Artificial Intelligence, Medical Engineering and Education
Z.B. Hu et al. (Eds.)

doi:10.3233/ATDE231319

Technical Scheme for Optimizing Urban and Rural Logistics Operations and Improving the Informatization of Rural Logistics

Zhong ZHENG[a,b], Wanxian HE[c,1], Ganglan WEI[d]
[a] *College of Business, Nanning University, Nanning, China*
[b] *King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand*
[c] *Artificial intelligence Research Institute, Guangxi Academy of Sciences, Nanning, China*
[d] *Administration Section, Guangxi Mingyang Farms, Nanning, China*

Abstract. In order to optimize the core problems encountered in the operation of urban and rural logistics and improve the informatization degree of rural logistics, the authors of this paper conduct research on the application of big data, cloud computing, and other technologies in urban and rural logistics and informatization. Based on the current problems, the authors adopt the hierarchical design, C/S architecture, and cloud API technology to improve the low level of informatization in urban and rural logistics, as well as optimize the dispersion and repetitive construction of logistics resources for logistics enterprises in urban and rural areas. Overall, a feasible sharing technology solution for urban-rural logistics informatization has been provided, providing a certain reference for optimizing urban-rural logistics operations and improving rural informatization issues.

Keywords. Urban and rural Logistics; Big data; Cloud computing; Informatization

1. Introduction

With the continuous development of China's economy and society, the rapid advancement of urbanization and industrialization, and the comprehensive development of rural revitalization strategy, opening the two-way circulation channel of "industrial products going to the countryside and agricultural products entering the urban" has become a hot spot of attention of theoretical circles and practical managers. More and more experts, scholars, and industry enterprise managers have accumulated certain achievements in theoretical and practical research on the integration mode and technology of urban and rural logistics.

In terms of theoretical research, experts analyze the development model, necessity, and effectiveness of urban and rural logistics service systems from a macro perspective. And experts analyze the characteristics of urban-rural logistics in the context of the new era, explore the driving force of urban-rural logistics integration, study the construction

[1] Corresponding Author: Wanxian HE, E-mail: hewx2022@163.com.

of new models of urban-rural logistics [1-3]. And focus on the research of information technology on the innovation of urban and rural logistics modes in the context of the Internet age. and analyze the effect of integrated services of urban and rural logistics [1, 3, 4]. There are experts based on the consumption of residents and urban and rural logistics needs for analysis [5]. In terms of resource allocation, many experts have studied the problems in the allocation of urban and rural logistics resources and proposed solutions [6-7]. At the same time, many experts put forward suggestions on the application of information technology such as big data and blockchain to cope with the development of urban and rural logistics and achieved certain results [8-12].

In the process of industrial development and practical application, large enterprises such as ZTO Express, JD.com, and Cainiao (A logistics brand) have laid out the integrated operation of urban and rural logistics [13]. By empowering the supply chain logistics and e-commerce platform in both directions, ZTO Express innovates the "express + e-commerce" model deeply in the origin and provides services such as setting up express stations, centralized receipt and delivery, direct distribution special lines, and e-commerce sales in rural areas. JD Logistics continues to improve its infrastructure construction, promote the sinking of its logistics network, and have achieved the coverage of large and small item networks in all administrative regions and counties in mainland of China. Cainiao proposed the concept of "technology going to the countryside", hoping to use a series of "feasible and user-friendly" technologies to digitize rural outlets, fill the gaps in rural logistics, activate rural market consumption power, and boost the rural economy.

The main research of experts is focused on the macro level, and the research on specific technology applications is not in-depth enough, and the research on key technologies is still in the initial stage. In terms of industrial applications, major enterprises are also beginning to lay out the integration of urban and rural logistics, and the development of urban and rural logistics integration has urgent needs and broad market space.

