Multicriteria Decision Aid: Evaluation and Comparison of the Main Tools

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ABSTRACT. Good decision making is increasingly more important to organizations. This work presents a review of the literature in multicriteria decision aid with a reference to the main techniques available in the area. We also present a research on the software tools available in this field. These software tools were then characterized and classified and their main characteristics summarized in the present work. This work is part of a project that has as final goal to implement a software tool using AHP to help on the selection of the right multicriteria decision aid software.

KEYWORDS. Multicriteria Decision Aids; Analytic Hierarchy Process.

1. INTRODUCTION

Over time it has been observed that the requirements of the process of decision making in industry and in the business world have increased. Competition among organizations is ever present. This means that companies increasingly pay more attention to the decisions that have to be made. For example, in the context of the choice of a new product to be introduced in the market, a wrong choice may represent a significant financial loss for the company.

Currently there are several software packages on the market to help make decisions. The problem is to choose the best software that the organization should use to solve a specific problem. The goal of this paper is to help on that choice. In particular, this research has the objective to compare the main Multicriteria Decision Aid (MCDA) techniques/tools in order to make the decisions under multiple criteria easier.

The paper is organized in four sections: the first section presents the motivation and objectives for this research. Section 2 gives the necessary background of MCDA. Section 3 compares the main software tools of MCDA, and the paper concludes with an outlook on future research in section 4.

2. MULTICRITERIA DECISION AID

2.1. Introduction to MCDA

Whenever a problem has more than one solution and a choice must be made on which one to adopt, we have a decision problem (Tereso, 2007). According to Zeleny (1982), the decision is an effort to solve problems of conflicting objectives, which presence prevents the existence of the optimal solution and leads to demand the best compromise. A multicriteria decision problem is a complex problem which, as the name suggests, involves several criteria and the evaluation of several alternatives (Canada and Sullivan, 1989) (Figueira et al., 2005) (Hammond et al., 1999) (Keeney and Raiffa, 1993) (Rogers, 2001). Many authors do not distinguish between multicriteria and multiattribute; in this work we consider these two terms to be synonymous.

2.2. Basic Concepts of the Decision Theory

In a multicriteria problem several agents act simultaneously. The following presents some basic definitions.

Decision-makers: It is a group of individuals that carry out choices and make preferences as a whole. The decision process depends on the decision makers, who may have different values and are influenced by culture, religion, technical training, among other factors.

Analyst: According to Rogers et al. (1999), the analyst is the agent that has the role of selecting the model to be used, the information necessary to model and interpret the results and explain the decision mechanism of the model chosen.

Model: It is a set of mathematical operations that represent the tastes and views of the decision makers, leading to the achievement of the desired result. Models can be classified into descriptive and normative: descriptive models represent what the decision makers do, and the normative models represent what the decision makers should do.

Actor: Roy (1985) and Bana e Costa (1993) define actor as a person or group of persons who, in a decision-making process, directly or indirectly influence the decision.

Alternatives: A set of alternatives is a set of choices. Sometimes the definition of the set of alternatives is the most difficult task of decision making. The alternatives are the entities that have the power to change the nature of the problem.

Criteria: According to Roy (1996), criteria are viewed as tools that allow comparing the actions in relation to views of each decision maker.

Objectives: According to Keeney (1992) an objective is the demonstration of something that somebody wants to reach. He defines two types of objectives: the fundamental objectives and intermediate objectives.

2.3. Classification of Multicriteria Methods

According to Vincke (1992), most of the researchers or authors divide the MCDA in three families of approaches:

• American School or School of the MultiAttribute Utility Theory (MAUT).

• French School or European school or methods of outranking and synthesis.

• Interactive methods or multiobjective mathematical programming models.

The interactive methods usually apply to interactive systems, which have the objective of supporting and improving decision-making processes. Vanderpooten (1995) argues that the French School directs his study to methodologies where the personal preferences of decision makers have less influence on the alternative chosen. To cite some methods of this school, we have the ELECTRE family methods (ELimination Et Choix Traduisant la REalité) which stems from the pioneering work of Roy (1985), and the PROMETHEE (PReference ranking Organization METHod for Enrichment Evaluations) method developed by Brans and Vincke (1985) from the ELECTRE method, in order to create a simpler method whereas ELECTRE requires many parameters that may not be meaningful to the decision maker. The American School seeks methods to better explain the preferences of the decision maker, which can have a major influence on the final choice. In this school we can cite the Multiattribute Utility Theory of Keeny and Raiffa (1993), that explicitly addresses the value tradeoffs in multiobjective decisions and the AHP (Analytic Hierarchy Process) method, developed by Thomas Saaty in the mid 1970s, that is based in pairwise comparisons between alternatives Saaty (1980). To our thinking a good decision will only be possible if there is balance between these two influences.

