Multi Factor Risk Assessment Algorithm in Digital Economy Platform

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Abstract: With the rapid development of the digital economy, the platform economy has become an important component of today's society. A digital economy platform refers to a form of economic activity that conducts transactions and provides services through online platforms. The platform economy has advantages such as efficiency, convenience, and openness, but it also faces risks such as data security, user privacy, and market competition. Therefore, how to effectively evaluate and manage risks in the platform economy has become an important issue in the field of digital economy. This article aimed to explore the application of multi factor risk assessment algorithms in digital economy platforms, in order to improve the risk management level of the platform and promote the healthy development of the platform economy. This article conducted research on user risk, internal risk, transaction risk assessment, and data security risk assessment. Through algorithm comparison and investigation, relevant data on internet digital platforms were obtained and the performance of evaluation algorithms was evaluated. Experimental data showed that the Relief algorithm performs best in enterprise competition risk classification, with an accuracy of 80% in data security, 79% in user trust, 84% in legal and regulatory accuracy, and 85% in talent and technology accuracy.

Keywords: Multi Factor risk, Evaluation Algorithms, Digital Economy, Risk Warning

1. Introduction

In the development process of the digital economy, risk assessment is an important link, and its importance is self-evident. The multi factor risk assessment algorithm provides certain assistance for enterprises when making online investment decisions, while also providing investors with a more accurate and efficient prediction method. By using a multifactor comprehensive evaluation method, a mathematical model is established to achieve quantitative processing of operational data and obtain objective digital information.

The digital economy is an emerging industry with high risk and huge market

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demand. Anna Mikhaylova considered digital supply management from the perspective of participating in international trade. He conducted an analysis of this concept (strengths and weaknesses, opportunities and threats) and studied the efficiency of the supply chain using digital technology. The increase in investment in supply chain management software has led to an increase in external traffic, which is related to the complexity and globalization of the supply chain, thereby improving the competitiveness of goods and services [1]. Vincenzo Iaia explored the interaction between copyright, contract freedom, and antitrust law in today's digital platform economy [2] . Saida Sultana stated that in order to adapt to the new creative era of continuous digital transformation, more and more industries are utilizing digital innovation to achieve sustainable business growth. On the basis of analysis, he conducted a detailed review of the systematic process of data-driven innovation development. Data driven innovation involves a standardized seven step process that includes product conceptualization, data collection, data extraction, data storage and retrieval, distribution, demonstration, and market feedback [3]. This article mainly introduced the application of entropy weight algorithm in the digital economy platform and evaluates the risks in the digital economy.

This article first provided a theoretical description and methodological exploration of risk assessment calculation methods, and then analyzed the role and advantages of multi factor assessment algorithms. Subsequently, the digital economy platform and its feature selection were introduced. Finally, an investigation was conducted on internet platforms and the performance of evaluation algorithms was compared, resulting in relevant data and results.

2. Multi Factor Risk Assessment Algorithm

2.1 Risk Assessment Calculation

The calculation of risk assessment refers to the process of analyzing, evaluating, and quantifying several factors [4-5]. In the risk assessment process, it is necessary to provide a comprehensive and scientific description of the reviewed system, and then establish an appropriate indicator system based on its characteristics. At this stage, it is necessary to consider several indicators, including their weights and the relationships between different factors. Multi factor risk analysis includes comprehensively determining the weight of each indicator. The entropy weight method is mainly used to determine the probability distribution eigenvectors of correlation matrices between different elements and provide approximate solutions to determine their meanings. The basic principle is to convert system information into a set of information, which is calculated, analyzed, and processed into sample set data. AHP (Analytical Hierarchy Process) refers to a comprehensive evaluation research method that considers information such as strong interdependence and relative independence between decision-makers and evaluated individuals, as well as the basic characteristics and attribute relationships of a system. Fuzzy hierarchical structure randomly classifies multiple factors in a matrix. Then, computer technology is used to create qualitative and quantitative evaluation models to calculate the membership relationships and weight distribution between individual individuals. Subsequently, the risk assessment results are determined and potential influencing factors and their

weights were analyzed. Multi factor quantitative evaluation mainly targets different types of datasets. For the uncertain digital economy, a combination of qualitative and quantitative analysis can be used to analyze the problem.

