Constructing a Customer Value Evaluation Infrastructure Model for Small and Medium-Sized Enterprises Using the K-Means Clustering Algorithm

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Abstract: Companies now understand that their customers are the source of valuable capital and earnings, and that their most loyal consumers represent an invaluable resource they cannot afford to lose. Therefore, measuring the value provided to customers is a crucial part of running a small or medium-sized business. In addition, clustering technology may help managers evaluate the veracity of different customer data, allowing for the successful differentiation of client value through cluster analysis and the subsequent implementation of focused customer relationship management (CRM) inside businesses. Therefore, this paper has completed the following tasks: 1) Introduced the research status of CRM, customer segmentation and cluster analysis algorithms at home and abroad. 2) Create a mechanism for measuring client value depending on their stage in the customer life cycle, and use it to assess them on two fronts: their present worth and their future potential. It disproved the one-and-only old model, which had relied on revenue alone. 3) The data mining cluster analysis method is applied to the customer value analysis, and a customer value calculation decision model based on K-means clustering is proposed. The model is applied in the empirical study, and the existing customers are classified. The results show that the modified model has excellent performance in the evaluation of customer value of small and medium-sized enterprises.

Keywords: Customer value; Evaluation; Customer relationship management; K-means clustering;
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1 INTRODUCTION

Business models throughout sectors of the social economy are being disrupted as a result of e-commerce enabled by Internet technology. This is particularly true of the dynamic between businesses and their consumers. Companies need to change their focus from products to customers in order to survive the cutthroat competition in their industries. That is, whoever can grasp the needs

of customers and respond with the fastest speed, who can attract new customers, keep old customers, and whoever can achieve the ultimate victory. CRM is to carry out related research on this issue [23]. The process management of the interactive generation of two distinct value streams, one from the business to the customer and the other from the customer to the company, is the basis of this system. These two value streams actually complement each other. Enterprises create and provide great value for customers, and customers return enterprises with profit and development potential. The end aim of CRM is to increase customer value from the viewpoint of the customers who provide direct benefits to the business [4]. How to maximize customer value, it is necessary to carry out customer value analysis to find the most valuable customers, carry out special promotional activities, and provide more personalized services. Try to retain these types of customers, so that the business can get the maximum return with the least investment. The current information system creates a mountain of data on customer characteristics and customer behavior, but this data is restricted to a superficial record of behavior and characteristics without any in-depth analysis. Using data mining methods such as cluster analysis for data mining, it is found that the rules and knowledge in the data can provide substantial suggestions and guidance for enterprise decision-making [1]. In recent years, due to the rise of data mining, cluster analysis has been more widely used and studied. Not only are the original algorithms continuously improved and innovated, but new algorithms with better performance are constantly being discovered. The application of better and updated cluster analysis technology to customer value analysis is also a research hotspot. In order to do a customer value analysis, you must first categorize your customers based on their worth to your business and identify your highest and lowest value consumers. Discover their characteristics and provide personalized services based on these characteristics to create maximum value with minimum resources [10]. There are classification methods and clustering methods for customer segmentation. Due to the difficulty of measuring customer value standards, the clustering method is generally used to cluster customers first. Then use the classification method to classify and discover rules and knowledge. Using the method of data mining clustering to analyze the customer value of enterprises, the purpose is to establish a customer value evaluation model based on current and potential value through a series of feasible index systems [6]. And use the analytic hierarchy process to conduct in-depth analysis of the index weights. Finally, the method of clustering is used to measure customer value and segment customers. It enables enterprises to effectively identify customers, evaluate customer value, conduct customer market segmentation, improve sales results, retain customers, improve customer satisfaction and loyalty, and so on. This provides intelligent decision support for enterprise customer management [16]. In the process of operation and development, many enterprises find that customers who account for a relatively small proportion of customers have created the vast majority of profits. This fully shows that not all customers are valuable to enterprises, and valuable customers are the source of enterprise value. Enterprises should treat customers differently, and a multi-angle quantitative analysis of customer value can help companies focus their efforts on the most valuable customers and customers with the most development potential. Prioritize the allocation of resources, establish stable customer relationships with them, and comprehensively improve the profitability and competitiveness of the enterprise [20]. Domestic enterprises must not only participate in the competition of domestic peers, but also face the challenges of large international multinational enterprises. Establishing a customer-centric business philosophy has become a guideline for domestic and foreign companies to operate in the market. There is a big gap between Chinese enterprises and foreign enterprises in this aspect, and most enterprises have not paid enough attention to the management of customer lifetime value. Although most of the company's profits are brought by a small number of customers, the company's attention is often concentrated on the largest sales customers or the easiest market to find. This leaves companies not only wasting direct costs on low-value transactions, but more importantly, wasting opportunity costs by not putting more effort into high-value customers. Therefore, in the face of fierce competition from domestic and foreign enterprises, Chinese enterprises need to catch up in scientific management of customer relations. Deepen the understanding of enterprise customer

