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Research on Decision Tree-Based Risk Control Strategies in E-Commerce Platforms

Meng Shi[1,✉], Jing Wu[1], Yue Peng[2]

[1] *Department of Economic Management, Changzhi Vocational and Technical College, Changzhi, Shanxi, 046000, China*

[2] *Financial Management, University of Hong Kong, Hong Kong, 999077, China*

ABSTRACT

In this paper, the weights of different risks in the management process of e-commerce platforms are calculated on the basis of hierarchical analysis. After that, with the help of fuzzy comprehensive assessment algorithm, the risk level is divided. Finally, with the assistance of decision tree, simulation is carried out to simulate the risk of the first-level indicators affecting the risk control of e-commerce platform. According to the survey results, reasonable countermeasures are given to the management of e-commerce platform risks. Among the first-level indicators of the five major risk categories, the business model risk belongs to the high-risk category of Class I, with a fuzzy comprehensive evaluation score of >4.5. The rest belong to the risk category of Class II, with fuzzy comprehensive evaluation scores ranging from 3.5 to 4.5. Among the Level II indicators, there are 6, 6 and 3 Level II indicators rated as high risk category, medium risk and low risk respectively, with their fuzzy composite scores ranging from 4.7495-5.6370, 3.6807-4.4988 and 3.1356-3.2435 respectively Between. In the comprehensive risk simulation prediction of the case-based e-commerce platform, only the logistics model risk belongs to the medium risk control strategy with a risk value of 4.8614 (day 60). The simulation results for the remaining four risk types were all low risk, and their risk values decreased (3.5 points) when the simulation time was day 60. The experimental results provide a prediction for the change of risk and provide reasonable countermeasures and suggestions for the risk control of e-commerce platforms.

Keywords: Hierarchical Analysis, Decision Tree, Fuzzy Comprehensive Assessment, E-commerce; Risk Control

1. Introduction

Risk management and control of e-commerce platforms are crucial to the success and development of enterprises. With the vigorous development of e-commerce, e-commerce platforms are facing increasing risks, such as data leakage, cyber-attacks, and transaction disputes. If enterprises do not pay attention to risk management and take corresponding measures to control, their business

✉ Corresponding author.
E-mail address: slb804@163.com (M. Shi).

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activities may be seriously affected or even face closure [1-4]. On the one hand, the rapid development and change of new technologies make the risk pattern change constantly, and enterprises need to follow up and update the risk management measures [5-6]. On the other hand, the technical means of malicious attackers are also advancing, the source of risk is more diversified and hidden, enterprises need to improve the risk prevention ability with the times. The use of decision trees for risk control in the field of e-commerce can effectively improve the security of e-commerce platforms [7-10].

Decision tree is a tree-structured model that simulates the human decision-making process, it models decisions in the form of nodes, branches and leaf nodes. Decision tree is a very common machine learning algorithm, in risk management and control, decision tree can be used for network security, help enterprises to prevent network attacks, identify network threats [11-14]. Enterprises can construct decision trees through network traffic, file attributes, user behaviour and other information, according to different features to determine whether there are abnormal behaviours and attack threats, which is of great significance for the risk control of e-commerce platforms [15-17].

Literature [18] created a network payment security assessment algorithm system, which can effectively assess the security of the network payment system and early warning of potential network threats, and changed the traditional network security management mode to achieve the security and stability of the network payment system. Literature [19] describes the characteristics of decision trees in detail and emphasises the importance of predicting customer credit risk in the era of big data. Customer credit risk on e-commerce platforms is discussed, and decision trees are constructed to assess customer credit rating decisions to maximise revenue. Literature [20] indicated that e-commerce enterprises play an important role in preventing information security risks, introduced the form and process of information security risk assessment, and analysed technical measures such as network encryption, information protection technology, and digital technology. Literature [21] provided a risk management framework to facilitate e-commerce platform enterprises to identify risks, and stood for the enterprise's point of view to identify the comprehensive risks of e-commerce platforms using fuzzy quality function deployment. Its findings show that the biggest problem of e-commerce is operational integration weaknesses, which can lead to a number of problems such as unreasonable response times. Literature [22] discusses the characteristics, problems and improvement strategies of risk management of cross-border e-commerce platforms. Many optimisation measures such as strengthening compliance and risk management, improving payment and currency exchange systems are proposed for the stable and secure operation of cross-border e-commerce platforms. Literature [23] explored the interaction between online retailers' financing strategies and e-commerce platforms' channel sales co-operation contracts, and concluded from the observation that the preferences of both parties were influenced by the retailers' working capital levels. Literature [24] points out that data from e-commerce communication is currently vulnerable to attacks, which poses a significant threat to data security. Therefore, the challenges of e-commerce information security are analysed based on the IoT data analytics platform in order to improve the security of e-commerce. Literature [25] launched the evaluation of biosecurity risk of agricultural supply chain management in e-commerce environment, proposed the indicators of multi-dimensional risk evaluation, and analysed the loss and contagion aspects of risk. The results of the study showed that the transport and storage techniques, additive misuse, etc. of agricultural products exhibited high risks.

In this paper, through the construction of risk evaluation system and risk causality analysis of decision management in e-commerce platform, using hierarchical analysis method with fuzzy comprehensive evaluation, we get the risk weights and risk levels of all levels affecting the operation of e-commerce platform, and use the decision tree algorithm to do the simulation prediction of the risk in the control of e-commerce platform, and finally combined with the experimental results, we carry out the risk of the e-commerce platform beforehand. Early Warning. At the same time, the risk changes within each time point are also simulated. Countermeasures and suggestions for risk management of e-commerce platforms are proposed through the analysis of the model and cases.

2. Comprehensive assessment model of e-commerce platform operation risk

2.1. Comprehensive determination of risk control on e-commerce platforms

2.1.1. Determination of integrated assessment parameters:

1) Risk level parameters. Risk control of e-commerce platform operation is a systematic and strong management work, which must not only take into account the possible security risks in the flow of goods and their processing and trade, but also comprehensively consider the sensitivity of the risks as well as the current status of the control and management of the relevant risks, and many other factors that are difficult to accurately quantify. However, the management process must be simple and clear in order to facilitate accurate and effective implementation. Therefore, in combination with the practical needs of work, from the operational considerations, different security risks can be divided into three degrees, and accordingly determine the three levels of risk control strategy. The three-level risk control strategies are: Ⅰ, Ⅱ and Ⅲ represent high-risk control strategy, medium-risk control strategy and low-risk control strategy respectively, and their weights are >4.5, 3.5-4.5, and <3.5. These strategies can be formulated and continuously adjusted by the risk managers according to the actual situation.

