

Study of Reputation Mechanism of Second-hand University Platform Based on E-sporas Model

Qi Liu, Zixuan Yang, Yafei Li, Xinru Qiao and Chao Wei

Abstract—Firstly, this paper makes a questionnaire analysis on the existing college students' second-hand market, uses the entropy weight TOPSIS model to sort the evaluation indexes, and determines the indexes with large weight. Secondly, combined with the questionnaire data, it is concluded that the buyer's reputation is the most important index. At the same time, the second-hand transaction behavior of college students is regarded as a transaction between buyers (C2C e-commerce). Finally, based on the Sporas model, the penalty factor is added to establish the E-Sporas model, improve the C2C e-commerce reputation evaluation model, and maintain the security of transactions.

Index Terms—Evaluation index system, reputation mechanisms, entropy-TOPSIS, second-hand transactions, consumer psychology

I. INTRODUCTION

WITH the advent and development of the industrial age, China's energy and environmental issues have attracted much attention. At present, there are 32.853 million college students in China, and college students are one of the main groups to improve the recycling rate of commodities. In order to thoroughly implement the "Thirteenth Five-Year Plan for Ecological Environment Protection" and promote college students to develop reasonable consumption habits and green consumption concept, it is urgent to develop a sound trading platform and measures to improve the ecological environment and second-hand goods trading market. Therefore, the establishment of college students second-hand trading platform has a very important practical significance. With the development of communication technology, the number of College Students' online communication and shopping increases, and most transactions are completed online. However, there will be a lot of dishonesty problems when second-hand transactions are carried out on the university campus. How to establish a reasonable evaluation model has become the research goal of

many scholars. Turuen described the development status of the second-hand market in major trading platforms, and analyzed people's consumption psychology when shopping ([4]). Chen et al used entropy weight method to calculate the weight of each index, and combined with principal component analysis to carry out feature engineering, and combined with analytic hierarchy process to construct evaluation indexes, and provided ideas to solve evaluation problems ([1]). Zhu, et al. studied the effectiveness of the entropy weight method evaluation ([7-8]). Zhang, et al analyzed the impact of China's urban transportation network on society, economy and ecology by using entropy weight TOPSIS method ([6]).

With the advent of the Internet era and the development of e-commerce, the number of people's consumption is gradually increasing, and the consumption caused by impulse is also gradually increasing, most of them are college students. However, the credibility problem in the process of second-hand trading has been perplexing them. More and more scholars are committed to the study of credit evaluation in C2C e-commerce ([20-22]). Leonard discussed the future development direction of C2C credit and described the natural propensity to trust (NPT), perception of website quality (PWSQ) and others' trust of buyer and sellers (OTBS) and third party recognition (TPR) would impact a person's trust ([3,5]). Zacharia provides a method of the reputation management through reputation mechanism, describes the Sporas model, and uses eBay data to evaluate the model. The reliability of reputation system is analyzed ([5]). Guo and Jiang added transaction volume and transaction times as penalty factors on the basis of sporas, improved the existing model and proposed E-Sporas model ([11-15]). Zacharia analyzed the transaction mechanism of online transactions, evaluated user credit by means of collaborative filtering, and simulated the Sporas model ([9-10]). You, et al. based on the original trust evaluation model, and the model is improved by considering factors such as consumers' purchase preference ([16-19]). Based on the original trust evaluation model, the model is improved by considering factors such as consumers' purchase preference. For any actual system, it will be disturbed by various factors in the normal operation process. It is necessary to optimize the system in combination with the current situation, so that the system can give different feedback for different environments. When the reputation system runs among college students, it will be affected by various consumer psychology. How to make a targeted response is very important. Ekstrom discusses the availability of the collected transaction reputation information, explains the relationship between users and raters, and gives a credit evaluation method ([2]). These reputation evaluation studies mainly focus on P2P and C2C platforms, but there is no

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targeted research on college students. On this basis, this paper analyzes the consumption psychology of college students, then finds out the problems existing in the campus trading platform, and improves the platform reputation system based on the E-Sporas model.

