EAI Endorsed Transactions
on Scalable Information Systems
Research Article EAI.EU

Deep Learning Algorithm Aided E-Commerce Logistics Node Layout Optimization Based on Internet of Things Network

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Abstract

INTRODUCTION: In recent years, e-commerce has shown a booming trend. Influenced by e-commerce, people's logistics needs have also increased sharply in recent years.
OBJECTIVES: Research on the node layout and optimization of e-commerce logistics is conducive to improving the scientificity and rationality of logistics node layout, improving logistics distribution efficiency, reducing logistics distribution costs, and better meeting consumers' logistics needs. However, due to the unreasonable layout of logistics nodes in some areas, it has brought huge logistics cost investment to e-commerce companies, and also laid hidden dangers for the long-term development of e-commerce companies.
METHODS: Based on this, this paper studied the node layout and optimization of e-commerce logistics by using IoT big data and deep learning algorithms, and proposed an improved logistics node layout scheme based on IoT big data and deep learning algorithms. The experimental research was carried out from five aspects: the transportation cost of logistics, the efficiency of logistics distribution, the accuracy of logistics information transmission, the location and traffic conditions of logistics nodes, and the evaluation of the plan by e-commerce enterprises.
RESULTS: The research results showed that the improved logistics node layout scheme can improve the efficiency of logistics distribution by 3.69% and the accuracy of logistics information transmission by 4.34%, and can reduce the logistics transportation cost of e-commerce enterprises.
CONCLUSION: The node locations selected by the improved logistics node layout scheme are more reasonable, and e-commerce companies have higher evaluations of the improved logistics node layout scheme.

Keywords: IoT Big Data; Deep Learning Algorithm; E-commerce Logistics; Logistics Node Layout and Optimization; Improved Logistics Node Layout Scheme

Received on 27 February 2023, accepted on 18 April 2023, published on 12 May 2023

doi: 10.4108/eetsis.v10i3.3089

1. Introduction

The rapid development of the economy has spawned a large number of logistics demands, which puts forward higher requirements for the logistics supply capacity of e-commerce companies. In order to better meet people's logistics needs, e-commerce enterprises should actively study the layout and optimization of logistics nodes. For e-commerce enterprises, a reasonable logistics node layout scheme can improve the utilization efficiency of logistics resources, reduce the layout cost of logistics nodes, reduce the transportation cost between logistics demand points and logistics nodes, and reduce the management cost of logistics nodes. Therefore, this paper conducts research on the layout and optimization of e-commerce logistics nodes based on IoT big data and deep learning algorithms.

The rationality and subsequent optimization of logistics node layout can improve the logistics efficiency of e-

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commerce and create more economic profits for enterprises. Many scholars have invested in the research work on the layout and optimization of e-commerce logistics nodes. He L Z established a rural three-level logistics node layout model. The genetic algorithm was used to solve the model, and it was verified that the model has strong operability and applicability for the "up" problem of fresh fruit and vegetable products [1]. Pathakota P conducted research on the layout and optimization of e-commerce logistics nodes based on machine learning algorithms.This reduced the service cost of multi-node multi-product order fulfillment in e-commerce [2]. Zou Y analyzed the layout of e-commerce logistics nodes, and proposed an e-commerce logistics node layout scheme based on particle swarm optimization algorithm [3]. Beranek L used an artificial neural network to establish a model of e-commerce logistics nodes in a certain region. Through studying this model, a weighted tripartite evolutionary network was proposed to provide a suggestion for complex system behaviors with more complex behaviors [4]. Wang X L analyzed the logistics node layout of rural e-commerce and proposed some suggestions for optimizing the layout of rural logistics nodes, such as improving the development system of rural e-commerce and coordinating the development of rural e-commerce and logistics [5]. Wang H Z used linear transformation and coefficient of variation method to process and analyze the economic and population data of a certain region, and divide the logistics nodes in the region into core nodes, main nodes and auxiliary nodes [6]. Based on the economic development and logistics demand in a certain region, Wu M W proposed a design scheme for the re-division of logistics nodes in this region [7]. Although many scholars have conducted research on the layout and optimization of logistics nodes, few scholars have specifically used IoT big data and deep learning algorithms to research logistics nodes [8].

IoT big data technology and deep learning algorithms, as advanced modern technologies, have been deeply used in the field of logistics. Lv H studied the application of Internet of Things technology in the logistics industry, and established an intelligent logistics development model based on the Internet of Things and cloud computing [9]. Li S S built a smart logistics system based on the Internet of Things technology, and the experimental research proved that the system can effectively improve the logistics transportation efficiency and reduce the transportation cost [10]. Hopkins J used big data analysis technology to establish an enterprise logistics resource planning system, which effectively guaranteed the safety of drivers and reduced logistics operation costs [11]. Raman S has demonstrated through analysis that demand management, supplier rating, the Internet of Things, analysis, and data science have an impact on the supply chain industry in terms of excellent operations, cost savings, customer satisfaction, visibility, and narrowing the communication gap between demand management and supply chain management, providing reference value for enterprise logistics resource allocation [12]. Zhang X B proposed a logistics distribution path optimization algorithm based on deep learning, effectively improving the problems of low efficiency and many unexpected situations in logistics and distribution [13]. Li M analyzed the problems of low matching accuracy of transaction information and low recommendation efficiency between supply and demand in logistics transactions. A swarm intelligence recommendation algorithm for logistics service transactions based on deep learning was proposed [14]. Li T J proposed an object detection algorithm based on convolutional neural networks. The results of verifying the improved algorithm in an internet logistics service transaction environment showed that its matching accuracy was 68%, and the recommendation effect was 76%, improving the recognition and classification accuracy of the object recognition system [15]. To sum up, IoT big data technology and deep learning algorithms are widely and deeply applied in the logistics industry [16].

