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A Hierarchical Model of Marketing Value Based on Vehicle Networking Data and Hierarchical Clustering

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Abstract: The rapid development of vehicle networking technology provides enterprises with rich data resources, which provides strong support for the precision marketing of automobile enterprises. This paper firstly systematically combs the characteristics and collection methods of vehicle networking data, including the diversity of data, real-time, high dimensionality and privacy protection. Secondly, combined with the characteristics of the Internet of vehicles data, a customer value stratification model based on hierarchical clustering is proposed. The model can divide automobile customers into four levels: high-value active customers, potential customers, ordinary customers and customers with loss risk according to the behavioral characteristics, driving style and consumption power of automobile customers. Finally, the corresponding marketing strategies are developed for customers of different value levels. The research finds that the hierarchical marketing strategy based on the data of the Internet of vehicles can effectively improve customer satisfaction and loyalty, and bring higher market share and profits for automobile enterprises.

Keywords: Internet of vehicles data, Hierarchical clustering, Marketing value hierarchical model, Customer value, Marketing strategy.

1. Introduction

With the rapid development of vehicle networking technology, vehicles are not only means of transportation, but also become an important node of the Internet, generating massive data resources. These data cover multi-dimensional information such as vehicle operating status, driving behavior, geographical location, and user preferences, providing automotive companies with unprecedented insight opportunities. Through the in-depth mining and analysis of these data, enterprises can not only optimize product design and improve user experience, but also provide strong support for precision marketing. However, in the face of such huge and complex data of the Internet of vehicles, how to efficiently collect, process and analyze, and build a scientific marketing system based on these data has become a key issue that automobile enterprises need to solve.

At present, the academic circle has put forward a variety of thoughts on the construction of scientific marketing system. For example, the literature [1] discusses the role of knowledge influencers in the marketing of popular science books, emphasizes the unique advantages of knowledge influencers in the dissemination of popular science knowledge and book marketing, and analyzes its important value to the marketing of popular science books by publishing houses. The study pointed out that publishing houses should make full use of the precision marketing ability of knowledge influencers and explore innovative paths for popular science book marketing to improve marketing effects and propagation efficiency. This view provides a new perspective and inspiration for the marketing model of the traditional publishing industry. Literature [2] points out that as enterprises enter the era of network economy, they have experienced significant changes in marketing needs, coverage areas and sales channels. Therefore, in the environment of network economy, enterprises need to strengthen the adaptability to network economy, and actively promote the innovation process of network marketing, so as to build a marketing model that is more in line with the development trend of network. The literature [3] studies because Xiaohongshu platform can successfully occupy the user's mind content. From the theoretical perspective of value co-creation, the authors draw the conclusion that "grass marketing" can be summarized into consumption mode, innovative mode and compound mode. The realization mechanism of value co-creation of these three modes depends on information service, resource cooperation and content sharing respectively. It can be seen that the research based on marketing value provides scientific methods and corresponding technical guidance for the precision marketing ability of social enterprises.

The objective of this paper is to establish a comprehensive hierarchical system of customer value by using the data of the Internet of vehicles. By deeply mining and analyzing the potential information in the data of the Internet of vehicles, it can help enterprises to identify customer needs more accurately, optimize the allocation of marketing resources, and thus improve the marketing effect. For customers of different value levels, this study puts forward different marketing strategies. For high-value active customers: High-value customers refer to those customers who use services frequently, spend a high amount of money, and have high loyalty. Enterprises can enhance customer loyalty by providing personalized services and exclusive offers; For potential customers: Potential customers refer to those customers who have a large room for improvement in the frequency of use and consumption amount, and can stimulate their consumption potential through accurate recommendation and targeted promotion; For ordinary customers: ordinary customers refer to those customers whose use frequency and consumption amount are at a medium level. Enterprises can appropriately provide preferential policies and organize activities to increase the

loyalty and satisfaction of these customers; For customers at risk of loss: Customers at risk of loss refer to those customers who rarely use services recently or have a tendency to lose, and the customer loss rate can be reduced through early warning mechanism and retention measures. The customer value stratification model based on the data of the Internet of vehicles can significantly improve the accuracy of marketing activities and return on investment, and provide theoretical support and practical guidance for enterprises to realize data-driven intelligent marketing.