When calculating risk assessment, it mainly consists of two levels. On the one hand, it is necessary to analyze the operational status of the digital economy platform system in order to obtain necessary data. The second is to determine the likelihood of risk occurrence by collecting information. It is necessary to define appropriate indicator systems and mathematical models at the basic level, and use entropy method to obtain relevant matrix values, which are then converted into vector values required for evaluating the results. The second and third level indicators provide information on parameters such as risk size and weight based on two different level standards. Risk assessment calculation is the core part of the digital economy platform, which can not only predict and estimate potential uncertainties in the future, but also find suitable solutions in different types of systems. By analyzing historical data, the correlation and relationship between different indicators can be obtained. By using mathematical models to calculate the weights, comprehensive scores, and other quantitative evaluation and ranking information of various factors, it is possible to determine whether the decision plan requires action.

2.2 Multi Factor Evaluation Algorithm

The multi factor risk assessment algorithm is a risk assessment method based on data and models [6-7]. This algorithm uses mathematical models to evaluate and predict risks by collecting and analyzing platform data. Its main advantage is that it can consider several factors simultaneously. In digital business platforms, the application of multi factor risk assessment algorithms is mainly manifested in the following fields:

Multi factor risk assessment algorithms play an important role in user risk assessment [8-9]. Digital economy platforms often face a large amount of data about user behavior and transactions, and traditional risk assessment methods usually only focus on specific behavioral factors of users, which cannot fully evaluate their situation [10-11]. By monitoring the data in the platform in real-time, potential risk factors can be identified in a timely manner and the likelihood of risk occurrence can be reduced in the event of early warning. By analyzing several factors such as user historical behavior, personal data, and transaction data, the credit and fraud risks of users can be evaluated. This helps the platform monitor risky users and prevent issues such as incorrect transactions, fraudulent behavior, and money laundering. This is also very important in internal risk assessment. For digital economy platforms, there are also risks to the behavior of internal employees [12-13]. Traditional risk assessment methods usually only consider specific behavioral indicators of employees and cannot fully assess their risk level. It monitors employee behavior patterns, authorized usage, and other factors to immediately identify and prevent internal risks such as data loss and illegal activities. It can analyze platform data, identify potential risk factors, support platform management decisions, and develop appropriate risk control strategies. Digital economy platforms typically involve a large number of transactions, and traditional risk assessment methods typically only consider personal factors such as transaction amount or frequency, which cannot comprehensively assess the level of risk in transactions [14-15]. The multi factor risk assessment algorithm can consider

factors such as transaction amount, frequency, and geographical location to identify risky transactions, and take appropriate measures, such as manual verification and mandatory authentication. The digital economy platform needs to process a large amount of user data and sensitive information, in order for evaluation algorithms to analyze factors such as data access rights and network security measures, so as to assess the risks of data loss and hackers, and propose appropriate security recommendations and measures. For digital economy platforms involving supply chains, when evaluating supply chain stability and predicting potential supply chain risks, factors such as supplier credit status, supply capacity, and production environment would be fully considered [16-17]. By analyzing multiple factors, different risks on the platform can be effectively identified and evaluated, and platform managers can take timely and appropriate actions to reduce the likelihood of risk occurrence and protect the interests of users and the platform.

3. Risk Assessment in Digital Economy Platforms

3.1 Digital Economy

The rapid development of the digital economy has led to the emergence of the platform economy as a new form of industrial organization [18-19]. However, with the rapid development of internet platforms, their market structure has gradually evolved into a competitive effect: the winner takes all, and the stronger would become stronger. The frequency of platform monopoly phenomenon affects the sustainable and healthy development of the digital economy [20]. The existence of monopoly on digital economy platforms not only damages the health and sustainable environment of digital economy platform development, but also damages the welfare and efficiency of multi-party production. Platform monopoly is mainly caused by the network externalities between users, that is, in a multilateral market, the interests of one user are proportional to the size of another user. Due to the size of the existing market, platform companies can increase user stickiness and continuously attract new users, thereby creating monopolies. Market structure is usually an important indicator determining the degree of monopoly in an industry. Market concentration is an important quantitative indicator for measuring market power within an industry, typically represented by market share analysis.

