Group MCDM Based on the Fuzzy AHP Approach

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INTRODUCTION

Multiple criteria decision making (MCDM) is one of the most important fields of management science. It is related to several different goals or criteria that are to a certain extent in conflict with each other. The purpose of the decision making is to find the best or the most desirable alternatives. The complexity of the decision-making problem makes it impossible for a single decision maker to consider all aspects of a problem. As a consequence, many decision-making processes take place in a group setting.

Analytic hierarchy process (AHP) (Saaty, 1980) is a powerful management science tool that successfully solves many multiple criteria decision problems. The main steps in the application of AHP are:

1. Structuring a decision problem in a hierarchy with different levels,
2. Determining the local priorities at each level of the hierarchy, and
3. Calculating the global priorities of the decision alternatives.

In the pure AHP, the relative importance of decision elements is evaluated from comparison judgments which are represented as crisp values. However, in many cases, the human preference is uncertain and decision makers usually feel more confident utilizing linguistic variables rather than expressing their judgments in the form of numeric values. In order to deal with more decision making problems in real situations, the fuzzy set theory (Zadeh, 1965) was incorporated into AHP. Being an extension of AHP, fuzzy AHP is able to solve the hierarchical fuzzy decision-making problems. Since its appearance, the fuzzy AHP method has been widely used by many researchers to solve different decision making problems in various areas, such as selection, evaluation, resource allocation, planning and development.

BACKGROUND

Group multiple criteria decision making is an overlapping field of group decision making and multiple criteria decision making. Decision making is the study of identifying and choosing alternatives based on the judgments of the decision makers. It has been proved that a decision made by a group tends to be more objective and effective than a decision made by an individual. Therefore, group decision making is an aggregate decision making process in which individuals' decisions are grouped together to solve a particular problem. A major part of decision making involves the analysis of a set of alternatives described in terms of some evaluative criteria. In order to find the most suitable alternative or determine the relative priority of each alternative, it requires to rank these alternatives. Solving such problems is the focus of Multiple Criteria Decision Making (MCDM) in decision and information sciences. MCDM is supported by a set of techniques, some of the main techniques are the analytic hierarchy

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process (AHP), technique for order preference by similarity to ideal solution (TOPSIS), preference ranking organization method for enrichment evaluation (PROMETHEE), and elimination and choice translating reality (ELECTRE) (Triantaphyllou, 2000). Among these, the AHP approach has appeared to be a very popular method and has been widely applied to deal with various complex decision making problems (Vaidya & Kumar, 2004). In the AHP, each alternative is compared with every other alternative in terms of the relative importance of its contribution to the criterion under consideration. The pairwise comparisons are represented in the form of crisp values. The comparison is repeated for each criterion and the pairwise comparison matrix is then formed. The weight vector can be obtained from the pairwise comparison matrix. The pure AHP method tends to be less effective when dealing with the uncertainty in the decision making process. This led to the development of fuzzy AHP methods.

There are several fuzzy AHP methods. The earliest work of fuzzy AHP was proposed by Van Laarhoven and Pedrycz (1983). They applied the logarithmic least square method to derive fuzzy weights and scores from triangular fuzzy pairwise comparison matrix. Since then, fuzzy AHP-related developments have been reported in the concomitant literature. Buckley et al. (1985, 1999) used the comparison ratios based on trapezoidal fuzzy numbers to deal with the imprecision. They extended Saaty's AHP (1980) and used the geometric mean method to obtain fuzzy weights and scores. Chang (1992, 1996) proposed a new extent analysis approach based on triangular fuzzy numbers for pairwise comparison. Since his method is similar to the conventional AHP and requires low computational capacity in implementation, many of the recent fuzzy AHP applications in various cases have utilized Chang's extent analysis. Buyukozkan et al. (2004) made comparisons of different fuzzy AHP methods and pointed out the advantages as well as the disadvantages of each method.

According to Moreno et al. (2005), there are three different situations for group decision making. They are:

1. Joint Action Group Decision,
2. Negotiated Decision, and
3. Systematic Decision.

In the first of these, all decision makers search for a common aim. In the second, in order to reach a consensus, each decision maker solves the problem independently, persuades others of their own judgment and then obtains a group solution through discussion with the other decision makers (e.g., Delphi method). Finally, in the third case, each decision maker acts independently, and a tolerance principle is used to look for a way of integrating all the positions. In this book chapter, we advocate Joint Action Group Decision for group decision making.

MAIN FOCUS

In order to search for a consensus, it is necessary to establish a representative and democratic decision process. In practical applications, the framework for the utilization of fuzzy AHP in group multiple criteria decision making should be as follows:

1. Structuring the decision-making problem into a hierarchical structure

This step dissects the decision-making problem into elements according to their common characteristics and produces a hierarchical model. The hierarchical structure is constructed by combining all the criteria, sub-criteria, and attributes specific to the research problem. Typically, the identification of appropriate criteria, sub-criteria and attributes to be used requires various brainstorming techniques and literature investigation (Stewart, 2003). A hierarchical structure is illustrated in Figure 1. It is developed in such a way that the decision goal is on the top level, decision criteria