I. IMPROVEMENT OF PLATFORM EVALUATION INDEX AND CROWD EDUCATION

In order to analyze the consumption habits of different college students and their understanding of the second-hand market, this paper analyzes the questionnaire data from seven aspects, sorts the indicators by using entropy weight TOPSIS method, and obtains the aspects that the platform needs to be improved.

A. Analysis of reliability and validity of questionnaire

Reliability analysis of model data can test the consistency, stability, and reliability of the data. The commonly used test method is to observe Cronbach's Alpha. The value range of the reliability coefficient is [0,1]. The formula is:

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum S_i^2}{S^2} \right) \quad (1)$$

When the coefficient value is less than 0.6, the reliability is considered insufficient, when it is 0.7-0.8, it is considered to have considerable reliability, and when it is greater than 0.8, the reliability is very good. The reliability test results of this article are shown in Table I.

TABLE I
QUESTIONNAIRE RELIABILITY TEST

Cronbach α	Cronbach α based on standardized terms	Number of items
0.964	0.968	56

The result shows that the Cronbach α coefficient is greater than 0.9, indicating that the reliability test of the questionnaire has passed, and the data of this questionnaire survey has a high degree of reliability.

This paper uses KMO test and Bartlett's sphere test to analyze the validity of the questionnaire. The calculation formula of KMO value is:

$$KMO = \frac{\sum \sum_{i \neq j} r_{ij}^2}{\sum \sum_{i \neq j} r_{ij}^2 + \sum \sum_{i \neq j} \alpha_{ij}^2} \quad (2)$$

The questionnaire has structural validity only when the KMO test coefficient is greater than 0.5 and the P value is less than 0.05. The test results of this paper are shown in Table II.

TABLE II
QUESTIONNAIRE VALIDITY TEST

Testing method	Index	Index value
KMO inspection		0.961
	Approximate Chi-Square	24596.124
Bartlett sphericity test	df	1540
	P value	0.000

The results show that the value of KMO is 0.961, which is greater than 0.9, and the correlation is strong. The p-value is

0.000. The original hypothesis is rejected, and the alternative hypothesis is accepted. The questions are considered to be more relevant. Through the reliability and validity test of the questionnaire data, the results show that the questionnaire has high reliability and validity and can be used for subsequent research.

B. Questionnaire data analysis of second-hand platforms

Through the statistical analysis of the questionnaire data, the living expenses of college students, the purchase experience of second-hand items, and the understanding of second-hand items are obtained, and the following conclusions are drawn.

- 1) The living expenses of college students are generally low. The living expenses provided by parents are the main source of income for college students. The amount of living expenses determines their consumption level. The low living expenses may be one of the important factors in choosing the second-hand market. The preliminary survey results show that the amount of living expenses is concentrated between 500 yuan and 1500 yuan. Students with living expenses between 500 and 1000 yuan are the most, and the proportion is close to half. The proportion of students with living expenses between 1000 yuan and 1200 yuan is the same as that of students with living expenses above 1500 yuan, which is 17%.
- 2) There are many people who use the second-hand market. In the context of environmental protection, many college students have the concept of environmental protection, and second-hand items have a price advantage and become the choice of many college students when shopping. The results of the questionnaire show that more than half of college students have bought Second-hand goods, 86.4% of students have a high degree of understanding of the second-hand market, but there are still some students who have not participated in second-hand transactions, indicating that the second-hand market still needs to be promoted in the development process.
- 3) The types of transactions are concentrated in books and daily necessities. Due to the characteristics of college students, the types of trading items and trading locations are restricted. The results show that the transaction volume of books in the second-hand market is the largest. The main reason is that there are more courses in the student group. Part of the reason is the short use time of books. The transaction volume of life products is second. Due to impulsive consumption and graduation, many life items cannot be taken away, and trading on second-hand platforms has become the main processing method.
- 4) The prospects of second-hand platforms are good. Most second-hand items cannot be brought back upon graduation, so second-hand platforms have become the first choice for handling graduation items, and the prospects for development are promising. Questionnaire data shows that most students think that the second-hand market is very useful on campus. Only 3% of students are more inclined to buy new products, indicating that the second-hand market is recognized by the vast majority of students and there is a need for development.
- 5) The network has a wide range of information sources and

a large amount of data. In the process of trading, we will encounter problems such as false information, bad merchants, fake and shoddy products and so on. Platform users may cancel the transaction because they are worried about the reputation of business during the transaction. Improving the platform trading system, truly reflecting the business reputation and eliminating users' concerns has become one of the urgent problems to be solved by the platform.