value, understand its important role in the enterprise, and provide a new marketing management concept for the operation and management of Chinese enterprises [21]. Under the situation that the consumption trend is turning to diversification and personalization, through customer value analysis, we can find out the purchase characteristics of similar customers and implement different marketing to customers, so as to realize the collective demand analysis and targeted satisfaction of specific customers. And collect and analyze customer responses at any time, and adjust product and service strategies in a timely manner. Thereby greatly improving the efficiency and quality of customer service, so that customers get a higher degree of satisfaction. This is beneficial to improve the long-term economic benefits of the enterprise. First, the customer's repeat purchase probability can be effectively understood through customer value analysis [11]. Loyal customer retention can lead to huge savings in marketing expenses, and obviously, maintaining a relationship is easier than building it. Through customer value analysis, it is very important to understand how much each customer makes, and to analyze the reasons for this gap, which is very important to reduce costs and improve corporate profits. Through the analysis of the customer's profit level, it is also possible to identify profitable and loss-making customers, and take corresponding countermeasures according to the specific situation, so as to improve the long-term profit level of the enterprise. It can also concentrate the use and rational allocation of enterprise resources, form a competitive advantage in a certain customer group, and gradually establish a good B to B, B to C and other aspects of customer relationships, so as to effectively improve the market competitiveness of enterprises [9]. On the other hand, this is also the most effective measure to avoid losing customers in the fierce market competition. Caring for customers in a timely manner and satisfying customers in a more targeted manner, strengthening the long-term stable relationship between enterprises and customers, and continuously improving customer loyalty. Once a company makes its customers highly satisfied and earns high loyalty, it will keep customers forever. Customer value analysis is the core of CRM, and conducting customer value research will surely promote the development of CRM. As a management software and technology, CRM brings not only the improvement of sales level to enterprises, but also helps enterprises to realize the transformation from traditional business models to modern enterprises based on e-commerce, so as to make the customer-centric marketing concept It is reflected in the whole process of business operations [17]. At present, the existing customer value evaluation system is not perfect. The actual evaluation indicators only involve two aspects: sales revenue and profit contribution, and different customers have great differences in terms of consumption amount, transaction frequency, customer life cycle and other factors. difference. This requires that enterprises should establish a comprehensive customer value evaluation index system suitable for enterprise development as soon as possible according to the actual situation, so as to better allocate marketing resources. The research content of this paper is based on this starting point, proposes a realistic and feasible customer value index system, and uses the analytic hierarchy process and clustering method to carry out in-depth analysis of customer value, which provides a theoretical basis for enterprise management.