In order to improve the logistics and distribution efficiency of e-commerce and better meet people's consumption needs, this paper studied the layout and optimization of e-commerce logistics nodes, summarized the levels, categories and modes of logistics node layout, analyzed the relevant factors that affect the regional e-commerce logistics demand, and proposed a logistics network based on the big data of the Internet of Things. The experimental study of node layout and optimization system was carried out. Compared with other studies, this study applies IoT big data and deep learning algorithms to the layout and optimization of e-commerce logistics nodes, and e-commerce enterprises have a higher satisfaction evaluation of the improved logistics node layout plan.

2. Levels, Categories and Patterns of Logistics Node Layout

Generally speaking, nodes that can store, distribute and transfer goods belong to logistics nodes, such as common freight terminals, airports, railway stations, freight distribution centers, large public warehouses, and logistics parks with modern logistics functions, logistics centers, Logistics service station, etc. Hierarchies, categories and patterns regarding the layout of logistics nodes are described below.

(1) Levels and categories of logistics node layout

The layout of logistics nodes can be divided into three levels, namely, the spatial strategic layout of logistics nodes at the macro level, the location analysis of logistics nodes at the meso level, and the execution plan at the micro level; the logistics node layout can be divided into four types: freight service type, production service type, business service type and comprehensive service type logistics node layout. The layout of e-commerce logistics nodes is naturally inclined to the layout of commercial service logistics nodes [17]. The layout of commercial service-oriented logistics nodes relies on commercial agglomeration areas, large professional markets, and large urban consumer markets, providing logistics services such as commodity warehousing, trunk and branch transportation, and distribution and distribution.

(2) Mode of logistics node layout

According to the number of subjects involved in logistics distribution tasks, the modes of logistics node layout can be divided into four types, as shown in Figure 1. The four types are single-layer node layout, double-layer node layout, three-layer node layout, and compound node layout.

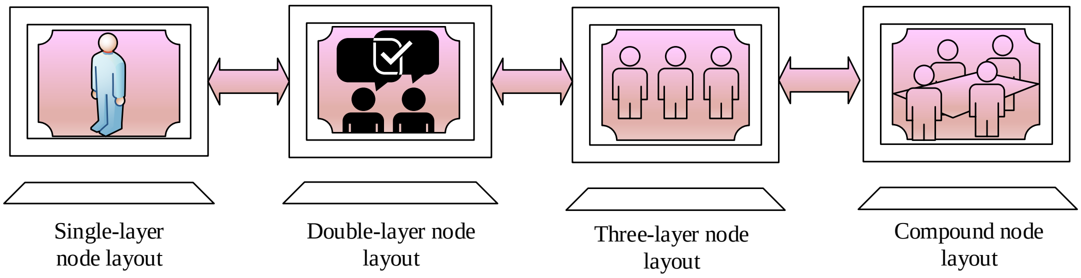

Figure 1. Pattern of logistics node layout

1) Single-layer node layout

The single-layer node layout is the most basic logistics node layout mode. Under the single-layer node layout mode, consumers can directly interact with the logistics nodes [18]. This mode is beneficial for e-commerce companies to accurately grasp the quality of logistics services, and is conducive to providing customers with faster logistics services. However, the service scope of the single-layer node layout mode is small. In order to meet the logistics needs of consumers, e-commerce companies need to build more logistics nodes. Of course, the establishment of logistics nodes should also be combined with the actual situation and the needs of the enterprise.

2) Double-layer node layout

The common manifestation of double-layer node layout is the logistics distribution system built by e-commerce enterprises. The logistics distribution system built by the enterprise has a fast response time for logistics services, and the storage and management costs of logistics nodes are low. However, the distribution cost under the self-built logistics distribution system is higher, and the logistics and transportation pressure of the distribution system is relatively large. For small enterprises, this model increases the investment burden and adopts self operated logistics, which cannot form a scale effect and can lead to high logistics costs.

3) Three-layer node layout

The node storage and management cost of the three-tier node layout is lower. However, compared with the double-layer node layout, a distribution link is added, which makes the logistics distribution time longer and affects the logistics experience of consumers. Similar to the double-layer node layout, the distribution cost of this layout scheme is higher [19].

4) Compound node layout

The compound node layout provides logistics distribution services under the scheduling of e-commerce companies, which improves the rationality of logistics distribution planning. The storage management cost of logistics nodes is low, but there is a problem of high logistics distribution costs [20].

3. Evaluation of Relevant Factors Affecting Regional E-commerce Logistics Demand

By querying relevant literature, this paper summarizes the factors that affect the logistics demand of regional e-commerce, as shown in Figure 2. It mainly includes the level of economic development, industrial structure, transportation and infrastructure, and the level of population development.