- 6) At present, the entry threshold of most platform businesses is low, and the punishment for businesses to obtain benefits through bad means is relatively light, but the interests of users are greatly lost. On the threshold of merchants, the questionnaire results show that many users have problems such as poor product quality, difficult refund and replacement of goods. The platform shall further strengthen the user qualification review and formulate the return and exchange process to protect the interests of both parties.
- 7) The results of the questionnaire on the setting of information transparency show that the main problems are privacy protection, business information transparency and commodity information transparency. 85% of the students thought that the platform had better privacy protection and had not received harassment information. However, 80% of the students pointed out that the platform had the problem of opaque business information and commodity information, and could not get the real information of all aspects of commodities. Therefore, when improving the platform, we should pay more attention to whether the merchants' description of goods is comprehensive and accurate, so as to meet the requirements of customers and improve the number of users of the platform.

C. Analysis of disposal methods of second-hand goods

This survey set up a questionnaire to analyze the way college students deal with second-hand goods. The question is set with four options: sell, give, save and discard. The question is set as multiple-choice questions, and the respondents can choose multiple treatment methods at the same time. Through the analysis of the answer results of this question, the main treatment methods of each grade are obtained, which can be used as a basis to judge whether there is a market for second-hand platforms in this grade. The percentage of people who choose this option in the total number of people in this grade is shown in table III.

TABLE III
QUESTIONNAIRE DATA

Grade	Give to others	Preservation	Discard	Sell
Freshman	68.8%	58.4%	17.6%	76%
Sophomore	76.2%	60.4%	21.7%	84.2%
Junior	67.2%	64.3%	25.4%	71%
Senior	83.7%	54.6%	35.4%	85.1%

On the whole, the proportion of people who tend to sell second-hand products in all grades is the largest, indicating that the profit from selling second-hand products is more attractive. Secondly, the proportion of giving second-hand items to others is not small, which shows that the

phenomenon of giving each other is common in college interpersonal communication. According to the results of the questionnaire data, the second-hand platform has development prospects in all grades.

From the data of all grades, 85.1% of senior students tend to sell second-hand goods, indicating that the second-hand market has the most development potential in this group. The reason may be that they are about to graduate. Freshmen may not form a good consumption concept because they have just entered the campus, resulting in a large number of useless goods, and relatively more people choose to sell second-hand goods.

In the publicity process of the later stage of the platform, we should grasp the characteristics of senior students about to graduate, so that more graduation goods transactions can be carried out on the platform. At the same time, the platform should publicize the concept of environmental protection, improve the habit of discarding second-hand goods, and let more goods participate in recycling.

D. Construction of evaluation index system

In the design of the questionnaire, this paper divides the research objects into 8 groups according to different grades and gender, selects seven indicators such as item quality, portability, and safety to analyze the current situation of the platform, and can get the aspects that different groups pay most attention to.

When selecting the evaluation indicators of second-hand platforms, we select the following factors.

- 1) Quality of product. Product quality is an important indicator for predicting product life. When the product quality is high, customers will be the first choice, while low product quality will lead to poor user experience and low score.
- 2) Convenience of transaction. Complex transaction processes may lead to operational errors and losses. At the same time, it may also reduce users' patience and reduce the number of consumption. Simple transaction process will save transaction time and improve transaction efficiency.
- 3) Transaction security. Transaction fraud and false transactions emerge one after another, which seriously endangers the interests of consumers. At the same time, secure transaction is one of the most concerned aspects in the transaction process. The security of the transaction website will have a great impact on the reputation and sales of the website. Actively maintaining the security of the transaction can not only safeguard the interests of consumers, but also conducive to the long-term development of the platform.
- 4) Green environmental protection. With the deepening of people's awareness of environmental protection, in today's increasingly deteriorating environment, buying second-hand goods is more friendly to the environment and produces less pollution than buying new ones. At the same time, the price of second-hand goods is also relatively low. Driven by lower price and less pollution, people take second-hand goods as one of their choices.
- 5) Trading channels. Legitimate trading channels will make users feel good, and consumers are more inclined to trade on legitimate second-hand platforms. When the

platform has relatively more sales channels, it means that sellers have more opportunities to sell goods and buyers are more likely to buy the required goods. The legitimacy and quantity of trading channels have become the development direction of second-hand platforms in the future.