To sum up, the goal of this study is not only to build a set of marketing value stratification methodology based on vehicle networking data for automobile enterprises, but also to verify its practical application effect through empirical analysis, which provides an important reference value for data-driven marketing practice in the industry.

2. Research Routes

The research route of this paper is carried out according to four steps. The first is to sort out the characteristics and collection methods of vehicle networking data, including data diversity, real-time, high dimensionality and privacy protection. The second is to put forward a customer value stratification model based on the Internet of vehicles data. This module combines the customer life cycle theory, RFM model and machine learning algorithm to build a customer value stratification model that is suitable for the automotive industry. The third is the development of marketing strategy based on customer value stratification. The model can divide customers into four different value levels: high-value active customers, potential customers, ordinary users and customers with loss risk according to the customer's behavior characteristics, driving style, basic information and other indicators. The research roadmap of this paper is shown in Figure 1 below.

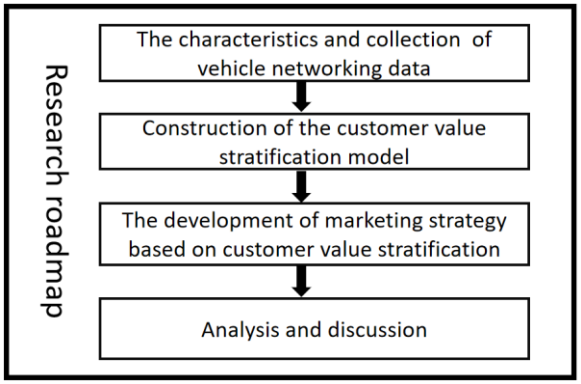

Figure 1. Research roadmap of this paper

2.1. Characteristics and Acquisition Methods of Vehicle Networking Data

2.1.1. Characteristics of vehicle network data

Vehicle networking data is comprehensive information comprehensively collected from the vehicle itself, road conditions, and other traffic participants through the integration of on-board equipment, precision sensors and advanced network communication technologies. The data set covers the specific behaviors and driving styles of car users, and is characterized by diversity, real-time, high dimensionality and privacy. It provides rich information resources for automobile enterprises to gain in-depth insight into user usage details, optimize product design and personalized service. The characteristics of the Internet of vehicles data are integrated with each other, cross each other and indivisible; The schematic diagram of data characteristics is shown in Figure 2 below.

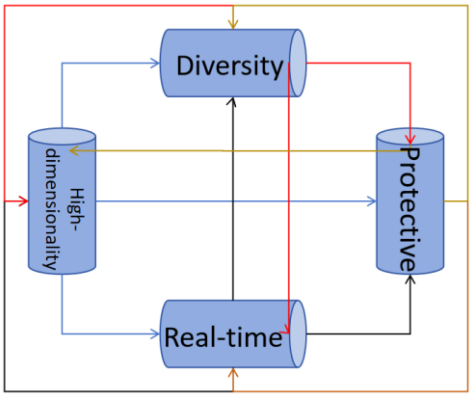

Figure 2. Schematic diagram of data characteristics

(1) Data diversity: Vehicle networking data covers vehicle operation data, driving behavior data, geographical location data, user interaction data and other types, showing significant diversity characteristics. These data include not only structured numerical information, but also unstructured data.

(2) Real-time data: Because vehicle sensors and communication equipment can continuously collect and transmit data, provide users with real-time updated information, showing a high degree of real-time.

(3) High latitude of data: each data dimension and feature may contain tens or even hundreds of feature variables, which are mixed together to form a combination of high-dimensional features, which provides a rich information basis for in-depth analysis.

