Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 110 (2014) 767 – 776

Procedia Social and Behavioral Sciences

Contemporary Issues in Business, Management and Education 2013

Synergies of data mining and multiple attribute decision making

Mohammad Hasan Aghdaie[a,b], Sarfaraz Hashemkhani Zolfani[c,d], Edmundas Kazimieras Zavadskas[a]*

[a] *Vilnius Gediminas Technical University, Institute of Internet and Intelligent Technologies Sauletekio al. 11, LT-10223 Vilnius, Lithuania*
[b] *Shomal University, Department of Industrial Engineering, P. O. Box 731, Amol, Mazandaran, Iran*
[c] *Amirkabir University of Technology (Tehran Polytechnic), Technology Foresight Group, Department of Management, Science and Technology, P.O. Box 1585-4413, Tehran, Iran*
[d] *Amirkabir University of Technology (Tehran Polytechnic), Futures Studies Research Institute, P.O. Box 1585-4413, Tehran, Iran*

Abstract

Data Mining (DM) and Multiple Attribute Decision Making (MADM) are two fast growing trends in Operations Research (OR) /Management Science (MS). In this article, we identify the synergies of data mining and MADM. Synergies can be attained by integration of MADM techniques into data mining and vice versa. The primary goal of the paper is to show a wide range of interactions between these two fields from a new perspective with an example of the integrated approach in supplier clustering and ranking. The integrated approach includes cluster analysis as a data mining tool and Step-wise Weight Assessment Ratio Analysis (SWARA) and VIseKriterijumskao ptimizacija i KOmpromisno Resenje (VIKOR) as the two MADM tools. More precisely, the features for clustering were selected and weighted by SWARA method and suppliers are clustered using two-stage cluster analysis. In addition, VIKOR technique is used to rank the clusters from the best to the worst one. The proposed integrated approach is presented to demonstrate the applicability of the proposed methodology.

Keywords: data mining; Multiple Attribute Decision Making (MADM); Clustering; SWARA;VIKOR; Supplier clustering and ranking.

1. Introduction

Recently, modern decision making needs much more sophisticated and accurate techniques. Organizations have very large databases of information and rival companies have to engage in cut-throat competition. Nowadays, we

* Corresponding author . Tel.: tel:+37069820779
E-mail address: edmundas.zavadskas@vgtu.lt

doi:10.1016/j.sbspro.2013.12.921

can use supercomputers to simulate a real decision making environment and solve the complicated real models. A demand for the integration between different fields in order to make better decisions is unavoidable.

Management Science (MS) /operations Research (OR) is an old and famous field that deals with making decisions. Data mining (DM) can be defined as the process of extracting important and useful information from large sets of data (Abello *et al.*, 2002). According to Han and Kamber (2001), some of the most important functions of data mining include concept description (characterization and discrimination), association, classification, clustering, and prediction. In addition, DM is an interdisciplinary field that combines artificial intelligence, database management, data visualization, machine learning, mathematic algorithms, and statistics (Tsai, 2012). Recently, there has been an increasing interest in the integration of OR and DM (Meisel & Mattfeld, 2010; Corne *et al.*, 2012). For instance, data mining can be helpful in many OR application areas and can be used in a complementary way to optimization method to identify constraints and reduce the search space (Olafsson *et al.*, 2008).

Multiple criteria decision making (MCDM) or multiple criteria decision analysis (MCDA) is a sub-discipline of OR which deals with multiple criteria in decision environment. Two main categories of MCDM are multiple attributes decision making (MADM) and multi objective decision making (MODM). The MADM methods deal with the process of making decisions in finding the optimum/best alternative in the presence of multiple, usually conflicting, decision criteria. MADM techniques can be used as an analytical approach to assess, weigh or rank a set of criteria or alternatives.

In the literature there are some papers about the integration of DM-MCDM techniques. For example, Rad *et al.* (2011) used K-mean clustering and analytic hierarchy process (AHP) to cluster and rank university majors. Peng *et al.* (2011) integrated data integration, data mining, and multi-criteria decision making and designed an incident information management framework. Khalili-Damghania *et al.* (2013) applied fuzzy logic, data mining and MODM in project selection. In addition, they developed a hybrid framework based on a hybrid fuzzy rule-based multi-objective framework and data envelope analysis (DEA). A combination between DM and MCDM methods in the decision support system (DSS) was introduced by Khademolqorani and Hamadani, (2012). Aghdaie *et al.* (2013a) used data mining and MADM for market segmentation and market segment evaluation and selection. Kim *et al.* (2011) proposed an approach which was comprised of two methods: association rule mining (ARM) and the analytic network process (ANP).

The aim of this paper is to propose a new hybrid DM-MADM approach to cluster suppliers, rank the clusters and finally grade them. A two-stage cluster analysis which is developed by Punj and Steward (1983) is applied as a DM tool. Two-stage clustering is based on a combination of K-means (MacQueen, 1967) algorithm and Ward's method (Ward, 1963). Two-stage clustering manipulates benefits of the two methods. In addition, in order to select and weigh attributes which two-stage cluster analysis is needed, SWARA is applied. Finally, two MADM methods including SWARA and VIKOR are used to rank the clusters of the suppliers.

The remainder of the paper is organized as follows. The next section outlines the proposed methodology combining, Clustering, SWARA, and VIKOR. In Section 3, a real-world data is given to prove the applicability of the proposed method on a car manufacturing industry in Iran. Also in Section 3, the results obtained. In Section 4, the article's conclusion will be presented and future directions are discussed.

2. The proposed model

The proposed model section describes three points. In the first part of this section, the proposed integrated DM-MADM model as a new approach is explained. In other parts, SWARA and VIKOR methods are explained.

2.1. The proposed integrated DM-MADM model

This section describes a three phase methodology which is used for suppliers clustering and cluster evaluation and selection (see Fig. 1). In this conceptual model two approaches, including DM and MADM have been combined.

The first phase is a data preparation phase and includes two steps. In the first step, the most important features needed for cluster analysis were selected by literature survey and experts' opinions. In DM approaches, feature/attribute selection is a very important part. A lot of output is based on the selected features. The attributes