- 6) Credit rating. Credit rating refers to rating the merchant's credit according to the merchant's transaction feedback. When purchasing products, consumers can refer to the merchant's reference rating to determine whether to trade. A perfect trading reputation mechanism is conducive to improve the recognition of buyers to bad businesses, improve the transparency of commodity information and avoid fraudulent transactions.
- 7) Additional services. Some goods need regular maintenance to ensure that the products can be used normally. When purchasing goods, additional maintenance, warranty, and other terms can effectively attract consumers to buy.

The evaluation matrix 3 can be obtained by analyzing the evaluation of 7 indexes by 8 objects. The satisfaction options and dissatisfaction options of different groups of each indicator can be found in the matrix. The matrix is shown below.

$$X = \begin{pmatrix} 4.38 & 3.93 & 4.46 & 3.93 & 3.88 & 4.14 & 4.11 \\ 4.67 & 4.28 & 4.73 & 4.06 & 4.29 & 4.50 & 4.53 \\ 4.42 & 4.01 & 4.39 & 4.01 & 3.93 & 4.11 & 4.34 \\ 4.57 & 4.28 & 4.42 & 4.22 & 4.07 & 4.10 & 4.19 \\ 4.46 & 4.17 & 4.49 & 4.09 & 4.13 & 3.97 & 4.01 \\ 4.13 & 3.88 & 4.08 & 3.83 & 3.79 & 4.16 & 4.04 \\ 4.45 & 4.28 & 4.51 & 4.40 & 4.16 & 4.16 & 4.29 \\ 4.86 & 4.50 & 4.88 & 4.65 & 4.68 & 4.68 & 4.67 \end{pmatrix} \quad (3)$$

It can be seen from the matrix that the most satisfactory item X_{\max} and the least satisfactory item X_{\min} of different evaluation objects of each index. For example, product quality $X_{\max} = 4.86$, $X_{\min} = 4.13$. Convenience of transaction process $X_{\max} = 4.50$, $X_{\min} = 3.88$.

E. Using entropy weight method to determine index weight

After collecting the questionnaire, we need to analyze the data obtained from the questionnaire. In order to improve the availability of data, it is necessary to preprocess the data. In this paper, the methods of inverse number and minimum value are used for data consistency and dimensionless processing. Finally, the normalized matrix is obtained.

- 1) The data is processed uniformly, and the formula is as follows.

$$X' = X_{\max} - X_{ij} \quad (4)$$

- 2) Eliminate the difference of data between different dimensions and normalize the data. The formula is as follows.

$$b_{ij} = \frac{X'_{ij} - X'_{\min}}{X'_{\max} - X'_{\min}} \quad (5)$$

By processing the elements in the matrix, the processed matrix can be obtained. Each element of the processed matrix is in the same order of magnitude to eliminate the singular

sample data. The processed data is suitable for comparative analysis. When constructing the comprehensive evaluation index system, we need to highlight the local differences of each index and find the index most valued by college students, so as to improve the trading environment of the second-hand market. When determining the index weight, this paper uses the entropy weight method to calculate the characteristic proportion, then calculates and modifies the entropy value. Finally obtains the entropy weight of each index entropy value, and determines the weight of 7 evaluation indexes.

