Research on Fresh Platform Selection and Online Evaluation of Logistics Attributes Based on Picture Fuzzy Set

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Abstract. Fully utilizing the online evaluation data of e-commerce platforms to achieve customer-oriented fresh logistics service attribute research and platform evaluation has certain practical significance. Based on online evaluation, picture fuzzy ordinal priority approach is proposed to study the logistics service attributes of fresh products, and then evaluate the fresh shopping platform. Firstly, using Python to extract online evaluation data for language processing and sentiment analysis, setting data collection rules to filter out logistics attribute words with higher frequency. Secondly, the data is converted into Picture fuzzy number and the four indicators of membership, neutrality, non-membership, and abstention of Picture fuzzy set are used to characterize the positive, neutral, negative, and unrelated forms of evaluation information in online evaluation, quantifying the relative importance of different logistics attributes. Then, the score function value of logistics attribute words is calculated, and the profit matrix is determined to obtain the local and global weights of product logistics attributes in Jingdong Fresh, Taobao Fresh, and Suning Fresh. Finally, a relative ranking of the importance of the logistics attributes of the three fresh food platforms and products is made, and through comparative analysis, the advantages and flexibility of the picture fuzzy ordinal priority approach are verified, providing reference for consumers to choose fresh food platforms.

Keywords: online evaluation; fresh platform; multiple attribute decision-making; picture fuzzy ordinal priority approach

1 INTRODUCTION

With the development of the Internet and e-commerce, the fast and convenient characteristics of online shopping are recognized by the public. For most consumers, referring to existing product evaluations has become a habitual practice for optimal selection. Gavilan et al. [1] found that consumers tend to provide their usage experience for potential customers to refer to after using the product. Zhou Y et al. [2] studied the content

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characteristics of online evaluations and explored the evaluation value from the perspective of consumers. Zhang HX [3] extracted key elements of consumer attention by analyzing high-frequency vocabulary in online reviews of fresh products. Wang W et al. [4] used online evaluation as a data source to calculate sentiment values and used sentiment analysis techniques to study the impact of online evaluation on customer purchases. At present, user demand mining [5] is widely used in the fields of information mining and product design. Bleil et al. [6] proposed the LDA topic model for user demand mining.

In the existing field of online evaluation, scholars have conducted research on logistics service quality in online evaluation. For example, Zhang XH et al. [7] provided a reasonable research paradigm for measuring and evaluating logistics service quality based on massive real evaluation data, combined with machine learning text and sentiment analysis methods. Xu SS [8] conducted a comprehensive evaluation of the logistics service quality evaluation index system for fresh e-commerce by screening online evaluations related to logistics service quality and conducting sentiment analysis. Zhang JD [9] implemented logistics service quality evaluation and supply chain optimization based on online evaluation, proposed an evaluation index system for fresh products, and used text analysis technology to evaluate logistics service quality. To express online evaluation information, Intuitionistic fuzzy set [10] typically utilize membership degree, neutrality degree, and non-membership degree to describe positive, neutral, and negative information. As an extension of Intuitionistic fuzzy set, Picture fuzzy set [11] introduced fourth indicator, namely abstention degree, which comprehensively considers factors that decision-makers may overlook but are not worthless, and has higher flexibility in handling and expressing fuzzy information. In comparison to existing literature on Intuitionistic fuzzy set [12-14], Picture fuzzy set employ membership degree, neutrality degree, non-membership degree, and abstention degree to characterize positive, neutral, negative, and unrelated evaluations. This effectively compensates for the shortcomings of conventional evaluation methods. Zhang S et al. [15] used the EDAS method combined with fuzzy information to evaluate candidate suppliers, while Wang L et al. [16] proposed a new VIKOR multi-attribute decision-making method that uses picture fuzzy distance to process uncertain data. References [17-19] delved into the theory and application of Picture fuzzy set, and proposed various picture fuzzy operators to process and analyze information with fuzzy properties.

