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*Research Article*

# Precise Marketing Classification of Agricultural Products for E-Commerce Live Broadcast Platform Using Clustering

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Live delivery of goods is a novel type of marketing model that has injected new vitality into the development of agricultural e-commerce. It is only in the last few years that live streaming has become a popular e-commerce marketing approach. Agriculture e-commerce in China has a new lease on life thanks to the advent of a new marketing model. This article comprehensively surveys the live broadcast delivery models in the e-commerce era. The comprehensive survey includes the significance and current state of the live broadcast delivery models and identifies the factors impeding the integration and development of agricultural products. The review includes the new marketing model of live broadcast delivery and makes pertinent recommendations. The article presents a novel model for precise marketing classification of agricultural products for e-commerce live broadcast platforms using clustering. Moreover, this article uses customer development space to achieve precise marketing for the e-commerce live broadcast platform. The article enhances K-means with local density and information entropy and proposes an improved TFA customer segmentation method. The results demonstrate that the proposed method is capable of efficiently classifying customers, accurately reflecting their value, and optimizing the algorithm's efficiency by optimizing the clustering technique.

## 1. Introduction

Product information is exhibited in an instinctive and three-dimensional (3D) manner through a variety of live-streaming platforms, and product features are made available to users through actual interaction with the products. Keeping track of audience preferences may allow the anchor to convince people to purchase while she is on the air. For this reason, traditional e-commerce has had to evolve to accommodate the new live delivery model, which was introduced in 2016 [1–3]. Traditional e-commerce has had to adapt to the new live delivery model because it is evolving at a quick speed. More than 800 million customers now have access to new commodity marketing tactics, including social networking-enabled live broadcasts and short films, which marketers can use to reach them. In 2019, the total gross merchandise value (GMV) of Taobao e-commerce live streaming reached 230 billion yuan. Taobao live-streaming GMV is expected to reach 400 billion yuan in 2020, representing a 74 percent raise over the previous year's [4, 5]. More individuals are becoming aware of the possibility of live streaming because of the staggering statistics that have been reported so far. As a result, a variety of sectors are beginning to examine the integration and development of the new format of live broadcast and delivery marketing model to support the transformation and improvement of their respective industries [6]. Today, the Chinese digital economy is gradually making its way up and down the country's extensive network of supply chains within the country's industrial industry.

The live broadcast e-commerce market in China is thriving with a penetration rate of 4.3 percent in 2019. E-commerce for live broadcasts is predicted to reach 9.3 percent of the market in various industries by 2020. Many industries and information technologies can be merged and grown using digital supply chains. Techniques such as big data and artificial intelligence have assisted in increasing the efficiency of industrial chains and the quality of external service levels provided to customers. Big data plays a vital role in the current era. Big data is the backbone of analytics and prediction. Big data analytics platforms are used to analyze big data in a parallel fashion. The parallel and distributed platforms are used to compute the big data. A significant impact on conventional agriculture has also been made through live streaming [7–13]. Agricultural e-commerce is being restricted, and the cost of distribution is being reduced as a first step. Agricultural planting has been scattered over the region, whereas industrial planting has not yet been completed. It is not possible to reduce the overall cost of the farm by increasing its size. Because of the emergence of live broadcasts, the agricultural supply chain has been shortened. The goal of using e-commerce platforms is to get control over one's sales and to realize the connection between producers and customers [14, 15]. Farmers can increase their revenue and wealth by watching agricultural products being broadcast in real time on the Internet, which eliminates the conflict that has arisen between agricultural production and sales as a result of the epidemic.