- 3) Calculate the characteristic proportion of each index. The calculation formula is as follows.

$$f_{ij} = \frac{1 + b_{ij}}{\sum_{i=1}^m (1 + b_{ij})} \quad (6)$$

- 4) Based on the calculated characteristic proportion, the entropy weight matrix is obtained, and the entropy value of each index is calculated by the formula. The entropy calculation formula is as follows.

$$M_j = \frac{-\left(\sum_{i=1}^m f_{ij} \ln f_{ij}\right)}{\ln m} \quad (7)$$

Entropy obtained by calculation:

$$M = (0.86 \quad 0.84 \quad 0.88 \quad 0.88 \quad 0.82 \quad 0.83 \quad 0.89 \quad 0.87)$$

- 5) In this paper, the entropy weight of the j -th index is modified, and the correction formula is as follows.

$$W_j = \frac{1 - M_j}{n - \sum_{j=1}^n M_j} \quad (8)$$

Among them, $0 \leq w_j \leq 1$ and $\sum_{i=1}^n w_j \leq 1$.

- 6) Determine the corrected weight coefficient. The calculation formula is as follows.

$$W = (w_j)_{1n} \quad (9)$$

After calculation, the weight of each index is:

$$W = (0.14 \quad 0.18 \quad 0.12 \quad 0.12 \quad 0.13 \quad 0.15 \quad 0.13)$$

By calculating the weight of each index, it can be concluded that the construction of the reputation system of the second-hand trading platform is the most important.

F. Establishment and solution of comprehensive evaluation model based on TOPSIS method

In this paper, TOPSIS method is used to determine the ideal point, select the ideal matrix, and calculate the proximity of the optimal value of entropy weight of each object. Finally, 8 groups of people are ranked according to their understanding of the second-hand platform.

- 1) Evaluation matrix weighting processing. The weighting formula is as follows.

$$C = [b_{ij}]_{mn} \times [W_j]_{1 \times n} = [c_{ij}]_{mn} \quad (10)$$

The weighted normative evaluation matrix can be calculated by using the formula, as shown below.

$$C = \begin{pmatrix} 0.04 & 0.01 & 0.06 & 0.02 & 0.02 & 0.12 & 0.01 \\ 0.11 & 0.02 & 0.11 & 0.12 & 0.08 & 0.04 & 0.10 \\ 0.05 & 0.06 & 0.05 & 0.03 & 0.02 & 0.15 & 0.02 \\ 0.08 & 0.11 & 0.56 & 0.06 & 0.04 & 0.11 & 0.06 \\ 0.06 & 0.08 & 0.01 & 0.04 & 0.06 & 0.12 & 0.03 \\ 0.00 & 0.00 & 0.00 & 0.00 & 0.00 & 0.15 & 0.00 \\ 0.06 & 0.12 & 0.01 & 0.00 & 0.81 & 0.10 & 0.53 \\ 0.15 & 0.18 & 0.13 & 0.12 & 0.13 & 0.00 & 0.13 \end{pmatrix} \quad (11)$$

2) Calculate the optimal proximity. Before calculating the optimal proximity, determine the ideal point by selecting the optimal index value of each row in C as P^* , $P^* = c_{ij}^*$, and c_{ij}^* is the optimal index of each column in the system. Select the ideal matrix as shown below.

$$P^* = (0.15 \quad 0.18 \quad 0.12 \quad 0.13 \quad 0.13 \quad 0.15 \quad 0.13)$$

Use formula 12 to calculate the optimal proximity of the index value. When T_i is small, it shows that the scheme is better, and $0 < T_i < 1$.

$$T_i = 1 - \frac{\sum_{j=1}^n c_{ij} P_j^*}{\sum_{j=1}^n (P_j^*)^2} \quad (12)$$

Using this formula, the optimal proximity of 8 groups of people to the understanding of campus second-hand platform is calculated as follows.

$$T_i = (0.94 \quad 0.86 \quad 0.96 \quad 0.95 \quad 0.95 \quad 0.85 \quad 0.95 \quad 0.70)$$

According to the entropy weight TOPSIS principle, if the comprehensive index is large, it is closer to the ideal solution, and the effect is better. Therefore, this paper ranks eight categories of college students according to their understanding of second-hand trading platforms. The ranking results are shown in table IV.

