



A Dominance-based Rough Set Approach to customer behavior in the airline market

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ABSTRACT

Market segmentation is a crucial activity in the present business environment. Data mining is a useful tool for identifying customer behavior patterns in large amounts of data. This information can then be used to help with decision-making in areas such as the airline market. In this study, we use the Dominance-based Rough Set Approach (DRSA) to provide a set of rules for determining customer attitudes and loyalties, which can help managers develop strategies to acquire new customers and retain highly valued ones. A set of rules is derived from a large sample of international airline customers, and its predictive ability is evaluated. The results, as compared with those of multiple discriminate analyses, are very encouraging. They prove the usefulness of the proposed method in predicting the behavior of airline customers. This study demonstrates that the DRSA model helps to identify customers, determine their characteristics, and facilitate the development of a marketing strategy.

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1. Introduction

In the face of a highly competitive and fast-changing airline market, managers must not only provide high-quality service but also react appropriately to changes in customer needs. However, it would be helpful if, instead of targeting all customers equally or offering the same incentives to all customers, enterprises could target only those customers who meet certain profitability criteria based on their individual needs or purchasing behaviors [5]. Customer behavior is the result of complex interactions between a number of factors, which can include the level of marketing activity, the competitiveness of the environment, brand perception, the influence of new technologies, and individual needs [34]. The characteristics and behaviors of airline customers are even more complex, and customer perception and behavior are affected by many factors, such as safety, service, technology, environment, price and many others. Hence, it is crucial that management determine the most important factors that affect the attitude and loyalty of airline customers. In the past, researchers have generally made use of statistical surveys to determine customer behavior. In such surveys, natural language or linguistic variables (e.g., “although the airline service is satisfactory, the price of the product being offered is high, the individual’s decision is not to purchase”) are used to describe customer patterns. Unfortunately, this can create an environment of imprecision, uncertainty, and partiality with regard to knowledge. These linguistic variables are then transformed into quantitative values, after which factor, cluster, and discriminant analyses are conducted. However, the semantic imprecision of natural languages leads to problems

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of computation, especially when the information described in a natural language is beyond the reach of existing bivalent logic and probability theory techniques [41].

Recently, data mining techniques have been adopted to predict customer behavior [6,30]. Data mining is one stage in Knowledge Discovery in Databases (KDD), involving the application of specific algorithms for pattern extraction [21]. Marketing managers can develop strategies to attract new customers and retain highly valued ones based on this mined knowledge. The Dominance-based Rough Set Approach (DRSA), originally developed by Greco et al. [8,9], is a relatively new approach in data mining that is very useful for data reduction in qualitative analysis. The rough set theory, a kind of natural language computation, is particularly useful for dealing with imprecise or vague concepts [23]. Basically, natural language computation is a system in which the objects of computation are simply predicates and propositions drawn from a natural language. A set of decision rules is generated by applying the rough set approach to analyze the classification data. These decision rules are in the form of logic statements of the type “if conditions, then decision”. The set of decision rules represents a preference model for the decision-maker that is expressed in a natural and understandable language. According to Zhu et al. [40], the rough set method does not require additional information about the data; it can work with imprecise values or uncertain data, is capable of discovering important facts hidden in that data, and has the capacity to express them in natural language. The rough set theory has been successfully applied in a variety of fields, including medical diagnosis, engineering reliability, expert systems, empirical studies of material data [15], evaluation of bankruptcy risk [29], machine diagnosis [39], business failure prediction [1,4], network intrusion detection [40], travel demand analysis [7], mining stock price [35], the insurance market [28], and accident prevention [36].

Although the Classical Rough Set Approach (CRSA) is a powerful tool for handling many problems, it is not able to deal with inconsistencies originating from the criteria, e.g., attributes with preference-ordered domains (scale) like product quality, market share, and debt ratio [10]. However, the DRSA has an advantage over the CRSA in that it has access to an information table that displays comprehensive dominance relations. It is able to deal with inconsistencies where decisive classes are not consistent with their criteria. The aim of this study is to mine data regarding airline customer behavior using the DRSA. The derived knowledge can help airlines identify valuable customers, predict future behavior, and enable firms to make proactive, knowledge-driven decisions.

2. Customer behavior

In most research on customer behavior, customer demographic variables are applied to analyze customer behavior [30]. However, Rayport and Sviokla [27] suggest that a customer's perception of product or service value is comprised of three basic elements: the product or service that a company offers, the context in which a company offers this product or service, and the infrastructure that enables the transaction to take place. In the traditional marketplace, content, context, and infrastructure are bundled together, usually offered by the same company; however, due to new technologies and new selling patterns, it is easy to separate these three elements in the air transport market. The importance of valuable customer behavioral variables—recency, frequency, and monetary (RFM)—has been extensively studied [20,31,32]. Researchers have observed that RFM variables are not only useful for the analysis of customer behavior but can also be effectively used to investigate customer value and niche markets. Hsieh [14] proposed a method that integrated data mining and behavioral scoring models for the management of banking customers. He divided customers into three groups according to their shared behaviors, characteristics and profitability. Marketers infer the profiles of each group of customers and propose management strategies appropriate to the characteristics of each group. Chen et al. [3] integrated customer behavioral variables, demographic variables, and transaction databases to establish a method of mining changes in customer behavior in the retail market. In their study, customer behavior patterns are first identified using association rule mining. After the association rules for customer behavior are discovered, changes in customer behavior are identified by comparing two sets of association rules generated from two datasets from different periods. The changes in patterns thus identified can then be investigated and assessed to provide a basis for formulating marketing strategies. Customer behavior analysis in Internet marketing has already been investigated by many researchers [16,18,19]. In most of such studies, data mining technologies are applied to produce a generalized customer profile of the Internet shopper and to further explore the Web usage pattern of the online consumer. The knowledge obtained through data mining helps foster informed Internet marketing decision-making and allows for the refinement of Web content and infrastructure to improve Internet marketing [18]. Wang and Hong [34], through the use of data mining techniques, developed a Customer Profitability Management (CPM) system for achieving marketing goals by leading customers to progress along pre-determined and desirable paths. Their system emphasizes continuous interplay between active and reactive monitoring procedures, from which any shift in customer behavior can be identified.

Just as in the conventional marketplace, airlines need to build customer loyalty as well as attract new customers. However, the unique characteristics of air transportation have altered the rules in the airline market. In a traditional business environment, where the seller meets a buyer in person, he can understand his behavior (intention to purchase, choice of product, etc.) from facial expressions, body language and verbal communication. The salesperson accumulates this knowledge while dealing face to face with the customer, and then uses this knowledge to increase the customer's satisfaction [16]. However, the average airline customer books his/her ticket via the Internet or through a travel agency. His/her decision may be based on previous experience with that airline's service, word-of-mouth, the airline's safety record, convenience, and so on. Also, the products offered by an airline are not physical objects; rather they are performance and reliability. Therefore,

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