2) Comprehensive Security Risk Assessment Parameters. Based on the above analysis of the composition of security risks and the interrelationships among factors in the operation of e-commerce platforms, it can be seen that when assessing the security risks of specific items in specific products destined for specific target markets from the perspective of an enterprise, only the management risks need to be considered. When, from the perspective of the government regulator, an assessment of the safety risk of a particular item in a particular product of a particular enterprise to a particular target market is considered, only the control risk needs to be taken into account. In this way, the parameters applicable to the assessment of risk in the operation of an e-commerce platform can be determined as follows: the parameter symbols A, B and C represent the inherent risk of a specific item in a product, the control risk or management risk, and the trade risk, respectively.

2.1.2. Integrated assessment of the risk judgement tree. The risk determination tree is shown in Fig. 1. The risk determination tree is a qualitative analysis method, which serves to transform the abstract risk determination logic into a tree structure so as to facilitate the operation of specific executives, so that different risk determination rules will produce different determination trees. Based on the current e-commerce platform security risk determination rules, the following indicative risk determination tree can be given for the two key factors A and C mentioned above. The decision questions for inherent risk A are shown in Table 1. The risk determination tree can assist the risk assessor to give a standardised risk determination for the key factors according to the established risk determination rules, and provide reference information for the subsequent quantitative analysis.

Table 1. The decision issue for the inherent risk A

Problem symbol	Question
AQ1	Is there a risk in product formation, storage, and transportation?
AQ2	Is monitoring the risk?
AQ3	Does the sampling amount of the monitoring satisfy the requirements for reasonable judgment (⩾10)?
AQ4	Is the distribution of sampling reasonable in time and space?
AQ5	Is there a check?

AQ6	Whether the mismatch rate is beyond acceptable levels (⩽10%)

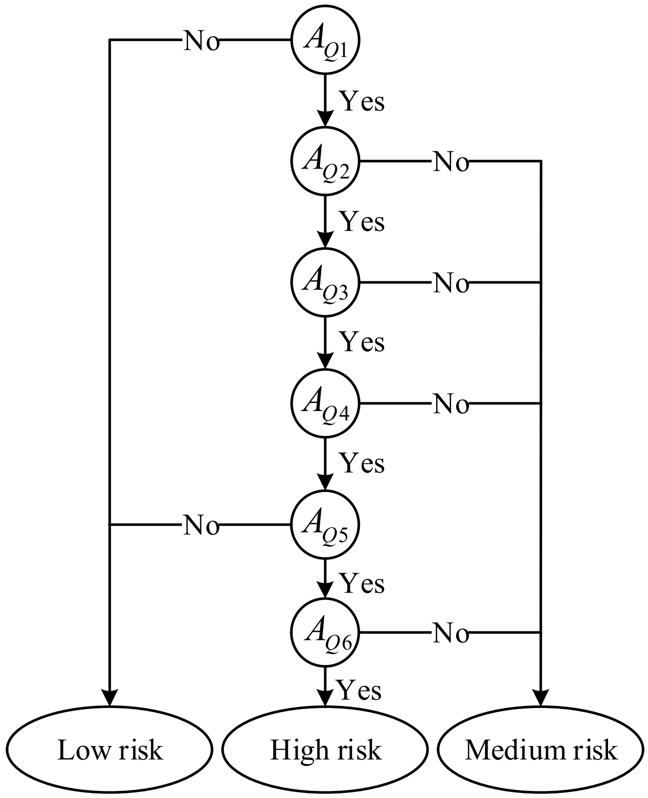

Fig. 1. Risk decision tree for factor A

2.1.3. Hierarchical analysis-based risk assessment model construction:

1) Constructing the hierarchical structure model. Based on the various types of parameters defined above for the comprehensive risk of e-commerce platform security, we can build a hierarchical model [26-27] assessment system based on the three criteria of A, B, and C. The hierarchical model is shown in Figure 2. The hierarchical model is formed by determining which security risk control strategy to choose among the three strategies I, II and III through the assessment and decision-making process.

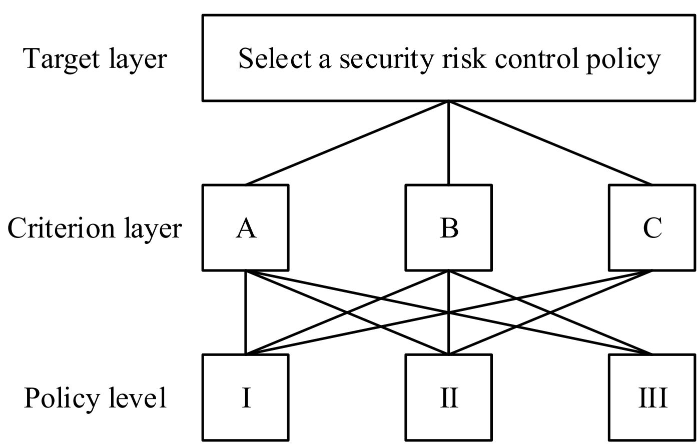

Fig. 2. Hierarchical structure model

2) Constructing the positive inverse matrix for each level. A third-order pairwise comparison matrix can be constructed for the criterion level and the strategy level, respectively, on the basis of the pre-determined intensity values of each factor (scale 1 to 9):

$$A=(a_{ij})_{3\times 3}=\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}, \text{And } a_{ij}=\frac{1}{a_{ji}}, \text{And} a_{ij}>0 \tag{1}$$

Assign intensity values to A, B, and C (or I, II, and III), respectively:

A(or I) = R_1, B(or II) = R_2, C(or III) = R_3.

Then the matrix is obtained:

$$A=\begin{bmatrix} 1 & \frac{R_1}{R_2} & \frac{R_1}{R_3} \\ \frac{R_2}{R_1} & 1 & \frac{R_2}{R_3} \\ \frac{R_3}{R_1} & \frac{R_3}{R_2} & 1 \end{bmatrix} \tag{2}$$

Since this matrix conforms to $a_{ik}\times a_{jk}=a_{ij}$ and is a consistent array, the consistency test can be omitted in practical applications. It should be noted that:

(1) The pre-agreed intensity values of each factor can be naturally formed into a positive inverse matrix [28-29] in practical use, thus omitting the calculation process of the consistency test, simplifying the assessment process without affecting the actual risk assessment and making the assessment model easier to understand and use in practice;

(2) The advantage of adopting the scale of 1~9 is that the intensity can be naturally agreed to be divided into three levels, with 1~3 denoting low intensity, 4~6 denoting medium intensity, and 7~9 denoting high intensity, thus enabling the operator to determine the intensity level before taking the value in the corresponding level, which can better reduce the arbitrariness of the human being when taking the value in a subjective manner.