TABLE IV
INDEX RANKING OF 8 GROUPS

Object of investigation	Index value	Ranking	Object of investigation	Index value	Ranking
Sophomore boys	0.957	1	Sophomore girls	0.946	5
Senior boys	0.952	2	Freshman girls	0.856	6
Junior boys	0.949	3	Junior girls	0.849	7
Freshman boys	0.948	4	Senior girls	0.702	8

The ranking results show that sophomore boys and senior boys occupy the top two places, while senior girls and junior girls occupy the bottom two places. The underlying reason may be that boys have lower requirements for goods than girls, and boys buy goods less often, so these people are more satisfied with the second-hand platform in the school. Girls will consider more factors when buying goods, and the more girls buy, the more they evaluate, which can better reflect the shortcomings of second-hand platforms. Therefore, it is necessary to improve the second-hand platform according to the evaluation of specific groups.

II. INDEX SYSTEM OF TRUST EVALUATION FOR SCHOOL C2C ECOMMERCE

The data analysis results of the questionnaire show that the seller's reputation is the most important indicator in the transaction. With the rapid development of second-hand e-commerce on campus, mainly through the Internet. Therefore, the reputation mechanism of campus second-hand platform can be regarded as the research on the reputation mechanism of C2C e-commerce. By analyzing the advantages and disadvantages of the Sporas model, the E-Sporas model is introduced, and the time factor is added to improve it. By setting the time attenuation function, the reputation mechanism of the second-hand platform is further improved.

A. Basic concepts of Sporas model

In order to improve the environment of e-commerce, Zacharia and other scholars improved the cumulative reputation evaluation mechanism of eBay, considered the recent reputation value of members and the reputation value of scoring members, and proposed the Sporas model, which is a reputation evaluation model based on statistics.

In the design of Sporas model, the factors such as the reputation value of evaluators and the recent reputation value of members are considered to reduce the evaluation weight of evaluators with low reputation value, which is in line with the actual transaction situation. Secondly, the buyer's reputation value is the lowest when entering the platform for the first time. In order to prevent the seller from repeatedly registering and reduce the occurrence of fraud against the buyer. Finally, in order to prevent some sellers from rapidly increasing their reputation value by some means, the damping function is therefore used to slow down the abnormal growth. The formula of reputation value calculated by Sporas model is as follows:

$$R_i = R_{i-1} + \frac{1}{\theta} \varphi(R_{i-1}) R_i^{other} (W_i - E_i) \quad (13)$$

$$\varphi \cdot (R_{i-1}) = 1 - \frac{1}{1 + e^{\frac{-(R_{i-1}-M)}{\sigma}}} \quad (14)$$

$$E_i = R_{i-1} / M \quad (15)$$

In the formula, R_i is the total reputation value of the buyer to phase i , R_{i-1} is the total reputation value of the buyer to phase $i-1$, R_i^{other} is the total reputation value of the buyer to phase i , φ is the damping coefficient, W_i is the evaluation of the buyer to the seller to phase i , ($0 \leq W_i \leq 1$), and M is the maximum reputation value.

Sporas model improves eBay's cumulative reputation model and increases the impact of the evaluator's reputation on Seller's reputation. It effectively prevents vicious competition and has a certain effect on the improvement of accumulation model. However, Sporas model does not consider the impact of transaction amount, evaluation time, transaction times and other factors, which is easy to cause businesses to take advantage of vulnerabilities to increase reputation scores and then commit fraud. Therefore, the E-Sporas model considers the transaction value and other

factors on this basis, but does not consider the evaluation time. Based on the E-Spoors model, this paper considers the evaluation time to further improve the model.

B. E-Sporas model and its basic theory of improved model

Because Sporas model does not consider the impact of transaction value, transaction times and other factors, some sellers can still commit fraud. On this basis, the E-Sporas model considers the impact of transaction times, fraud penalty factor, transaction amount, evaluator's reputation and other factors, and provides a more real and reliable reputation scoring mechanism.