There are two network effects in the platform economy market. One is that the utility value of users increases as the number of users increases, and the other is that the utility on one side of the platform increases as the number of other users increases. The economies of scale, coverage, and user responsibility have also increased the concentration of the platform market to a certain extent, thereby weakening the possibility of large internet platform competitors expanding or even entering the market. In the era of digital economy, due to factors such as technology, economy, and strategy, small and medium-sized enterprises face some market entry barriers compared to large internet platforms. There are two main technical barriers to entering the digital economy platform: one is digital analysis technology, and the other is a lack of digital talent. Whether traditional digital enterprises or new internet platform enterprises, in order to enter the internet industry and stabilize production, they must invest a large amount of funds in the long term. Due to insufficient income

and solvency, small and medium-sized enterprises find it difficult to obtain direct financing. Large internet platforms prioritize market dominance due to their technological and time advantages. In order to further segment the market and generate more monopoly profits, the platform is using algorithms to create hidden protocols, disrupt fair competition in the digital economy and set obstacles for entering the industry.

3.2 Feature Selection

When establishing a multi factor risk assessment model, it is necessary to determine the correlation between various factors in the multi-level indicator system. The correlation coefficient matrix between various indicators can be calculated based on the correlation degree formula. Due to the differences in multiple sub comprehensive indices corresponding to each evaluation factor, it is necessary to analyze each evaluation factor. Feature selection is the process of obtaining the optimal feature subset from the original feature set. The method of selecting features after filtering is usually used as a data preprocessing step. In practical feature selection problems, filtering feature selection algorithms are favored due to their high efficiency and good performance. This algorithm has the advantages of simplicity, ease of use, and fast computation. The symbol of the sliding threshold function moves the decision limit of a single feature classifier, taking the feature values of all samples as the score of each sample. Random forests use decision trees as the basic classifier to form a subset of samples, and then coordinate to receive the final classification results. The Minimum Redundancy Maximum Relevance (mRMR) algorithm reduces computational complexity to a certain extent. For two random variables M and N, the mutual information calculation method is:

$$I(M;N)=\sum_{m\in M}\sum_{n\in N}q(m,n)\log\frac{q(m,n)}{q(m)q(n)} \tag{1}$$

T represents the set of currently selected features, and D represents the class label. The correlation is expressed as:

$$x(T,d)=\frac{1}{|T|}\sum_{M\in T}I(M,D) \tag{2}$$

Redundancy is expressed as:

$$R(T)=\frac{1}{|T|^2}\sum_{M_i,M_k\in T}I(M_i,M_k) \tag{3}$$

AHP is a mathematical model that transforms multi-objective decision-making problems into multiple factors and quantifies them through methods such as decomposition, comparison, and evaluation. Using this method, elements with specific features or attributes can be divided into multiple indicators in complex systems. Firstly, the influencing factors are disseminated and quantified, and then a hierarchical model is constructed using mathematical models to establish connections

between different elements. Afterwards, each solution is solved by constructing corresponding weight vectors based on the actual situation, ultimately leading to a more reasonable evaluation result. The hierarchical analysis method decomposes several objective indicators into relatively independent factors, which are paired and compared to determine the total share of each element in each level, and then standardized. If there is a certain connection between different elements of the system, it is called a hierarchical sequence.

The large amount of data involved in digital economy platforms may face security risks, such as leaks, hacker attacks, and data abuse. These risks may lead to the theft of users' personal data, causing significant losses to users, businesses, and society. The success of digital economy platforms is closely related to the trust of users in the platform. However, some platforms may have the risk of false advertising, dishonest behavior, fraud, and even leakage, damaging the trust of users and their use and promotion of the platform. Competitors can challenge the platform's position through low prices, high quality, and innovation. The platform must continuously improve its competitiveness, otherwise it may be marginalized by the market. The operation of the platform includes many laws, regulations, and regulatory guidelines, and must comply with relevant regulations, otherwise it may face risks such as administrative penalties and legal litigation. The platform also requires a stable technical team and professionals to address the challenges of technological innovation and system modernization. If the platform is unable to attract and retain top talents, or if the technical level does not meet market demand, there may be operational problems. Therefore, this article proposed risk assessments for data security, trust, competition, law and regulation, talent, and technology.

3.3 Survey of Internet Platforms

Using computer software, the input-output index data of 20 selected internet platform enterprises were calculated to obtain the overall and industry specific changes in comprehensive technical efficiency, pure technical efficiency, and scale efficiency. The efficiency changes of internet platforms are shown in Table 1.

Table 1. Overall efficiency of Internet platform enterprises

	Comprehensive technology	Pure technology	Scale
2016	0.87	0.93	0.94
2017	0.95	0.96	0.99
2018	0.86	0.91	0.95
2019	0.90	0.92	0.97
2020	0.94	0.96	0.98

The overall technical efficiency of internet platform companies is not high, and the overall utilization rate of industry resources is low, leading to a certain degree of resource waste or efficiency loss. Both pure technical efficiency and scale efficiency have not reached effective efficiency values, resulting in efficiency losses, indicating that resource allocation and investment scale need to be improved. Internet platform companies should pay more attention to improving resource allocation management, rather than investing excessively in resources, which would more effectively improve the overall efficiency level.