2 RELATED WORK

In the research of customer segmentation and clustering analysis algorithm, many scholars have their own achievements in their respective fields. Reference [12] believes that according to the design principles of the evaluation system indicators, and some indicators of the transfer value and behavior dimensions are added. In order to evaluate customer value, use scatter plots and perform customer segmentation according to customer value evaluation, and divide customers into high value, potential value and low value. Reference [3] believes that customer value should include current value and potential value, and customer segmentation classifies customers according to their different values based on their value. Reference [5] believes that the most important part of customer value-based segmentation is to evaluate the current value and potential value of customers in detail, and then cluster them by their value. Based on this, the consumer groups are

divided, and the targeted resource allocation and customer management strategies are adopted and formulated according to the different characteristics of the consumer sub-groups, so as to increase the efficiency of the enterprise. Reference [15] believes that the use of C-means technology can produce good results in the study of telephone network user segmentation. The main content of customer segmentation should be divided into three perspectives: consumer value, customer characteristics and demographic characteristics. Through the different research methods of scholars, scientific customer segmentation methods have been applied to customer management and marketing practices in many industries. Reference [24] believes that accurate customer segmentation and customer-centric improvement of customer satisfaction are not only the basis for implementing customer retention strategies, but also the main source of corporate competitive advantage. Only by effectively utilizing enterprise resources for valuable customers can the ability of enterprises to obtain sustainable profits be improved. Reference [7] believes that one of the most important reasons for the success of an enterprise is customer retention. Accurate segmentation is the first priority to implement customer retention, and it is an important guarantee for the company to adopt effective strategies. Through the research of scholars, customer segmentation is conducive to the development of new customer sources, maintaining old customers, and improving customer loyalty, thereby improving corporate efficiency and enhancing competitiveness. It has great positive significance for enterprise development and even economic development. Reference [8] believes that starting from the current value of customers, potential value of customers, and customer loyalty, a customer evaluation system is constructed to adapt to online member evaluation. And it is found that the current segmentation methods are all carried out from a single dimension, build static models and most of them have no predictive function. It considers the new three angles of customer segmentation method: multi-dimensional, dynamic, predictive. That is, the segmentation model can not only present the results, but also predict the future behavior probability of customers. Based on data mining, reference [18] established a subdivision model of consumption behavior by combining the theory of electricity consumption classification and customer value evaluation indicators. With the deepening of customer segmentation research, there are more and more related segmentation technology models and methods, and the practical applications in various industries have become mature. Reference [26] believes that loyalty can be divided into behavior, awareness and emotional loyalty, emphasizing the analysis of customer behavior trends, and expressing the feelings between customers and the company's products or services. Reference [13] believes that due to effective customer segmentation, it is beneficial to meet customer needs, and that products and services that are beneficial to enterprises can satisfy customers, and are more beneficial to more efficient and rational allocation of resources. In terms of cluster analysis technology, reference [22] proposes to use the data layer to obtain the upper limit of the number of search groups, and proposes to obtain the optimal number of clusters based on the cluster evaluation index. Reference [2] proposes a clustering method of how to select the sampling point as the starting center if there are multiple parameter values with the highest density, and the results are consistent. Moreover, the efficiency is improved, but the disadvantage of this method is that it takes a long time to calculate. In terms of K-means algorithm in cluster analysis, reference [19] divides the data set into groups according to the noise threshold and average density, and sets a high-density set of noise point sets. And according to the situation, the clustering is selected to eliminate the k-means problem caused by noise points. Reference [25] studied the customer segmentation of SMS services, in order to improve the quality and efficiency of the construction model. First perform factor analysis on the original data, which can reduce redundant fields, and then use the k-means algorithm to perform customer segmentation. According to reference [14], the clustering impact is different when choosing the initial center point, and the algorithm's clustering effect may be inferred from how well the center point is chosen. A sluggish convergence of the objective criteria function, a rise in the number of iterations required by the algorithm, and an unstable solution all stem from a haphazard selection process.