After constructing according to the above requirements, a total of four third-order positive inverse matrices are obtained, one of which is the criterion level matrix (A) and three strategy level matrices (B_1, B_2, B_3).

(3) Hierarchical single sorting. Calculate the eigenvectors of the 4 matrices separately:

$$\begin{aligned} A_w &= \{a_1, a_2, a_3\} \\ B_{1w} &= \{b_{11}, b_{12}, b_{13}\} \\ B_{2w} &= \{b_{21}, b_{22}, b_{23}\} \\ B_{3w} &= \{b_{31}, b_{32}, b_{33}\} \end{aligned} \tag{3}$$

(4) Total hierarchical ranking. Using the resulting feature vectors of each layer, the total weight value of the strategy layer on the target layer is found:

$$\begin{aligned} b_1 &= \sum_{j=1}^{3}(a_j b_{1j}) \\ b_2 &= \sum_{j=1}^{3}(a_j b_{2j}) \\ b_3 &= \sum_{j=1}^{3}(a_j b_{3j}) \end{aligned} \tag{4}$$

2.2. Decision tree-based risk prediction and control

2.2.1. Decision tree algorithm. A decision tree [30-31] is a hierarchical structure consisting of nodes and inquired edges and generally contains three types of nodes:
1) Root node: no incoming edges but zero or more outgoing edges.
2) Internal nodes: have exactly one incoming edge and two or more outgoing edges.
3) Leaf node or end node: exactly one incoming edge and no outgoing edges.

Starting from the root node of the tree, the test conditions are used to examine the records, and an appropriate branch is selected based on the test results. Reach another internal node along this branch, using the new test condition, or reach a leaf node. Upon reaching a leaf node, the name of the class item mostly represented by the leaf node is assigned to that test record.

The Hunt algorithm is then used, which is the basis for many decision tree algorithms, including ID3, C4.5, and CART.In the Hunt algorithm, a decision tree is built recursively by successively dividing the training records into purer subsets. Let D_t be the set of training records associated with node t and $y=\{y_1,y_2,\dots,y_n\}$ be the class label, the recursion of Hunt algorithm is defined as follows:
1) If all records in D_t belong to the same class y_t, then t is a leaf node, labelled with y_t.
2) If D_t contains records belonging to more than one class, select an attribute test condition that divides the records into smaller subsets. For each output of the test condition, create a word node and distribute the records in D_t into sub-nodes based on the test results. The algorithm is then used recursively for each sub-node.

2.2.2. Decision Tree-Based Risk Control for E-Commerce Platforms. There can be two types of variables in a decision tree:
1) Numeric: The variable type is an integer or floating-point number, such as "cash" in the previous model. Use ">=", ">", "<", or "<=" as the segmentation conditions (after sorting, the time complexity of the segmentation algorithm can be optimized by using the existing segmentation cases).
2) Nominal: Similar to the enumeration type in a programming language, variables can only be selected from a limited number of options, such as the "external environmental state" in the previous example, which can only be "good", "bad" or "intermediate". Use "=" to split.

The basic steps for building a decision tree are as follows:
(1) Beginning, all records are regarded as one node
(2) Iterate through each variable of each split, find the best split point
(3) Split into two nodes t_1 and t_2
(4) For t_1 and t_2 respectively, continue to perform steps 2-3, until each node is sufficiently pure

Metrics for optimal partitioning:

Let $k(i|t)$ denote the proportion of a given node t that belongs to class i. Sometimes we omit node t and denote the proportion directly by k_i. In a two-class problem, the class distribution of any node can be denoted as (k_0,k_1), where $k_1=1-k_0$. The metric for choosing the best division is usually based on the degree of impurity of the child nodes after the division. The lower the degree of impurity, the more skewed the class distribution. Measures of impurity include:

$$Entropy(t)=-\sum_{i=0}^{n-1}k(i|t)\log_2 k(i|t) \tag{5}$$

$$Gini(t)=1-[k(i|t)]^2 \tag{6}$$

$$Classification\,error(t)=1-\max_t[k(i|t)] \tag{7}$$

The larger the value of the above three measures, the higher the degree of ‘impurity’, and the smaller the value, the lower the degree of ‘impurity’, i.e., the more ‘pure’. It has been proven that the choice of the three formulas does not have a significant impact on the final classification accuracy, and shopping malls generally tend to use the entropy formula. If you need to determine the effect of the test conditions, compare the degree of impurity of the parent node before the division and the degree of impurity of the child node after the division, the larger the difference between the two, the better the effect of the test conditions.

Training records are sampled using bootstrap sampling, i.e., a record that has been selected for training is put back into the original set of records, and yes it has an equal probability of being re-sampled. Since the probability of a record being sampled by bootstrap sampling is $1-(1-1/N)^N$, this probability is continuously approximated when N is sufficiently large $1-e^{-1}=0.632$. Records that are not sampled automatically become part of the test set, and the model built in the training set is applied to the test set to obtain an estimate of the accuracy of the bootstrap samples ε_j. The sampling process is repeated b times, yielding b bootstrap samples. Thus, the total accuracy (acc_{boot}) is calculated from the accuracy (acc_s) calculated from the training set containing all labelled samples:

$$acc_{boot}=\frac{1}{b}\sum_{1}^{b}(0.632*\varepsilon_j+0.368*acc_s) \tag{8}$$

How to control risk after determining whether an e-commerce platform is in a risky business model and knowing the cause of the warning through a decision tree model? How to apply the logistics model to the risk control model? After predicting the business model crisis, the strategy is given in five directions, namely, the risk of enterprise network architecture, the risk of application architecture and the reasonableness of management risk. According to the following five attribute judgement conditions again as above to build a decision tree model can be:

(1) If it is caused by the e-commerce platform business model, the business model can be tracked to increase business supervision to ensure the normal operation of the platform business model.

(2) If the entrepreneurial mismanagement leads to the emergence of logistics model risk unloading caused by the crisis warning, can increase incentives, enhance supervision or replacement.

