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The Analysis of Two-Way E-Commerce Credit Evaluation Model Based on the C2C Mode

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ABSTRACT

As an important mode of e-commerce, C2C has become a trading mechanism favored by consumers. However, for C2C transaction in a virtual environment, there is an issue of congenital transaction asymmetry, leading to increased uncertainties and transaction risks as well as credit speculation, false transactions, and other credit problems. These problems not only affect the development of enterprises to a large extent, but also hinder the development of e-commerce ultimately. In order to guarantee the safety of both transaction parties, it is particularly important to establish a sound credit evaluation system for shopping sites. Through the analysis of the shortcomings of the existing C2C e-commerce credit evaluation model, this paper proposes a two-way e-commerce credit evaluation model based on the C2C mode. Firstly, a cross-platform two-way credit rating center with a unified rating standard was constructed; secondly, the credit evaluation indicator was reset and revised; then the credit rating of buyers and sellers was unified by combining fuzzy comprehensive evaluation algorithm.

KEYWORDS

Analytic Hierarchy Process, C2C, Electronic Commerce, Fuzzy Comprehensive Evaluation Algorithm, Two-Way Credit Evaluation Center

INTRODUCTION

E-commerce has become a new business model for business activities. With the rapid progress of China's economy and the popularity of the Internet, more and more people participate in online transactions. According to the *37th Statistical Report on China's Internet Development,* released by the China Internet Network Information Center (CNNIC), by the end of December 2015, the number of Internet users in China had reached 688 million, and the Internet penetration rate had reached 50.3%. According to the *2014 China Online Shopping Market Research Report,* released by CNNIC, as of December 2014, the number of online shopping users in China had reached 361 million, and annual online retail sales reached 2,789.8 billion yuan. Statistics show that 76.1% of user online

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shopping accounts for less than 20% of their daily consumption. Online shopping has become one of the mainstream consumption modes. However, while e-commerce is convenient for shopping, its own virtual environment intensifies the information asymmetry of online transactions. Online consumers can only judge the quality of goods according to the text, images, and other descriptions of businesses. To sell goods and earn profits, merchants often describe goods selectively, which causes frequent credit problems such as inconsistent descriptions, false descriptions, and exaggerated publicity. Besides, money and goods are separated for online transactions, and the time and place are not unified. False transactions, such as non-timely delivery or non-delivery, may also occur after payment.

Amazon, eBay, Taobao, JD, and other major e-commerce websites generally adopt online credit evaluation mechanisms to reduce information asymmetry in online transactions, restrict the behavior of both parties, and promote the establishment of trust between both parties. However, China's e-commerce credit evaluation mechanism is basically transplanted from foreign eBay, resulting in the lack of a basic credit evaluation system and business atmosphere similar to foreign countries. The credit evaluation mechanism used by eBay plays a very limited role in solving the credit problems of domestic e-commerce, and may even cause adverse market reactions, such as bad evaluation retaliations, bad professional evaluations, and malicious purchases. Therefore, it is urgent to establish a network credit evaluation mechanism in line with the domestic environment. The research innovation is to establish an e-commerce credit evaluation model based on Customer-to-Customer (C2C) and use the fuzzy comprehensive evaluation method and analytic hierarchy process to grade both parties' credit to effectively reduce the credit risk in e-commerce transactions.

RELATED WORK

According to CNNIC's survey on online shopping users' dissatisfaction in 2012, dissatisfaction caused by inconsistent publicity and fake and shoddy products accounted for 49% and 23.3%, respectively, seriously affecting consumers' confidence in online shopping. Fu and Cristhian (2020) studied credit evaluation in e-commerce. A two-way credit evaluation method was put forward by analyzing the defects of credit evaluation. This method simultaneously evaluated and analyzed both sides of the transaction to ensure the consistency and authority of e-commerce transaction credit evaluations. The framework of the two-way e-commerce credit evaluation model was summarized, its operation mode and implementation method were designed, and the analytic hierarchy process was used for simulation. To ensure the construction of an e-commerce network platform through risk evaluation, Xu et al. (2019) discussed the uncertainty and transaction risks between e-commerce sellers and buyers, and then evaluated the application of artificial intelligence models of the artificial neural network, decision tree, and dynamic Bayesian network in the seller's credit risk evaluation. The results showed that the model could effectively promote the transaction of e-commerce platforms, so the excellent credit risk evaluation model could improve the e-commerce environment and provide a decision-making reference for buyers and investors. Liu and Li (2020) evaluated the application of blockchain technology in supply chain management in the context of cross-border e-commerce, and formulated corresponding technical processes based on blockchain technology. The model can effectively deal with the problem of key recovery and solve the problems of network attack and credit.

Xu et al. (2019) believed that social media marketing had a certain impact on C2C buyers' decisions, and there was a certain correlation between sellers' marketing enthusiasm and marketing popularity. The stronger the marketing enthusiasm, the higher the buyer's trust in the seller, which can strengthen the buyer's trust in the seller. However, in the proposed two-way evaluation model indexes, the changes of seller's credit caused by relevant contents were not analyzed. Therefore, it is impossible to judge the changes in the seller's credit evaluation results caused by the seller's marketing and potential transaction risks, and the possible positive credit improvement (Ayyildiz et al., 2020; Yu et al., 2021). Therefore, in future research, the relevant indexes of the two-way e-commerce credit evaluation center need to be strengthened to further improve the accuracy of credit evaluation

and reduce the transaction risk as much as possible. Compared with similar studies, the algorithm designed here can play a more efficient role in e-commerce.

METHOD

Characteristics of E-Commerce

E-commerce usually refers to a wide range of global commercial and trade activities in the open network environment; based on browser/server applications, buyers and sellers do not meet each other in a variety of business activities. It is a new mode of business operation for online shopping, online transactions, and online electronic payments among merchants, as well as business activities, trading activities, financial activities, and related integrated service activities. In short, e-commerce is a process based on business activities and computer networks within the scope permitted by law. E-commerce has the following characteristics:

1. **Ability to Use is More Important Than Channel Capacity:** Generally speaking, the traditional offline sales mode is to develop a large number of distributors by continuously expanding sales channels, and the sales mode is usually flat. Compared with traditional enterprises, e-commerce has less demarcation of national boundaries, and online commodity trading is only a matter of instantaneous display, so sales channels are not as important now as they were in the past. In the original offline sales model, it was necessary to distinguish between primary and secondary agents. By contrast, the sales channels have been greatly shortened in e-commerce, so the distribution of color distinction is not so important, and more manufacturers directly sell online. Therefore, one of the characteristics of e-commerce is that in the e-commerce environment, enterprises should learn to use a whole set of systematic marketing tools and enhance their operational capacity.