- 1) This model weighs the credibility of evaluation. When the credibility of evaluators is high, the credibility of evaluation will be improved.
- 2) This model considers the impact of the value of traded goods. In case of fraud, the transaction loss of high-value goods is large. Therefore, in order to avoid merchants from cheating on high-value goods transactions after using low-price products to boost their reputation value, the larger the transaction amount, the more accurate the score is set in this model.
- 3) According to the characteristics of low-speed rise and high-speed decline of reputation value, this model sets the fraud penalty factor. When there is fraud in the transaction, the reputation value is reduced by the penalty factor. When there is no fraud, the penalty factor is invalid.
- 4) In order to solve the phenomenon of using more transaction times to cover up fraud, this model considers the impact of transaction times and increases the cost of cheating.

By adding the factors that influence the reputation value and adding the penalty factor, this model makes the reputation value obtained by this model more real and reliable. The formula of the model is as follows.

$$R_i(x) = R_{i-1}(x) + \frac{1}{\theta} (R_{i-1}) \left[\frac{\sum_{i \in I(x)} [M(x, a) - E_i] R_{i-1}(a) V(x, a)}{|I(x)|} \right] + (x) \frac{R_{i-1}(x)}{1 + e^{-n}}$$

$$(2 \leq \theta, n \leq |I(x)|)$$

$$\varphi \cdot R_{i-1} = 1 - \frac{1}{1 + e^{-\frac{-(R_{i-1}-D)}{\sigma}}}$$

$$E_i = R_{i-1}(x) / D$$

$$\varphi(x) = \begin{cases} -1 & \text{(Fraud occurred)} \\ 0 & \text{(No fraud occurred)} \end{cases}$$

In the formula, $R_i(x)$ represents the reputation value of member x in the i -th period. θ represents the adjustment parameter. $R(a)$ represents the reputation value of trading partner a of member x , E_i represents the expected value of scoring in the i -th period, and D represents the set maximum expected value.

The E-Sporas model is improved on the basis of the original model to improve the credibility of reputation value, but it does not consider that the credibility of evaluation will be affected by time factors. Therefore, this paper adds time

factors on the basis of E-Sporas to further improve the reputation evaluation system.

Since the seller's reputation value will change according to the buyer's evaluation results after each transaction, the reputation value will fluctuate. In the actual trading process, people tend to pay more attention to the latest comments and ignore the past comments, that is, with the increase of evaluation time, the weight of evaluation will decrease. This pattern is also consistent with human memory patterns. By increasing the time decline function, the recent evaluation has a great impact on the seller's reputation score, so that the seller can improve the reputation value and change the impression of low reputation value by maintaining honest trading for a long time. The model after adding the time decreasing function is as follows.

$$R_i(x) = \sum_{i=1}^i e^{-\frac{\Delta i}{\omega}} R(i)$$

$$R(x) = \frac{1}{\theta} (R_{i-1}) \left[\frac{\sum_{i \in I(x)} [M(x, a) - E_i] R_{i-1}(a) V(x, a)}{|I(x)|} \right] + \varphi(x) \frac{R_{i-1}(x)}{1 + e^{-n}}$$

$$(2 \leq \theta, n \leq |I(x)|)$$

$$\varphi \cdot R_{i-1} = 1 - \frac{1}{1 + e^{-\frac{-(R_{i-1}-D)}{\sigma}}}$$

$$E_i = R_{i-1}(x) / D$$

$$\varphi(x) = \begin{cases} -1 & \text{(Fraud occurred)} \\ 0 & \text{(No fraud occurred)} \end{cases}$$

Based on the original model, the time function $e^{-\frac{\Delta i}{\omega}}$ is set, Δi represents the evaluation time interval, and ω is the attenuation degree of the function. $R(i)$ represents the reputation value obtained by the seller in phase i transaction.

Using this model, sellers with high reputation score and sellers with low reputation score can be encouraged at the same time. Sellers with high reputation score need to continue good faith transactions to maintain their reputation value. Sellers with low reputation score can reduce the impact of past scores on the present through good faith transactions and improve their reputation score. By optimizing on the basis of the original model, the factors considered in this model are more comprehensive and more in line with the real transaction situation.

III. ILLUSTRATIVE EXAMPLE

In the survey of College Students' consumer groups, this paper collects some data from the existing campus second-hand trading platform. The data includes transaction amount, transaction time, transaction quantity, transaction method and other information. Through the simulation of the data, the credit values of merchants before and after the improvement of the model are obtained, which verifies the reliability of the model. Some transaction data are shown in table V.