The picture fuzzy multi-attribute decision-making method has found applications in various areas, as evidenced by references [15-19]. However, it has not yet been applied to logistics attributes of fresh products or the evaluation and ranking of fresh e-commerce platforms. A new decision-making method called “picture fuzzy ordinal priority approach” is proposed by combining Picture fuzzy set with online evaluation, aiming to accurately capture the needs and emotional tendencies of users on fresh platforms regarding logistics attributes. By collecting a large amount of online evaluation data, the evaluator's fuzzy cognition and subjective feelings towards fresh logistics attributes are captured and fuzzified. The relationship and relative importance of logistics attributes are analyzed, leading to the development of a comprehensive and interpretable evaluation ranking system to assess and compare the performance of fresh food platforms.

2 CONCEPT

2.1 Picture Fuzzy Set

Definition1[11] Let X be a non-empty set, it is referred to as:

$$P=\{(x,\mu_p(x),\eta_p(x),\nu_p(x),\xi_p(x))\mid x\in X\}$$

Picture fuzzy set (PFS). $\mu_p(\mathrm{x}),\eta_p(\mathrm{x}),\nu_p(\mathrm{x})\in[0,1]$, They are membership degree, neutrality degree, and non-membership degree, respectively. $\xi_p(\mathrm{x})=1-\mu_p(\mathrm{x})-\eta_p(\mathrm{x})-\nu_p(\mathrm{x})$ abstention degree, for the convenience of memorization $\alpha=(\mu_p,\eta_p,\nu_p)$ is called Picture fuzzy number (PFN).

Definition2[19] Let X be a non-empty set, $\alpha=(\mu_p,\eta_p,\nu_p)$, $\beta=(\mu_\beta,\eta_\beta,\nu_\beta)$ are two PFNs, then there exists:

1) $\alpha\oplus\beta=(\dfrac{\mu_\alpha+\mu_\beta-\mu_\alpha\mu_\beta,\eta_\alpha\eta_\beta,}{(\eta_\alpha+\nu_\alpha)(\eta_\beta+\nu_\beta)-\eta_\alpha\eta_\beta})$

2) $\alpha\otimes\beta=\left(\dfrac{(\mu_\alpha+\eta_\alpha)(\mu_\beta+\eta_\beta)-\eta_\alpha\eta_\beta,}{\eta_\alpha\eta_\beta,\nu_\alpha+\nu_\beta-\nu_\alpha\nu_\beta}\right)$

3) $\lambda\alpha=(1-(1-\mu_\alpha)^\lambda,\eta_\alpha^\lambda,(\eta_\alpha+\nu_\alpha)^\lambda-\eta_\alpha^\lambda)$

4) $\alpha^\lambda=((\mu_\alpha+\eta_\alpha)^\lambda-\eta_\alpha^\lambda,\eta_\alpha^\lambda,1-(1-\nu_\alpha)^\lambda)$

Where in $\lambda>0$

Definition3[20] Let X be a non-empty set, if the Picture fuzzy number $\alpha=(\mu_\alpha,\eta_\alpha,\nu_\alpha)$ exist in the set, the score function L and accuracy function H are respectively $L(\alpha)=\mu_\alpha-\nu_\alpha$, $\mathrm{H}(\alpha)=\mu_\alpha+\eta_\alpha+\nu_\alpha$.

2.2 Ordinal Priority Approach

The ordinal priority approach is a decision-making strategy that ranks options based on their relative priority, using orders as input data. It only requires consideration of the attributes of alternative solutions and evaluation objects to fulfill the decision-making process, enabling decision-makers to reserve opinions on attributes they are not proficient in. This approach can be applied to both individual and group decision-making, and is suitable for various situations. For instance, the fuzzy ordinal priority approach

[21] can be used when the input is ambiguous, while the grey ordinal priority approach [22] is applicable when the input contains objective uncertainty.