Based on current theoretical research and industry operations analysis, the core issues encountered in urban and rural logistics operation include three aspects. First, the degree of information is low. At present, logistics in counties, townships, and villages mainly exist in the form of franchises, with a relatively small operating entity and a lack of motivation for logistics informatization. Moreover, there is a lack of investment in logistics technology research and development, resulting in a relatively low level of logistics informatization in urban and rural areas. The data structure of logistics systems adopted by different franchised logistics enterprises is different, the information level is different, and the knowledge representation is not uniform. The inability to use semantic information systematically is an urgent problem for the efficient development of urban and rural logistics. Secondly, it has high costs, low efficiency, and slow delivery time. The delivery time is generally 4-5 days, which is a significant difference compared to 2-3 days for urban delivery. It is difficult to return or exchange goods, and the challenges faced include low volume, low profits, high costs, and high seasonal fluctuations, which make it difficult for express delivery to enter the village. Thirdly, the integration of resources is weak, making it difficult to achieve economies of scale. However, currently in China, rural logistics resources and businesses are scattered, with duplicate construction and a self-contained system. The current model is difficult to sustain, mainly due to the inability to balance costs and benefits well, and enterprises cannot proceed without subsidies. Rural areas are vast and different from urban centralized residences, the logistics business in rural areas is relatively scattered, the frequency of orders is low, and the integration of resources is small and cannot play the scale economy, which are important reasons for the high cost of urban and rural logistics. Therefore, it is necessary to effectively integrate urban and rural logistics resources.

To solve the above problems, there is a need for a platform that can collect the overall resource information of urban and rural logistics enterprises, including the size of enterprises, regional distribution, and the amount of logistics assets invested [6,13]. At the same time, it is necessary to collect information on the logistics needs of each township, as well as information on the unique products and material needs of each township. By collecting and analyzing information to provide appropriate feedback to logistics enterprises and urban and rural residents.

In this way, on the one hand, it is possible to analyze the overall distribution of logistics and determine how to optimize and dispatch logistics resources overall. On the other hand, logistics companies can understand the logistics and material needs of various regions and consider whether they need to invest in adding post stations, logistics personnel, etc. based on their own enterprise situation. At the same time, urban and rural residents can also choose appropriate logistics methods based on their own needs by understanding the distribution of logistics resources, prices, timeliness, and other information. By showcasing the local specialties and material needs of townships, to some extent, it can also stimulate consumption and increase logistics demand. Guided by this idea, the authors of this paper study the application of big data [14-16], cloud computing [17-19], and other technologies in urban and rural logistics and informatization and propose a technical scheme to optimize urban and rural logistics operations and improve rural logistics informatization.

2. The Application of Big Data and Cloud Computing Technology in Urban and Rural Logistics and Rural Informatization

2.1. Big Data and Cloud Computing Technology

The most obvious feature of big data is "large". From a technical point of view, the problems that big data can solve are divided into three main aspects: effective management of data, data analysis, and data application. Data management involves operations such as data collection, cleaning, storage, and security. Data analysis mainly involves performing specific operations on data based on scenarios, which is also the process of achieving data value. The application of data depends on the export of big data applications, such as analyzing and screening out useful information for logistics enterprises and individuals from a big number of logistics information and providing external output.

Cloud computing is an emerging method of shared infrastructure that unifies the management of a mass of physical resources and virtualizes them, forming a huge pool of virtualized sources. Cloud computing is an emerging method of shared infrastructure that unifies the management of lots of physical resources and virtualizes them, forming a huge pool of virtualized sources. The cloud is a quasi-parallel and distributed system consisting of clusters of virtual computers that can be interconnected. These dynamically deployed virtual machines exist as unified computing resources and comply with service-level agreements.; Online games; Online medical care; Transportation logistics; Financial investment. Other aspects such as smart home, storage of video data, but also remote dialogue, monitoring, and so on.