On the other hand, the ability to use is more important than channel capacity, which does not mean that channel capacity is unimportant. Each e-commerce platform is a big channel that needs to carry distributors and expand the channel for business. For an e-commerce website, the key lies in the management of channels; even if there is only one channel, a great channel support capacity is still vital. In addition, e-commerce is a traffic-reselling center. When operating on the platform, it is unnecessary to distinguish in terms of regions, prices, transparent information, and price uniformity.

2. **Multi-Platform Situation:** E-commerce is a platform for individuals or enterprises to provide online transactions to negotiate. Often, e-commerce is not a single-platform situation. Generally, many platform chambers of commerce continue to operate, and different chambers of commerce have their own strengths. According to the current development trend of e-commerce, multi-planar situations will remain. Generally speaking, the multi-platform of e-commerce is equivalent to many governments, many enterprises need to use multiple platforms to divide management, and the entire platform enterprises are often the entire ecological chain. Alibaba, the e-commerce leader in China, has been rated as the world's largest Business-to-Business (B2B) website for five consecutive years.
3. **Shortening the Trading Chain:** The traditional off-line trading product supply chain is relatively long, especially vulnerable to the shortage of product inventory, oversupply, or defective sales channels. In the context of e-commerce, manufacturers sell the goods directly to end customers. In this way, e-commerce saves a lot of manpower and financial and material resources in the product supply chain, shortens the transaction chain effectively, and refrains from the limit of time and space, so that information flow and capital flow can be interactive and promote the convergence of business flow and logistics. Compared with e-commerce that has a shorter

transaction chain, traditional enterprises have been affected significantly, and the serious ones have almost collapsed.

4. **Traffic is the King:** In the transaction process, traffic is not only the core of e-commerce but also a business competition center. The larger the traffic flow, the greater is the passenger flow. Precisely because of its strong flow, Taobao can attract a large number of customers. The analysis of e-commerce website traffic is mainly conducted from the perspectives of efficiency conversion and user characteristics. No matter how strong the financial strength of enterprises or how good the brand effect, everything is empty talk if there is no traffic. E-commerce enterprises have to invest significant money, gather traffic, attract customers, and promote transactions.
5. **Cost Orientation:** In e-commerce, price is a preferred factor for consumers; most businesses rely on lower prices to survive, and only about 10% of businesses survive by relying on their brand. In the field of e-commerce, most people constantly reduce the investment and rely on low prices to attract customers. In the actual operation process of e-commerce, because of its powerful background operation and maintenance costs, the e-commerce costs cannot reach the ideal price in consumers' minds, and the operating costs of some websites are even higher than the traditional business costs. Nevertheless, cost orientation is still a development trend recognized by all industries. Many enterprises invest huge capital in big brands, and the ultimate goal is to carry out low-cost, fast, marketing activities.
6. **Overall Competition:** With the rapid development of e-commerce, almost all enterprises want to share a piece of cake for benefits. As a result, the enterprises are confronted with fierce competition from raw materials to product production.

The Role of Credit in E-Commerce

For e-commerce, the most fundamental guarantee is credit, which is the basis of honest transactions. More than 70% of buyers will check the seller's credit before purchasing the goods, and they will be satisfied with the seller's credit before they consider whether to buy. In view of the virtual nature of e-commerce transactions and the asymmetry of time and space, false transactions or malicious fraud may occur, greatly hindering the e-commerce development. Credit speculation has increasingly become a means by which illegal businesses increase their credit and further gain illegal wealth. Therefore, the credit evaluation system has become an important part of e-commerce (Djuitaningsih & Arifiyantoro, 2020; Liu et al., 2021; Shen et al., 2019).

Credit is an inevitable product of social and economic development as well as an indispensable part of modern economic and social operation. Maintaining and developing credit relations is an important prerequisite for the protection of social and economic order. With the establishment of China's market economic system, credit evaluation has become increasingly important for preventing credit risk and maintaining normal economic order.

First of all, credit evaluation helps enterprises prevent commercial risks and provides good conditions for the construction of modern enterprise systems. The ultimate goal of transforming the enterprise management mechanism and establishing a modern enterprise system is to make the enterprise a self-sustaining, self-developing, and self-restraining competitive market player, operating independently according to the law. Credit evaluation will maximize the enterprises' effective economic benefits. Furthermore, credit evaluation is a comprehensive inspection and evaluation of the internal quality of enterprises, and enterprises with high credit ratings can enjoy more preferential credit policies in economic exchanges, which can reduce financing costs. Therefore, it is not only conducive to timelyidentifying weaknesses in business management, but it also provides motivation for enterprises to improve business management.

Secondly, credit evaluation is conducive to equity, fairness, and integrity in the capital market. It can provide investors with fair and objective information, so as to protect the interests of investors. It can be used as a basis for reviewing decisions by the capital market management department and maintaining stable order in the capital market, and it also helps enterprises to raise funds at low cost.

Thirdly, credit evaluation is the basis for determining the loan risks by commercial banks. Credit evaluation is also the foundation of credit asset risk management. As the main units of economic activities, enterprises have a close credit relationship with banks. Bank credit is one of the important sources of capital for their production and development. The quality of their production and operation activities and the standardization of their behavior are directly related to the use of bank credit funds and to their efficiency. This requires banks to give a scientific evaluation of business activities, operating results, profitability, and solvency, so as to determine the uncertainty in the loss of credit assets and to prevent loan risks (Deng et al., 2021; Wang et al., 2019).

Therefore, a sound business credit evaluation system can not only solve the buyer's hesitation about the seller's credit, but also ensure that the transaction is carried out in good faith. Additionally, the smooth transaction can also drive the development of related industries. Virtual money, logistics, and related advertising industries can get a lot of space for development, which can also boost the further growth of the entire trading platform.

Through the analysis of the shortcomings of the existing C2C e-commerce credit evaluation model, this paper proposes a two-way e-commerce credit evaluation model based on the C2C mode. The specific contributions of this study are as follows:

1. Build a cross platform credit rating center with a unified rating standard.
2. Reset and amend credit evaluation indicators.

By combining a fuzzy comprehensive evaluation algorithm and the analytic hierarchy process, the credit rating of buyers and sellers is unified.

Construction of Two-Way Credit Evaluation Model

The so-called C2C e-commerce credit evaluation system is as follows.

After a transaction is completed, within the evaluation validity period, both parties of the transaction evaluate each other according to the situation of the transaction to form credit information feedback.

It is then essential to aggregate all the evaluations obtained by a user into the user's credit degree and credit record in a certain way to reflect the user's credit status and provide a reference for other users to make transaction decisions.