3 APPLICATION ANALYSIS

3.1 Data Acquisition and Preprocessing

By utilizing online reviews from Jingdong, Taobao, and Suning as data sources, using Python programming to collect comments on Jingdong fresh products, and establishing a standardized set of logistics attribute words. The same standardized analysis will then be performed on fresh products from Taobao and Suning. To improve the accuracy of evaluations when dealing with unstructured online reviews, positive, neutral, negative, and unrelated evaluations related to logistics service attributes will be filtered out.

This article conducted a comprehensive analysis by crawling online reviews of all fresh products on Jingdong from July 2022 to July 2023, resulting in a total of 67330 entries and comprehensive data. The key-words were extracted based on the collected data, ensuring consistency of logistics attribute words for Taobao Fresh and Suning Fresh. Using Pandas, Jieba, and human participation methods for comment screening and sentiment analysis, the result was 50654 positive comments, 5930 neutral comments, 5233 negative comments, and 4851 unrelated comments from Jingdong Fresh. There were 2983 positive comments, 342 neutral comments, 305 negative comments, and 144 unrelated comments on Taobao Fresh. Suning Fresh has 4663 positive comments, 807 neutral comments, 727 negative comments, and 372 unrelated comments.

3.2 Extraction of Logistics Attribute Words

To form a high-frequency vocabulary table, theme words were extracted from the online evaluation data of Jingdong Fresh. Since there are numerous theme words extracted from the comments, this article focuses on analyzing the logistics attributes of fresh products and selects ten representative logistics service attribute words as follows: fresh (11797), taste (11715), package (10296), purchase (8935), receive (8863), fast (7641), repurchase (6740), quality (5722), express (5341), price (5106).

3.3 Picture Fuzzy Number Characterization of Evaluation Information

To effectively handle decision-making problems related to online text evaluations, four indicators of membership, neutrality, non-membership, and abstention of Picture fuzzy number are used to characterize the positive, neutral, negative, and unrelated forms of online text evaluation information. The logistics attribute keywords appearing in the evaluation are statistically analyzed and transformed into Picture fuzzy number for analysis.The specific data is shown in Table 1.

Table 1. Emotional Attitudes towards Jingdong, Taobao, Suning Fresh Logistics Attribute Words

logistics keywords	positive evaluation	neutral evaluation	negative evaluation	unrelated evaluation
fresh	9461,1286,596	1034,106,98	446,60,41	96,5,2
taste	9093,853,549	1201,73,82	573,60,29	174,7,6
package	8719,577,445	784,48,76	438,36,29	123,4,2
purchase	7094,329,499	466,27,54	211,22,20	58,1,3
receive	6370,625,288	915,99,91	587,49,77	174,6,15
fast	6640,349,229	370,20,23	82,5,5	52,2,1
repurchase	5274,382,207	845,60,43	140,15,7	62,3,1
quality	4911,185,188	292,16,17	163,11,8	34,2,2
express	3826,438,131	604,45,28	416,40,42	94,3,1
price	4992,238,266	276,9,28	159,6,11	39,4,2

Taking the positive evaluation of fresh as an example, 9461 represents positive evaluation related to fresh on Jingdong platform, 1286 represents positive evaluation related to fresh on Taobao platform, and 596 represents positive evaluation related to fresh on Suning platform.

Record Jingdong Fresh, Taobao Fresh, and Suning Fresh as follows: A_1, A_2, A_3 ,Ten logistics attribute words are used as ten evaluation attributes: fresh (C_1), taste (C_2), packaging (C_3), purchase (C_4), receive (C_5), fast (C_6), repurchase (C_7), quality (C_8), express (C_9), price (C_{10}) .After characterizing with Picture fuzzy number, the picture fuzzy decision matrix is obtained, as shown in Table 2.