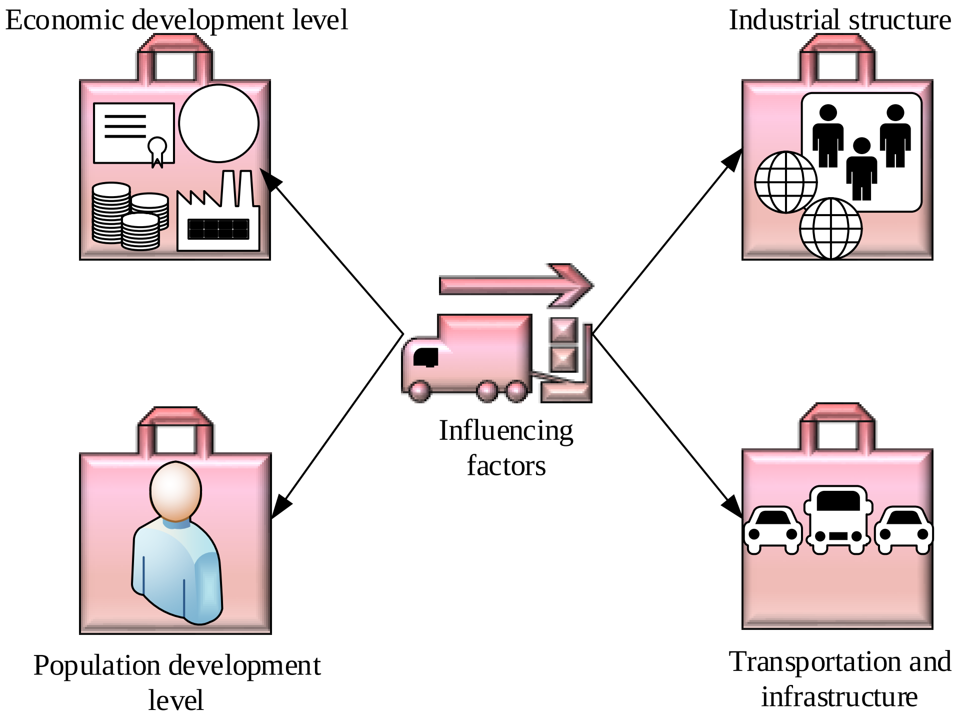

Figure 2. Analysis of relevant factors affecting regional e-commerce logistics demand

1) The level of economic development

The higher the level of economic development in a region, the more active its trade activities would be, which would increase the total logistics demand in the region, and the quality of the region's economic development also determines the quality of e-commerce logistics demand [21]. For example, the total demand for trade activities and logistics in urban areas is higher than that in rural areas. Cities with high levels of economic development have a higher total demand for trade activities and logistics than cities with low levels of economic development.

2) Industrial structure

The level of logistics demand in a region is affected by the industrial structure. Generally speaking, the region with more developed tertiary industry has a relatively high level of logistics demand. The development of a service-oriented economy is conducive to the rapid improvement of logistics demand level.

3) Transportation and infrastructure

The pros and cons of transportation and infrastructure conditions have a profound impact on the size of the logistics demand. The better the transportation and infrastructure conditions, the greater the logistics demand. Compared to areas with inconvenient transportation, areas with convenient transportation can provide convenience for meeting logistics needs.

4) Population development level

The level of population development includes the concepts of resident consumption level and resident consumption structure. Resident consumption level in a region affects the scale of logistics demand, and residents consumption structure affects the level of logistics demand [22]. The higher the consumption level of residents, the larger the scale of logistics demand; The more optimized the consumption structure of residents, the higher the level of logistics demand.

4. E-commerce Logistics Demand Forecast Indicators

The forecast indicators of e-commerce logistics demand can be divided into first-level indicators and second-level indicators according to the influencing factors of regional e-commerce logistics demand. The first-level indicators include four aspects: economic development level, industrial structure, population development level, and transportation and infrastructure conditions. The secondary index is a specific extension of the content of the primary index. The secondary index of the economic development level is mainly reflected in the regional GDP; the secondary index of the logistics demand forecast on the industrial structure is the output value and proportion of the tertiary industrial structure; secondary indicators of population development level are the number of permanent residents and the per capita disposable income of residents; the secondary indicators of traffic and infrastructure conditions are freight traffic and passenger traffic.

5. Application of Back-propagation Neural Network in E-commerce Logistics Demand Forecasting

This paper uses the back-propagation neural network to forecast and analyze the demand of e-commerce logistics. The back-propagation neural network includes the forward propagation process and the back propagation process.

The input layer of the neural network is set to have a total of v nodes. $\chi_1, \chi_2, ..., \chi_v$ is the input of neuron $1,2,..., p,...v$, the hidden layer of the neural network is set to have j nodes in total, o_{cp} is the weight of the input layer and the hidden layer, and T_{zc} is the net input value of the cth neuron of the hidden layer.

The formula for calculating T_{zc} is:

$$T_{zc} = \sum_{p=1}^{v} o_{cp}\chi_v + \beta_{zc} \tag{1}$$

The output of the neuron and the weights of the input layer and the hidden layer satisfy the following conditions:

$$X = [\chi_1, \chi_2, ..., \chi_p, ..., \chi_v]^s \tag{2}$$

$$o_c = [o_{c1}, o_{c2}, ..., o_{cp}, ..., o_{cv}] \tag{3}$$

Then the calculation formula of T_{zc} is:

$$T_{zc} = o_c X + \beta_{zc} \tag{4}$$

It is assumed that the output of the neuron and the weights of the input layer and the hidden layer satisfy the above conditions, and $\chi_0 = 1, o_{c0} = \beta_{zc}$.

Then the formula for calculating T_{zc} is:

$$T_{zc} = o_c X \tag{5}$$

Assuming that the transfer function of the hidden layer is $g_1(\cdot)$, then the output of the hidden layer is:

$$z_c = g_1(T_{zc}) = g_1\left(\sum_{p=0}^{v} o_{cp}\chi_p\right) = g_1(o_c X) \tag{6}$$

Among them, $c \in (1,2,..., j)$.

The net input value of the qth neuron in the input layer is:

$$T_{\gamma q} = \sum_{c=1}^{j} \xi_{qc} z_c + \beta_{\gamma q} \tag{7}$$

Among them, $z_1 \in (z_1, z_2, ..., z_c, ..., z_j)$ and $z_1, z_2, ..., z_c, ..., z_j$ are the output results of neuron $1,2,..., c,... j$.

ξ_{qc} is the weight between the hidden layer and the output layer, and $T_{\gamma q}$ is the net input value of the qth neuron in the output layer.