Life services, technological innovation, and media entertainment platforms are the

three major platforms of the Internet. This article calculated the input-output indicators and obtains the relevant efficiency changes of various internet platform industries.

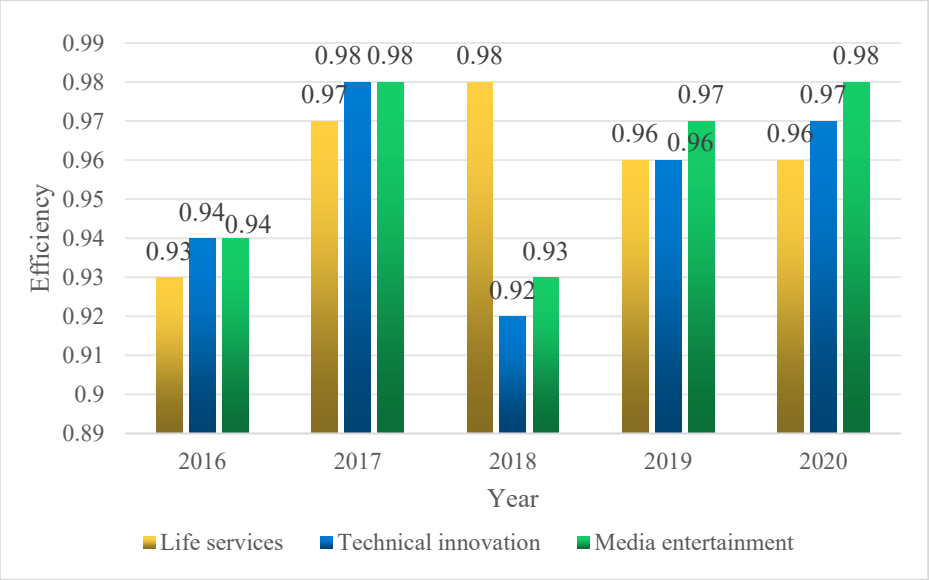

Fig. 1. The average change trend of the industry scale and efficiency of the Internet platform

In Fig. 1, the average trend of scale efficiency in various industries of internet platforms was basically the same. Internet media and entertainment platforms experienced the largest decline in scale efficiency between 2017 and 2018, with a scale efficiency of over 0.95 for three years. Compared to life services, the technology innovation platform and internet media entertainment platform in 2018 had greater room for scale and efficiency improvement, and it is necessary to continuously optimize the input-output allocation of resources.

Fig. 2. Confirmatory factor analysis of digital market exploration

The reliability of the digital market exploration portfolio is good, and the digital market exploration scale has good convergence validity. In Fig. 2, the highest goodness of fit value was 0.99, and the maximum factor load was 0.88.

3.4 Experimental Comparison

This article used the mRMR, relief, and random forest algorithms mentioned earlier to conduct a detailed analysis of common risks in the digital economy such as data security, user trust, enterprise competition, laws and regulations, and talent technology. By collecting data from previous digital economy platforms and conducting experiments using these three algorithms, the accuracy of determining relevant risk factors was obtained.