2.2. The Application of Big Data and cloud Computing Technology in Urban and Rural Logistics and Rural Informatization

The application of big data and cloud computing technology in urban and rural logistics and rural logistics informatization is aimed at the low degree of urban and rural logistics informatization. The purpose is to design a cloud data center for information storage, analysis, and processing, as well as a rural APP for information collection and sharing for individual users. Through the rural APP, individual users can register and upload personal basic information, submit daily logistics demand information, retrieve personal scarce items information, etc. Cloud data centers can use big data technology to store, clean, analyze, mine, predict and other processing of these data. At the same time, the cloud data center uses cloud computing technology to provide cloud API interface services to various logistics enterprises. Logistics enterprises can access the cloud data center through the cloud API, upload the resource information of logistics enterprises, seek or provide logistics sharing information, and retrieve potential logistics business information, so as to optimize the logistics resources in urban and rural areas and improve the low degree of information technology in rural logistics.

From the concept design, system architecture design, and system module design of the system, the authors of this paper will elaborate on how to use big data and cloud computing technology to design a technical scheme to optimize the operation of urban and rural logistics and improve the informatization degree of rural logistics.

3. Urban and Rural Logistics Information Sharing Technology Scheme Based on Big Data and Cloud Computing Technology

3.1. Conceptual Design of the System

The Conceptual design of urban and rural logistics information system is shown in Figure 1.

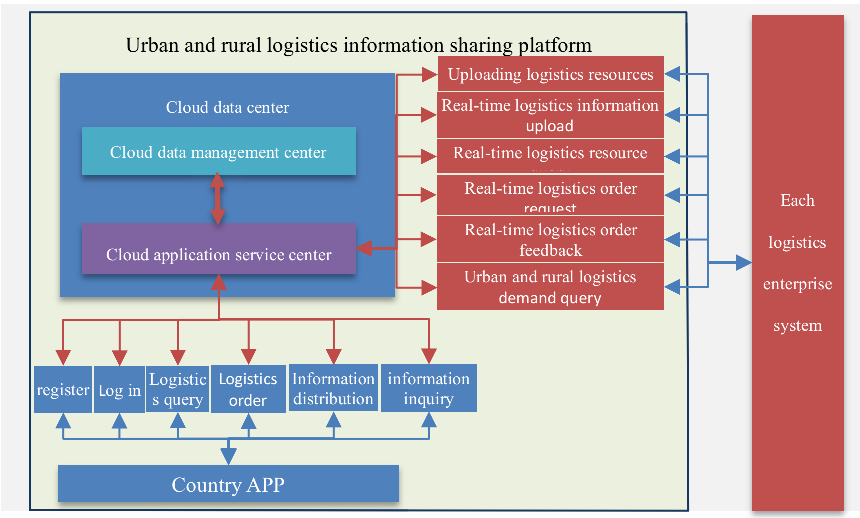

Figure 1. System deployment architecture diagram

3.1.1. Deployment Architecture Design

First, from the perspective of deployment architecture, the objects involved in this technical solution are: cloud data center, rural app, logistics enterprise system. A cloud data center includes a cloud data management center and a cloud application service center.

1) Cloud data center: using big data technology to store, clean, analyze, mine, forecast, and other processes of these data, and providing external cloud computing application services.

2) Rural APP: Completing registration and uploading personal basic information, submitting daily logistics demand information, searching for personal scarce item information, and other functions.

3) Enterprise logistics system: Accessing cloud data centers through cloud APIs, uploading resource information of logistics enterprises, and seeking or providing logistics sharing information, searching for potential logistics business information, etc.