3 METHOD

3.1 Customer Value Index System Design

3.1.1 Design Principles of Customer Value Evaluation System

1) The principle of purpose. The selection of any index system is to serve the research of a specific field, so the selected indicators should be based on the purpose of the research problem.
2) The principle of comprehensiveness. The selected indicators should reflect all aspects of the research object as much as possible, and can reflect all aspects of the evaluated object.
3) The principle of feasibility. The selected evaluation indicators should not only be representative, but also feasible. The data of the indicators should be easy to obtain, and the quality of the data can be guaranteed, which can be truly reliable.
4) The principle of stability. The selected evaluation indicators should change regularly, and some indicators that are affected by accidental factors and have big fluctuations should not be selected.
5) The principle of associativity. When constructing an index system, qualitative analysis methods should be combined with quantitative analysis, and it is inappropriate to unilaterally emphasize qualitative methods or quantitative methods.
6) Scientific principles. The entire evaluation index system must be scientific, reasonable and accurate from the element composition to the structure, from the calculation content to the calculation method of each index.
7) The principle of hierarchy. Establish a hierarchical structure of the comprehensive evaluation index system to create conditions for further factor analysis.
8) The principle of comparability. The constructed evaluation index system should treat each evaluated object fairly, and the index should not be biased.

3.1.2 Establishment of Customer Value Evaluation Index System

Companies often employ a broad categorization of customers into high-value customers and low-value customers since there is currently no comprehensive index system in our nation to analyze customer value. Corporations often divide their clientele into "high-value" and "low-value" categories based on the dollar amounts of their product purchases. With the increase of the number of customers and the expansion of the scale of the enterprise, this method of classifying customers is increasingly unable to adapt to the development of the enterprise, especially in evaluating the quality of customers. This classification method also fails to take into account future profits, market expansion, and company development, which seriously affects the win-win situation between enterprises and customers. This study will attempt to design a multi-level index system for customer value assessment by combining aspects such the customer life cycle. Many domestic and international researchers have identified the core structure of the customer lifetime value assessment system, and this serves as the basis for the already established customer value evaluation system. A customer's present worth and future prospective value are both included in a holistic evaluation that employs a mix of qualitative and quantitative calculation methodologies. The present value of customers is an essential part of the perceived value of customers since it impacts the current profit level of an organization. Consumers' future financial contributions to the company's bottom line are a major consideration in determining whether or not to maintain contact with such customers. Each index in the customer value assessment index system is explained in detail below.

1) The current value of the customer refers to the value of the customer to the enterprise under the condition that the customer's operating conditions and purchasing lines remain unchanged. The current value of customers is mainly composed of three indicators: the amount of products purchased by customers, the profits brought by customers to the enterprise, and the cost of

service to customers. Profit is a necessary condition for the survival of an enterprise. To develop an enterprise, a considerable number of customers must provide enough profit space for it to maintain the survival and development of the enterprise. Therefore, profit is the most basic indicator for evaluating customer value. It consists of two sub-indicators, the maximum single profit amount and the average single profit amount. Profit has a higher weight in monetary value, but for some customers' value creation, this indicator does not reflect the actual situation. These customers are usually not very profitable per unit, but they have a larger volume of purchases. It may help businesses achieve the break-even point more quickly, lower product manufacturing costs, and reap the advantages of economies of scale sooner. When a company has high fixed costs, the importance of its client base becomes more glaring. It consists of two sub-metrics: cumulative transaction value and average purchase volume.