Farmers can also increase their revenue and wealth by promoting their products on social media platforms. It is possible to connect traditional agriculture to the Internet platform, which will reduce the distance between farmers on the production end and consumers on the demand end [16–18], double the sales of various characteristic agricultural products, realize the connection between the production and sales of agricultural products, and assist agriculture in its industrialization of production. Also vital is to rethink agricultural e-commerce and introduce new ideas to improve the current state of the business. We anticipate that the usage of live-streaming e-commerce will aid in the restructuring of social production relations as well as the revitalization of traditional e-commerce. It is possible that the live delivery technique, which can force a shift in traditional agricultural methods, will spur a change in the agricultural product's production and operating mode [19]. By viewing the planting environment of the origin of the characteristic agricultural products on a screen, consumers can establish a connection with the product's source and learn more about the product's characteristics. Compared to static product displays and browsing after the fact, real-time images of the live broadcast in vegetable greenhouses, orchards, and fields are more effective. Consumer confidence in acquired agricultural products is increased as a result of the real-time contact with the host and other users of the live broadcasting room. Using a new online e-commerce model that makes use of live broadcasting, two-thirds of consumers will be able to buy fresher and more dependable agricultural products directly from the source.

Finally, the live broadcast marketing model is inexpensive to implement, allowing growers to complete the sale of agricultural products without having to leave their homes, thereby eliminating the information gap that currently exists between the supply of agricultural products and the demand for them on the market, as previously mentioned. In this case, there is the problem of increasing output but not growing revenue [20, 21]. Developing rural e-commerce also has the purpose of assisting the region in leapfrogging. Rural economies must be supported by Internet technology and the digital economy if they are to grow in their current state. Note that the sale of agricultural products in this environment is strongly tied to the rapid growth of the rural economy, which should be taken into consideration. Time and distance are involved in the transmission of agricultural goods [22]. The popularity and traffic generated by antennas can help to expand the potential client base indefinitely, bring together dispersed consumers, and complete the product relationship between producers and online consumers. Boosting farmers' enthusiasm for planting, providing consistent income for rural residents, and creating a virtuous production cycle are all benefits of live broadcasting, which allows the rural economy to leapfrog development by increasing the number of agricultural product transactions. Customer relationship analysis models such as the RFM model, which assesses the worth of consumers across a variety of aspects, are the most frequently employed. Various research has been conducted to widen the model's applicability because of this. According to RFM, the RFMP is focused on the potential value of consumers [23, 24].

Other academics have constructed the RVS model, which is based on the RFM model and contains industrial elements, based on the RFM model. These tactics do not consider the development of the customers. It is all due to the development of computer data mining techniques. It is possible to apply the K-means clustering method to address the management problem of corporate customers since it is similar in application to enterprise customer relationship management (CRM) [25–27]. Customers are segmented using K-means clustering since it has a greater result in terms of algorithm time measurements and large-scale data when compared to other methods [28]. The article presents a novel model for precise marketing classification of agricultural products for e-commerce live broadcast platforms using clustering. Moreover, this article uses customer development space to achieve precise marketing for the e-commerce live broadcast platform. RFM model based on customer development has been provided along with optimization and enhancements to the K-means clustering algorithm. In addition, statistical methods and the impacts of clustering have been used to verify the experimental results. The article enhances K-means with local density and information entropy and proposes an improved TFA customer segmentation model.

The rest of this paper is organized as follows. In Section 2, background studies are presented. In Section 3, the proposed classification about precise marketing approach is presented. In Section 4, experimental results are discussed. Finally, we conclude the paper in Section 5.

## 2. Insufficient Delivery of Live Broadcasts and Suggestions

This section provides a bird's eye view of the e-commerce live broadcast platform. Emerging rural e-commerce also has the purpose of supporting the area in leapfrogging. Two-thirds of consumers will be able to buy fresher and more dependable agricultural products directly from the source with the exploitation of the novel online e-commerce method that makes usage of live broadcasting. The background and literature are discussed in the context of constraints and suggestions.