3.1.2. Functional Design

Table 1. Function design of the system

System name	subsystem	Modular function	Functional Description
Urban and rural logistics information sharing platform	Cloud data center	Cloud data management center	Use big data technology to store, clean, analyze, mine and predict these data
		Cloud application service center	Provide registration interface for app
			Provide login interface for app
			Provide logistics query interface for app
			Provide logistics order interface for app
			Provide an information query and browsing interface
			Provide an information publishing interface for app
			Provide logistics resources upload cloud api for enterprises
			Provide real-time logistics information upload cloud api
			Provide real-time logistics resource query cloud API
			Provide real-time logistics order request cloud api for logistics enterprises
			Provide real-time logistics order feedback cloud api for logistics enterprises
			Provide cloud api for logistics enterprises to query urban and rural logistics demand
	Country APP	Register	Through the registration interface
		Log in	Through the login interface
		Logistics query	Through the logistics query interface
		Logistics order	Through the logistics order interface
		Information release and display	Through the information release interface
		Information retrieval browsing	Browse interface through information query
		Other functions	

The function of the system includes cloud data center and country APP, as Table 1 shown.

3.2. System Architecture Design

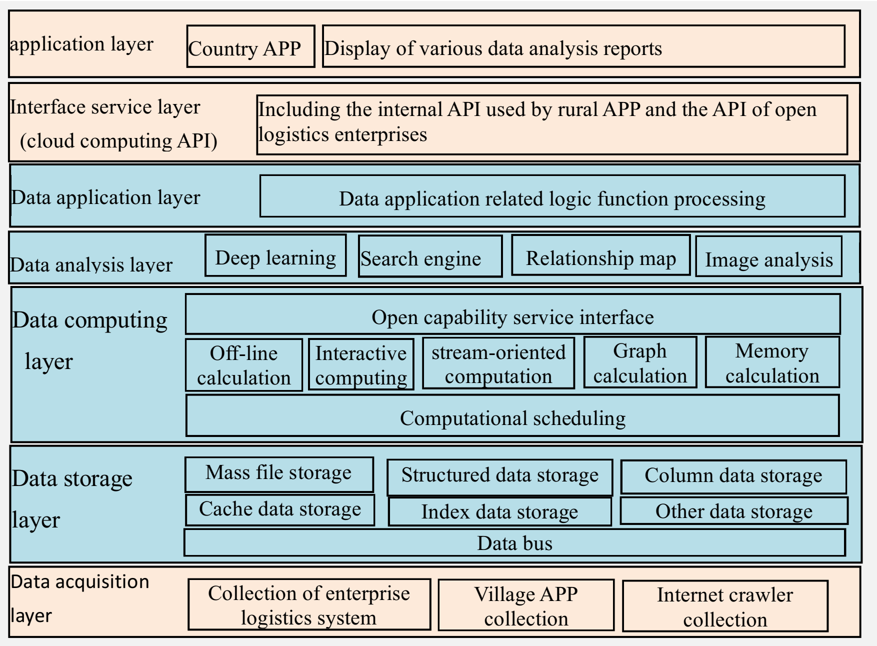

Figure 2. System architecture diagram

As shown in the figure 2 above, the overall hierarchical design method is adopted, and the interaction between the server and the app client is built using the C/S architecture. Referring to the big data technology architecture design, it is divided into interface service layer, data application layer, data analysis layer, data calculation layer, data storage layer and data acquisition layer.

1) Data collection layer: Mainly collecting information on logistics enterprises, logistics and material demand information of urban and rural residents;

2) Data storage layer to data application layer: It is a general big data technology architecture reference structure level to complete big data-related technical functions;

3) Interface service layer: Completing the interface functions of logistics enterprises and rural apps.

4) Application layer: rural app client and various report displays.

3.3. System Module Design

Since the data storage layer to the data application layer is a general big data technology architecture reference structure level to complete big data-related technical functions, this chapter mainly introduces the data acquisition layer, interface service layer, and application layer.

3.3.1. Data Collection Layer and Application Layer

The data acquisition layer is mainly concentrated in the rural APP and the system of various logistics enterprises that access the cloud API, and the interface design involving the front end is also the main part of the application layer of the system. The basic logic follows. As shown in Figure 3.