Aiming at the defects of the existing C2C e-commerce credit evaluation model, this exploration proposes a two-way e-commerce credit evaluation model based on the C2C model. A two-way cross-platform credit rating center with unified rating standards will be established after collecting information and data from C2C e-commerce websites, banks, third-party payment platforms, buyers, and sellers. Figure 1 provides the basic framework of the established model.

The two-way e-commerce credit evaluation model is shown in Figure 2. The following are the main steps and procedures of the operation according to their order:

1. **Establishment of Two-Way Credit Rating Center:** With the two-way credit rating center as the core, non-profit organizations (i.e., banks, payment gateways, e-commerce websites, and other participants in the transaction) provide the most timely e-commerce transaction information and a strong guarantee. This model can be established by drawing lessons from the credit investigation system established by Japan's Banking Association (Yatim et al., 2019). Its advantage lies in the cooperation between credit investigation and financial institutions, which can ensure the fairness and authority of economic data provided by banks, and meet the demand of credit investigation for economic data, because economic data is an important indicator of credit evaluation. On the other hand, government departments act as supervisors in the credit evaluation process. Since the government is an object not directly related to the transaction subject, its intervention can strengthen the authority of credit results, avoid artificial modification of data, and thus reduce

Figure 1. Framework structure of two-way e-commerce model

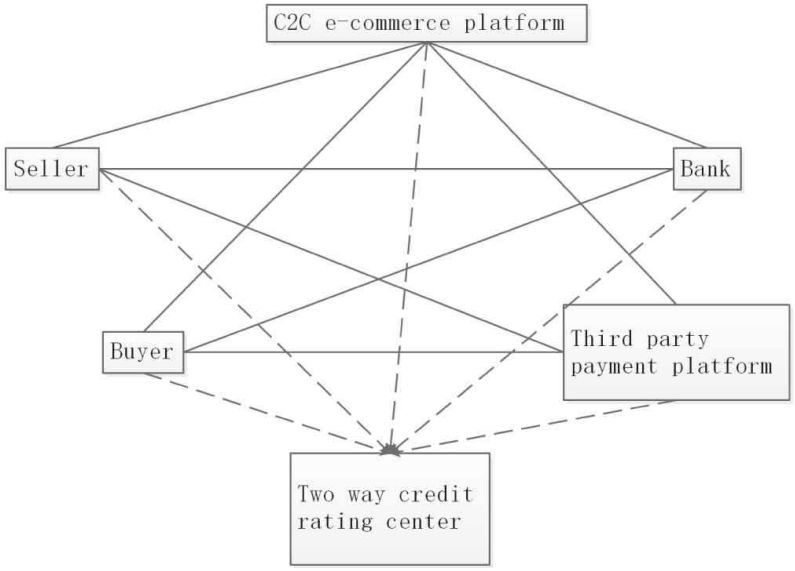
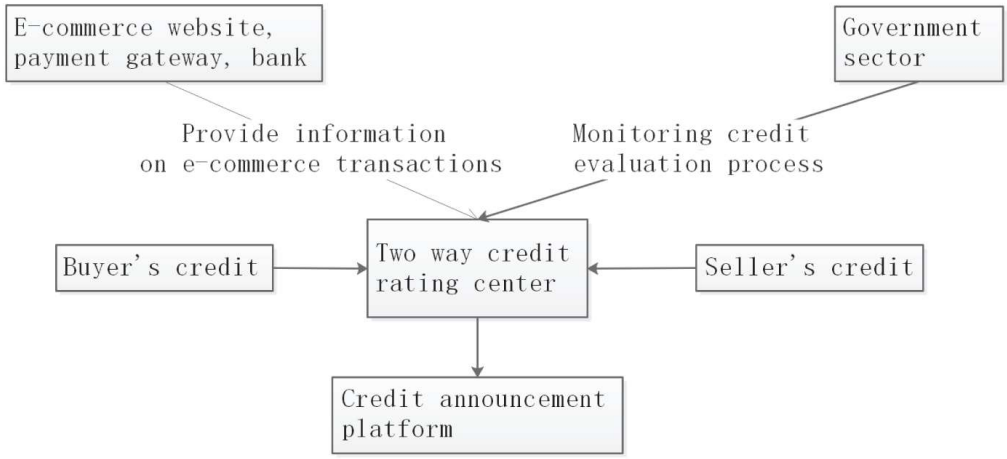


Figure 2. The operation mode of two-way e-commerce credit model



the impact of human interference on credit justice. At the same time, these two forces should be combined to jointly implement credit evaluation.

2. **Implementation of Two-Way Credit Evaluation:** The two-way credit rating center starts with all relevant parties involved in the transaction process, such as banks, the third payment platform, and C2C e-commerce website with the purpose of obtaining the buyers' and sellers' basic information, personal assets status, personal bank reputation, seller's store transaction records, user credit score, etc. Later, the two-way credit rating center uses a certain evaluation method, collates and analyzes the collected data according to a certain weight, and obtains the credit evaluation results of the buyers and sellers.
3. **Announcement of the Credit Rating Results:** In order to ensure the fairness, impartiality, transparency, and openness, the two-way credit evaluation center will also be responsible for issuing the evaluation results. In the process of issuing, the national legal organs will participate in monitoring and control, and the credit evaluation results will be updated on a monthly, quarterly,

semi-annual, or annual basis. In addition, the results can be viewed and quoted by e-commerce websites, banks, third-party payments, buyers, and sellers.

