented as stochastic values. In such circumstances the comparison process becomes complex. It is usually supported by stochastic MCDM methods, but most of them concentrate on decision maker's stochastic preferences. Based on the author's experience the methods dedicated to solve complex decision problems with stochastic criteria values are not efficient enough.

The procedure presented in this chapter shows that the combination of a classical group of MCDM methods aiming at ranking of variants, e.g. Electre III, Promethee II, with probability formula or a classical method of artificial intelligence aiming at classification of objects, e.g. Bayes classifier, could solve these complex problems.

Electre III method (Roy, 1985; Vincke, 1992) belongs to the European school of MCDM and it is based on the outranking relation. The method requires determination the model of DM's preferences by the indifference q, preference p, and veto v thresholds, as well as weights w for each criterion j. The aggregation procedure starts from the calculation of concordance and discordance indices. The first one measures the arguments in favor of the statement that alternative a outranks alternative b, while the second index represents the strengths of evidence against the above hypothesis. Based on these indices the outranking relation is calculated. The ranking of variants is based on two classification algorithms: descending and ascending distillations. Descending distillation procedure starts from choosing the best alternative i.e. the one with the highest value of qualification index $Q(a)$ and placing it at the top of the ranking. $Q(a)$ equals the difference between the number of alternatives, which are outranked by the alternative a and the number of alternatives that outrank a. In the consecutive steps, the best alternative from the remaining set of alternatives is selected and placed in the second position of the ranking. The procedure stops, when the set of alternatives is empty. Ascending distillation procedure starts from choosing the worst alternative and placing it at the bottom of the ranking. Then the worst alternative from the remaining set of alternatives is selected and placed in the second worst position of the ranking. The final graph corresponding to the outranking matrix is the intersection of the two distillations. It constitutes a graphical representation of indifference I, preference P and incomparability R relations between alternatives.

Related Content