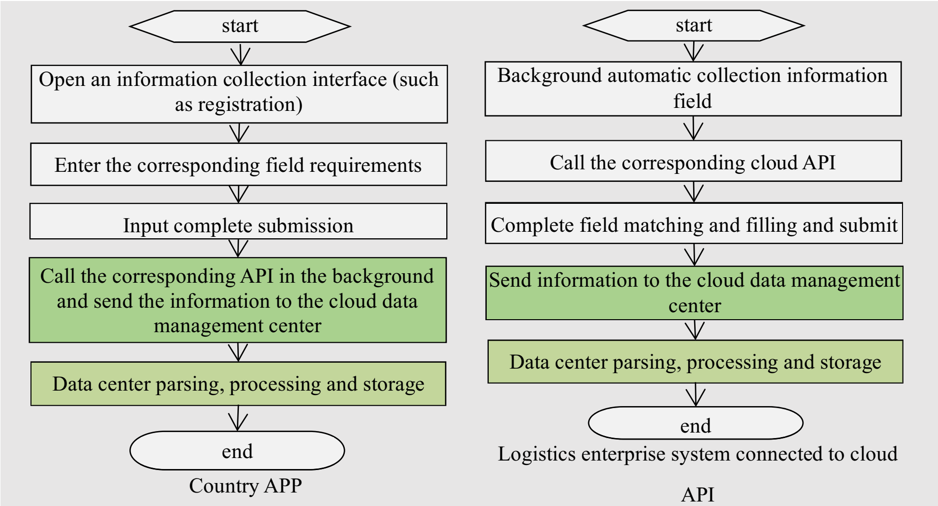

Figure 3. Data Acquisition Layer and Application Layer

3.3.2. Interface Service Layer

Logistics enterprise system parameter design is shown in Table 2- Table 13.

1）Logistics Resources Upload Cloud API, using http-post mode, input parameter：

Table 2. Logistics Input Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Name of logistics enterprise	Logistics Name	String	Y	
Enterprise taxpayer identification number	Tax ID	String	Y	
Brief introduction of logistics enterprises	Logistics Info	String	N	
Ordinary express unit price	Regular Price	Float	Y	Yuan
Unit price of heavy-duty express delivery	Weight Price	Float	Y	Yuan/kg
Number of post stations	Delivery Station Num	Int	Y	
Number of vehicles transported by enterprises	Vehicles Num	Int	Y	
Post distribution information	Delivery Station Info			Json array

Return parameter:

Table 3. Logistics Return Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Success or Fail	Success	Int	Y	0-Success，1-Failure
Cause of failure	Error Msg	String	N	Cause of failure

2）Real-time Logistics Information Upload Cloud API, using http-post mode, input parameter：

Table 4. Real-time Logistics Information Upload Cloud API Input Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Name of logistics enterprise	Logistics Name	String	Y	
Enterprise taxpayer identification number	Tax ID	String	Y	
Station number	Delivery Station ID	String	Y	
Post address	Delivery Station Addr	String	Y	
Type and quantity of inventory information	Goods Type Num	Int	Y	
Inventory information	Goods Info			Json array

Return parameter:

Table 5. Real-time Logistics Information Upload Cloud API Return Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Success or Fail	Success	Int	Y	0-Success，1-Failure
Cause of failure	Error Msg	String	N	Cause of failure

3）Cloud Resource Query Interface (API) initiated by Cloud Center, adopts http-get mode, input parameter：

Table 6. Cloud Resource Query Interface (API) Input Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
The sender's address	Sender Addr	String	Y	
Address of the recipient	Recipient Addr	String	Y	

Return parameter:

Table 7. Cloud Resource Query Interface (API) Return Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Success or Fail	Success	Int	Y	0-Success，1-Failure
Cause of failure	Error Msg	String	N	Cause of failure
Specific logistics information	Logistics Info		N	

4）The Cloud Center initiates a single-interface Cloud API under the logistics, using the http-post mode, input parameter：