(4) Data protection: Internet of vehicle data involves user location track, user driving habits, user behavior data and other private information. This paper strictly keeps all kinds of data confidential in the process of data collection and processing.

2.1.2. Vehicle network data collection method

The collection methods of vehicle network data include vehicle equipment collection, network communication, and third-party data collection, as follows.

(1) Vehicle equipment acquisition: By installing sensors, controllers and other devices on the vehicle, the system can collect and record the real-time status data of the vehicle and the user's driving path information in real time.

(2) Network communication collection: The use of vehicle networking communication technology, such as vehicle network, mobile communication network, etc., to collect the user's driving status, the use of intelligent network equipment, intelligent connection interaction, driving trajectory and other interactive information.

(3) Collection of third-party data sources: through network operators such as China Mobile, China Unicom and China Telecom, third-party data related to user vehicle driving can be obtained.

2.1.3. Data processing method of vehicle networking

The processing and analysis methods of vehicle networking data mainly include data cleaning (outlier and missing value), data standardization, etc [4-5].

(1) outlier processing methods

Outliers are detected based on the boxplot visualization method, which is a method of visualizing the distribution of data and can display the minimum, maximum, median, first

quartile and third quartile of the data set. In a boxplot, any data point beyond 1.5 times the interquartile (IQR) is considered an outlier.

(2) Missing value handling method

In R, you can use a specific function: is. na () function to check for missing values in a data box or vector. This function will return a vector of logical values indicating whether each element is a missing value. The complete. cases () function checks the complete rows in the data box (i.e., rows with no missing values) and returns a logical value vector. By summing or tabulating this vector, you can get an idea of the number and proportion [4] of missing values in the data set.

(3) Data standardization

This paper adopts max-min standardization, and the formula for Min-Max standardization is shown [5] in the following formula (1).

$$x' = \frac{x - x\_\min}{x\_\max - x\_\min} \tag{1}$$

In formula (1), x' is the normalized data, x is the original data point, X_min is the minimum value of the data set, and X_max is the maximum value of the data set. After max-min normalization, all values of the data set are scaled to between 0 and 1. This method is suitable for situations where the data needs to be compressed into the same range, especially if there is a significant skew in the data distribution. In addition, max-min normalization can preserve the original distribution characteristics of the data.

2.2. Customer Value Stratification Model Based on Internet of Vehicles Data

2.2.1. Definition of customer value stratification model

Customer value stratification model is a strategic classification framework, which divides customers into different value levels according to their driving habits, behavior characteristics, consumption habits, running track and other dimensions, so as to customize the design of marketing strategies that meet the characteristics of customers at all levels. In this way, enterprises can more effectively meet the needs of different customer groups, improve customer satisfaction, and optimize the allocation of resources to achieve more efficient customer management and marketing.

2.2.2. Customer value stratification model based on Internet of Vehicles data

This paper uses the algorithm based on hierarchical clustering to divide customers into different value levels. The steps of the hierarchical clustering algorithm are shown below.

(1) Split hierarchical clustering: Using the top-down strategy, it first places all objects in a cluster, and then gradually subdivides into smaller and smaller clusters until a certain terminal condition is reached. The splitting method refers to the initial classification of all samples into a cluster, and then gradually split according to some criteria until a certain condition is reached or the set number [6] of classifications is reached.

(2) Description of the algorithm

Input: sample set D, the number of clusters or a condition (generally the threshold of the sample distance, this leaves you without setting the number of clusters) [7-8].

Output: Cluster result

① All the samples in the sample set are classified into a class cluster;

repeat:

② Calculate the distance between the two samples in the same class cluster (c) and find the two samples a and b with the farthest distance;

③ Assign samples a and b to different class clusters c1 and c2;

(4) The distance between the remaining sample points in the original cluster (c) and a and b is calculated. If dis(a)<dis(b), the sample points are assigned to c1; otherwise, they are assigned to c2;

until: the number of clusters is reached or the set conditions are reached.

