Optimization Model of Shortest Distribution Path Selection in Intelligent Logistics

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Abstract. In order to quantitatively analyze the relationship between intelligent distribution path selection and logistics economic development and promote the development of logistics economy, an optimization model of intelligent logistics shortest distribution path selection is proposed. This paper analyzes the statistical characteristics of intelligent distribution path selection to the development of logistics economy, adopts the shortest path optimization method to select the intelligent distribution path, constructs the big data statistical analysis model of intelligent distribution path selection and logistics economic development by using quantitative regression analysis method, analyzes the development factors of logistics economy by intelligent distribution path selection combined with multiple linear fusion method, and combines the fuzzy constraint control method. Realize the optimization of logistics intelligent distribution path. According to optimization The distribution effect is modeled by statistical analysis of logistics economic development, and the quantitative relationship between intelligent distribution path selection technology and logistics economic development is analyzed. The results of empirical analysis show that the intelligent distribution path selection has a significant level to the development of logistics economy. This method has good optimization for logistics distribution path selection, improves logistics throughput and promotes the development of logistics economy.

Keywords: Intelligent Logistics, Distribution Path, Logistics, Economic Development

1 Introduction

With the continuous improvement of regional logistics efficiency, it is necessary to build an optimal scheduling model for regional logistics. The intelligent selection of logistics distribution paths can reduce the economic overhead in logistics distribution and promote the development of logistics economy. Using big data information processing technology to optimize the logistics distribution path, combined with intelligent logistics scheduling technology, previous researches analyze the relationship model of logistics distribution path optimization to logistics economic development and tap the intelligent distribution path selection to logistics. The quantitative characteristics of economic development that affect big data, combined with feature extraction and information fusion methods, can improve the development level of logistics economy.[1] In this regard, a method for modeling the
impact of intelligent distribution path selection on the development of logistics economy based on the shortest path planning and panel data verification is proposed. An intelligent object analysis model for the selection of statistical characteristics of the development of the logistics economy by intelligent distribution path selection is constructed. The selection of intelligent distribution paths analyzes the development factors of logistics economy. Combined with fuzzy constraint control method, the logistics intelligent distribution path optimization is realized, and the effect of intelligent distribution path selection technology on the development of logistics economy is modeled. Finally, an empirical analysis is carried out to draw a conclusion of effectiveness.

2 Optimization Model for Logistics Distribution Path Selection

In order to achieve an accurate assessment of the logistics economic development by selecting intelligent distribution paths, the shortest path planning and quantitative evaluation of statistical characteristics are used for intelligent distribution path selection\[2\], and the shortest path planning is combined with the logistics transportation network structure model, using road sections Network analysis of logistics paths. The network networking structure model \( \frac{ds(t)}{dt} \) for logistics path planning is:

\[
\frac{ds(t)}{dt} = -\beta i(t)s(t) \quad \frac{di(t)}{dt} = \beta i(t)s(t)\tag{1}
\]

In the formula, \( i(t) \) and \( s(t) \) respectively mark the node location and route planning length of the logistics distribution path, \( \beta \) is the quantified coefficients of the path characteristics. When \( t > \beta \), the Small World network model is used to construct the SIRS model of logistics distribution\[3\]. The dynamic model of intelligent distribution path selection can be described as:

\[
\begin{align*}
\frac{ds(t)}{dt} &= -\beta i(t)s(t) + \alpha r(t) \\
\frac{di(t)}{dt} &= \beta i(t)s(t) - \mu i(t) \\
\frac{dr(t)}{dt} &= \mu i(t) - \alpha r(t)
\end{align*}\tag{2}
\]