Table 8. Cloud Center initiates a single-interface Cloud API Input Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Order request number	Order ID	String	Y	
The sender's address	Sender Addr	String	Y	
Address of the recipient	Recipient Addr	String	Y	

Table 8. Cloud Center initiates a single-interface Cloud API Input Parameter (continued)

Parameter meaning	Parameter name	Type	Is it required	Explain
Address of the recipient	Tax ID	String	Y	
Post address	Delivery Station Addr	String	Y	
Station number	Delivery Station ID	String	Y	
Selected courier type	Delivery Type	Int	Y	Value: 1 is ordinary express, 2 is heavy express

Return parameter:

Table 9. Cloud Center initiates a single-interface Cloud API Return Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Success or Fail	Success	Int	Y	0-Success，1-Failure
Cause of failure	Error Msg	String	N	Cause of failure

5）Logistics enterprise orders Feedback Cloud API, using http-post mode, input parameter：

Table 10. Logistics enterprise orders Feedback Cloud API Input Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Request number	Order ID	String	Y	
Whether to take orders or not	Is Agreed	int	Y	Value: 1 agree to take the order, 0 disagree to take the order

Return parameter:

Table 11. Logistics enterprise orders Feedback Cloud API Return Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Success or Fail	Success	Int	Y	0-Success，1-Failure
Cause of failure	Error Msg	String	N	Cause of failure

6）Urban and rural logistics demand Query Cloud API, input parameter：

Table 12. Urban and rural logistics demand Query Cloud API Input Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
place name	Place Name	String	Y	It can be the name of a city, county, township, etc
Regional number	Place ID	String	Y	According to the national unified number

Return parameter

Table 13. Urban and rural logistics demand Query Cloud API Return Parameter

Parameter meaning	Parameter name	Type	Is it required	Explain
Success or Fail	Success	Int	Y	0-Success，1-Failure
Cause of failure	Error Msg	String	N	Cause of failure
Logistics demand	Logistics Needs	String	N	Average monthly logistics order volume and transaction amount, with the unit of RMB.
Local specialty products	SpecialProduct	String	N	List the top 5 items.

4. Conclusion

In order to optimize the core problems encountered in the operation of urban and rural logistics and improve the informatization degree of rural logistics, the authors of this paper carry out research on the application of big data, cloud computing, and other technologies in urban and rural logistics and informatization. In combination with the existing problems, hierarchical design, C/S architecture, and cloud API technology are adopted to improve the low degree of information technology in urban and rural logistics, and to optimize the dispersion and repeated construction of logistics resources in urban and rural areas. Overall, a feasible sharing technology scheme for logistics informatization in urban and rural areas is provided, and a certain reference for optimizing logistics operations in urban and rural areas and improving rural informatization is provided.

The shortcomings of this paper are that it is not designed in conjunction with a specific scenario, and there is a lack of specific data input. Therefore, the next step is to apply the system designed in this paper with actual cases and verify the effect through data input and calculation. And the design has not been implemented and ill-considered or the design is not ideal and needs to be more systematically studied and demonstrated.

Acknowledgment

This paper is supported by: Young and middle-aged teachers basic ability improvement project of Guangxi University “Research on Key Technologies of Urban and Rural Logistics Integration Operation Based on Big Data and Cloud Computing” (2023KY1862) and Guangxi Education Department teaching reform project(2022JGB440).