The output of neuron $1,2,..., c,... j$ and the weight between the hidden layer and the output layer satisfy the following conditions:

$$Z = [z_1, z_2, ..., z_c, ..., z_j]^s \tag{8}$$

$$\xi_q = [o_{q1}, o_{q2}, ..., o_{qp}, ..., o_{qv}] \tag{9}$$

The formula for calculating the net input value is:

$$T_{\gamma q} = \xi_q Z + \beta_{\gamma q} \tag{10}$$

Assuming that Z and ξ_q satisfy the above conditions and $z_0 = 1, \xi_{q0} = \beta_{\gamma q}$, the calculation formula of the net input value is:

$$T_{\gamma q} = \xi_q Z \tag{11}$$

The transfer function of the output layer is $g_2(\cdot)$, and the output of the output layer is:

$$\gamma_q = g_2(T_{\gamma q}) = g_2\left(\sum_{c=0}^{j} \xi_{qc} z_c\right) = g_2(\xi_q z) \tag{12}$$

E learning samples about e-commerce logistics demand forecasting are input, and the ith sample is input to the neural network to obtain the output γ_q^i, and then the data error of this sample is:

$$F_i = \frac{1}{2}\sum_{q=1}^{w} \left(s_q^i - \gamma_q^i\right)^2 \tag{13}$$

The global error is:

$$F = \frac{1}{2}\sum_{i=1}^{E} F_i = \frac{1}{2}\sum_{i=1}^{E}\sum_{q=1}^{w} \left(s_q^i - \gamma_q^i\right)^2 \tag{14}$$

The weight adjustment process of the output layer is as follows:

$$\Delta\xi_{qc} = -\varepsilon\frac{\mu F}{\mu\xi_{qc}} = -\varepsilon\frac{\mu F}{\mu\xi_{qc}}\left(\sum_{i=1}^{E} F_i\right) = \sum_{i=1}^{E}\left(-\varepsilon\frac{\mu F_i}{\mu\xi_{qc}}\right) \tag{15}$$

$$\frac{\mu F_i}{\mu\xi_{qc}} = \frac{\mu F_i}{\mu\gamma_q}\frac{\mu\gamma_q}{\mu T_{\gamma q}}\frac{\mu T_{\gamma q}}{\mu\xi_{qc}} = -\sum_{q=1}^{w}\left(s_q^i - \gamma_q^i\right)g_2'(T_{\gamma q})z_c \tag{16}$$

$$\Delta\xi_{qc} = \sum_{i=1}^{E}\sum_{q=1}^{w} \varepsilon\left(s_q^i - \gamma_q^i\right)g_2'(T_{\gamma q})z_c \tag{17}$$

The weight adjustment process of the hidden layer is as follows:

$$\Delta o_{cp} = -\varepsilon\frac{\mu F}{\mu o_{cp}} = -\varepsilon\frac{\mu}{\mu o_{cp}}\left(\sum_{i=1}^{E} F_i\right) = \sum_{i=1}^{E}\left(-\varepsilon\frac{\mu F_i}{\mu o_{cp}}\right) \tag{18}$$

$$\frac{\mu F_i}{\mu o_{cp}} = \frac{\mu F_i}{\mu \gamma_q} \frac{\mu \gamma_q}{\mu z_c} \frac{\mu z_c}{\mu T_{zc}} \frac{\mu T_{zc}}{\mu o_{cp}} = -\sum_{q=1}^{w} \left(s_q^i - \gamma_q^i\right) g_2'\left(T_{\gamma q}\right) \xi_{qc} g_1'\left(T_{zc}\right) \chi_p \tag{19}$$

$$\Delta o_{cp} = \sum_{i=1}^{E} \sum_{q=1}^{w} \varepsilon \left(s_q^i - \gamma_q^i\right) g_2'\left(T_{\gamma q}\right) \xi_{qc} g_1'\left(T_{zc}\right) \chi_p \tag{20}$$

6. E-commerce Logistics Node Layout and Optimization System Based on IoT Big Data

(1) Node layout and overall architecture of the optimization system

The node layout and optimization system constructed in this paper has four layers, as shown in Figure 3. The four layers are the data acquisition layer, the data storage layer, the data processing layer and the presentation layer.