In the formula, \( r(t) \) is the total length of the distribution path selected, \( \alpha \) is the capacity factor of the distribution demand, and \( \mu \) is the matching coefficient of the logistics vehicle, which is used to calculate the impedance of the segment of the logistics distribution path and to design the dynamic location network. When the flow of the segment is 0, the choice of logistics distribution path is a linear programming problem\[4\]. Assume that there are \( m \) logistics distribution sink nodes in the Power-Law structure, expressed as \( A_1, A_2, \ldots, A_n \), and the load of logistics distribution at each node is \( a_i = a_1, a_2, \ldots, a_n \). The shortest path search is used for the linear planning and design of the logistics distribution path, and the logistics distribution scheduling transportation function is obtained:

\[
\min(f) = \sum_{i=1}^{n} \sum_{j=1}^{m} C_{ij} X_{ij}\tag{3}
\]
\[
\begin{align*}
\sum_{j=1}^{X} x_{ij} &= a_i, i = 1, 2, \cdots, m \\
\sum_{i=1}^{X} x_{ij} &= b_j, j = 1, 2, \cdots, n \\
X_{ij} &\geq 0, i = 1, 2, \cdots, m, j = 1, 2, \cdots, n
\end{align*}
\]

In the formula, \( C_i \) is the demand relationship between the relaxation time \( i \) and the line fitting index \( J_i \), and \( X_s \) is the fitting relationship between the relaxation time \( i \) and the line fitting index \( J_i \). The linear planning and design of the logistics distribution path is performed through complex network theory and select logistics distribution paths using spatial planning and scheduling methods in neighboring nodes. Assume that the optional number of distribution routes is \( N \), the distribution route is represented by \( N_1, \cdots, N_m \), the shortest route node is \( C_{P_1, P_2, \cdots, P_m} \) when in the idle state, and the maximum load logistics flow of each route is \( L_1, \cdots, L_n \). The energy distribution special analysis method is used for flow control of logistics distribution. At the observation points \( \{t_1, y_n\} \) and \( \{t_n, y_n\} \), under the shortest path optimization, the network load of the path center of the logistics distribution is \( C N \), and the statistical analysis method is used to obtain the maximum load distribution \( N_i : \)

\[
N_i = N + 1, \quad N \geq 0
\]

\( C \) represents the maximum transmission probability density function of the relaxation time \( i \). Under linear programming conditions, the road network topology structure of logistics distribution is described as:

\[
C = \frac{N}{T}
\]

In the formula, \( T \) represents the time window, and establishes a dynamic search model for logistics distribution routes based on rough set theory, which combines adaptive route planning and optimal control to improve route planning capabilities.

### 3 Modeling the Impact of Logistics Distribution Paths on the Development of Logistics Economy

Intelligent distribution path selection combined with multivariate linear fusion method is used to analyze the logistics economic development factor \( \hat{g}_{ij}^c \). Linear index \( \sigma_i^c \) analysis method is used to perform vector quantization \( V \) decomposition on the intelligent distribution path selection. Feature decomposition form:

\[
\sum_{(i, j) \in E} \hat{g}_{ij}^c - \sum_{j \in V} \sum_{(p, q) \in E} \hat{g}_{pq}^c = T \sigma_i^c, \quad \forall i, c
\]

\[
\left( \sum_{c \in E} \sum_{(i, j) \in E} \epsilon_i^c \hat{g}_{ij}^c + \sum_{c \in E} \sum_{j \in V} \sum_{(p, q) \in E} \epsilon_i^c \hat{g}_{pq}^c \right) T \leq E_c, \quad \forall i
\]

Let \( \epsilon_i^c \) denote the contribution of intelligent distribution path selection to the development of logistics economy, and mark the information transfer matrix \( F_{N \times 1} \) online. Under fuzzy constraint
control, the optimal decision cost function $\Delta M'_{ij}$ of intelligent distribution path selection for the development of logistics economy is:

$$\Delta M'_{ij} = y_i (B_i - A_i)$$  \hspace{1cm} (9)

According to the results of big data mining \cite{7}, the relationship between the intelligent distribution route selection and the logistics route cross deviation $B_i$ and the route cross deviation $A_i$ is analyzed. Then calculate the quantification set $C$ for promotional contribution level of logistics path selection:

$$y_i = T \text{sgn}(u - 0.5) \left[ \frac{1}{1 + \frac{u}{T}} \right]^{\frac{k}{1 - k}}$$  \hspace{1cm} (10)