References

[1] Zhao Dongqiang. Construction of an Integrated Urban-rural Logistics Model in the Context of the Internet[J]. Journal of Commercial Economics.2020, (17):93-96.
[2] Wu Susu. Exploring and Promoting the Integrated Development of Urban and Rural Logistics Services[J]. Chinese Journal of Agricultural Resources and Regional Planning. 2022, 43(06):184+241.
[3] Dai Xiaoting & Hu Yongshi. Research on Measuring the Development Level of Urban Rural Logistics Integration[J]. Journal of Technical Economics & Management. 2021, (04):72-77.
[4] Ji Lianggang & Wang Jiahao. Research on the Integration Mode of Urban and Rural Commercial Circulation under the Background of "Internet ＋"[J]. Economy and Management. 2020,34(02):77-84.
[5] Zhao Xingjun & Lou Feng. Coupling and Coordination Analysis of Urban-rural Circulation Integration and Resident Consumption[J]. Journal of Commercial Economics.2022, (17):46-50.
[6] Zhang Mei. Research on Optimizing the Allocation of Urban and Rural Commercial Logistics Service Resources[J]. Journal of Commercial Economics.2020, (17):101-104.
[7] Li Ziyuan & Ge Xiaowei. Research on Reconstruction of Urban and Rural Commercial Circulation Network in the Big Data Era[J]. Journal of Commercial Economics. 2017, (17):15-17.
[8] Tao Juncheng, Pan Lin & Chu Yeping. Research on Reconstruction of Urban and Rural Logistics Network in the Era of Big data[J]. China Business and Market.2016,30(11):22-32. DOI: 10.14089/j.cnki.cn11-3664/f.2016.11.003.
[9] Chen Kun. The Impact of Internet Technology on the Integrated Development of Urban Rural Bilateral Commercial Circulation from the Perspective of Overall Planning[J]. Journal of Commercial Economics. 2022, (21):14-17.
[10] Zhang Yanling. The Impact of Urban-rural Information Integration on the Development of Integrated Logistics in the Context of Digital Rural Areas[J]. Journal of Commercial Economics. 2022, (13):175-178.

[11] Chien C F, Dauzère-Pérès S, Huh W T, et al. Artificial intelligence in manufacturing and logistics systems: algorithms, applications, and case studies[J]. International Journal of Production Research, 2020, 58(9): 2730-2731.
[12] Woschank M, Rauch E, Zsifkovits H. A review of further directions for artificial intelligence, machine learning, and deep learning in smart logistics[J]. Sustainability, 2020, 12(9): 3760.
[13] Boute R N, Udenio M. AI in logistics and supply chain management[M]//Global Logistics and Supply Chain Strategies for the 2020s: Vital Skills for the Next Generation. Cham: Springer International Publishing, 2022: 49-65.
[14] Halil ARSLAN, Mustafa YALCIN and Yasin ŞAHAN, "SBIoT: Scalable Broker Design for Real Time Streaming Big Data in the Internet of Things Environment", International Journal of Information Technology and Computer Science, Vol.13, No.4, pp.47-52, 2021.
[15] Asma Omri, Mohamed Nazih Omri, "Towards an Efficient Big Data Indexing Approach under an Uncertain Environment", International Journal of Intelligent Systems and Applications, Vol.14, No.2, pp.1-13, 2022.
[16] Iram Mehmood, Sidra Anwar, AneezaDilawar, IsmaZulfiqar, Raja Manzar Abbas, "Managing Data Diversity on the Internet of Medical Things (IoMT)", International Journal of Information Technology and Computer Science, Vol.12, No.6, pp.49-56, 2020.
[17] Rasim M. Alguliyev, Rashid G. Alakbarov, "Integer Programming Models for Task Scheduling and Resource Allocation in Mobile Cloud Computing", International Journal of Computer Network and Information Security, Vol.15, No.5, pp.13-26, 2023.
[18] S. Sureshkumar, G. K. D. Prasanna Venkatesan, R. Santhosh, "Detection of DDOS Attacks on Cloud Computing Environment Using Altered Convolutional Deep Belief Networks", International Journal of Computer Network and Information Security, Vol.15, No.5, pp.63-72, 2023.
[19] Prabhakara B. K., Chandrakant Naikodi, Suresh L., "Ford Fulkerson and Newey West Regression Based Dynamic Load Balancing in Cloud Computing for Data Communication", International Journal of Computer Network and Information Security, Vol.15, No.5, pp.81-95, 2023.