2.3. Application of Customer Value Stratification Model

The customer value stratification model based on the data of the Internet of vehicles can be applied to the precision marketing of automobile enterprises. For customers of different value levels, develop different marketing strategies and promotional plans for high-value active customers, potential customers, ordinary users and customers with loss risk to improve the marketing effect.

(1) High-value active customer marketing strategy

High-value active customers refer to customers with strong purchasing power, good consumption habits and high brand loyalty. For high-value active customers, automobile companies should consolidate and deepen their loyalty. The key strategy is to strengthen the lasting relationship with customers through a series of customized and exclusive service measures. It covers the provision of personalized service solutions tailored to individual needs, exclusive preferential treatment and value-added services, aiming to firmly attract customers. For example, the in-depth data analysis capabilities of the Internet of Vehicles technology are used to accurately capture and analyze customers' driving behaviors and preferences, and then tailor insurance packages or vehicle maintenance plans to achieve accurate service docking. Build a VIP exclusive customer service system to ensure that these valued customers can enjoy fast priority service response and one-on-one exclusive customer service support, so as to enhance their satisfaction and loyalty experience in every detail.

(2) Ordinary customer marketing strategy

Ordinary customers refer to those who have moderate spending power, relatively fixed consumption patterns and maintain a certain degree of trust in the brand. To target this customer group, enterprises should focus on activating their activity and enhancing their satisfaction. To this end, strategies such as regularly sharing useful information and providing timely service reminders can be adopted to maintain positive interactions with customers. For example, a series of interesting and engaging marketing campaigns, such as the Safe Driving Skills Challenge, can be designed to deepen customer identification with the brand and increase customer engagement and loyalty.

(3) Potential customer marketing strategy

For potential customers, enterprises should focus on exploring and releasing their potential spending power, and promote them to the ranks of high-value customers. This can be achieved by implementing precise product recommendation and targeted promotion strategies to effectively stimulate customers' purchase desire. For example, formulate a hierarchical reward mechanism to encourage customers to gradually increase the use frequency and

consumption number of services, so as to meet customer needs and promote the growth of customer value.

Customers with loss risk marketing strategy

In the face of customers with loss risk, enterprises should take the initiative to attack and adopt effective retention strategies. The first is to build a customer loss early warning system, which can accurately identify the customer group that may lose by analyzing the customer behavior characteristics in the data of the Internet of vehicles. Then, according to these early warning information, customized retention plans, such as providing exclusive offers, giving new product experience services, etc., to attract customers to return. We should also actively use questionnaire survey or telephone interview to deeply understand the specific reasons for customers who consider leaving, so as to quickly adjust and optimize our products and services to ensure that we can effectively reduce customer turnover.

3. Summary and Outlook

3.1. Summary

This paper deeply explores the application potential of car networking data, and creatively constructs a hierarchical system of marketing value including four levels. This system can effectively improve customer satisfaction and loyalty by carefully analyzing a large amount of multi-dimensional customer data collected by the Internet of Vehicles, bring higher market share and profits to automobile companies, and provide a solid foundation for precision marketing.

3.2. Future Outlook

In the future, with the continuous leap of vehicle networking technology, its data acquisition and processing capabilities will usher in a qualitative leap. Automobile enterprises should firmly grasp this opportunity, make full use of the valuable resource of car networking data, in-depth insight and accurate grasp of the diversified needs and personalized preferences of customers. On this basis, they should continuously optimize marketing strategies and innovate product design in order to stand out in the fierce market competition and further enhance market share and competitiveness.

At the same time, automobile enterprises should actively seek in-depth cooperation with external partners such as scientific research institutions and universities to jointly explore the latest progress and broad application prospects of vehicle networking technology. Through cross-border integration, technological innovation and achievement transformation will be accelerated, and enterprises will be promoted from the traditional "product oriented" to the modern "customer oriented" strategy transformation. This transformation will not only lead the profound change and comprehensive upgrade of the marketing model, but also inject strong impetus into the high-quality development of the automobile industry, and jointly create a more brilliant future for the automobile industry.

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