2) Potential customer value is the present worth of future revenues attributable to consumers, given that they alter their buying habits. A client's potential value is the amount the firm stands to gain in the future from that customer if it is prepared to raise its investment in the relationship with that customer. Considering the actual situation, choose the following 5 indicators: company size, customer loyalty, customer credit, customer relationship and customer growth. The larger the company, the stronger the strength of the customer and the greater the purchasing power of the customer. The size of the company consists of two sub-indicators: the number of specialty stores and whether it is listed. Customer loyalty includes three indicators: transaction continuity, wallet share, and brand recognition. Transaction continuity reflects whether customers continuously purchase the company's products. The value of customers who continuously purchase the company's products is far greater than those who buy occasionally. Wallet share is the proportion of a customer's purchase of a company's products and services in his total spending budget. The greater the share of a business's customer's wallet, the greater the value the customer brings to the business. Brand awareness refers to the importance of the brand of a company's products or services in the purchasing process, which strongly affects customers' expectations and perceptions of the relationship between suppliers. A brand established through long-term efforts and recognized by customers can enhance customer loyalty, strengthen the connection with customers, and maintain customers' repeat purchases.
3) Customer credit includes bank credit rating and average arrears rate. The bank credit rating mainly refers to the credit status of the customer enterprise in the bank and whether there is any behavior to evade the bank debt. Usually bank credit is divided into six grades: AAA, AA, A, BBB, BB, B. The average arrears rate reflects the transaction status between the customer and the enterprise. The lower the arrears rate, the higher the creditworthiness of the customers who take the initiative to pay back on time and have no bad arrears, and the greater the customer value.
4) Customer relationship includes relationship establishment time and average transaction time interval. The relationship establishment time refers to the length of time that the customer establishes the relationship with the enterprise, which directly reflects the closeness of the relationship between the enterprise and the customer. The longer the relationship is established, the more opportunities customers will have face-to-face with the business. A better exchange of views is more conducive to the formation of a community of values and a strategic alliance. The average transaction interval shows the size of the transaction interval between the customer and the business. The larger the interval, the more unstable the customer relationship is, and the smaller the interval, the more loyal the customer is to the company, and the more stable the customer relationship is.
5) Customer growth refers to the ability and prospect of customers' future development. Customer growth includes both customer life cycle and cross-selling likelihood. The customer life cycle is the entire cycle from the beginning to the end of the customer-business relationship. The customer lifetime value refers to the total value of the direct and indirect contributions of a single customer to the company's expenses and costs. The longer the customer's life cycle, the greater

the value of the customer. Cross-selling possibilities are when customers buy a type of product they have never bought before or expand their reach with a business. The greater the possibility of cross-selling, the greater the potential for cooperation between the customer and the business, and the greater the value created for the business. The specific index system is shown in Table 1.

Index	Label
Maximum single profit	C11
Average single profit	C12
Cumulative purchases	C21
Average purchase	C22
Number of branches	D11
Number of brands owned	D12
Transaction continuity	D21
Wallet share	D22
Brand popularity	D23
Bank credit rating	D31
Average default rate	D32
The time the relationship was built	D41
Average transaction time interval	D42
Customer life cycle	D51
Cross-selling possibility	D52

Table 1: Customer value evaluation index system.

The results of the final cluster analysis divide customers into different categories. According to the current value and potential value of each category of customers, customers can be divided into four categories: low-value customers, potential value customers, sub-value customers and value customers. Low-value customers are those with low current and potential value. Potential value customers refer to customers with low current value but high potential value and a good trend of developing into valuable customers. Sub-value customers are those customers whose current value is higher, but their potential value is lower. The development capacity in the later stage is limited, and there is a greater possibility or risk of value decline. Value customers refer to customers with high current value and potential value. They not only have good value at present, but also have a great possibility to continue to create good value for the company in the future.

3.2 K-Means Algorithm

The K-means algorithm is a clustering algorithm based on distance, and the similarity evaluation variable is set according to the distance, that is, the samples with the short distance are more similar. This algorithm has matured and is applicable to the fields of commerce and trade, biology, image technology, medical data, etc.

1) The basic principle of K-means algorithm. Users may choose how many categories will be used in the K-means algorithm's step-by-step cluster analysis of huge samples of data. In this approach, the sample data is seen as a point in a k-dimensional space, and the distance between

points is employed as an indication of the distance connection between the data; in return for a faster execution rate, several solutions are wasted. The K-means algorithm's central principle is to first classify the data by clustering into clusters with similar means, and then to iteratively refine the clustering to arrive at a final classification.