*2.1. State-of-the-Art Constraints.* In the agricultural digital economy, real-time broadcasting of agricultural commodities is now possible with no constraints on time or location, and this has become an increasingly important marketing paradigm for the sector. Due to a variety of factors, live broadcast of agricultural products has been restricted. As a result, it has been difficult to incorporate live broadcasts into the actual sales of agricultural products. Live broadcasting of agricultural commodities involves the cargo impact, which includes packaging and storage, logistics and distribution, live broadcasting capabilities, and industry oversight, among other things. The first concern is that the quality of live broadcast items cannot be consistently checked, which is a problem. The inadequate agricultural organization is caused by the fact that agriculture is a traditional business that has never been successful in becoming a large-scale and recognizable industry. Since most existing planting, production, and processing facilities are small, information technology is out of date, and contemporary data chain management concepts are not in place, there are not many agricultural products that can be utilized for live broadcasting. Storage facilities for fresh agricultural products, on the other hand, are severely limited. Agriculture products that have been moldy and deteriorated due to poor storage conditions are less likely to be purchased by consumers in the live broadcast room.

Then, the cold chain logistics for agricultural products offered by online retailers are not as efficient as they could be. The infrastructure for cold chain logistics includes equipment for storing and transporting agricultural products. However, while China's cold chain logistics have seen significant growth in recent years, its level of development remains well behind that of the logistical infrastructure of developed nations. There is a disparity in the distribution of cold chain logistics infrastructure across the nation. Even though the urban and rural cold chain infrastructure has been completed in the economically developed eastern provinces, there remains a substantial gap between existing cold chain storage facilities and actual demand in the center and western regions. Even though a complete and rapid logistics system is required for agricultural products e-commerce, in practice, only 40% of agricultural items can be transported through a cold chain, and the remaining 60% are transported using ice cube refrigerants and other methods that slow down the process significantly. As a result of traditional logistics and transportation systems, agricultural items have suffered enormous losses. In contrast to what is customary in developed countries, most of China's cold chain transit is carried out by vans.

In addition, there is a dearth of live broadcasting expertise. Alive broadcasters must be able to accurately recognize the quirks of agricultural products and utilize words and actions to entice viewers to avoid the uniformity of agricultural products from occurring. Live broadcasters must be knowledgeable about agricultural products and product operation abilities to effectively broadcast agricultural products. They must also be able to provide innovative and nonrepetitive material, which is difficult for most anchors and farmers to do. This has harmed the development of live broadcast marketing channels for agricultural products. According to the current situation, the live broadcast sector is a new industry, and the absence of expertise is even more evident. Live broadcasters are unfamiliar with the processes involved in the production and distribution of agricultural products. As a result of rural network information technology, farmers are unable to learn how to market their products online, which means they are unable to obtain clients to purchase their products, so limiting their ability to expand their businesses. It properly depicts the influence of e-commerce on agricultural products that are exhibited live on television.

Lastly, with live broadcasting, the absence of market monitoring is a significant issue. Although agricultural commodities have a low entrance barrier and market participants are complicated, market monitoring of live broadcasts of agricultural products is difficult as a result of these variables. Agricultural items are broadcast in real time. Because agricultural goods have such distinct characteristics, it is hard to categorize them using statistical methods alone. Consequently, it is hard to assure that the food sold is of high quality and is safe to consume. The product quality of items sent by live broadcast delivery, on the other hand, cannot be guaranteed because they are not classified and evaluated. Because agricultural products are perishable and difficult to store, the requirements for logistics and distribution efficiency are higher than those for other commodities as a result. In the event of a problem with the product's quality, no one may be held responsible.

*2.2. Suggestions.* Agricultural goods e-commerce has seen a significant increase in its development prospects as a result of the rapid advancement of new digital infrastructures such as big data analytics, 5G, and artificial intelligence. The live broadcast of agricultural products' online sales has emerged as a critical link in the process of digital transformation. Producing agricultural products, packaging them, warehousing them, shipping them, following up with customers, and ensuring that they reach their destination are all part of the supply chain. This requires the participation of agricultural product producers as well as logistics companies and e-commerce platforms in the process. Flawless functioning of every link in the agricultural product supply chain is essential for the delivery of the agricultural product live broadcast marketing model effect. Through the use of live streaming, this essay will examine agricultural e-commerce and client demand to enhance agricultural product sales. To overcome the limitations of agricultural product live broadcasting, it is being investigated for approaches and proposals for improving the marketing mode of agricultural product live broadcasting, as well as for expediting the transformation of the agricultural product distribution model upgrade. Before certain agricultural products may be offered, they must first be evaluated to verify that they fit the requirements for live broadcast items.