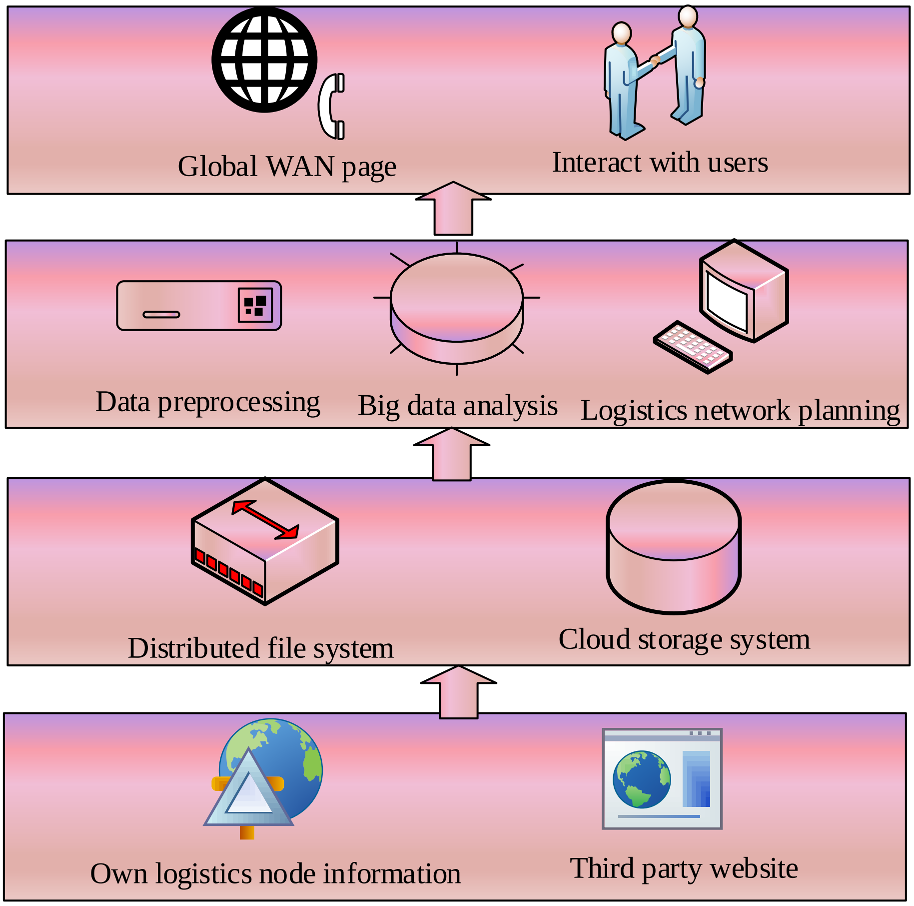

Figure 3. The overall architecture of the node layout and optimization system

The data collection layer is responsible for collecting data information about logistics nodes, including their storage status and transportation from nodes to demand points. In addition to collecting information about their own logistics nodes, e-commerce enterprises also need to use third-party websites to collect information related to logistics nodes, thereby increasing the amount of information about logistics nodes; The data storage layer is mainly responsible for the storage and management of logistics node data, and uses the distributed file system or cloud storage system to store unprocessed data; The data processing layer specifically includes data preprocessing, big data analysis, and logistics node planning. The data processing layer is responsible for analyzing and processing logistics node data, and planning and designing logistics nodes from the data layer; The presentation layer is responsible for presenting the resulting data processed by the data processing layer on global wide web pages, while interacting with users.

(2) Function design of node layout and optimization system

The node layout and optimization system has four functions, as shown in Figure 4. Specifically, it includes data collection and preprocessing, big data analysis, logistics node layout, and user management.

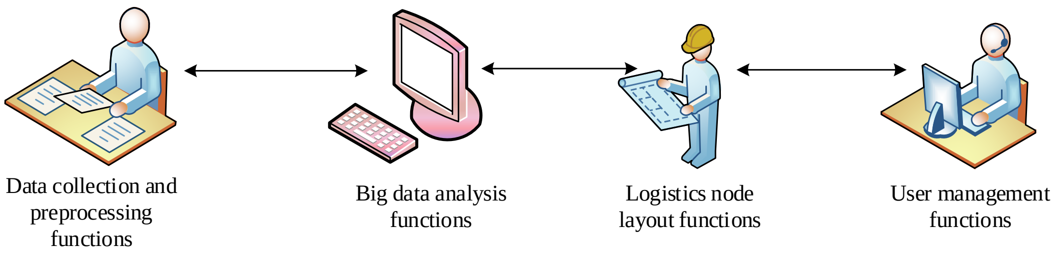

Figure 4. Functional design of node layout and optimization system

The functions of data collection and preprocessing are reflected in the node layout and optimization system, which can collect more and more accurate information, and obtain high-quality and reliable data. It is convenient for subsequent data analysis work; the function of big data analysis is reflected in the fact that e-commerce companies can use data preprocessing to perform data cleaning and data integration operations on logistics node-related data, and use distributed computing systems to perform big data analysis on logistics node layout data, including the construction cost of the logistics node, the distribution cost between the production center and the logistics node, the logistics demand point and the transportation cost between the logistics nodes, etc. The function of logistics node layout is reflected in the fact that e-commerce enterprises can use the node layout and optimization system to reduce the overall layout cost of logistics nodes and improve the efficiency of logistics distribution; the user management function means that e-commerce enterprises can use the node layout and optimization system to achieve efficient management of user logistics information and improve the efficiency and accuracy of logistics distribution.

7. Experimental Results of the Layout and Optimization of E-commerce Logistics Nodes

This paper selects an e-commerce enterprise, obtains the logistics node layout planning of the e-commerce enterprise in a city by querying relevant information, and establishes a simulation model of the logistics node layout between the enterprise and the enterprise in a city through computer technology. In the model, a deep learning algorithm and an e-commerce logistics node layout and optimization system based on the big data of the Internet of Things are introduced to improve and optimize the original logistics node layout, and obtain the relevant information of the enterprise under the conditions of the improvement and optimization of the logistics node layout. The company's existing logistics node layout scheme in a city is called a conventional logistics node layout scheme, and the logistics node layout scheme based on IoT big data and deep learning algorithms is called an improved logistics node layout scheme. The logistics activities of e-commerce enterprises under the two schemes were studied for six months, and the five aspects of logistics transportation cost, logistics distribution efficiency, accuracy of logistics information transmission, location and traffic conditions of logistics nodes, and e-commerce enterprises' evaluation of the plan were specifically studied.

(1) Transportation cost of logistics

The logistics cost of e-commerce enterprise logistics in reality is recorded, and then the logistics transportation cost of e-commerce enterprise in the simulation model is obtained. The unit of logistics transportation cost is 10,000 yuan. The result is shown in Figure 5.