Indicators of the Two-Way Credit Evaluation Model

- **Principles of Setting Credit Evaluation Indicators:** The construction of evaluation indicator system is the foundation of the credit evaluation model. The quality of a credit evaluation model largely depends on the induction and summary of the indicators and the selection of the indicators. The credit indicator system must be set up under certain principles to ensure that the established evaluation indicator system is scientific, reasonable, and effective (Lei et al., 2021; Lin, 2012; Zheng et al., 2021a).
- **Scientific Rationality Principle:** The credit rating indicator system is established to provide a basis for the construction of the credit evaluation model, so the evaluation indicator system must be set up in a scientific and reasonable manner. To avoid the overlap and contradiction of indicators, the data selection and the calculation method should have a certain theoretical basis, prevent the arbitrary setting of indicators according to the relevant data and expert opinions, and gradually enrich the scientific nature of the indicator system in practice (Chen, 2019; Chen et al., 2020; Meng et al., 2021; Wu et al., 2020; Zheng et al., 2021b).
- **Comprehensive Systematic Principle:** The setting up of the evaluation indicator should satisfy the comprehensive and systematic requirements. It should reflect the evaluation needs of users in all aspects, and also embody the characteristics of e-commerce credit evaluation. In terms of the content, the evaluation indicator should not only include the requirements of current users, but also predict the development trend of credit evaluation in the future. In Addition, the evaluation indicator should not only consider the situation of users themselves, but also involve the influence of external conditions on the credit evaluation.
- **Fairness and Legality Principle:** The selection of the evaluation indicators should be fair, impartial, and in line with relevant laws and regulations of the state. The researcher should set up the evaluation indicators in an objective and impartial manner, reflecting the real situation of e-commerce credit evaluation. At the same time, the indicator system should conform to the national macroscopic policies and abide by relevant national policies, laws, and regulations.
- **Practical Feasibility Principle:** The evaluation indicator must be operable, practical, and feasible. It should be convenient for users to understand at various cultural levels, for the application of major e-commerce websites, and for the design and input of computer system programs. Meanwhile, when selecting and setting evaluation indicators, the researcher should remain consistent with the concept of indicators put forward by e-commerce websites, conform to China's basic national conditions, and comply with international practices, so as to create the credit evaluation in line with international standards.
- **Quantitative Comparability Principle:** The selection and setting of the credit evaluation indicator follows the quantitative comparability principle. On the one hand, the evaluation indicator design combines qualitative analysis with quantitative analysis, refers to the expert opinion and the knowledge, and achieves a quantifiable research as far as possible; it also guarantees the establishment of credit evaluation model objectivity, and overcomes the uncertainties of the subjective evaluation establishment model. On the other hand, the credit evaluation model is widely used in various e-commerce websites on the premise of the comparability of evaluation indicators. The evaluation indicator should ensure the comparability of the credit value formed by the evaluation of sellers, accumulate the reputation of sellers, and standardize the transaction behavior of both parties, so as to provide reference for sellers or buyers in future transactions.
- **Buyer's Credit Evaluation Indicator:** Taking into full consideration the personal credit system in China and the characteristics of C2C e-commerce transaction subject, and referring to the mature personal credit evaluation indicator system in foreign countries, this paper provides seven credit evaluation indicators for buyers: age, gender, educational level, nature of work, monthly

income, city, and bank credit. In this paper, the fuzzy membership function of the buyer credit evaluation indicator and the specific scoring criteria are given, as shown in Table 1 (Dong et al., 2021; He et al., 2020; Huang & Bae, 2017; Mohammadi & Taban, 2016; Wu et al., 2018).

- **Seller's Credit Evaluation Indicator:** To construct the seller's credit evaluation indicator system is to construct some factors related to the seller's credit, which can reflect the seller's credit situation according to the indicators concerned by consumers in the process of online shopping. Based on the existing online shopping platform and literature research, this paper, by consulting experts and investigating consumers, sets up four primary indicators: product quality, information quality, distribution quality, and service quality, and sets up relevant secondary indicators under the primary indicators. The specific seller's credit evaluation indicator system in this paper is constructed as shown in Table 2.

The seller's credit indicator system mainly reflects the related factors of the seller's credit. The seller's related credit indicators are displayed through four primary indicators and corresponding secondary indicators. Buyers can use secondary indicators to evaluate the seller's credit, so as to choose their own satisfied sellers, and prompt sellers to pay attention to their own defects and enhance their credit in future transactions. In this paper, the fuzzy comprehensive evaluation method is used to dynamically evaluate the seller's credit and promote the transaction. Each primary indicator contains a number of secondary indicators, and a number of secondary indicators reflect the overall primary indicators, so as to reduce evaluation errors as far as possible and achieve scientific and reasonable results.

Fuzzy Comprehensive Evaluation Algorithm

The fuzzy comprehensive evaluation method is developed based on fuzzy mathematics theory. Fuzzy mathematics was founded in 1965 by L. A. Zadeh, an American expert in automatic control. It is a mathematics that describes studies and deals with things with fuzzy characteristics and concepts. Zadeh proposed to describe fuzzy concepts with Membership Function, and founded fuzzy set theory, which laid the foundation for fuzzy mathematics. The advantage of the fuzzy comprehensive evaluation method is that it considers the complexity of the internal relations of objective things and the fuzziness of the value system, weighs the influence of many factors, and makes a comprehensive evaluation with fuzzy mathematics tools (Jiao et al., 2016; Kumar et al., 2017; Li et al., 2017; Liu et al., 2020a, 2020b; Zhang et al., 2017). Figure 3 shows the algorithm flow.

The development of a fuzzy comprehensive evaluation can be carried out in the following steps:

Step 1: Determining the Evaluation Indicator System

The evaluation indicator system refers to the collection of various factors that affect the evaluation objects. Evaluation factors are set to be U, and there is $U = \left\{U_1, U_2, \cdots, U_n\right\}$, where U_i is the evaluation factor. The evaluation must be based on a certain evaluation indicator system. The evaluation objectives can determine which indicators are necessary and which indicators can be ignored.

Step 2: Determining the Weight Matrix of Evaluation Factors

In the indicator system, weight is the importance of a factor in the concentration of factors, which reflects the objective imbalance between the indicators. The expert scoring method, Delphi method, and analytic hierarchy process are commonly used to determine the weight (Chen, 2019; Li et al., 2021; Yang et al., 2021).

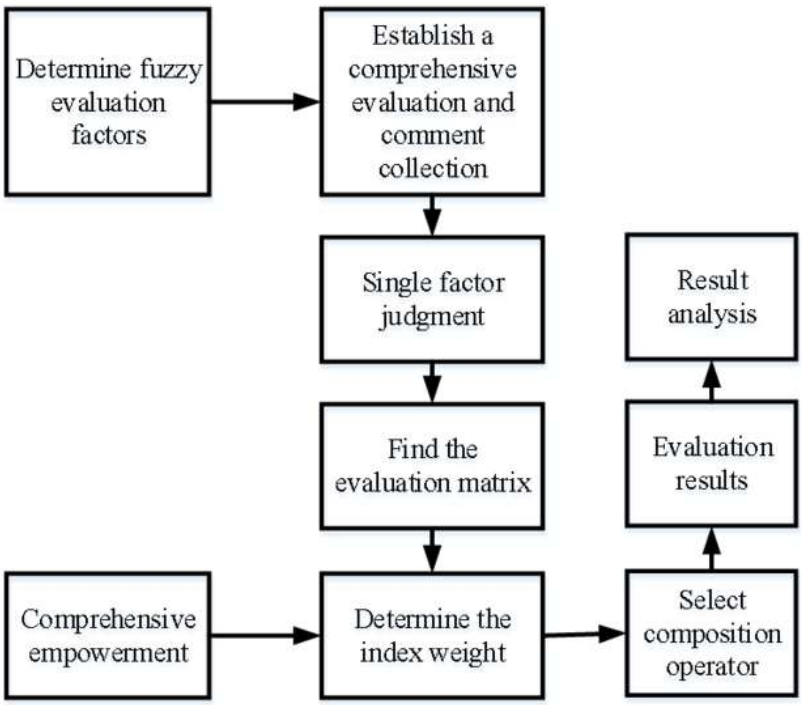
Table 1. Scoring function of buyer's credit evaluation indicator