Live broadcasts of agricultural products may be carried out using e-commerce platforms and social media platforms dedicated to the living broadcast of agricultural things. The use of sexuality in live broadcasts of agricultural commodities gives viewers an engaging product experience and allows broadcasters to make use of social network traffic to continually reach out to new consumers.

It was developed in the framework of the creation and development of e-constant commerce that the marketing concept of live-streaming agricultural products came about. When it comes to global digital economy development, e-commerce broadcasting in agriculture is an inescapable decision. It is necessary to continuously improve live broadcast marketing to keep up with agricultural growth and to encourage the transformation and improvement of the model for the distribution of agricultural products to aid in the acceleration of rural economic development. Live broadcast marketing is a valuable tool for promoting rural economic development. First and foremost, develop a digital distinctive agricultural product planting and breeding foundation, as well as reassemble the agricultural product live broadcast interest chain. Establishing a distinctive agricultural product for the region, putting reliance on the region's top agricultural product producers, and encouraging the industrialization of the region's agricultural products are all goals. It is possible to carry out agricultural product data management as a result of live broadcasts and the effect of brands and online merchants, and sales have an impact on the production of agricultural products. The rapid dissemination of information in today's digital age, which follows the path taken by small farms and large enterprises equally, encourages the production of regionally distinctive agricultural commodities by both individuals and businesses.

A computer program has been developed to operate the base. A primary focus for this government is the establishment of specific agricultural product industrial parks. As a unit, the industrial park's top enterprises and base farmers have built a clear system for checking product quality to give e-commerce live broadcasts of consistently high-quality agricultural goods to customers worldwide. In a live broadcast of agricultural commodities, a variety of parties are involved, including farmers, e-commerce companies, and purchasers. Keeping an agreed-upon price for agricultural commodities requires re-balancing the chain of interests from the perspectives of the three major players involved. A farmer's principal goal is to sell his or her agricultural products. Farmers should sell as much agricultural produce as they can at the present market price to protect their interests and that of their customers. Step-by-step instructions on how to use the online commerce platform may be provided to live broadcasters to encourage them to deliver things to viewers. For e-commerce platforms to be successful, it is necessary to invest in quality control of distinctive agricultural commodities. However, the benefits of agricultural product sales can only be achieved if buyers are willing to purchase the things. Producers and e-commerce companies must grasp the concept of transferring advantages from viewers, as well as the raising of red envelopes and shopping coupons, during the live broadcast process, to increase the sales of agricultural products and improve overall interest in the sale of agricultural products.

To expedite the development of cold chain logistics facilities for agricultural goods, it is necessary to establish a digital cold chain logistics system. According to the plan, the government supports the construction of low-temperature distribution processing facilities, cold storage, closed cold chain vehicles, and other logistics sector areas to promote the growth of agricultural product cold chain logistics growth. With the support of the government, cold storage containers and thermal insulation vehicles that have been in use for decades will gradually be phased out over time. Improving the database system for agricultural products and accelerating the development of the cold chain logistics infrastructure for agricultural products are both urgently needed. It is also critical to expanding support for integrated storage and cold storage facilities, such as those for agricultural product sorting and processing, as well as to improve the storage and precooling of agricultural commodities. At the industrial plants, modern cold chain logistics facilities are being constructed. A smart information management platform will be developed as a result of this, which will accelerate the development of a digital cold chain logistics network. It is vital in the digital economy to have cold chain logistics for agricultural products. A gradual shift toward intelligent allocation of cold chain logistics resources may be accomplished by the collection, archiving, analysis, and use of information on agricultural goods.