Table 2. Picture Fuzzy Decision Matrix

	C_1	C_2	C_3	C_4	C_5
A_1	(0.857,0.094,0.040)	(0.821,0.109,0.052)	(0.866,0.078,0.044)	(0.906,0.060,0.027)	(0.792,0.114,0.073)
A_2	(0.883,0.073,0.041)	(0.859,0.074,0.060)	(0.868,0.072,0.054)	(0.868,0.071,0.058)	(0.802,0.127,0.063)
A_3	(0.809,0.133,0.056)	(0.824,0.123,0.044)	(0.806,0.138,0.053)	(0.866,0.094,0.035)	(0.611,0.193,0.163)

continue（Table 2）

	C_6	C_7	C_8	C_9	C_{10}
A_1	(0.929,0.052,0.011)	(0.834,0.134,0.022)	(0.909,0.054,0.030)	(0.774,0.122,0.084)	(0.913,0.050,0.029)
A_2	(0.928,0.053,0.013)	(0.830,0.130,0.032)	(0.864,0.075,0.051)	(0.833,0.086,0.076)	(0.926,0.035,0.023)
A_3	(0.888,0.089,0.019)	(0.802,0.167,0.027)	(0.874,0.079,0.037)	(0.649,0.139,0.208)	(0.866,0.091,0.036)

3.4 Picture Fuzzy Ordinal Priority Approach Model

Construction of Picture Fuzzy Ordinal Priority Approach Model for Fresh Evaluation. The sets, indexes, parameters, and variables of the proposed method used in the model are shown in Table 3.

Table 3. Sets, Indexes, Parameters, and Variables of the proposed method

Sets	
I	Set of experts $\forall i \in I$
J	Set of attributes $\forall j \in J$
K	Set of alternatives $\forall k \in K$
Indexes	
i	Index of the experts (1, …, p)
j	Index of preference of the attributes (1, …, n)
k	Index of the alternatives (1, …, m)
Parameters	
r_i	The rank of expert i
r_j	Obtaining the level of attribute j based on picture fuzzy decision matrix
r_k	Obtaining the level of alternative solution k based on picture fuzzy de-
Variables	
Z	objective function
W_{ijk}^{rk}	Weight (importance) of k alternative based on j attribute by expert at k

$$
\begin{aligned}
&Max\ Z \\
&s.t: \\
&Z \le r_i\left(r_j\left(r_k\left(w_{ijk}^{r_k} - w_{ijk}^{r_{k+1}}\right)\right)\right) \quad \forall \text{i,j,}r_k \\
&Z \le r_i r_j r_m w_{ijk}^{rm} \qquad \forall \text{i,j,}r_k = r_m \\
&\sum_{i=1}^{p}\sum_{j=1}^{n}\sum_{k=1}^{m} w_{ijk} = 1 \quad w_{ijk} \ge 0 \quad \forall i, j, r_k
\end{aligned} \tag{1}
$$

where Z is unrestricted in sign.

After solving Model (1), the alternatives' weight can be calculated using Eq. (2).

$$w_k = \sum_{i=1}^{p}\sum_{j=1}^{n} w_{ijk} \quad \forall k \tag{2}$$

To calculate the weights of the attributes, Eq. (3) can be utilized.

$$w_j = \sum_{i=1}^{p}\sum_{k=1}^{m} w_{ijk} \quad \forall j \tag{3}$$

Equation (4) can be used to calculate the weight difference between attributes.

$$w_{ijk}^{1} - w_{ijk}^{2} \geq 0$$

$$w_{ijk}^{2} - w_{ijk}^{3} \geq 0$$

$$....$$

$$w_{ijk}^{m-1} - w_{ijk}^{m} \geq 0 \tag{4}$$

In case of need, the experts' weights can be determined by employing Eq. (5).

$$w_i = \sum_{j=1}^{n}\sum_{k=1}^{m} w_{ijk} \quad \forall i \tag{5}$$

Decision Steps. Step 1: Determine attributes.

Based on the online evaluation data of fresh food crawled in Python, select the top ten fresh food logistics attributes with the highest frequency of occurrence as the analysis objects.

Step 2: Calculate the score function for logistics attributes.