TABLE V
TRANSACTION DATA

Buyer	Score	Quantity	Transaction	Time	Credit	Transaction
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			amount	score	mode	
Yang	1	2	20	7days	5	on-line
Liu	3	3	60	7days	7	on-line
Zhao	2	5	100	5days	6	on-line
Sun	2	1	15	5days	5	on-line
Zhang	3	3	150	3days	6	off-line
Wang	0	1	30	1day	5	on-line
Lee	1	1	40	1day	7	on-line

When the score of this transaction is 0, it means that the seller has committed fraud in the process of transaction. The parameter ω for determining the time influence factor of the model is 49.5. Suppose the time weight of the last evaluation is 0.98. The time cycle of the reputation system is 1 day $\Delta i = 1$. The reputation evaluation of the merchant is calculated once a day, which will fluctuate. In the model, the parameter θ is set to 2.5 and the damping function σ is set to 0.1. In the reputation evaluation system, the user's maximum reputation value is set to 100. Time represents the time from the last evaluation to the present, in days.

Different transaction amounts have different weights in evaluation. The weight of transaction amount less than 100 is 0.3, the weight of transaction amount greater than 100 but less than 200 is 0.5, the weight of transaction amount greater than 200 but less than 500 is 0.8, and the weight of transaction amount greater than 500 is 1.

According to the calculation method of the Sporas model, the merchant's reputation value is 2. According to the calculation method of the E-sporas model considering the penalty factor and other factors, the merchant's reputation value is 1.7. According to the improved E-sporas model, considering the time factor, the merchant's reputation value is 1.5. It can be seen that the merchant's fraud after introducing the penalty factor will reduce its reputation score and have a warning effect. After introducing the time factor, considering that the evaluation weight will decay with the evaluation time, and the merchant's reputation value will decrease again, it can be seen that the improved model can better reflect the merchant's real reputation, and the result is true and reliable.

IV. CONCLUSIONS

By analyzing the questionnaire and using the entropy weight TOPSIS method, this paper obtains the understanding of Chinese college students on the second-hand platform and the urgent problems to be solved in the second-hand market. It is concluded that transaction reputation is an important index. By introducing C2C E-commerce reputation evaluation model, time factor is added to improve the E-Sporas model, and the superiority of the model is verified by simulation of actual transaction data. This model can be used to calculate the reputation score of the seller, facilitate the transaction matching between the buyer and it, and reduce the occurrence of transaction fraud.

Although the original cumulative evaluation model is relatively simple and easy to use, there are many situations that are not considered in the evaluation, and the evaluation method is single, subjective and prone to reputation fraud.

This model is used to evaluate the reputation of e-commerce website users. Considering the impact of transaction amount, transaction times, transaction volume and other factors on the reputation value, the result is relatively objective and reliable. Compared with the cumulative model, this model has three main advantages.

- 1) The model considers the dynamic characteristics of trust. In the actual transaction process, the more recent transactions can accurately reflect the real credit level of businesses. The introduction of time factor into the model can well describe the dynamic characteristics of credit and reduce the impact of past evaluation on the current credit value.
- 2) The trading website uses this model to calculate the reputation value, which can improve the situation that bad merchants use the original accumulated reputation value to mislead consumers to trade, and supervise the trading behavior of merchants. Setting the time factor also gives businesses with reputation problems a chance to change. Businesses with much lower reputation value in the past can improve their reputation value and reduce the impact of low reputation value in the past by maintaining honest transactions.
- 3) By using this model, consumers can give a more objective reputation value, and improve the transaction information asymmetry by referring to the seller's reputation value before the transaction. At the same time, the platform can have a better reputation and increase the number of potential users.

In the actual transaction process, it is obviously insufficient to evaluate the merchants only through the reputation system. In order to further improve the reputation system and enhance the trust of buyers, relevant departments should also formulate laws and regulations and improve the transaction system. The platform should set a stricter threshold, which can ensure the transaction order of the market and make the campus second-hand platform develop healthily, faster and longer.

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