(3) If it is the network architecture risk problem, due to the comprehensive e-commerce platform operating model review, update the operating environment of the network architecture, reduce the platform network construction of the operational risk.

(4) If it is a problem with the application architecture, aim to adjust the application architecture amount ρ to $\rho^*(\tau)$, such as upgrading τ, and if it is not possible to achieve, terminate the project and stop the loss in a timely manner.

(5) If it is a management risk problem, a multi-party supervision model can be carried out to attach great importance to the problematic links, and at the same time, an emergency treatment programme process can be formulated in case of emergencies.

2.3. Comprehensive risk assessment models in e-commerce platforms

Using the above risk determination and assessment methods, a comprehensive risk assessment model for e-commerce platforms is obtained as shown in Figure 3.

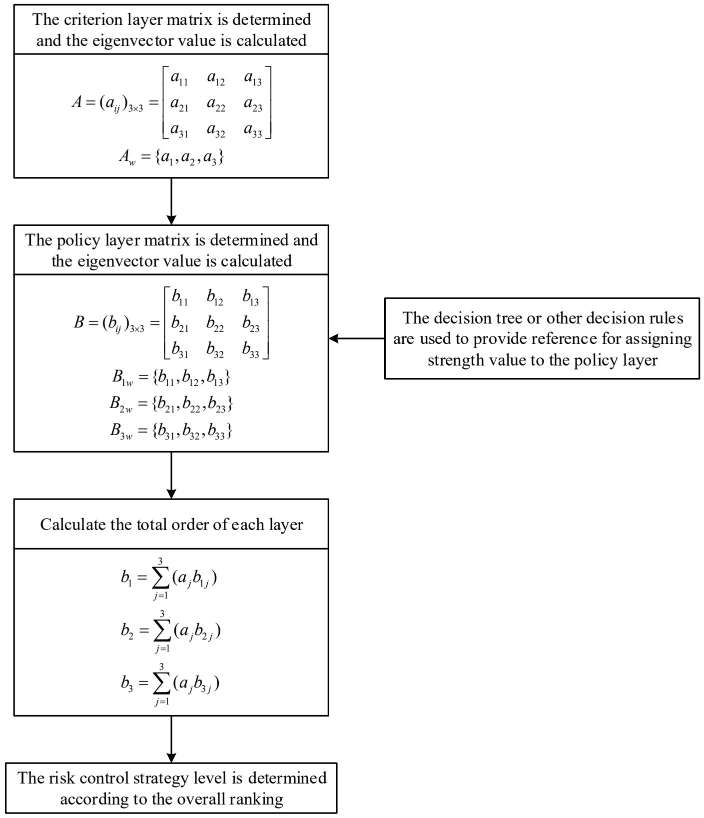

Fig. 3. Comprehensive risk assessment model of export aquatic food

3. Decision Tree-based Comprehensive Risk Assessment and Response for E-commerce Platforms

3.1. E-commerce platform risk management

The results of the e-commerce platform system risk weights are shown in Table 2. According to the hierarchical analysis method, the risk weight categories are: business model risk, logistics model risk, network architecture risk, application architecture risk and management risk, and the five risk factors ranked in the top of these five categories are: the impact of international exchange rate fluctuations, the sustainability of the policy dividend, the timeliness of the express logistics, the efficiency of the data access, and bonded warehousing inventory.The weights of these five risks are 0.1327, 0.1138, 0.1014, 0.0801 and 0.0762, respectively. The corresponding weights of the five major risks are 0.1327, 0.1138, 0.1014, 0.0801 and 0.0762, respectively.The high-risk factors obtained by analysing the above methodology are used to update the risk management register and formulate corresponding risk response plans.

Table 2. The risk weighting of the electronic commerce platform system

Risk category	Risk factor	Weighting	Sort
Risk of business model	Policy dividend sustainability	0.1138	2
	International exchange rate fluctuations	0.1327	1
	The establishment of a profit model	0.0492	11
	Competitors' development	0.0549	9
Risk of logistics model	Supplier stability	0.0533	10
	Bonded warehouse storage	0.0762	5
	Delivery limitation	0.1014	3

Network risk	Data leakage possibility	0.0468	12
	Disaster readiness scheme completeness	0.0669	7
	Network communication robustness	0.0625	8
Applied framework risk	Architecture implementation complexity	0.0727	6
	Data access efficiency	0.0801	4
Management risk	Management support	0.0298	14
	Managerial ability	0.0374	13
	Team member collaboration efficiency	0.0223	15

3.2. Risk evaluation results and analyses

Using the hierarchical analysis method combined with the fuzzy comprehensive evaluation method to carry out the comprehensive evaluation of e-commerce platform risk, with the help of hierarchical analysis software Yaahp to determine the weights of the second-level risk evaluation indexes, and then carry out the risk calculation step by step. The fuzzy comprehensive evaluation vector of each indicator is obtained, and the risk level evaluation results of indicators at all levels are finally obtained based on multi-level fuzzy calculation. The analysis and summary of the evaluation results can guide the risk control and future development of the industry in which the case is located. This paper takes cross-border e-commerce enterprise system risk management as the research object to carry out research.

3.2.1. Comprehensive risk evaluation of e-commerce platforms for tier 1 indicators. The results of the fuzzy comprehensive evaluation of e-commerce platform level risk indicators are shown in Table 3. It can be seen that in the e-commerce platform system, the fuzzy comprehensive evaluation score of the business model risk is 5.9925, which belongs to Class I high-risk control strategy in the risk classification. The rest of the fuzzy comprehensive evaluation scores for “logistics model risk, network architecture risk, application architecture risk, and management risk” are 4.3159, 3.8938, 3.7861, and 3.6875 respectively, which belong to medium-risk control strategy (Class II) in the risk classification.