Convert attributes into numerical form, calculate logistics attribute scores based on the score function [21] combined with the fuzzy decision matrix in the picture.

Step 3: Sort attributes and alternative options within attributes.

The sorting of attributes is a comprehensive analysis process, which use Eq. (4) to sort attributes and distinguish priorities. Moreover, quantifying the scores of alternative solutions under different attributes can compare the degree of superiority and inferiority between solutions.

Step 4: Solve the model, calculate attribute weights, and rank alternative solutions.

By solving Model (1), determine the weight ranking of k alternative solutions based on the j attribute preference index, and use Eq. (2) and Eq. (3) in the model to determine the final weights of the attributes and alternative solutions.

3.5 Analysis of Model Application Process

Step 1: Determine the analysis attributes, select the top ten logistics attribute words with the highest frequency.

Step 2: Calculate the fuzzy decision matrix in Table 2 based on the score function formula [21], and then obtain the score function table for logistics attribute words in different evaluation schemes. As shown in Table 4.

Table 4. Score Function Table

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
A_1	0.817	0.769	0.822	0.879	0.719	0.918	0.812	0.879	0.690	0.884
A_2	0.842	0.799	0.814	0.810	0.739	0.915	0.798	0.813	0.757	0.903
A_3	0.753	0.780	0.753	0.831	0.448	0.869	0.775	0.837	0.441	0.830

Step 3: By combining Eq. (4) with the score function values in Table 4, the picture fuzzy benefit matrix is obtained, and the ranking of different alternative solutions under the same attribute is calculated. The calculation results are shown in Table 5.

Table 5. Picture Fuzzy Benefit Matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
A_1	2	3	1	1	2	1	1	1	2	2
A_2	1	1	2	3	1	2	2	3	1	1
A_3	3	2	3	2	3	3	3	2	3	3

Step 4: Use LINGO software for calculation to obtain local and global matrix data for alternative solutions and attributes. Among them, the weight is denoted as W . The specific operating results are shown in Table 6.

Table 6. Local and Global Matrix Data Tables for Alternative Solutions and Attributes

W	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	Total
A_1	0.01581	0.00474	0.20864	0.04173	0.01054	0.10432	0.02981	0.05216	0.00948	0.03161	0.50884
A_2	0.03477	0.02608	0.09484	0.00759	0.02318	0.04742	0.01355	0.00948	0.02086	0.06955	0.34732
A_3	0.00632	0.01185	0.03794	0.01897	0.00422	0.01897	0.00542	0.02371	0.00379	0.01265	0.14384
Total	0.05690	0.04267	0.34142	0.06829	0.03794	0.17071	0.04878	0.08535	0.03413	0.11381	1

Note: rows represent attributes, while lists indicate alternative options.

Sort logistics attributes based on the global matrix data of attributes, and the sorting result is: $C_3 > C_6 > C_{10} > C_8 > C_4 > C_1 > C_7 > C_2 > C_5 > C_9$ .Ranking is based on the score data of alternative solutions, and the sorting result is: $A_1 > A_2 > A_3$.

Based on the analysis above, it can be concluded that when consumers purchase fresh products, they prefer Jingdong over Taobao and Suning. However, it is important to note that each major e-commerce platform has its own focus on products and development direction, and the ranking of fresh food platforms should only be used as a reference for consumers when choosing fresh food. This ranking does not provide a comprehensive evaluation of each platform's overall strengths and capabilities.

3.6 Comparative Analysis

The following is a comparison between the method proposed in references [15-19] and the picture fuzzy ordinal priority approach proposed in this paper. The results are shown in Table 7.