4. Comparison of Evaluation Algorithms

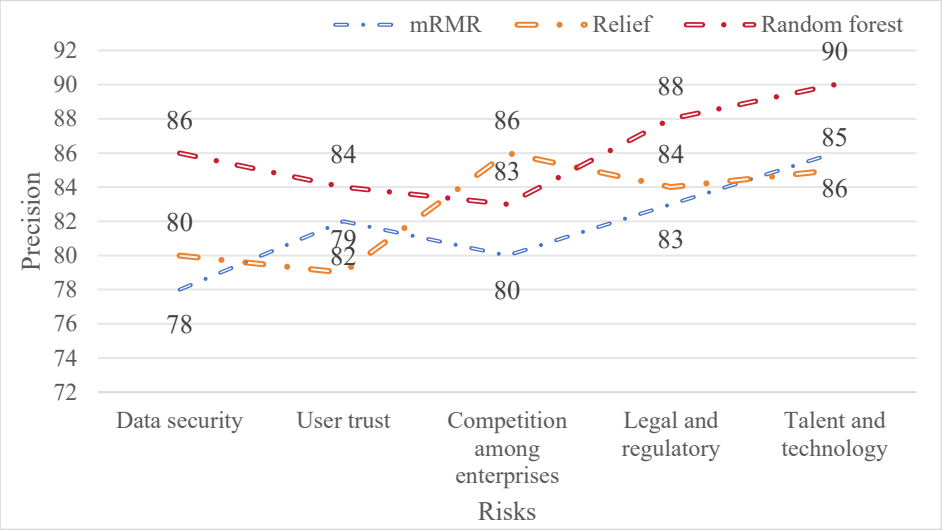

Fig. 3. Precision analysis of the risk classification

In Fig. 3, the mRMR algorithm performed average in risk classification accuracy, with the best performing in talent and technology risk classification and the worst performing in data security. Random forests perform relatively best. Among them, the accuracy of risk classification for talent and technology was the highest (90%), and the performance of enterprise competition was the worst (83%).

In Fig. 4, the performance of entropy weight method in data security, trust, competition, law and regulation, talent and technology risks was gradually strengthening, and the accuracy of talent technology risk assessment was the highest, at 96%. The performance of the AHP method was slightly better than that of the entropy weight method, with an accuracy of 92% in data security evaluation. The best performing method was risk assessment at the level of enterprise competition. The overall accuracy of the multi factor analysis method was the highest, with the lowest accuracy of 93% and the highest accuracy of 99%.

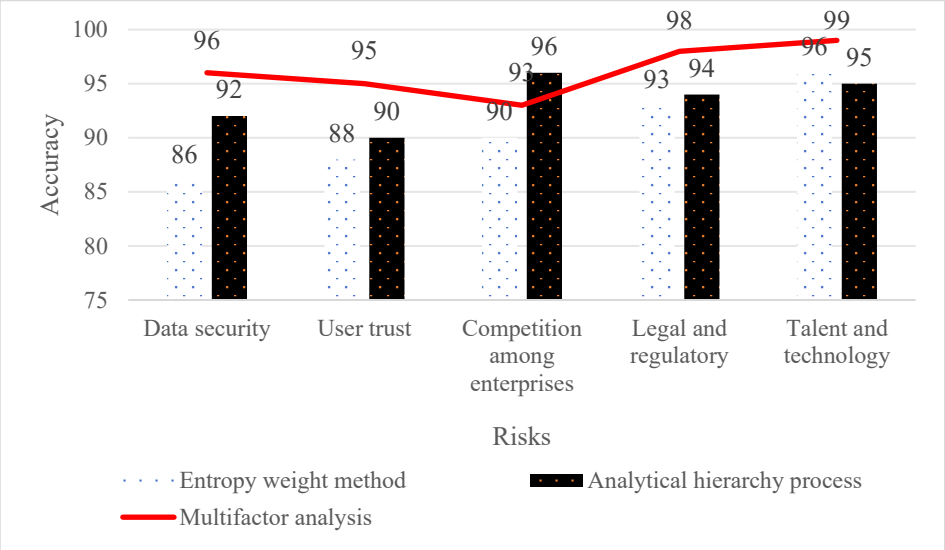

Fig. 4. Accuracy analysis of the different assessment algorithms

5. Conclusions

This article analyzed the multi factor risk assessment methods in the digital economy platform and proposed a fuzzy comprehensive evaluation model based on probability distribution, taking into account the current market environment. The multi factor risk assessment algorithm has broad application prospects in digital economy platforms. By comprehensively considering multiple factors, various risks can be more accurately and comprehensively evaluated, and platform managers can take corresponding measures in a timely manner to reduce the likelihood of risk occurrence and protect the interests of users and the platform. The performance of multi factor risk assessment algorithms was relatively good in digital economy platforms. However, in practical applications, due to limitations in data collection, transmission, and storage, it is not possible to fully meet its characteristics, so multiple indicators need to be combined.