3. MAIN MCDA SOFTWARE TOOLS

3.1. Introduction

In the literature there are many methods for solving multicriteria decision analysis problems, and a wide range of software to implement them. Many of the tools are still in experimental phase, combined with academic research. So to do a survey of software in this area is a difficult task, not only because of the rapid developments in computer science, but also because its commercialization is associated with its author or the university that developed it. The MCDA software reaches several levels of the decision

making process, starting at the structure of the problem, continuing to the modeling of the preferences, and finally providing the solution. In this study the software analyzed to help solve MCDA problems was divided into six categories: Qualitative Problem Structuring, General Multiple Attribute Decision Making, General Multiple Objective Decision Making, Multiple Criteria Sorting Problems, Specific Applications Software and Group Decision Support. A similar approach was used in Weistroffer et *al*. (2005).

3.2. Qualitative Problem Structuring

The software in this category implements the initial stages of the decision making process: exploration and formulation of the problem. In this category we found the DECISION EXPLORER [1].

3.3. General Multiple Attribute Decision Making

The software in this category deals with any problem of decision, where it is necessary to choose a finite set of alternatives, characterized by a set of attributes. In this category we have CRITERIUM DECISION PLUS [2], DAM (Decision Analysis Module) (Podinovski, 1999), DECISION DECK [3], DECISION LAB [4], ELECTRE IS [5], ELECTRE III-IV [6], EQUITY [7], EXPERT CHOICE [8], GMAA (Generic MultiAttribute Analysis) [9], GRIP (Figueira et al., 2007), HIVIEW [10], IDS [11], LOGICAL DECISIONS [12], MACBETH [13], MACMODEL [14], M&P: MAPPAC (Matarazzo, 1986) and PRAGMA (Matarazzo, 1988), MIIDAS (Siskos et al., 1999), MINORA (Siskos et al., 1993), MUSTARD (Beuthe and Scannella, 1999), NAIADE [15], ON BALANCE [16], PREFCALC [17], PRIAM (PRogramme utilisant l'Intelligence Artificielle en Multicritère) (Levine and Pomerol, 1986), PRIME DECISIONS [18], REMBRANDT (Lootsma, 1992), RPM (Robust Portfolio Modeling) [19], SANNA [20], SMAA.fi [21], TOPSIS [22], UTA PLUS [23], VIP ANALYSIS [24], VISA [25], WEB-HIPRE [26] and WINPRE [27].

3.4. General Multiple Objective Decision Making

In models with multiple objectives, decision criteria are expressed in the form of mathematical objective functions that must be optimized. These models may involve linear or nonlinear objective functions and continuous or discrete variables. In this category we have ADBASE (Steuer, 2000), TEC ADVISOR [28], FGM (Feasible Goals Method) [29], GUIMOO [30], KAPPALAB [31], MULTIGEN (Mirrazavi et al., 2003), MULTISTAT [32], PARADISEO [33], SOLVEX [34], TRIMAP (Clímaco and Antunes, 1989), TOMMIX (Antunes et al., 1992) and WWW-NIMBUS [35].

3.5. Multiple Criteria Sorting Problems

The software in this category classifies the alternatives into predefined groups or classes. In this category we have ELECTRE TRI [36], IRIS [37], PREFDIS (Zopounidis and Doumpos, 2000) and TOMASO [38].

3.6. Specific Applications Software

In this category we cite some applications developed for specific areas, namely AUTOMAN [39], BANKADVISOR (Mareschal and Brans, 1991), CASTART (Gandibleux, 1999), , DIDASN++ (Wierzbicki and Granat, 1999), ESY (Papamichail and French, 2000), FINCLAS (Zopounidis and Doumpos, 1998) , INVEX (Vrane et al., 1996), LPA VISIRULE [40], MARKET EXPERT (Matsatsinis and Syskos, 1999), MEDICS (Du Bois et al., 1989), MOIRA [41], PROAFTN [42], SANEX [43], SKILLS EVALUATOR [44], TELOS (Grigoroudis et al., 2000) and WATER QUALITY PLANNING DSS [45].

3.7. Group Decisions Support

The software in this category serves primarily to deal with problems where there is more than one decision-maker. In this category we have AGAP (Costa et al., 2003), ARGOS (Colson, 2000), ATHENA [46], GMCR (Hipel et al., 1997), HIPRIORITY [47], MEDIATOR [48], OPINIONS-ONLINE [49], SCDAS (Lewandowski, 1989) and WINGDSS [50].

4. CONCLUSIONS AND FUTURE WORK

Several authors maintain that decision-making is a vast and difficult problem: there are many types of decisions and numerous ways to deal with them. There are various methods and decision making processes, with each being unique in context and consequences. Thus there is no single model that fits all circumstances. Decision analysis presents rational methods to select an alternative (the best) or a group of alternatives from among a set of possible alternatives.

In this context, the use of a decision support methodology can be seen as a comprehensive approach since it considers the various factors surrounding the decision making process from the vantage point of the decision maker.

Most of the software referenced in this paper has characteristics of more than one category. We chose to put it in the category where the most prominent feature resides.

Some of the tools presented in section 3 of the paper are not available on the open market; others have a web page where one can download a free version for testing the product and learn of purchasing information.

When purchasing MCDA software, one needs not only to be concerned with the technology (i.e., hardware and software), but also with the role of the decision maker in the process and the ease of use of the tool.

This review of software analysis tools for multicriteria decision making is far from complete since new tools appear every day.

After this literature review, a decision tool will be developed to help in the selection process of the right decision software available, among the ones studied, depending on the goals of the decision maker.

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