Table 7. Comparison of Results from Different Decision Methods

Methods	A_1	A_2	A_3	Ranking of alternatives
EDAS[15]	0.9934	0.9270	0	$A_1 > A_2 > A_3$
VIKOR[16]	0.0603	-0.0078	0.5000	$A_3 > A_1 > A_2$
PFWA[17]	0.8519	0.8447	0.7887	$A_1 > A_2 > A_3$
PFWG[17]	0.8459	0.8395	0.7758	$A_1 > A_2 > A_3$
PFDWA[18]	0.8752	0.8707	0.8153	$A_3 > A_1 > A_2$
PFWMM[19]	-0.0204	-0.0281	-0.1251	$A_1 > A_2 > A_3$
Picture Fuzzy Ordinal Priority Approach	0.50884	0.34732	0.14384	$A_1 > A_2 > A_3$

From Table 7, it is evident that the ranking results obtained by using the picture fuzzy ordinal priority approach in this article are the same as those obtained by the EDAS method and three picture fuzzy information aggregation operators in references [15,17,19]. The ranking result is $A_1 > A_2 > A_3$,the best solution is A_1.The ranking results of VIKOR method [16] and PFDWA operate [18] are $A_3 > A_1 > A_2$.

Certain methodologies employed in other references exhibit inconsistencies with the sorting results elucidated in this article. The reason is that the research on the VIKOR method in reference [16] is based on decisions given attribute weights, and subjective judgment of attribute weight values may lead to bias in the results. Reference [18] points out that once the preference function and distance measurement method are determined, the operator itself may not be able to adjust, and changes in environment or demand may limit the application scope of the operator. When other conditions are the same, the picture fuzzy numbers are sorted based on the size of the score function.

Schemes with higher score function values usually have better logistics properties. The logistics attribute score function value of A_1 is higher than A_3,and after comprehensive analysis, the optimal ranking result is $A_1 > A_2 > A_3$,indicating that the method proposed in this article is more flexible and in line with reality when making decisions.

4 CONCLUSIONS

Using text analysis tools to mine online evaluation data of fresh products from multiple platforms and extract fresh logistics attributes with high customer attention. The study leverages Picture fuzzy number to characterize logistics attribute evaluation data, proposing the picture fuzzy ordinal priority approach to analyze multiple fresh logistics attributes and shopping platforms, providing reference for consumers to choose fresh platforms. By integrating the evaluation ranking system and considering logistics attribute preferences, consumers can obtain objective information about the logistics service quality of different fresh food platforms, this enables them to make more informed decisions when choosing platforms, resulting in improved decision-making quality and efficiency. In addition, major fresh food platforms can clearly identify their shortcomings in logistics services and market competition based on the attributes of fresh products, improve logistics service quality and optimize marketing strategies in a targeted manner, and enhance market competitiveness.

This article provides a new research approach from the perspective of logistics service attributes, which has certain reference value for exploring more complex and diverse service evaluations in the field of fresh logistics.

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REFERENCES

1. Gavilan D, Avello M, Martinez-Navarro G. The influence of online ratings and reviews on hotel booking consideration[J]. Tourism Management,2018,66:53-61. DOI: 10.1016/j.tourman.2017.10.018
2. Zhou Y, Yang S, Li Y, et al. Does the review deserve more helpfulness when its title resembles the content? locating helpful reviews by text mining[J]. Information Processing & Management,2020,57(2):102179. DOI: 10.1016/j.ipm.2019.102179
3. Zhang HX. Factors influencing consumer satisfaction in e-commerce for fresh agricultural products: an exploratory analysis based on online reviews [J] Jiangsu Agricultural Sciences, 2019,47 (17) DOI: 4-8. 10.15889/j.issn.1002-1302.2019.17.002