Table 3. Fuzzy comprehensive evaluation of level 1 risk index of e-commerce platform

Risk category	Fuzzy comprehensive evaluation score	Risk level
Risk of business model	5.9925	I
Risk of logistics model	4.3159	II
Network risk	3.8938	II
Applied framework risk	3.7861	II
Management risk	3.6875	II

3.2.2. Comprehensive risk evaluation of e-commerce platforms for secondary indicators. The results of the comprehensive risk evaluation of the e-commerce platform's secondary indicators are shown in Table 4. The results show that the secondary indicators rated as high risk are international exchange rate volatility, policy dividend sustainability, delivery constraints, data access efficiency, bonded warehouse, and architectural implementation complexity, with corresponding fuzzy composite scores of 5.6370, 5.4091, 5.3254, 5.1928, 4.8341, and 4.7495, respectively, whereas the secondary indicators of moderate risk are The fuzzy composite scores for “disaster preparedness, program integrity, network communication robustness, competitor development, supplier stability, establishment of a profit model, and leakage likelihood” are 4.4988, 4.3918, 4.2513, 3.9666, 3.7969, and 3.6807, respectively. There are three secondary indicators of risk, which are management ability, management support and team member collaboration efficiency, and their fuzzy composite scores are 3.2435, 3.2161 and 3.1356, respectively.This suggests that the e-commerce platform industry is an industry where there is a high level of risk. E-commerce platforms should be made to balance the advantages of all parties while working more closely together. In the new e-commerce platform decision-making and management process, efforts should be made to improve the e-commerce platform's cooperation mode innovation, so that it has a closer cooperation, thus balancing the risks of all parties.

Table 4. The second level risk comprehensive evaluation of e-commerce platform

Secondary indicator	Fuzzy comprehensive evaluation score	Risk assessment
International exchange rate fluctuations	5.6370	I
Policy dividend sustainability	5.4091	I
Delivery limitation	5.3254	I
Data access efficiency	5.1928	I
Bonded warehouse storage	4.8341	I
Architecture implementation complexity	4.7495	I
Disaster readiness scheme completeness	4.4988	II
Network communication robustness	4.3918	II
Competitors' development	4.2513	II
Supplier stability	3.9666	II
The establishment of a profit model	3.7969	II
Data leakage possibility	3.6807	II
Managerial ability	3.2435	III
Management support	3.2161	III
Team member collaboration efficiency	3.1356	III

3.3. Decision Tree-Based Risk Simulation Prediction for E-Commerce Platforms

This paper uses Vensim software to simulate the risk of the constructed e-commerce platform. For the case of cross-border e-commerce risk control cycle is characterized by one month to two months, the degree of change in the risk value is recorded in terms of months. Finally, the decision on the direction of risk control of e-commerce platform is made according to the degree of change.

3.3.1. Change in the level of business model risk. In the case-based e-commerce platform risk simulation run, the results of the business model risk level change are shown in Figure 4. In the case-based business model risk simulation run, its risk level gradually decreases in the first month and reaches the bottom on the 30th day. At this point, the business model risk value is 0.1435, which is 5.849 lower than the initial risk value of 5.9925.Subsequently, the business model risk of the case slowly increases over time. By day 60, the business model risk level of the case reaches about 3.0876, but it is still lower than its initial value, and according to the risk level classified by the decision tree, it is found that the business model risk of the e-commerce platform belongs to the low risk zone.

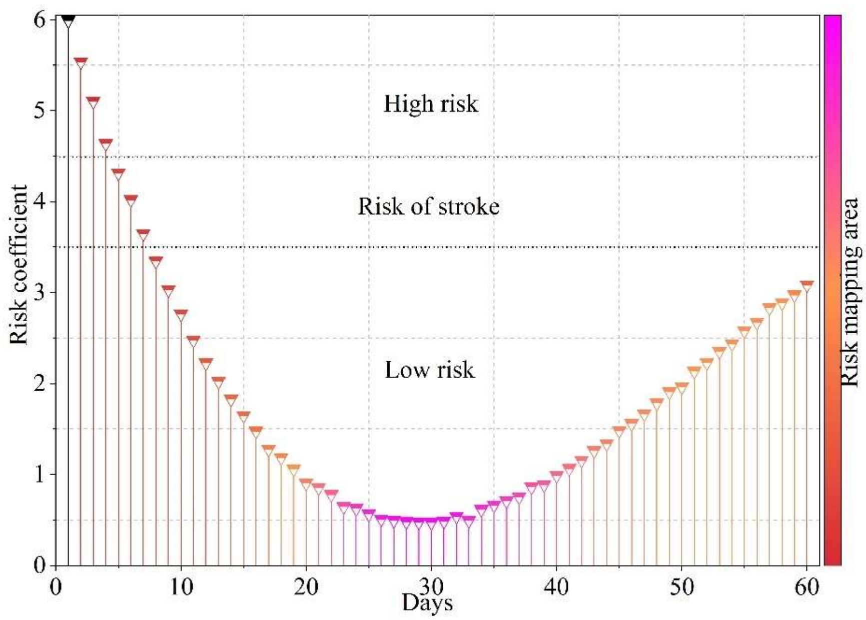

Fig. 4. Business model risk level changes

3.3.2. Changes in the level of risk in the logistics model. In the case-based e-commerce platform risk simulation run, the results of logistics model risk changes are shown in Figure 5. It is found that the reduction of the logistics model risk is all negative, which is indicated by the fact that the macro and industry risks are in the state of increasing. Therefore, in the whole simulation process, the logistics model risk is in the state of slow and uniform increase, and its risk value rises from the initial 4.3159 to 4.8614, the risk value increases by 0.5455. According to the risk level of the decision tree, the e-commerce platform logistics model risk is classified as a high-risk zone, which should be highly valued in the subsequent operation and management of the platform.

