A MULTI-ATTRIBUTE DECISION MAKING PROCEDURE USING FUZZY NUMBERS AND HYBRID AGGREGATORS

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Abstrak

Proses Hierarki Analitikal (PHA) klasik mempunyai dua kelemahan utama. Pertama, ia mengabaikan aspek ketidaktentuan yang lazimnya wujud dalam kebanyakan data atau maklumat yang ditafsir oleh manusia. Kedua, ia tidak mengambil kira aspek interaksi antara atribut semasa pengagregatan. Penggunaan nombor-nombor kabur dapat membantu mengatasi isu pertama, manakala penggunaan Kamiran Choquet membantu mengatasi isu kedua. Namun, penggunaan nombor-nombor kabur dalam pembuatan keputusan berbilang atribut (PKBA) memerlukan beberapa langkah dan maklumat tambahan daripada para pembuat keputusan. Sementara itu, proses pengenalpastian nilai ukuran monoton yang perlu dilaksanakan sebelum menggunakan Kamiran Choquet juga memerlukan bilangan langkah pengiraan dan jumlah maklumat yang tinggi daripada para pembuat keputusan terutamanya dengan peningkatan bilangan atribut. Justeru, kajian ini memperkenalkan satu prosedur PKBA yang mampu mengurangkan jumlah langkah pengiraan dan maklumat yang diperlukan daripada para pembuat keputusan apabila kedua-dua aspek tersebut dipertimbangkan secara serentak. Untuk mencapai objektif utama kajian ini, sebanyak lima fasa telah dilaksanakan. Pertama, konsep set kabur dan aplikasinya dalam PHA telah dikaji. Kedua, analisa berkenaan pengagregat-pengagregat yang boleh digunakan dalam masalah PKBA telah dilaksanakan. Ketiga, fokus kajian telah dijuruskan kepada Kamiran Choquet dan konsep sekutunya, ukuran monoton. Seterusnya, prosedur yang dicadangkan dibangunkan dengan kombinasi lima komponen utama iaitu Analisis Faktor, Penganggar Kabur-Linguistik, Kamiran Choquet, PHA Kabur Mikhailov, dan Purata Berwajaran Mudah. Akhirnya, satu masalah PKBA sebenar telah diselesaikan untuk menguji kebolehfungsian prosedur tersebut di mana imej tiga buah pasaraya yang terletak di Sabak Bernam, Selangor, Malaysia telah dikaji dari perspektif suri rumah. Kajian ini berpotensi untuk mendorong lebih ramai pembuat keputusan mengambil kira aspek ketidaktentuan dalam data dan interaksi antara atribut secara serentak ketika menyelesaikan sesuatu masalah PKBA.

Kata kunci: Proses Hierarki Analitikal (PHA), Kamiran Choquet, Teori set kabur, Pembuatan Keputusan Berbilang Attribut (PKBA).

Abstract

The classical Analytical Hierarchy Process (AHP) has two limitations. Firstly, it disregards the aspect of uncertainty that usually embedded in the data or information expressed by human. Secondly, it ignores the aspect of interdependencies among attributes during aggregation. The application of fuzzy numbers aids in confronting the former issue whereas, the usage of Choquet Integral operator helps in dealing with the later issue. However, the application of fuzzy numbers into multi-attribute decision making (MADM) demands some additional steps and inputs from decision maker(s). Similarly, identification of monotone measure weights prior to employing Choquet Integral requires huge number of computational steps and amount of inputs from decision makers, especially with the increasing number of attributes. Therefore, this research proposed a MADM procedure which able to reduce the number of computational steps and amount of information required from the decision makers when dealing with these two aspects simultaneously. To attain primary goal of this research, five phases were executed. First, the concept of fuzzy set theory and its application in AHP were investigated. Second, an analysis on the aggregation operators was conducted. Third, the investigation was narrowed on Choquet Integral and its associate monotone measure. Subsequently, the proposed procedure was developed with the convergence of five major components namely Factor Analysis, Fuzzy-Linguistic Estimator, Choquet Integral, Mikhailov's Fuzzy AHP, and Simple Weighted Average. Finally, the feasibility of the proposed procedure was verified by solving a real MADM problem where the image of three stores located in Sabak Bernam, Selangor, Malaysia was analysed from the homemakers' perspective. This research has a potential in motivating more decision makers to simultaneously include uncertainties in human's data and interdependencies among attributes when solving any MADM problems.

Keywords: Analytical Hierarchy Process (AHP), Choquet Integral, Fuzzy set theory, Multi-Attribute Decision Making (MADM).

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CHAPTER ONE
INTRODUCTION

1.1 Multi-attribute Decision Making

In today's highly competitive environment, be it in profit or non-profit based organizations, it is unfeasible to make decisions by considering a single attribute or objective. As a result, multi-criteria decision making (MCDM) emerges as one of the prominent branches of decision making (Triantaphyllou, 2000) where it offers various scientific or quantitative techniques to aid decision makers in identifying, comparing, and evaluating alternatives based on varied, usually conflicting, attributes or objectives (Choo, Schoner, and Wedley, 1999; Tavares, Tavares, and Parry-Jones, 2008). Herein, decision makers are referred as an individual or a group of individuals who has the obligation to provide some critical information on the existing evaluation problem and to carry out the quantitative decision analysis by employing the developed decision-aid tools.

In general, MCDM can be split into two domains namely multi-objective decision making (MODM) and multi-attribute decision making (MADM) (Lu, Zhang, Ruan, and Wu, 2007). Chen, Kilgour, and Hipel (2009) defined MODM as a field which applies mathematical algorithms to identify alternatives that are optimal or efficient, under certain constraints, with respect to a few objectives which are expressed mathematically using decision variables. Linear programming is an example of MODM technique. On the other hand, MADM aims to assist the decision makers in making preference assessment on finite or available set of alternatives described by a set of predefined, usually conflicting, attributes. To recapitulate, the primary divergence between the two domains is MODM deals with infinite number

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