4. Wang W, Wang HW. The impact of feature perspectives on purchase intention: an sentiment analysis method for online reviews [J]. Systems Engineering-Theory & Practice, 2016,36 (01): 63-76. https://link.cnki.net/urlid/11.2267.n.20150512.1150.059
5. Atanassov K. Intuitionistic fuzzy sets[J]. Fuzzy Sets and Systems, 1986(20)87-96. http://dx.doi.org/10.1016/S0165-0114(86)80034-3
6. Blei D M, Ng A Y, Jordan M I. Latent dirichlet allocation[J]. The Annals of Applied Statistics, 2003(3):993-1022. https://www.jmlr.org/papers/volume3/blei03a/blei03a.pdf
7. Zhang XH, Xiao L. Research on quality evaluation of express logistics services based on consumer online comment data [J]. Journal of Chongqing Technology and Business University (Social Science Edition), 2023,40 (02): 66-79. https://kns.cnki.net/kcms/detail/50.1154.C.20211119.0938.002.html
8. Xu SS. Research on quality evaluation of fresh e-commerce logistics services based on online comments[D]. Donghua University, 2023.DOI:10.27012/d.cnki.gdhuu.2023.000133
9. Zhang JD. Research on logistics service quality evaluation and supply chain optimization of fresh products considering online comments [D]. Jiangxi University of Finance and Economics, 2023. DOI: 10.27175/d.cnki.gjxcu.2023.000802
10. Zadeh L A. Fuzzy sets[J]. Information and Control, 1965(8): 338-353. http://dx.doi.org/10.1016/S0019-9958(65)90241-X
11. Cuong B C, Kreinovich V. Picture fuzzy sets[J]. Journal of Computer Science and Cybernetics, 2014, 30(4): 409-420. DOI:10.15625/1813-9663/30/4/5032
12. Su JF, Wang D, Xu BK, et al. An online knowledge payment product evaluation method based on improved interval intuitionistic fuzzy multi-attribute group decision-making [J/OL]. Computer Integrated Manufacturing Systems:1-17. http://kns.cnki.net/kcms/detail/11.5946.TP.20230410.1227.004.html
13. Li XL. Mining and utility evaluation of tourism reviews by integrating emotional analysis and Intuitionistic fuzzy features [D]. Shanxi University, 2023.DOI: 10.27284/d.cnki.gsxiu.2023.002120
14. Kong R. Construction of intuitionistic fuzzy set and merchant sorting based on text mining [D]. Dalian University of Technology, 2022. DOI: 10.26991/d.cnki.gdllu.2021.001953
15. Zhang S, Wei G, Gao H, et al. EDAS method for multiple criteria group decision making with picture fuzzy information and its application to green suppliers selections[J]. Technological and Economic Development of Economy, 2019, 25(6):1-16. DOI: 10.3846/tede.2019.10714
16. Wang L, Yao XN. VIKOR multi-attribute decision approach with the aid of novel picture fuzzy distance[J]. Operations Research and Management Science, 2022, 31(5): 49-54. DOI: 10.12005/orms.2022.0147
17. Wang CY. Hesitant fuzzy set and picture fuzzy set with their application research [D]. Hunan University, 2015.
18. Long HF, Luo MX. Picture fuzzy aggregation operators and their application to multi-attribute decision making[J]. Journal of China University of Metrology, 2020, 31(4): 524-530. DOI: 10.27819/d.cnki.gzgjl.2021.000408
19. Wang R, Wang J, Gao H, et al. Methods for MADM with picture fuzzy muirhead mean operators and their application for evaluating the financial investment risk[J]. Symmetry, 2018, 11(1): 6. DOI:10.3390/sym11010006
20. Wei GW. Picture fuzzy aggregation operators and their application to multiple attribute decision making[J]. Journal of Intelligent & Fuzzy Systems, 2017, 33(2): 1-12. DOI:10.3233/JIFS-161798

21. Mahmoudi A, Javed SA, Mardani A. Gresilient supplier selection through fuzzy ordinal priority approach: decision-making in post-COVID era[J]. Operations Management Research, 2022,15(1-2), 208-232. DOI:10.1007/s12063-021-00178-z
22. Mahmoudi A, Deng X, Javed SA, Zhang N. Sustainable supplier selection in megaprojects through grey ordinal priority approach[J]. Business Strategy and The Environment, 2021,30(1), 318-339.https://doi.org/10.1002/bse.2623