2) A review of the steps in the implementation of the K-means algorithm. The data set $S = (x_1, x_2, \ldots, x_n)$ that needs to be clustered, and the k cluster centers are $(c_1, c_2, \ldots, c_k)$. The Euclidean distance of the two bodies (X_i, X_j) of the K-means algorithm is the square root of the sum of the squares of the differences between the K variable values of the two bodies. The formula is:

$$d(x_i, x_j) = \sqrt{(x_{i1} - x_{j1})^2 + (x_{i2} - x_{j2})^2 + \cdots + (x_{ip} - x_{jp})^2} \quad (1)$$

where x_i and x_j represent the data objects of two P-dimensional attributes.
The formula for the average dista nce of all sample points is as follows:

$$Meandist(S) = \frac{2}{n(n-1)} \times \sum_{i \neq j, i, j=1}^{n} d(x_i, x_j) \quad (2)$$

where n is the total number of sample objects in the dataset, and $d(x_i, x_j)$ is the Euclidean distance between sample points x_i and x_j.
The objective function is the square error criterion function and the formula is as follows:

$$E = \sum_{i=1}^{k} \sum_{j \in N_i} \| x_j - c_i \|^2 \quad (3)$$

where N_i represents the ith cluster set, and c_i represents the center of the ith cluster.
The steps of the K-means algorithm can be briefly described as follows. In the first step, k samples are selected as the initial center points, or all samples are divided into K initial classes, and then the k means are used as the initial center points. In the second step, other samples except the center point are classified, and each sample is grouped into the class with the closest center point. The center point of this class will be updated and will be the current mean until all samples have been classified. The third step is to repeat the second step until the termination condition is met. There are two termination conditions, one is based on the number of iterations, and the other is based on the offset of the class center point. The iteration can be terminated when one of the two termination conditions is satisfied. The flow chart of the classic K-means algorithm is shown in Fig. 1.

3) Applicability of K-means algorithm. The advantages of the K-means algorithm are as follows: It has a wide range of applications. The real world is multi-dimensional, and it cannot be classified by a certain index, while the K-means algorithm analyzes multi-dimensional indicators. The similarity measure is used to convert the similarity between samples to perform clustering. This algorithm is widely used in many fields such as business field, biological field, image technology, medical data, statistics and so on. The algorithm is simple and efficient. The K-means algorithm has a simple structure, good scalability and effectiveness when solving large data sets, and the results are easy to understand. The algorithm has a good clustering effect on numerical data, because the Euclidean distance is generally selected as its similarity measure, and the geometric meaning of all the obtained results is clear and clear. Algorithms are objective and realistic. When the K-means algorithm processes numerical data sets, there are no special requirements for the category of the data set. The classification is also implemented according to the similarity between samples, rather than the selection of k values based on the so-called empirical division, and the results obtained have nothing to do with the order of data entry.

The shortcomings of the K-means algorithm are as follows: Without a thorough understanding of the domain under study, it is impossible to choose the most appropriate K starting condensation points, leading to skewed output from the K-means method. K-means is able to relocate the cluster's center of gravity for random samples. Therefore, it is affected by noise, edge points and isolated points, which will interfere with the stability and accuracy of the output results.

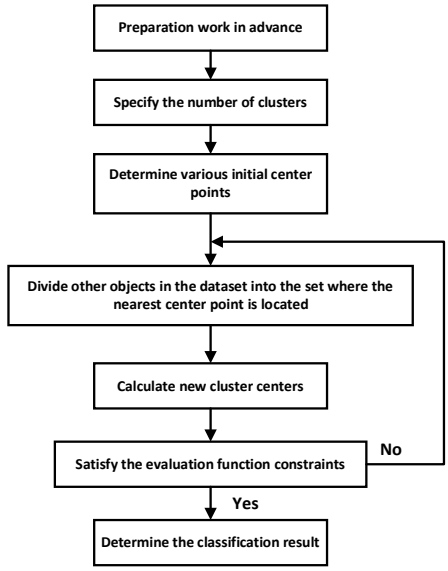

Figure 1: Flowchart of the classic K-means algorithm.