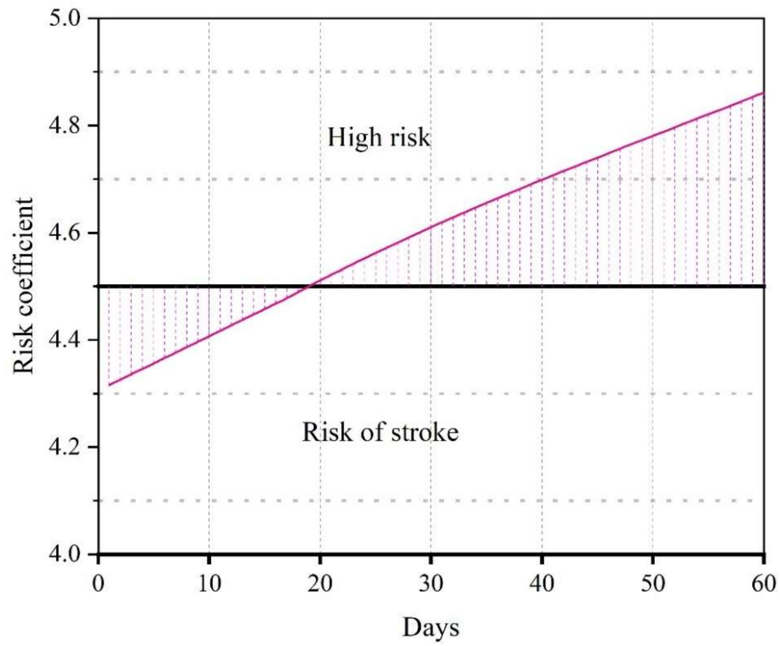

Fig. 5. Logistics model risk change results

3.3.3. Changes in the level of network architecture risk. The results of the change in the network architecture risk level during the case-based e-commerce platform risk simulation are shown in Figure 6. The simulation results show that the network architecture risk value is reduced from the initial 3.8938 to 0.4315 (day 60), which is 3.4623 compared to the initial one, and the network architecture risk level decreases gradually and almost uniformly and rapidly over time. And from day 4 onwards, the network architecture risk is at a low risk level. The predicted trend shows that the level of credit risk reaches its lowest value when the value of network architecture risk reduction starts to be negative at the previous point in time. The result of decision making for network architecture risk is low risk, and the network architecture risk of the e-commerce platform will not be a big problem in the later operation as long as the right operator is chosen.

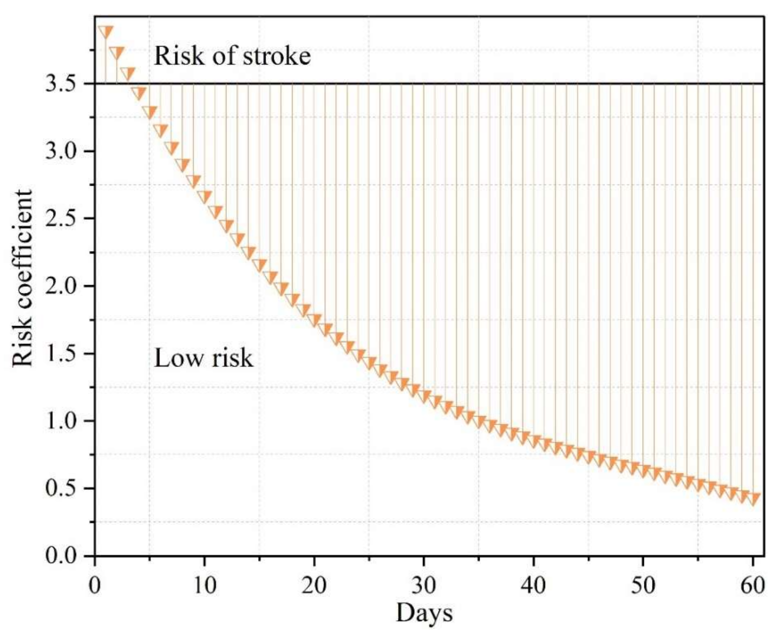

Fig. 6. Network architecture risk level changes

3.3.4. Changes in application architecture risk levels. In the case-based e-commerce platform risk simulation process, the results of the application architecture risk level change are shown in Figure 7. The experimental results show that the supply chain risk level decreases uniformly and gradually over time because the value of the reduction of supply chain relationship risk at each time point is higher than the supply chain relationship risk level credit value, and the difference between the two values is large. From the 3rd day, the risk value of architecture risk level is 3.2400 < 3.5, which is a low risk area. And in one month the value of supply chain relationship risk level has been reduced to a very low level, in the 60th day, the risk value is only 0.1167, which belongs to a very low risk level. The results of the decision tree determination of the e-commerce platform application architecture risk are consistent with the results of the determination of the network architecture risk and the solution measures.

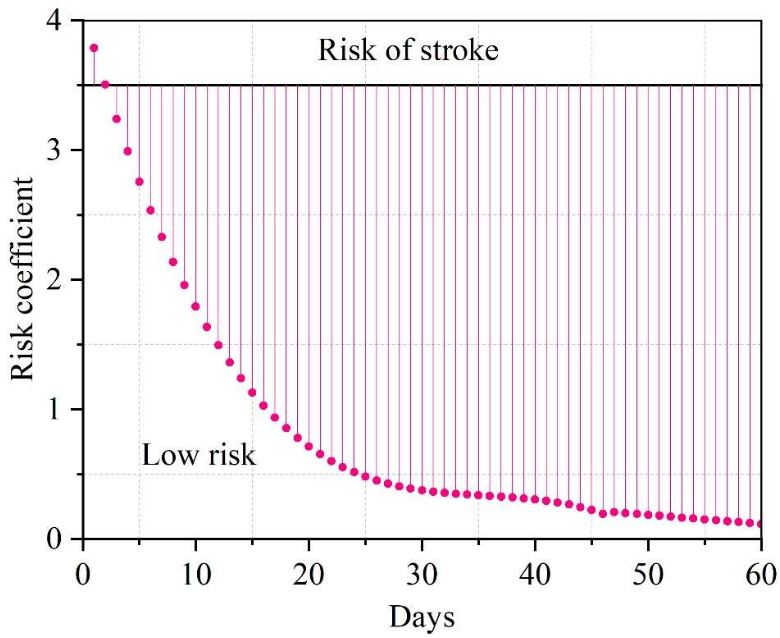

Fig. 7. Application architecture risk level changes

3.3.5. Managing changes in risk levels. The results of the change in the level of management risk during the case-based simulation of e-commerce platform risk are shown in Figure 8. The increase of management risk is all negative, which is indicated as the decrease of management risk. So the management risk level is decreasing during the simulation process. By the end of the first month the management risk value is only 0.2808, which is a small risk. By the 60th day, the risk value is even smaller, only 0.1020. At this time, the decision tree's determination of the management risk of e-commerce platform is low risk, which indicates that as long as the management of the early stage is in place, the operation risk of the platform in the later stage will be extremely low.