Indicator	Scoring Function	Indicator Score Explanation
Age	$r_1 = \begin{cases} 1, & 31 \le m_1 \le 55 \\ \frac{m_1}{10}, & other \\ 0, & m_1 < 16 \end{cases}$	16-30 years old: 8 points 55-70 years old: 6 points Over 70 years old: 4 points
Gender	$r_2 = \begin{cases} 1, & m_2 = 2 \\ \frac{m_2}{2}, & m_2 = 1 \end{cases}$	Woman: 2 Man: 1
Educational Level	$r_3 = \begin{cases} 1, & m_3 = 10 \\ \frac{m_3}{10}, & 0 < m_3 < 10 \\ 0, & m_3 = 0 \end{cases}$	Ph.D. and above: 10 points Master's degree: 9 points University: 8 points Junior College: 7 points Technical secondary school / High school: 6 points Junior high school and below: 4 points
Nature of Work	$r_4 = \begin{cases} 1, & m_4 = 10 \\ \frac{m_4}{10}, & 0 < m_4 < 10 \\ 0, & m_4 = 0 \end{cases}$	State organs: 10 points Enterprises and institutions: 8 points Student / staff / individual: 6 points Others: 4 points
Monthly Income	$r_5 = \begin{cases} 1, & m_5 \ge 5000 \\ \left(\frac{m_5 - 500}{5000 - 500}\right)^{\frac{1}{2}}, & 500 < m_5 < 5000 \\ 0, & m_5 < 500 \end{cases}$	Income level affects personal consumption level
City	$r_6 = \begin{cases} 1, & m_6 = 10 \\ \frac{m_6}{10}, & 0 < m_6 < 10 \\ 0, & m_0 = 0 \end{cases}$	First-tier cities: 10 points Strong second-tier cities: 8 points Middle second tier cities: 6 points Weak second-tier cities: 4 points Third-tier cities: 2 points
Bank Credit	$r_7 = \begin{cases} 1, & m_7 \ge 70 \\ \frac{m_7}{10}, & 20 < m_7 < 70 \\ 0, & m_7 < 20 \end{cases}$	AAA "excellent": 90-100 points; AA "excellent": 80-99 points A "good": 70-79 points BBB "good": 60-69 points BB "fair": 50-59 points B "general": 40-49 points CCC "poor": 30-39 points CC "poor": 20-29 points C "very poor": 10-19 points D "very poor": 1-9 points

Table 2. Seller's credit evaluation indicator system

Explanation	Primary Indicator	Secondary Indicator
Reflect the quality of the seller's products	Product quality	Is the product genuine?
		Is the product intact?
		Product packaging satisfaction
Reflect the accuracy of the seller description	Information quality	Does the seller describe details?
		Seller description consistency
Response to the efficiency of seller distribution	Distribution quality	Is the seller shipped correctly?
		Seller's delivery speed
Reflect the seller's service	Service quality	Seller's service attitude
		Seller's returns timely
		Seller's after-sales service

Figure 3. Algorithm flow of fuzzy comprehensive evaluation



Step 3: Building the Comment Set

The combination of comment sets is flexible, which is determined by the general law of "good, general, and bad." Comment sets can be determined according to different requirements of various indicators or by using the membership function. Usually, the evaluation field is given by grading and quantifying synthesis. The comments set up in this paper are as follows:

$$V = \{highest, higher, general, lower, lowest\}$$

Step 4: Establishing the Fuzzy Evaluation Matrix R

The fuzzy evaluation matrix is established according to the evaluation indicator and membership function. Let the evaluation set be V, there are n evaluation grades, and then $V = \{V_1, V_2, \cdots, V_n\}$ (Strand et al., 2017). If there are m evaluation factors, the fuzzy relationship between the evaluation factor set U and the evaluation factor set V can be expressed by the evaluation matrix R: $R = (r_{ij})_{n\times m}$, where $r_{ij}(i = 1,2,\cdots,n; j = 1,2,\cdots,m)$ indicates that the membership level of grade j evaluation is evaluated for the i indicator (Lian et al., 2017).

Step 5: Comprehensive Evaluation

The comprehensive evaluation result is $B = A \circ R$.

EXPERIMENTS

In the experimental simulation, the computer hardware configuration is as follows:

Processor: Inter i5 2.50GHz; Memory: 4GB
Operating System: Windows 7, 64 ultimate
Development Platform: Visual Studio 2005
Development Language: VB.NET

In this paper, a shop in Taobao was selected as the simulation object, and 20 trades in one day were selected to evaluate the store. The evaluation of 20 transactions is shown in Table 3.

RESULTS

The accuracy of the credit evaluation indicator affects the credit evaluation results as well as the transaction decisions of buyers and sellers in e-commerce transactions. In order to verify the

Table 3. Evaluation on the transactions of a shop in taobao

Primary Indicator	Secondary Indicators	Higher	High	General	Lower	Low
Product Quality	Is the product genuine?	6	5	2	5	2
	Is the product intact?	11	6	1	1	1
	Product Packaging Satisfaction	10	5	2	1	2
Information Quality	Does the seller describe details?	14	2	1	3	0
	Description Consistency	9	3	5	2	1
Distribution Quality	Correct Shipment	16	3	1	0	0
	Delivery Speed	8	5	2	1	4
Service Quality	Service Attitude	10	4	3	1	2
	Timely Response	7	6	1	1	5
	After-sales Service	8	3	2	2	5

effectiveness and feasibility of the proposed two-way credit evaluation model and obtain accurate results, the simulation test method was used to determine the weight of the buyer's personal credit evaluation indicator system established by the expert method, which is shown in Table 4.