The number of iterations is equal to the specified number of iterations to terminate the clustering, and it is uncertain whether the appropriate convergence and divergence can be obtained. The output result sometimes does not meet the termination condition, and the sample class will be continuously adjusted, resulting in the result not being the optimal solution.

4 EXPERIMENT AND ANALYSIS

4.1 Data Preparation and Statistics

Now randomly select the data of 10 customers of Company A, and the sample data drawn from the customer information starts from two quarters. Using the expert scoring method, these experts must be composed of Company A experts, company managers, customer representatives and business executives. Combined with the customer's previous sales status, combined with the expert's understanding of the company's customers, comprehensively scored each indicator of the 10 customers. Then substitute into the formula $Y = x_1m_1 + x_2m_2 + \cdots + x_jm_j$, where m represents the weight of each factor, and x represents the corresponding score. Thereby, the relative value score of each customer is obtained, and the scoring interval is specified as [1, 5]. Combined with the weight of each indicator, the relative value, current value and potential value of 10 customers can be calculated. For accuracy, 10 customers were classified by K-means algorithm of SPSS software. Fig. 2 shows the current value and potential value of 10 customers.

4.2 K-Means Cluster Analysis Experimental Results

Use K-means in SPSS to classify customers. Select Iterate and classify to first specify the initial category center point. The K-means iteration process is shown in Table 2 and Table 3. X1, X2, and X3 are customer value, current value and potential value, respectively. The classification of customers is based on three quantities, and customers are divided into four categories.

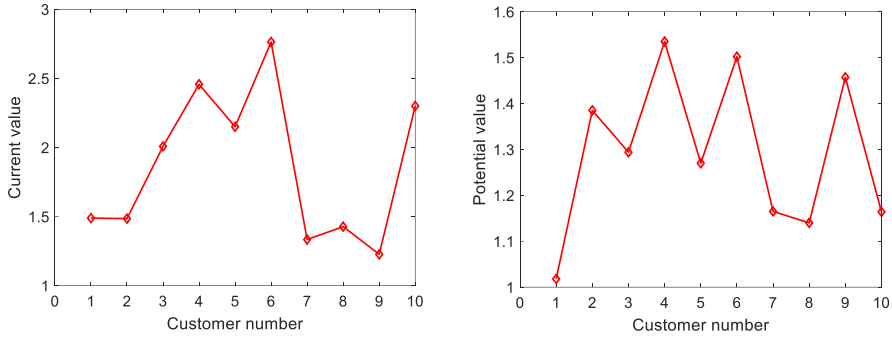

Figure 2: Current and potential value of 10 customers.

Value	Cluster			
	1	2	3	4
X1	2.4968	2.7262	3.4112	4.2575
X2	1.4789	1.2686	2.1404	2.7546
X3	1.0179	1.4576	1.2708	1.5029

Table 2: The value of four different types of customers.

Iteration	Change in Cluster Centers			
	1	2	3	4
1	0.116	0.128	0.035	0.205
2	0	0	0	0

Table 3: Euclidean distance of center points formed after the first iteration.

According to Table 2 and Table 3, the SPSS system designates customer 1, customer 9, customer 5, and customer 6 as the center points of the four initial classes. In the process of completing the iteration, the Euclidean distances of the four new class center points formed after the first iteration from the initial class center point are 0.116, 0.128, 0.035, 0.205, respectively, while the four new class center points formed after the second iteration The class center point is almost indistinguishable from the center point determined in the previous iteration. The classification effect is shown in Fig. 3 and Table 4.