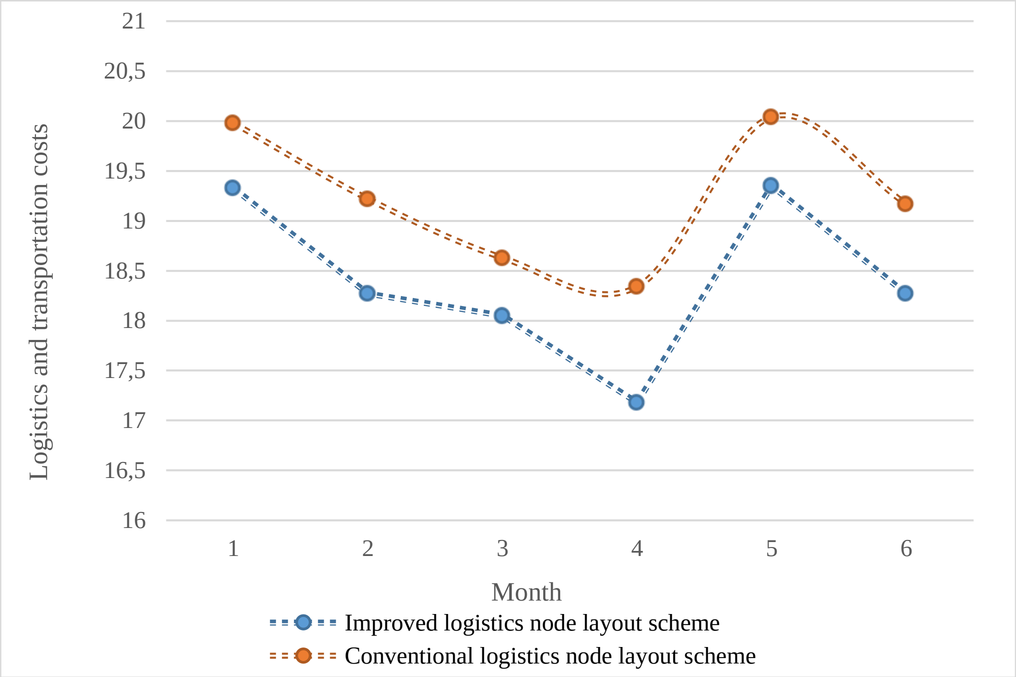

Figure 5. Shipping costs for logistics

As shown in Figure 5, the logistics and transportation cost of the first month of the e-commerce enterprise using the conventional logistics node layout scheme is 199,800 yuan. After the calculation of the simulation model, the enterprise can use the improved logistics node layout scheme under the premise of using the improved logistics node layout scheme. The logistics transportation cost in the first month is 193,300 yuan. Compared with the conventional logistics node layout plan, the improved logistics node layout plan reduces the logistics transportation cost by 6,500 yuan in the first month. Combined with the total amount of logistics transportation costs, the improved logistics node layout scheme has a more significant effect in reducing logistics transportation costs. Judging from the overall logistics and transportation cost data, the logistics and transportation cost of the enterprise when implementing the improved logistics node layout plan is lower than the logistics transportation cost when the enterprise implements the conventional logistics node layout plan. From the specific data, the logistics transportation cost of e-commerce enterprises in the sixth month when using the improved logistics node layout plan is 182,700 yuan, and the logistics transportation cost in the sixth month when using the conventional logistics node layout plan is 191,700 yuan. There is a difference of 9,000 yuan between the two, and the gap is more obvious. The average logistics and transportation cost of e-commerce enterprises in six months when using the improved logistics node layout plan is 184,100 yuan. When using the conventional logistics node layout scheme, the average logistics and transportation cost for six months is 192,300 yuan, and the difference between the transportation costs of the two schemes is 8,200 yuan. It shows that compared with the conventional logistics node layout scheme, the improved logistics node layout scheme based on IoT big data and deep learning algorithm has certain effectiveness in reducing the logistics transportation cost of e-commerce enterprises.

(2) Logistics distribution efficiency

The task volume of the logistics distribution of the e-commerce enterprise is substituted into the simulation model, and the logistics distribution completion of the e-commerce enterprise when using the improved logistics node layout scheme is observed, and the logistics distribution efficiency of the e-commerce enterprise when using different schemes is obtained. The specific results are shown in Figure 6.