In equation (15), $T$ represents a time window, and $u$ represents a random number of a contribution factor between 0 and 1. Based on the intelligent distribution path, select the analysis results of the logistics economic development factors and calculate the weight of node $N_i (k > 2)$:

$$\bar{W}_k = \bar{W}_{k-1} \frac{p(z_k / x_k') p(\tilde{x}_k' / x_{k-1}')}{q(\tilde{x}_k' / x_{k-1}')}$$  \hspace{1cm} (11)

Select the initial economic development index series $\{x_i', i = 1,2,\cdots,N\}$. When $N_e < N_h$, the embedded state of the big data is counted, and the transmission probability of the output influencing factors is $k$. Therefore, the predicted value of the quantitative characteristics of the logistics economic development selected by the intelligent distribution path is:

$$x(\varepsilon_k)' = X_{m+1}(m)\varepsilon_k + D_0$$  \hspace{1cm} (12)

The output intelligent distribution path selects the expected value $m$ and standard deviation $\varepsilon_k$ of the statistical characteristic sequence $D_0$ of the logistics economic development. Assume $N_0 = 0$, set the initial value $\phi_j$ to $k = 1,2,\cdots,n-1$, and perform regression analysis with iterative method to model the impact of logistics intelligent distribution path on economic development.

4 Empirical Analysis and Test

In order to test the application performance of the proposed method in analyzing the impact of intelligent distribution path selection on the development of logistics economy, simulation experiments were performed. The experiment is designed with statistical analysis software SPSS 14.0 and VC ++. The prior sample sampling scale set for the statistical characteristics of logistics economic development is 500, the number of logistics distribution path nodes is 1,000; the information transmission rate is 12 Mbit / S, and the training sample set is 10; the initial sampling rate of the statistical analysis of logistics economic development data is 100 KHz, and the end sampling rate is 150 KHz. The statistical analysis results of the robustness test are shown in Table 1.
### Table 1. Results of Statistical Analysis of Robustness Tests

| Project                  | Contribution Weight | Correlation Coefficient | Decision Coefficient |
|--------------------------|---------------------|-------------------------|----------------------|
|                          | min     | max     | mean   | min     | max     | mean   | min     | max     | mean   |
| Communication software   | 2.543   | 5.322   | 3.434  | 5.223   | 9.323   | 7.212  | 4.355   | 6.322   | 5.354  |
| Surroundings             | 0.234   | 2.355   | 1.213  | 2.776   | 5.343   | 3.232  | 2.221   | 4.121   | 3.464  |
| Specification            | 2.453   | 5.675   | 3.433  | 4.234   | 8.333   | 6.553  | 5.254   | 6.255   | 5.321  |
| Economic transaction volume | 3.635 | 4.327   | 3.448  | 6.454   | 10.87   | 8.211  | 8.213   | 9.332   | 8.876  |
| Load regulation          | 2.457   | 3.214   | 2.212  | 5.232   | 9.232   | 7.232  | 5.355   | 6.864   | 5.344  |
| Profitability            | 1.864   | 4.655   | 3.233  | 2.367   | 4.322   | 6.343  | 6.366   | 7.548   | 6.732  |

Based on the results of the above statistical analysis, the effect of intelligent distribution path selection on the development of logistics economy is modeled, and the optimal distribution path plan is obtained as shown in Figure 1.

**Figure 1. Intelligent Distribution Output**

**Figure 2. Comparison of Throughput of Path Selection Different Models**

Based on the selection of intelligent distribution paths, the impact of intelligent distribution path selection on the development of logistics economy is analyzed, and the throughput of different models is tested[8-10]. The test results are shown in Figure 2. The selection of intelligent distribution path has a significant level for the development of logistics economy. The model's logistics throughput is higher than the traditional model. The proposed model improves the logistics throughput, optimizes the selection of logistics distribution path, and promotes the development of logistics economy.

### 5 Conclusions

In summary, the optimization of logistics distribution path selection and the development of logistics economy are studied, and an optimization model of the shortest distribution path selection of intelligent logistics is proposed. By comparison with the traditional model, the root mean square error of the proposed model is lower, more stable, and has higher practical applicability. However, there are still many shortcomings. In terms of root mean square error control, there is still room for improvement. This is also my future research direction.

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