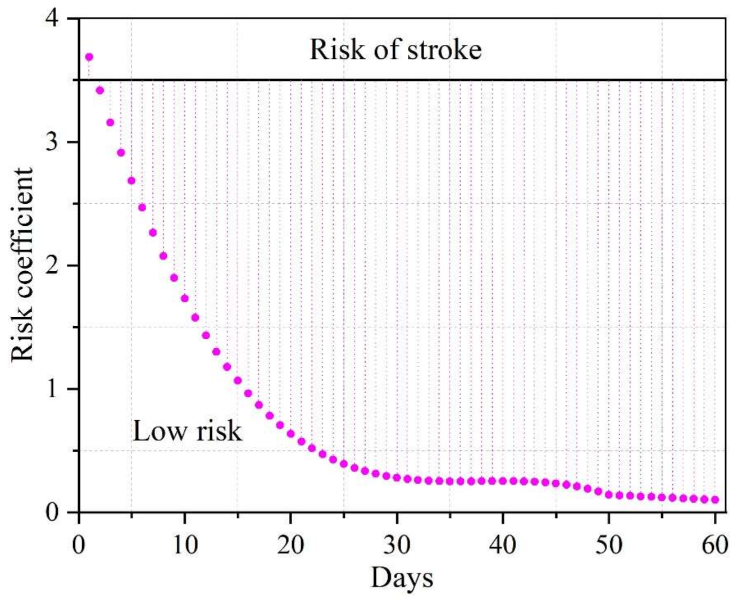

Fig. 8. Managing risk levels of changes

3.4. Risk Management Response Measures and Recommendations for E-Commerce Platforms

When risks are identified, a dedicated person arranges for the collation of a list of risks into a risk register. The risk register is categorized according to the list of identified risks and the list of potential countermeasures, and the corresponding management register is adopted. After the risk analysis, the most likely risks are known and protective measures can be taken to make it difficult for the risks to occur, thus protecting the decision-making of the e-commerce platform.

3.4.1. Risk management responses for e-commerce platforms:

1) The impact of international exchange rate fluctuation can take measures such as negotiating with suppliers to settle payment in RMB and shortening the payment cycle.

2) Policy risk can be taken to standardize the current system architecture, advance the interconnection with the customs system, and take the initiative to incorporate the customs supervision and other effective measures.

3) Data access efficiency can take measures such as caching part of the data through the use of data caching servers, the use of data caching software. In addition and then save the picture in the file server, thus effectively improving the efficiency of data access by purchasing a server in an off-site location of Ali Cloud, regular backups, and improve the security of the cross-border e-commerce platform.

4) Customs commodity inspection clearance timeliness of the measures taken to: improve the stocking in the bonded area to avoid the depletion of the safety stock, to ensure the quantity and stability of the source of goods.

5) Bonded warehousing inventory can take the following measures: sign a long-term cooperation agreement to protect the stability of cooperation between the two sides, and strengthen the supervision of third-party logistics enterprises to prevent the misdelivery of goods leakage and other aspects of the problem.

3.4.2. Suggestions for Risk Management Responses on E-commerce Platforms:

1) Strengthening quality training. Strengthening the quality of all employees of participating enterprises should be carried out in terms of both training of employees' business skills and cultivation of their moral standards. Regularly organizing business and technical training for employees in management knowledge, financial knowledge, risk knowledge and computer technology can improve

the technical level of employees in the actual operation of the business and reduce the risks arising from operational errors.

2) Enhancement of business level. In the design of the e-commerce platform process, the business operation process design, position design, formation of professional risk management department, improvement of risk management system and refinement of job division of labor should be carried out according to the characteristics of the online platform.

3) Upgrade the technical level. After upgrading the information management system of the participating enterprises, the third-party B2B e-commerce platform can establish an effective information platform to comprehensively manage the information, logistics and capital flows in the e-commerce platform with the active cooperation of all parties. Encourage the participating enterprises to invest in hardware equipment, develop software and train professional personnel, establish information sharing mode and mechanism, cultivate risk management awareness of information platform, and strengthen the exchange of various information among enterprises. Transfer the risk of platform funds to members outside the platform through insurance channels to ensure that the risk of e-commerce platform funds occurring in a closed environment is controllable.

4) Establishment of credit mechanism. In order to improve their own credit level and credit rating, enterprises should take the initiative to cooperate with the third-party B2B e-commerce platform and commercial banks in their financing review work, and take the initiative to transmit their own financial information and business information in a timely manner. It is also necessary to achieve full sharing and smooth transmission of information to prevent misunderstanding caused by information asymmetry. E-commerce platform can also integrate its information system with logistics enterprises to keep the logistics information smooth.

5) Improve the risk warning system. E-commerce platform to improve the risk warning system, first of all, the establishment of monitoring and early warning system, followed by the establishment of emergency warning mechanism, again the establishment of risk standard example library, and then also establish the risk of emergency plan library, in addition to the establishment of early warning coordination mechanism, and finally to establish the risk of stop-loss control mechanism.

4. Conclusion

In this paper, hierarchical analysis and fuzzy comprehensive evaluation method are used to get the weights and risk levels of risk control factors in e-commerce platform. After that, under the decision tree assisted algorithm, it simulates and predicts the first-level risk results in the e-commerce platform, and according to the prediction results, it gives the appropriate risk countermeasures and response suggestions.

1) The top 5 risk factors derived from hierarchical analysis in this paper are: the impact of international exchange rate fluctuations, sustainability of policy dividends, express logistics timeliness, data access efficiency and bonded warehouse inventory. The corresponding weights are 0.1327, 0.1138, 0.1014, 0.0801 and 0.0762 respectively. Business model risk belongs to the high-risk category of level I, with a fuzzy comprehensive evaluation score of 5.9925. The rest belong to the risk category of level II. There are 6 Level II indicators rated as high risk category and their fuzzy composite scores range from 4.7495 to 5.6370. There are also six secondary indicators of medium risk, with their respective corresponding fuzzy composite scores ranging from 4.4988, 4.3918, 4.2513, 3.9666, 3.7969, and 3.6807 in descending order.There are three secondary indicators of Class III risk, with their fuzzy composite scores ranging from 3.1356-3.2435.

2) In the case-based business model risk, network architecture risk, application architecture risk and management risk to the 60th day, their initial values of risk are all reduced to 3.0876, 3.4623, 0.1167 and 0.1020, respectively, which are all low risk. The logistics model risk, on the other hand, is in a state of slow and even increase, with its risk value rising from the initial 4.3159 to 4.8614, which is a medium risk control strategy.

References

[1] Rosillo-Díaz, E., Blanco-Encomienda, F. J., & Crespo-Almendros, E. (2020). A cross-cultural analysis of perceived product quality, perceived risk and purchase intention in e-commerce platforms. Journal of Enterprise Information Management, 33(1), 139-160.

[2] Fan, Y., Ju, J., & Xiao, M. (2016). Reputation premium and reputation management: Evidence from the largest e-commerce platform in China. International Journal of Industrial Organization, 46, 63-76.