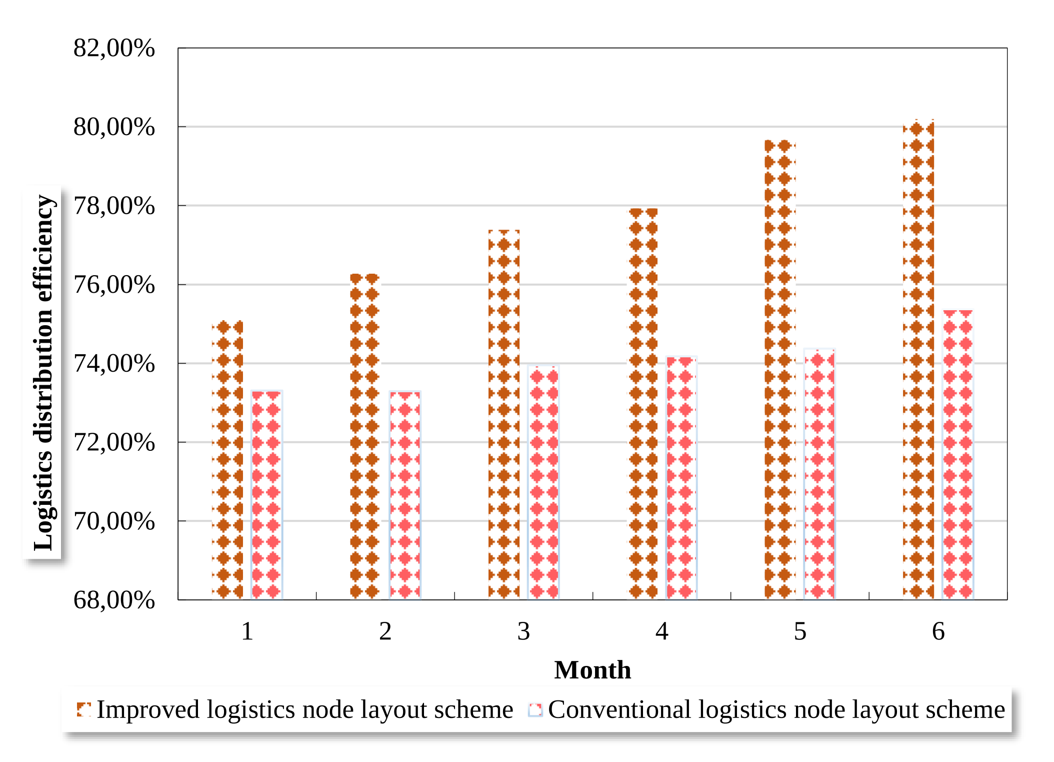

Figure 6. Logistics distribution efficiency

As shown in Figure 6, the logistics distribution efficiency of e-commerce enterprises in the first month is 73.31% when using the conventional logistics node layout plan, the logistics distribution efficiency in the sixth month is 75.37%, and the logistics distribution efficiency in the sixth month is 75.37%. The logistics distribution efficiency in the sixth month is only 2.06% higher than that in the first month, and the improvement in logistics distribution efficiency is not obvious enough. When using the improved logistics node layout scheme, the logistics distribution efficiency of e-commerce companies is 75.13% in the first month and 80.2% in the sixth month. The logistics distribution efficiency in the sixth month is 5.07% higher than that in the first month, and the logistics distribution efficiency has improved significantly. In the sixth month, the logistics distribution efficiency of e-commerce enterprises using the improved logistics node layout scheme is 4.83% higher than that of e-commerce enterprises using the conventional logistics node layout scheme. The improved logistics node layout plan can achieve higher results. The six-month average logistics distribution efficiency of e-commerce companies using the improved logistics node layout scheme is 77.77%, and the average logistics distribution efficiency when using the conventional logistics node layout scheme is 74.08%. The average logistics distribution efficiency of the two schemes differs by 3.69%. It shows that the improved logistics node layout scheme can play an important role in improving the efficiency of logistics distribution compared to the conventional logistics node layout scheme.

(3) Accuracy of logistics information transmission

This paper uses the mathematical simulation model to analyze the logistics information transmission accuracy of e-commerce enterprises when using the improved logistics node layout scheme. Then, the results are compared with the accuracy of the actual logistics information transmission of the collected e-commerce enterprises, and the results are shown in Figure 7.

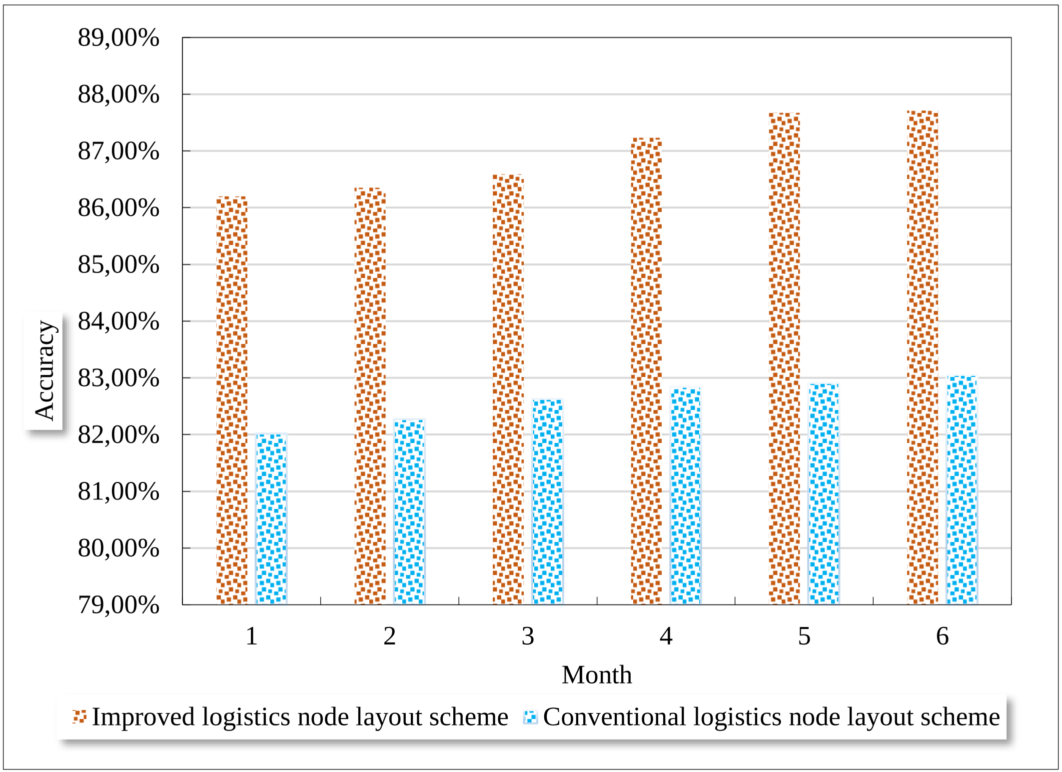

Figure 7. Accuracy of logistics information transmission

As shown in Figure 7, when e-commerce companies use the conventional logistics node layout plan for logistics operation and distribution, the accuracy is 82.02% in the first month and 83.05% in the sixth month, a difference of 1.03%. When e-commerce enterprises use the improved logistics node layout scheme for logistics operation and distribution, the accuracy of logistics information transmission is 86.2% in the first month and 87.71% in the sixth month. The accuracy of logistics information transmission in the sixth month is 1.51% different from that in the first month. When e-commerce companies use the improved logistics node layout plan, the accuracy of logistics information transmission has improved. From the first month to the sixth month, the accuracy of logistics information transmission shows that the conventional logistics node layout scheme is not as effective as the improved logistics node layout scheme. The average logistics information transmission accuracy of e-commerce enterprises when using the conventional logistics node layout scheme is 82.62%. When using the improved logistics node layout scheme, the average logistics information transmission accuracy of e-commerce enterprises is 86.96%. For e-commerce companies, the improved logistics node layout scheme is 4.34% more accurate in delivering logistics information than the conventional logistics node layout scheme, explaining that the improved logistics node layout scheme is more effective in improving the accuracy of logistics information transmission.

(4) Location and traffic conditions of logistics nodes

By analyzing the traffic situation of the logistics node location of the conventional logistics node layout scheme and the improved logistics node layout scheme, the traffic condition indicators of the logistics node location of the two schemes are obtained. The value range of the logistics node location traffic condition index is 1-100, and the results are shown in Figure 8.