References

[1] Anna Mikhaylova, Tatyana Sakulyeva, Tamara Shcherbina, Natalia Levoshich, Yuri Truntsevsky:Impact of Digitalization on the Efficiency of Supply Chain Management in the Digital Economy. Int. J. Enterp. Inf. Syst. 17(3): 34-46 (2021)

[2] Vincenzo Iaia:The remodelled intersection between copyright and antitrust law to straighten the bargaining power asymmetries in the digital platform economy. Int. J. Law Inf. Technol. 29(3): 169-203 (2021)

[3] Saida Sultana, Shahriar Akter, Elias Kyriazis, Samuel Fosso Wamba:Architecting and Developing Big Data-Driven Innovation (DDI) in the Digital Economy. J. Glob. Inf. Manag. 29(3): 165-187 (2021)

[4] Ben Green, Yiling Chen:Algorithmic Risk Assessments Can Alter Human Decision-Making Processes in High-Stakes Government Contexts. Proc. ACM Hum. Comput. Interact. 5(CSCW2): 418:1-418:33 (2021)
[5] A. Sheik Abdullah:Assessment of Risk Factors in Medical Data Using Improved Binary Artificial Fish Swarm Algorithm With Classification Upon Evaluation From F-Test. Int. J. Swarm Intell. Res. 13(1): 1-26 (2022)
[6] Mohsen Abbaspour Onari, Samuel Yousefi, Mustafa Jahangoshai Rezaee:Risk assessment in discrete production processes considering uncertainty and reliability: Z-number multi-stage fuzzy cognitive map with fuzzy learning algorithm. Artif. Intell. Rev. 54(2): 1349-1383 (2021)
[7] Riccardo Fogliato, Alexandra Chouldechova, Zachary C. Lipton:The Impact of Algorithmic Risk Assessments on Human Predictions and its Analysis via Crowdsourcing Studies. Proc. ACM Hum. Comput. Interact. 5(CSCW2): 428:1-428:24 (2021)
[8] Qianming Zhou, Jin Xie:Mobile client data security storage protocol based on multifactor node evaluation. J. Supercomput. 76(2): 1144-1158 (2020)
[9] Hui Kang, Jiajin Xu:A Multifactorial Analysis of Concessive Clause Positioning. J. Quant. Linguistics 28(4): 356-380 (2021)
[10] J. Fahey-Gilmour, B. Dawson, P. Peeling, J. Heasman, B. Rogalski:Multifactorial analysis of factors influencing elite Australian football match outcomes: a machine learning approach. Int. J. Comput. Sci. Sport 18(3): 100-124 (2019)
[11] Philip L. Frana:Demographics, Inc., Computerized Direct Mail, and the Rise of the Digital Attention Economy. IEEE Ann. Hist. Comput. 45(2): 15-28 (2023)
[12] Patanjal Kumar, Sachin Kumar Mangla, Yigit Kazançoglu, Ali Emrouznejad:A decision framework for incorporating the coordination and behavioural issues in sustainable supply chains in digital economy. Ann. Oper. Res. 326(2): 721-749 (2023)
[13] Mehdi Kargar:Enhancing knowledge accessibility in digital economy with search over enterprise data. Pers. Ubiquitous Comput. 27(4): 1645-1652 (2023)
[14] Rui Pedro Silva, Henrique S. Mamede:The Role of the Digital Economy in Market Disruption: Analyzing a Case Study That Demonstrates the Role of New Digital Base Entrants. Int. J. Innov. Digit. Econ. 13(1): 1-13 (2022)
[15] Henry Chima Ukwuoma, Ifeanyi Solomon Williams, Ibrahim Dinju Choji:Digital Economy and Cybersecurity in Nigeria: Policy Implications For Development. Int. J. Innov. Digit. Econ. 13(1): 1-11 (2022)
[16] Liliya Satalkina, Lukas Zenk, Gerald Steiner:Transdisciplinary multistage system modeling: migrant entrepreneurship in the digital economy. Kybernetes 51(13): 219-240 (2022)
[17] George Zarkadakis:Toward Emancipation Through a Regenerative Digital Economy. IEEE Technol. Soc. Mag. 41(2): 111-112 (2022)
[18] Miroslav Tushev, Fahimeh Ebrahimi, Anas Mahmoud:A Systematic Literature Review of Anti-Discrimination Design Strategies in the Digital Sharing Economy. IEEE Trans. Software Eng. 48(12): 5148-5157 (2022)
[19] E. N. Chizhikov, A. A. Gorbunov, A. S. Belov, E. L. Trakhinin, D. V. Stavitskii:Theoretical Approach for Evaluating the Connectivity of Distributed Systems and Telecommunications for the Digital Economy. Autom. Control. Comput. Sci. 55(8): 1149-1152 (2021)
[20] Nikolaos Laoutaris, Costas Iordanou:What do information centric networks, trusted execution environments, and digital watermarking have to do with privacy, the data economy, and their future? Comput. Commun. Rev. 51(1): 32-38 (2021)