In order to verify the effectiveness of the buyer's personal credit evaluation system, the information of a customer was selected. The basic information is as follows: (1). Age: 34; (2). Gender: female; (3). Educational Level: Master's degree; (4). Nature of Work: enterprises and institutions; (5). Monthly Income: 5300 yuan; (6). City: Wuhan; (7). Bank Credit: good reputation in the bank. Based on the information in Table 1, $V = \left(1,1,0.9,0.8,1,0.6,1\right)$ can be obtained. The evaluation matrix is obtained as follows:

$$R' = \begin{bmatrix} 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.9 & 0 \\ 0 & 0.8 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0.6 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{bmatrix}$$

According to Table 4, the buyer's credit evaluation information was processed. The weight distribution matrix can be obtained:

$$w' = \left(0.1,0.1,0.2,0.15,0.2,0.1,0.15\right)$$

The personal credit score is:

$$B' = w' \circ R' = \left(0.25,0.18,0.3,0.18,0\right)$$

In addition, the cumulative credit value of each evaluation indicator was added to obtain the initial credit evaluation result of the buyer in the e-commerce transaction:

Table 4. Weight of buyer's personal credit rating indicator

Indicator	Weight	Explanation of Indicator Score
Age	0.1	The credit of the middle-aged is higher than that of the young and the old.
Gender	0.1	Women are generally more trustworthy than men.
Educational Level	0.2	The basic quality of the highly-educated group is generally high.
Nature of Work	0.15	The credibility of the nature of the work is relatively stable.
Monthly Income	0.2	The higher the income, the stronger the ability to pay.
City	0.1	The city credit environment is better, and the citizens are generally more honest.
Bank Credit	0.15	The higher the credit, the less the loan; the credit card is kept well.

$$T_{bo} = \sum_{i=1}^{n} b_i = 0.25 + 0.18 + 0.3 + 0.18 + 0 = 0.91$$

The seller's credit was evaluated from four aspects: product quality, information quality, distribution quality, and service quality. Based on the actual situation, the four evaluation indicators of the four sellers were refined and graded, and more detailed stimulation indicators were used to obtain accurate results to promote the smooth progress of e-commerce transactions. Based on the seller's credit evaluation indicator system in Table 2, the analytic hierarchy process was used to obtain the weight of each indicator, as shown in Table 5.

Based on the credit evaluation indicator in Table 2 and the weight of evaluation indicator in Table 5, the seller's credit was evaluated from four primary indicators: product quality, information quality, distribution quality, and service quality, as well as their subordinate secondary indicators. First, the four primary indicators were evaluated independently. Then, the fuzzy comprehensive evaluation was carried out for the overall credit.

Product Quality

Product quality includes three sub-indicators. According to Table 5, the secondary indicator weight of product quality is $w_1 = \{0.635, 0.346, 0.019\}$. Figure 4 shows a bar chart of the weight of product quality. This chart shows that whether the product is genuine or not is more important. Therefore, the sellers should pay more attention to this aspect.

According to Table 3, the fuzzy evaluation matrix of product quality can be obtained:

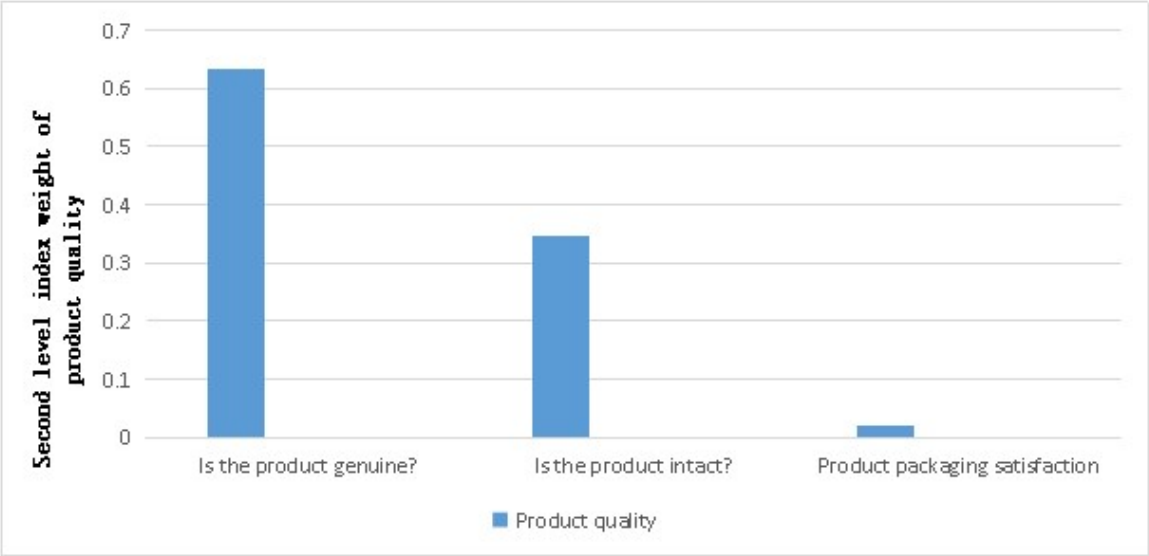
$$R_1 = \begin{bmatrix} 0.3 & 0.25 & 0.1 & 0.25 & 0.1 \\ 0.55 & 0.3 & 0.05 & 0.05 & 0.05 \\ 0.5 & 0.25 & 0.1 & 0.05 & 0.1 \end{bmatrix}$$

The result of the fuzzy comprehensive evaluation is:

Table 5. Weight of seller's credit indicator

Primary Indicator	Weight	Secondary Indicator	A_1	A_2	A_3	A_4	Weight
A_1	0.453	1	0.635				0.288
		2	0.346				0.157
		3	0.019				0.009
A_2	0.221	4		0.285			0.063
		5		0.715			0.158
A_3	0.094	6			0.689		0.065
		7			0.311		0.029
A_4	0.232	8				0.381	0.088
		9				0.279	0.065
		10				0.34	0.079

Figure 4. Chart of the weight of secondary indicators of product quality



$$B_1 = w_1 \circ R_1 = \left(0.39, 0.267, 0.083, 0.177, 0.083\right)$$

Information Quality

Information quality includes two sub-indicators. According to Table 5, the weight of the secondary indicators under the information quality is $w_2 = \left\{0.285, 0.715\right\}$. Figure 5 shows a histogram of the weight of information quality, indicating that sellers should be more careful in describing consistency.

According to Table 3, the fuzzy evaluation matrix of information quality can be obtained:

$$R_2 = \begin{bmatrix} 0.7 & 0.1 & 0.05 & 0.15 & 0 \\ 0.45 & 0.15 & 0.25 & 0.1 & 0.05 \end{bmatrix}$$

The result of the fuzzy comprehensive evaluation is:

$$B_2 = w_2 \circ R_2 = \left(0.521, 0.136, 0.193, 0.114, 0.036\right)$$

Distribution Quality

Distribution quality includes two sub-indicators. According to Table 5, the weight of the secondary indicator under the distribution quality is $w_3 = \left\{0.689, 0.311\right\}$. Figure 6 shows the bar chart of the weight of distribution quality, indicating that the seller should check again whether the product is ordered by the customer.