## 3. Proposed Precise Marketing Classification

The proposed model utilizes the customer development space to realize precise marketing for the e-commerce live broadcast platform. The proposed model improves the K-means clustering algorithm of machine learning with information entropy and recommends an enhanced integrated model. The prosed model features too many client groups after subdivision and a multicollinearity flaw between buy frequency and purchase amount, making it the most widely employed in customer relationship management. This study suggests TFA as a replacement for the RFM model. Customers are less likely to return to a store with a high value of $T$, and customers are less likely to return to a business with a low value of T. There is a greater want to consume when there is a greater desire. The $T$ is calculated using the equation.

$$T = \frac{t_T - t_t}{|t|}, \tag{1}$$

where $t_T$ represents the last time the customer returned to the store, $t_t$ represents the time, and $|t|$ represents the shopping interval.

$F$ represents the consumption frequency of the customer in the judgment time base point. A represents the total purchase amount and total purchase amount of the customer within the limited time period. The ratio of times "A" value is directly related to customer contribution.

As a result, the standard RFM model is unable to accurately capture the significance of each indication in actual sales. The updated model now incorporates AHP for greater accuracy. The formula for the calculation is

$$W_i^{(l)} = \sum_{j=1}^{n} u_{ij}^{(l)} W_j^{(l-1)}, \quad (2)$$

where $u_{ij}^{(l)}$ is the element of the matrix.

The index weight is computed as

$$W = 0.25T + 0.13F + 0.62A, \quad (3)$$

where $\lambda_{max}$ is the largest feature root. If CR < 0.1, the weight coefficient is acceptable. The CR is computed as

$$CR = \frac{\lambda_{max} - n}{(n-1)RI}. \quad (4)$$

The RFM technique has strain being applied in real settings as it is extremely granulated. Artificial rules necessitate the use of nonpremise division methods, which are then classified according to the rules of datasets. Unsupervised computer techniques have been introduced as a result of data mining, as has been predicted. Clustering is one of the leading unsupervised learning algorithms of machine learning. It is widely used. The unsupervised learning approach is utilized for the unlabeled dataset that does not include the result and outcome against the feature list. The proposed model integrates the K-mean clustering algorithm. The proposed model optimizes and enhances the traditional K-mean clustering approach.

The basic flow of the K-means algorithm is as follows:

Step 1: Randomly select K points.

Step 2: For each point $x$ in the dataset, calculate the distance from the center by using

$$d = \sqrt{\sum_{i=1}^{n} (v_i - o_i)^2}. \quad (5)$$

Step 3: Assign each point by the nearest to each cluster center.

Step 4: Determine the new center.

Step 5: Execute steps (2) to step (4) cyclically; if the new cluster center no longer moves, terminate the calculation; otherwise, go to step (2).

The K-mean clustering is a widely used clustering approach. The original K-means model also has the benefit of being scalable and effective when processing huge data. It is fast and straightforward which makes it an exceptional option for numerous requests. The value is difficult to estimate, and the choice of the starting point has a significant impact on the number of iterations and the outcome of the calculation. Therefore, the density value and information entropy are introduced in this paper.

The formula for calculating the density value $\rho_i$ is (6) with integration of (7).

$$\rho_i = \sum_{j=1}^{k} \sigma\left(d_{ij} - d_c\right), \quad (6)$$

$$\sigma(x) = \begin{cases} 1, & x < 0, \\ 0, & \text{else}, \end{cases} \quad (7)$$

where $d_c$ is the cutoff distance; then, we have the local density probability. The $\rho_i$' is calculated as

$$\rho_i' = \frac{\rho_i}{\sum_{i=1}^{k} \rho_i}. \quad (8)$$

Calculate the density probability of all samples, and introduce information as the objective function; the calculation formula is

$$H = -\sum_{i=1}^{k} \rho_i \log(\rho_i). \quad (9)$$

The steps of our algorithm are as follows.

Step 1: Determine the density $\rho_i$.

Step 2: Determine the extreme value of $H$ and the local density probability $\rho_i'$.

Step 3: Sort according to the best intercept and add it to set $C$ based on density.

Step 4: Figure out how far away from each other in the entire dataset the densest points are and use that distance as your second pivot point.