[3] Shi, J., Guo, J. E., Wang, S., & Wang, Z. (2015). Credit risk evaluation of online supply chain finance based on third-party B2B e-commerce platform: an exploratory research based on China's practice. International Journal of u-and e-Service, Science and Technology, 8(5), 93-104.

[4] Su, J., Wang, D., Zhang, F., Xu, B., & Ouyang, Z. (2023). A multi-criteria group decision-making method for risk assessment of live-streaming E-commerce platform. Journal of Theoretical and Applied Electronic Commerce Research, 18(2), 1126-1141.

[5] Shen, H., Wu, G., Xia, Z., Susilo, W., & Zhang, M. (2023). A privacy-preserving and Verifiable statistical analysis scheme for an E-Commerce platform. IEEE Transactions on Information Forensics and Security, 18, 2637-2652.

[6] Harish, A. R., Liu, X. L., Zhong, R. Y., & Huang, G. Q. (2021). Log-flock: A blockchain-enabled platform for digital asset valuation and risk assessment in E-commerce logistics financing. Computers & Industrial Engineering, 151, 107001.

[7] Duan, X., & Gao, J. (2020, September). Third-party E-commerce Trading Platform Prevents Economic Contract Legal Risk Causes and Monitoring. In Proceedings of the 2020 12th International Conference on Information Management and Engineering (pp. 7-9).

[8] Chang, S., Li, A., Wang, X., & Zhang, J. (2023). Optimal combination of platform channel contract and guarantee financing strategy in e-commerce market. Transportation Research Part E: Logistics and Transportation Review, 172, 103094.

[9] Wang, X., Wang, X., Yu, B., & Zhang, S. (2019). A comparative study of entry mode options for E-commerce platforms and suppliers. Electronic Commerce Research and Applications, 37, 100888.

[10] Yang, Y., Yang, L., Chen, H., Yang, J., & Fan, C. (2020). Risk factors of consumer switching behaviour for cross-border e-commerce mobile platform. International Journal of Mobile Communications, 18(6), 641-664.

[11] Rana, K. K. (2014). A survey on decision tree algorithm for classification. International journal of Engineering development and research, 2(1), 1-5.

[12] Priyanka, & Kumar, D. (2020). Decision tree classifier: a detailed survey. International Journal of Information and Decision Sciences, 12(3), 246-269.

[13] Charbuty, B., & Abdulazeez, A. (2021). Classification based on decision tree algorithm for machine learning. Journal of Applied Science and Technology Trends, 2(01), 20-28.

[14] Rai, K., Devi, M. S., & Guleria, A. (2016). Decision tree based algorithm for intrusion detection. International Journal of Advanced Networking and Applications, 7(4), 2828.

[15] Sahu, S., & Mehtre, B. M. (2015, August). Network intrusion detection system using J48 Decision Tree. In 2015 International Conference on Advances in Computing, Communications and Informatics (ICACCI) (pp. 2023-2026). IEEE.

[16] Guezzaz, A., Benkirane, S., Azrour, M., & Khurram, S. (2021). A reliable network intrusion detection approach using decision tree with enhanced data quality. Security and Communication Networks,

2021(1), 1230593.

[17] Relan, N. G., & Patil, D. R. (2015, January). Implementation of network intrusion detection system using variant of decision tree algorithm. In 2015 International Conference on Nascent Technologies in the Engineering Field (ICNTE) (pp. 1-5). IEEE.

[18] Xu, B., Huang, D., & Mi, B. (2020). Research on E-commerce transaction payment system basedf on C4. 5 decision tree data mining algorithm. Computer Systems Science and Engineering, 35(2), 113-121.

[19] Yunyan, H., Weiwei, W., & Qiuju, Z. (2021). Prediction of Credit Risk in Electronic Commerce Financial Industry Based On Decision Tree Method. In Advances in Smart Vehicular Technology, Transportation, Communication and Applications: Proceeding of the Third International Conference on VTCA, 15–18 October 2019, Arad, Romania (pp. 227-236). Springer Singapore.

[20] Zhang, R., Fang, L., He, X., & Wei, C. (2023). Controlling information risk in E-commerce. In The Whole Process of E-Commerce Security Management System: Design and Implementation (pp. 61-120). Singapore: Springer Nature Singapore.

[21] Urrea, N. T., Vishkaei, B. M., & De Giovanni, P. (2024). Operational Risk Management in E-Commerce: A Platform Perspective. IEEE Transactions on Engineering Management.

[22] Su, H. (2024). Research on operational strategy and risk management of cross-border e-commerce platform. Financial Engineering and Risk Management, 7(3), 51-56.

[23] Chang, S., Li, A., Wang, X., & Wang, X. (2022). Joint optimization of e-commerce supply chain financing strategy and channel contract. European Journal of Operational Research, 303(2), 908-927.

[24] Dai, Z., & Guo, X. (2022). Investigation of E‐Commerce Security and Data Platform Based on the Era of Big Data of the Internet of Things. Mobile Information Systems, 2022(1), 3023298.

[25] Wang, J. (2024). Strategic Analysis of Biosafety in Agricultural Product Supply Chain Management within E-commerce Platforms. Journal of Commercial Biotechnology, 29(1).

[26] Vasco Miguel, Yin Hang, Melo Francisco S. & Paiva Ana. (2022). Leveraging hierarchy in multimodal generative models for effective cross-modality inference. Neural Networks238-255.

[27] Gaoyuan Yu, Yunfeng Lou, Hang Dong, Junjie Li & Xianlong Jin. (2023). A New Hybrid Hierarchical Parallel Algorithm to Enhance the Performance of Large-Scale Structural Analysis Based on Heterogeneous Multicore Clusters. Computer Modeling in Engineering & Sciences(1),135-155.

[28] Susana Furtado & Charles R. Johnson. (2024). Efficiency analysis for the Perron vector of a reciprocal matrix. Applied Mathematics and Computation128913-128913.

[29] Furtado Susana & Johnson Charles R.. (2024). Efficiency of any weighted geometric mean of the columns of a reciprocal matrix. Linear Algebra and Its Applications83-92.

[30] Weijia Gong, Hangbin Xu, Jinyan Lu, Jungbin Kim, Yan Zhao, Ni Li... & Heng Liang. (2024). Gradient boosting decision tree algorithms for accelerating nanofiltration membrane design and discovery. Desalination118072-118072.

[31] Atsushi Waseda, Ryo Nojima & Lihua Wang. (2024). A Differentially Private (Random) Decision Tree without Noise from k-Anonymity †. Applied Sciences(17),7625-7625.