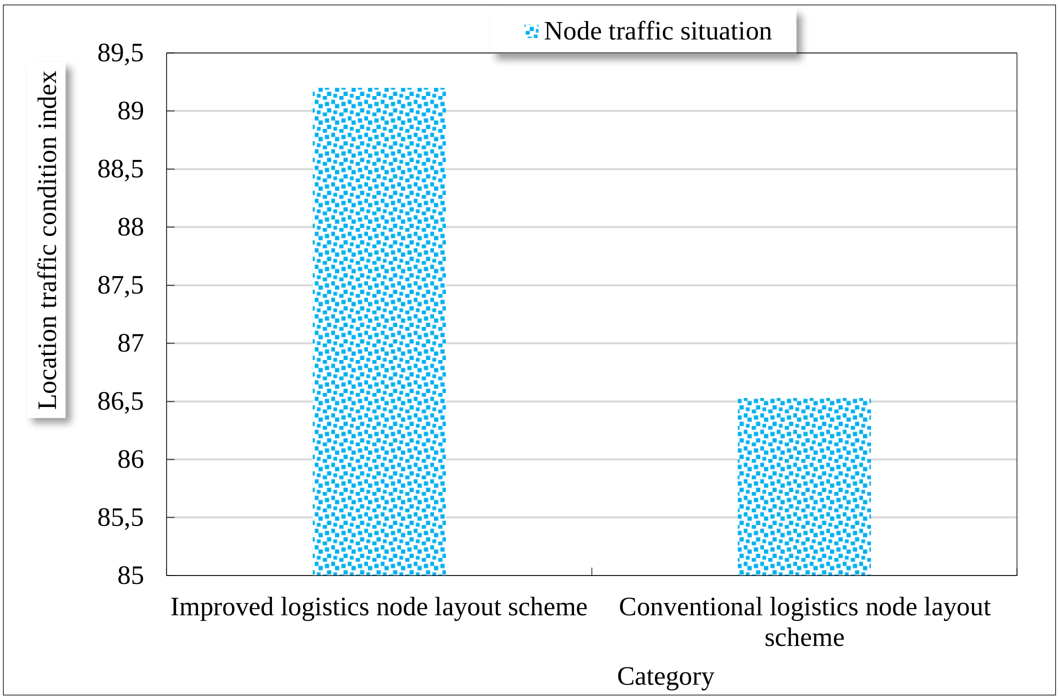

Figure 8. Location traffic situation of logistics nodes

As shown in Figure 8, the location and traffic condition indicators of logistics nodes are relatively fixed. This paper only studies the location and traffic condition indicators of the conventional logistics node layout scheme and the improved logistics node layout scheme in the sixth month. The traffic condition index of the logistics node location in the conventional logistics node layout scheme is 86.53, and the logistics node location traffic condition index in the improved logistics node layout plan is 89.2. The traffic condition index of the logistics node location of the improved logistics node layout scheme is 2.67 higher than that of the conventional logistics node layout plan. It shows that compared with the conventional logistics node layout scheme, the node positions selected by the improved logistics node layout scheme are more reasonable.

(5) E-commerce companies' evaluation of the two schemes

Through interviews with the logistics leaders of 6 e-commerce enterprises, the evaluation of the e-commerce enterprises on the conventional logistics node layout plan and the improved logistics node layout plan was obtained. The six e-commerce enterprises are respectively named as Enterprise A, Enterprise B, Enterprise C, Enterprise D, Enterprise E, and Enterprise F, and the evaluation results are shown in Table 1.

Table 1. E-commerce companies' evaluation of the two schemes

	Improved logistics node layout scheme	Conventional logistics node layout scheme
Enterprise A	86.08%	85.61%
Enterprise B	85.33%	79.67%
Enterprise C	89.27%	82.49%
Enterprise D	92.39%	89.15%
Enterprise E	81.25%	80.03%
Enterprise F	83.36%	75.03%

As shown in Table 1, overall, the evaluation of the improved logistics node layout plan by the six e-commerce enterprises is higher than that of the conventional logistics node layout plan. From the specific data, in the satisfaction evaluation of the improved logistics node layout plan, Enterprise D has the highest evaluation satisfaction, at 92.39%; The evaluation satisfaction of Enterprise E is the lowest, at 81.25%. In the satisfaction evaluation of the conventional logistics node layout plan, the highest satisfaction rate of Enterprise D is 89.15%; Enterprise F has the lowest evaluation, at 75.03%. The average evaluation of the improved logistics node layout scheme by six e-commerce enterprises is 86.28%, while the average evaluation of the conventional logistics node layout scheme is 82%. The average evaluation of the improved logistics node layout scheme by six e-commerce enterprises is 4.28% higher than the average evaluation of the conventional logistics node layout scheme, indicating that compared to the conventional logistics node layout scheme, the improved logistics node layout scheme can better obtain the support of e-commerce enterprises.

8. Conclusions

This paper analyzed the layout and optimization of e-commerce logistics nodes, and proposed an improved logistics node layout scheme based on IoT big data technology and deep learning algorithms. Through research and experiments, it was proved that the improved logistics node layout scheme can improve the logistics distribution efficiency and logistics information transmission accuracy of e-commerce enterprises, and can effectively reduce the cost of logistics and transportation, which is conducive to the improvement of economic benefits of e-commerce enterprises, and is conducive to better satisfaction consumers' shopping needs. In addition, the improved logistics node layout scheme can also increase the rationality of the node layout, and e-commerce companies also recognize the improved logistics node layout scheme. Although the research in this article can provide some reference for the layout and optimization of e-commerce logistics nodes, the research objects selected in this article are not enough. In the next step of research, the number of experiments will be increased to make the improved logistics node layout scheme more reliable. In future works, we will apply some intelligent algorithms such as the works in [23]-[28] into the considered system, to further enhance the system performance.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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