Step 5: A clustering procedure is complete when all $K$ centers have been selected and $K$ clusters have been formed because of this process.

## 4. Results and Discussion

This section provides the results of the proposed improved model. The datasets utilized to show the applicability of the proposed model are shown in Table 1. Four datasets in UCI are nominated for testing and validation including Iris, Digits, Wine, and Glass. The Iris dataset includes 150 samples with 4 features and 3 centers. The Digits dataset includes 1794 samples with 64 features and 3 centers. Similarly, the Wine dataset includes 178 samples with 13 features and 3 centers. Finally, the Glass dataset includes 600 samples with 2 features and 15 centers. The implementation is carried out using the Python programming language. The machine learning libraries are utilized to train the clustering model. The comparison of the required four different datasets is also depicted in Figure 1.

The accuracy comparison of the required four different datasets in the context of different algorithms is also depicted in Figure 2. The proposed algorithm accuracy is much better than the traditional K-mean and DBSCAN. Different algorithms are compared in Figures 1 and 2 for the number of iterations and the accuracy.

Table 1: Detail of four datasets.

| Datasets | Number of samples | Number of features | Number of centers |
|---|---|---|---|
| Iris | 150 | 4 | 3 |
| Digits | 1794 | 64 | 10 |
| Wine | 178 | 13 | 3 |
| Glass | 600 | 2 | 15 |

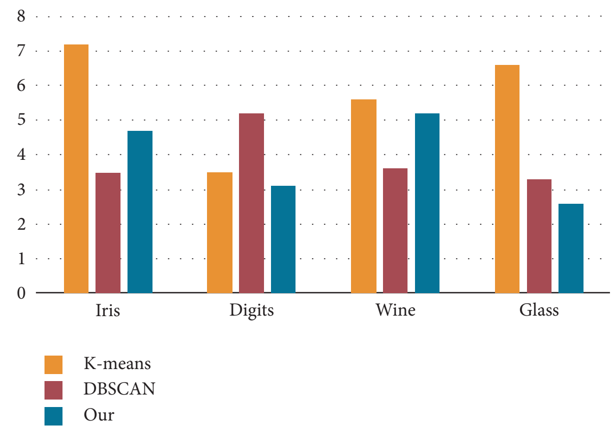


Figure 1: Comparison of iteration times of different algorithms.

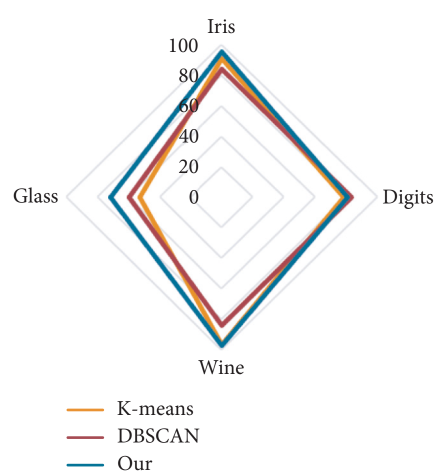


Figure 2: Comparison of accuracy (%) of different algorithms.

Figures 1 and 2 show that the algorithms in this paper are more efficient in terms of iterations and much more stable in terms of clustering accuracy, and the approach in this paper is superior to the unimproved K-means and DBSCAN methods. All algorithms are performed 100 times in the same environment to effectively count and compare the outcomes, and the average value of the relevant algorithms is used as the analysis data. The clustering effect of the Digits and Glass datasets is shown in Figure 3.

The modified K-means method overcomes the problem where the original approach is easy to fall into a local optimum and has a poor clustering effect on nonclustered datasets through density information, as shown in the above algorithm verification results. With the clustering approach, you do not have to rely on any particular dataset, and it is a good fit for grouping enormous datasets.

Figure 4 shows the results of the silhouette coefficient and the CH index [4, 6, 9], which were used to test the TFA model. According to TFA's assessment method, when $K = 6$, there is a discrepancy between SC and CH values. The RFM model has a poor clustering effect in the unsupervised clustering technique. As an illustration, the optimal clustering in the silhouette coefficient is $K = 2$; however, in the CH clustering evaluation, the optimal clustering is $K = 8$.