After K-means fast clustering of customer value, the accompanying probability values of F statistic are customer value 0.000, of course value 0.000, and potential value 0.003. These three indicators are determined by the customer itself, and the F statistic is the accompanying probability value is very small. It can be considered that the data in this paper have significant differences in the average value of customer value, current value and potential value, and the clustering effect is ideal. The obtained results are then compared with the results analyzed by experts, and the experimental results are shown in Fig. 4.

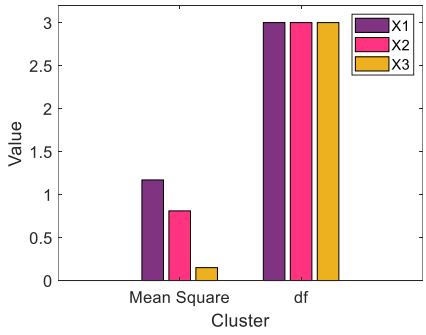

Figure 3: Analysis results of various single-factor variance.

Value	F	Sig.
X1	108.622	0.000
X2	38.270	0.000
X3	18.498	0.003

Table 4: Analysis results of F statistic and accompanying probability values.

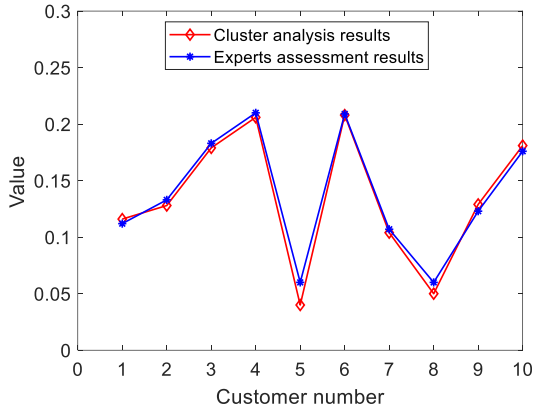

Figure 4: Comparison of cluster analysis results and expert evaluation results.

Through cluster analysis, it can be divided into four categories. Among them, customers 1, 7, and 8 are low-value customers. Customers 2 and 9 are potential value customers. Customers 3, 5, and 10 are sub-value customers. Customers 4 and 6 are value customers.

5 CONCLUSION

This paper mainly studies the methods and strategies of customer value analysis, in order to enhance the competitiveness of enterprises and prepare for the implementation of CRM. The core of customer relationship management is customer value management. Today, in this rapidly developing information society, many companies still use traditional methods to estimate customer value based on sales or some simple indicators. There are still many enterprises that have not brought good

development to the enterprise after the implementation of CRM. This is mainly due to the lack of understanding of CRM theory and the lack of a good grasp of customer value. Through the analysis of customer value, enterprises can pay more attention to customer value, calculate and classify customer value reasonably, and formulate marketing policies reasonably, so as to provide guarantee for the better development of enterprises. The analysis result of enterprise's customer value includes two parts, one part is the weight result of each impact index of customer value. The other part is the size of customer value and classification results. The analysis and application of these two parts is an important part of enterprise customer value analysis. Therefore, this paper has completed the following tasks: 1) Introduced the research status of CRM, customer segmentation and cluster analysis algorithms at home and abroad. 2) Build a customer value evaluation index system based on customer life cycle, and evaluate customers from two dimensions of current value and potential value. It broke the single traditional model that only used sales as an evaluation method in the past. 3) The data mining cluster analysis method is applied to the customer value analysis, and a customer value calculation decision model based on K-means clustering is proposed. The model is applied in the empirical study, and the existing customers are classified. The results show that the modified model has excellent performance in the evaluation of customer value of small and medium-sized enterprises. By investing in infrastructure development, enterprises can effectively leverage customer value analysis to gain insights, make informed decisions, and tailor marketing strategies to enhance customer satisfaction and loyalty.

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