According to Table 3, the fuzzy evaluation matrix of distribution quality can be obtained:

$$R_3 = \begin{bmatrix} 0.8 & 0.15 & 0.05 & 0 & 0 \\ 0.4 & 0.25 & 0.1 & 0.05 & 0.2 \end{bmatrix}$$

Figure 5. Chart of the weight of secondary indicators of information quality

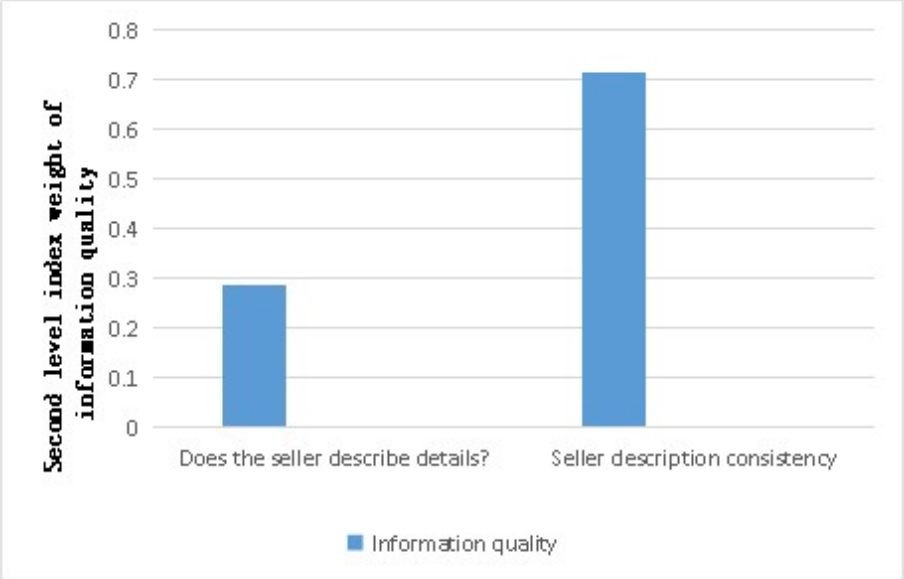


Figure 6. Chart of the weight of secondary indicators of distribution quality

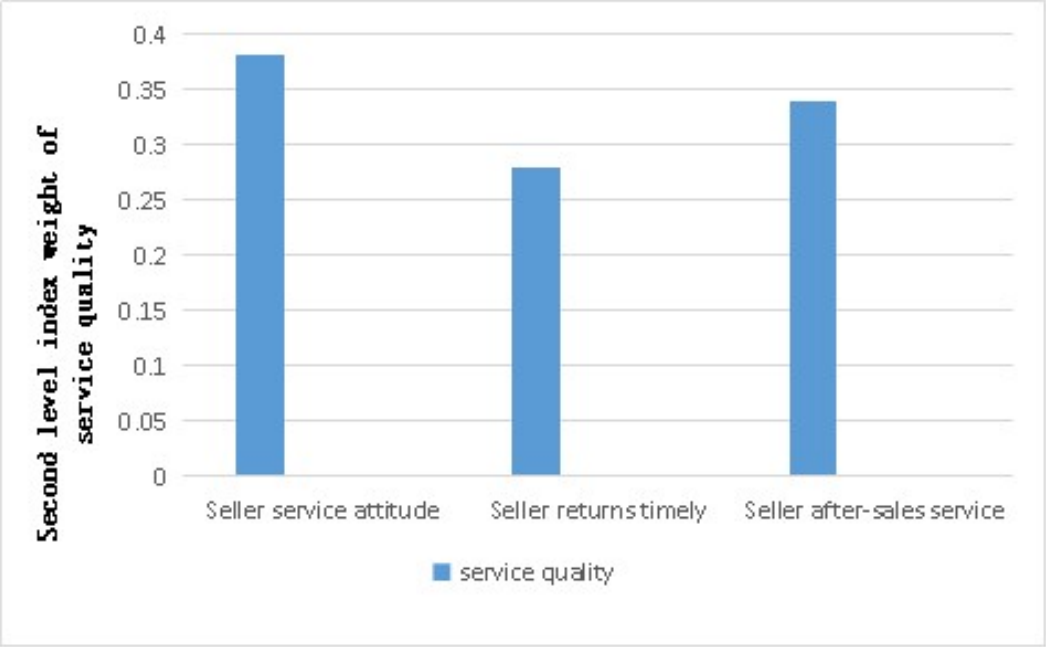
The result of the fuzzy comprehensive evaluation is:

$$B_3 = w_3 \circ R_3 = \left(0.676, 0.181, 0.06, 0.016, 0.062\right)$$

Service Quality

Service quality includes three sub-indicators. According to Table 5, the weight of the secondary indicators under the service quality is $w_4 = \left\{0.381, 0.279, 0.34\right\}$. Figure 7 is a bar chart of the weight

Figure 7. Chart of the weight of secondary indicators of service quality



of service quality, indicating that sellers should pay more attention to their own service attitude and after-sales service, and improve the service quality in the transaction process.

According to Table 3, the fuzzy evaluation matrix of service quality can be obtained:

$$R_4 = \begin{bmatrix} 0.5 & 0.2 & 0.15 & 0.05 & 0.1 \\ 0.35 & 0.3 & 0.05 & 0.05 & 0.25 \\ 0.4 & 0.15 & 0.1 & 0.1 & 0.25 \end{bmatrix}$$

The result of the fuzzy comprehensive evaluation is:

$$B_4 = w_4 \circ R_4 = \left(0.424, 0.211, 0.105, 0.067, 0.193\right)$$

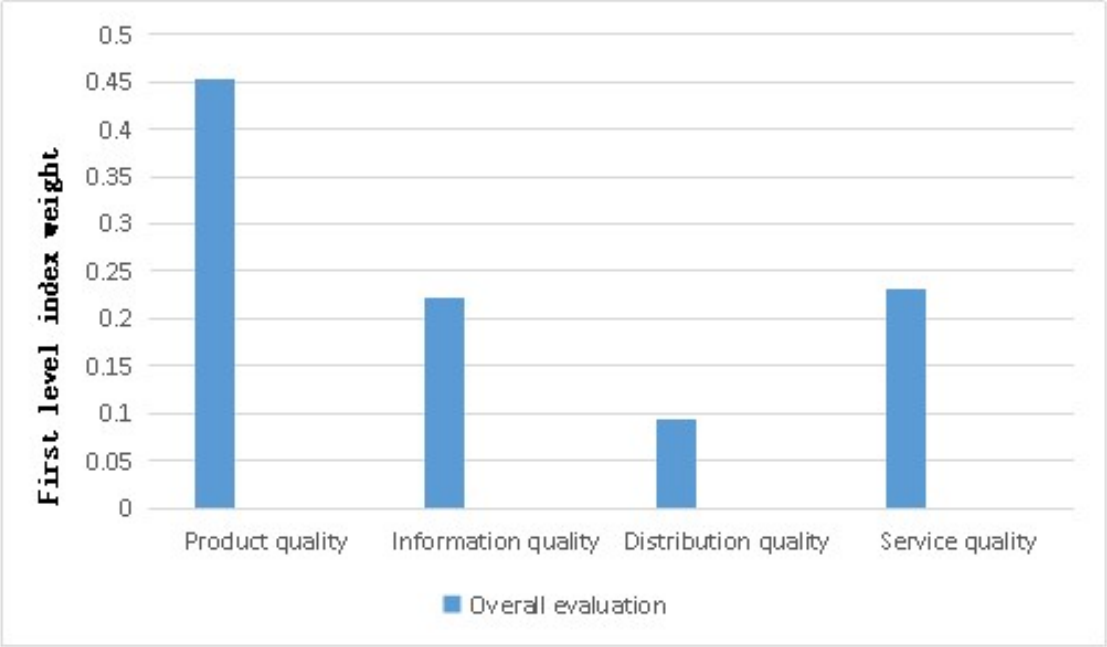
Seller's Overall Evaluation

According to Table 5, the weight of seller's primary indicator $w = \left\{0.453, 0.221, 0.094, 0.232\right\}$ can be obtained. The histogram of the weight of the primary indicator is drawn, as shown in Figure 8. The results show that the seller's product quality has the greatest impact on the business credit, followed by service quality, information quality, and distribution quality. Therefore, businesses should try their best to improve the product quality while ensuring the overall service quality.

According to the fuzzy distribution of each indicator level, the comprehensive evaluation matrix of merchant credit was obtained:

$$w = \left\{0.453, 0.221, 0.094, 0.232\right\}$$

Figure 8. Chart of the weight of primary indicators



$$R = \begin{bmatrix} 0.39 & 0.267 & 0.083 & 0.177 & 0.083 \\ 0.521 & 0.136 & 0.193 & 0.114 & 0.036 \\ 0.676 & 0.181 & 0.06 & 0.016 & 0.062 \\ 0.424 & 0.211 & 0.105 & 0.067 & 0.193 \end{bmatrix}$$

The result of the fuzzy comprehensive evaluation is:

$$B = w \circ R = \left(0.454, 0.217, 0.11, 0.122, 0.096\right)$$

In this paper, a five-point system, that is:

$$V = \left\{highest, higher, general, lower, lowest\right\} = \left\{5, 4, 3, 2, 1\right\}$$

is used, and the merchant credit evaluation value is:

$$Fs = \left(0.454, 0.217, 0.11, 0.122, 0.096\right)\left(5, 4, 3, 2, 1\right)^{T} = 3.808$$

According to the principle of maximum membership degree, if 0.454 is the maximum membership degree, then the consumer's credit evaluation of the store should be "high." By contrast, this paper gives the commercial credit evaluation value of 3.808, which is a more accurate evaluation of the seller's credit, so that the buyers can also get their indicator credit from the four primary indicators.

Therefore, the two-way credit evaluation model based on the C2C mode can be used to evaluate the credit of the buyers and sellers in the process of e-commerce transactions, improve the fairness of the transaction, and reduce possible risks.

DISCUSSION

In the e-commerce mode, credit evaluation is the basis for ensuring the integrity of transactions that can weaken the information asymmetry, shorten the space between buyers and sellers, and avoid malicious fraud in the virtual transaction. The proposed two-way credit evaluation model can be used to evaluate both transaction parties simultaneously so as to ensure the fairness and transparency of transactions. The results of a credit evaluation depend on the selection of the credit evaluation indicators. Based on the characteristics of e-commerce transactions and their characteristics in China's trading market, the credit evaluation systems of buyers and sellers were established, respectively. Finally, the fuzzy comprehensive evaluation algorithm was used to obtain the comprehensive evaluation results of credit.

According to the simulation of the two-way e-commerce credit evaluation model based on the C2C mode, the proposed model can evaluate the credit from multiple primary and secondary indicators of the buyer and the seller, obtain the complex internal correlation between them by applying the fuzzy mathematics theory, accurately evaluate the credit of the two parties under the influence of related factors, and improve the success rate of e-commerce transactions. Therefore, the two-way credit rating center can be employed to solve credit speculation and false transactions in e-commerce, and effectively reduce the credit risk of virtual transactions between buyers and sellers.

In the related studies, in order to reduce the uncertainties and transaction risks between buyers and sellers in e-commerce, the buyer's credit risk evaluation system, based on artificial intelligence technology, has been studied. In addition, 609 cases of Taobao sellers with 23 attribute categories were analyzed. It was found that the combination of decision tree and neural network can provide more accurate credit risk evaluation results, but they cannot solve the risk factors of buyers in e-commerce transactions. However, the type-2 trapezoidal fuzzy analytic hierarchy process has certain sensitivity and applicability to the ranking and evaluation results of credit rating, but it cannot provide a more accurate quantitative result (Guo et al., 2016). In this way, the proposed two-way e-commerce credit evaluation model, based on the C2C mode, evaluates credit from multiple perspectives of both transaction parties, obtains the fuzzy comprehensive evaluation results under different indicators by using fuzzy mathematics theory, and then obtains the overall credit evaluation results. Therefore, the proposed model can provide more practical credit evaluation data for both parties in e-commerce transactions so that buyers and sellers can make transaction decisions more in line with their own interests. Therefore, the relevant indicators of the two-way e-commerce credit evaluation center needs to be strengthened in future studies, so as to further improve the accuracy of credit evaluation and reduce the transaction risks as much as possible.

CONCLUSION

To cope with the increasing credit problems of credit speculation and false transactions in C2C, this paper proposed a two-way e-commerce credit evaluation model based on the C2C mode to ensure the security of both parties, and constructed a cross-platform two-way credit rating center with unified standards. Then, combined with the fuzzy comprehensive evaluation algorithm and the analytic hierarchy process, the credit rating of buyers and sellers was unified, and the evaluation results were unified in the cross-platform two-way credit rating center, thereby avoiding transaction credit problems and promoting Internet consumption. In the simulation analysis, this paper calculated the credit rating of both transaction parties, and proved that the proposed model is feasible. Compared with the traditional credit evaluation method, the proposed credit evaluation method can rate the credit of both transaction parties very well, and effectively reduce the credit risk in transactions.

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