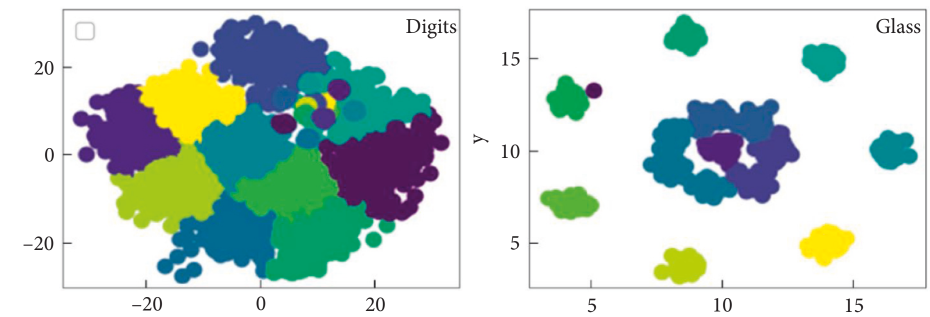


Figure 3: Clustering results of Digits and Glass datasets.

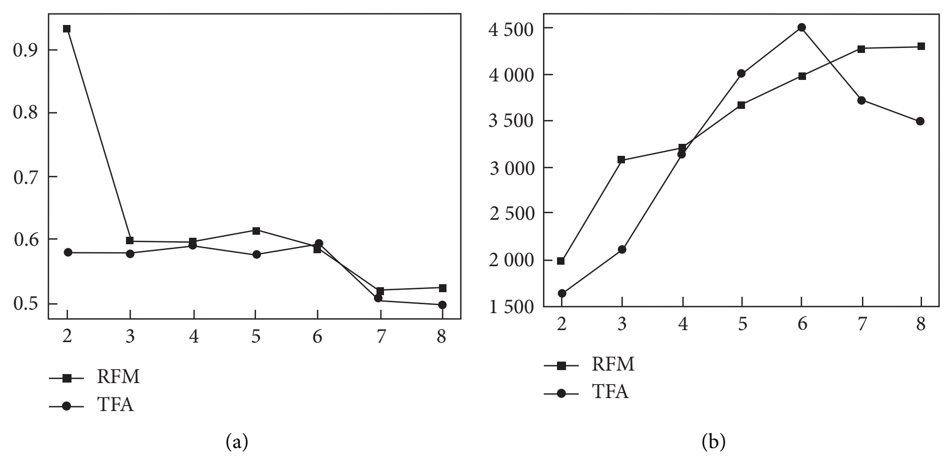


Figure 4: Comparison of silhouette coefficient and SC of different algorithms. (a) Silhouette coefficient results, (b) SC results.

Based on TFA and weighted by AHC, this research provides a customer classification model that incorporates a weighted coefficient based on AHC for each customer classification index characteristic. To begin with, this study provides an improved K-means method that eliminates the problem of selecting an initial center that plagued the original approach. Classification accuracy and operational efficiency were both increased in the experiments, as shown by the findings.

## 5. Conclusion

Live broadcast delivery models in the age of e-commerce are the starting point of this paper, which then goes on to examine their current significance and current state, as well as the factors limiting the integration and development of agricultural products into this innovative new marketing model of live broadcast delivery. Furthermore, this paper uses customer development space to introduce local density and information entropy to improve K-means and proposes an improved TFA customer segmentation model to achieve precise marketing. Results from the experiments display that the proposed method can accurately identify clients, accurately imitate client value and its growth potential, and expand algorithmic efficacy by enhancing its use of clustering algorithms. Moreover, this paper proposes a new model for precise marketing classification of agricultural products for e-commerce live broadcast platforms using clustering. The proposed model improves the K-means clustering algorithm with local density. The results reveal that the model can classify customers efficiently and accurately.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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