# Direct Logistics Path Transportation Modeling Optimization Analysis

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**Abstract.** In recent years, China's urban logistics has been developing rapidly, providing a new and convenient development channel for the city, and at the same time accelerating the efficiency of material exchange. Traditional logistics not only consumes more energy, but also fails to realize the direct development goal. Under the direct development goal, the concept of urban direct logistics and distribution has been reintroduced and gradually tried. However, there are still problems such as the authorities and logistics enterprises do not pay enough attention to it, the indicators of urban direct logistics and distribution are incomplete, and the social level has not built a relatively complete system, etc. This paper adopts the construction of the basic indicators of logistics, the indicators of functional elements, and the supporting indicator system, and carries out the systematic analysis by means of hierarchical analysis method and fuzzy evaluation method.

**Keywords:** direct logistics; path modeling; optimization analysis

## 1 INTRODUCTION

With the rapid development of the economy, the logistics industry's position in the national economy is becoming more and more prominent, and the optimization of the logistics and transportation path of the development of high standards has become an important goal of economic development in the new era.Jiang et al. [1]In this study, the improved adaptive genetic algorithm (IAGA) was used to solve the multi-vehicle dynamic vehicle path optimization problem under low-carbon conditions through two phases of pre-optimization and dynamic adjustment, with the goal of reducing the total cost, which provided an effective optimization scheme for the enterprise distribution strategy. Wu et al. [2]Optimization study of urban electric vehicle distribution-charging path using hybrid ant colony algorithm to reduce cost, improve efficiency and provide decision-making reference for urban distribution planning. Chen et al. [3]studied the optimization model of logistics network under different carbon policies, taking the road logistics network in Guangdong, Hong Kong and Macao as an example, and the results show that it is optimal under carbon trading policy. zeng et al. [4]


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Path optimization for cold chain logistics trucks reduces transportation cost, optimizes routes, and improves transportation efficiency by improving the ant colony algorithm. Gao Lili[5] that the rapid development of the economy, the status of the logistics industry highlights the importance of promoting high-quality development of the logistics and transportation economy has become an important goal, proposed to optimize the path to promote the development of the industry. Han Songqi et al.[6] analyzed the scheduling problem of Company A and proposed a solution to calculate the optimal scheduling path by using the operation method on the graph to improve market competitiveness, transportation efficiency, and reduce costs. Haiyan Wang et al. [7] Optimizing the reverse process of shipbuilding materials can reduce cost and improve efficiency, using Petri network and Six Sigma management method to establish DMAIC-Petri model to successfully optimize the process, providing practical reference for the industry. Bai Wenjun[8] believes that in the diversified development environment, international logistics enterprises should pay attention to the audit work, through scientific internal audit to enhance the level of internal control and reduce risks, but still need to explore the audit optimization countermeasures to achieve healthy development and enhance the strength. Yang Qidong et al.[9] promote the optimization of automated warehousing logistics through information technology and automation technology, genetic algorithm optimizes the path of automated guided vehicles to achieve cost minimization and path minimization, and improves logistics efficiency. Ding Bo et al. [10]studies the optimization of logistics information interaction in intelligent transportation product design, using intelligent algorithms and optimization models to improve efficiency, reduce costs, and advance the development of logistics business.

## 2 CONTENTS OF THE EVALUATION OF COST REDUCTION, EFFICIENCY AND ENERGY SAVING AND EMISSION REDUCTION

Direct logistics itself is the original intention is to allow enterprises to reduce logistics costs, whether in distribution or in the receipt and delivery of courier, to reduce the circulation costs, reduce costs is to reduce costs, then the same output under the premise of increasing profits. Direct logistics advantage is destined for the future development of the logistics industry advantages.

## 3 SELECTION OF INDICATORS

Taking customer satisfaction theory and public satisfaction theory as the theoretical basis and combining with the actual situation of direct logistics work, we constructed an evaluation system with the logistics system as the target level, three secondary indicators of direct development environment, direct facilities and equipment, and direct logistics operation as the guideline level, and nine tertiary indicators of institutional mechanism, basic equipment, and innovative organization mode as the analytical elements.

## 4 DETERMINATION OF WEIGHTS

In this paper, the hierarchical analysis method is used to determine the weight share of each index. This method divides the target system into three levels, then structurally stratifies them according to a certain logic, and finally constructs a matrix using the expert scoring method, calculates the priority weights of each level using the eigenvector method, and finally weights the final weights of each level, and establishes the hierarchical model according to the selected measurement indexes, which is shown in the Table 1.

**Table 1.** Hierarchical model of measurement indicators

<table>
<tr><th>Target layer A</th><th>Guideline layer B</th><th>Indicator layer C</th></tr>
<tr><td rowspan="9">Satisfaction with the city's direct logistics operation system</td><td rowspan="3">Direct Development Environment (B1)</td><td>Institutional mechanisms (C1)</td></tr>
<tr><td>Policy measures (C2)</td></tr>
<tr><td>Facilitating transportation (C3)</td></tr>
<tr><td rowspan="3">Direct Facilities Equipment (B2)</td><td>Infrastructure (C4)</td></tr>
<tr><td>Logistics equipment (C5)</td></tr>
<tr><td>Transportation equipment (C6)</td></tr>
<tr><td rowspan="3">Direct Logistics Operations (B3)</td><td>Innovative Organizational Models (C7)</td></tr>
<tr><td>Direct packaging development (C8)</td></tr>
<tr><td>Packaging recycling system (C9)</td></tr>
</table>

Define the importance of satisfaction indicators by querying the reference data and calculate the preliminary results, complete the judgment matrix and adopt the consistency recommendations. Determine the weight of each indicator layer,As shown in Table 2:

**Table 2.** Results of Direct Development Environment (B1) Analysis

| norm | Institutional mechanisms | Policy measures | convenient transportation |
|---|---|---|---|
| Institutional mechanisms | 1 | 0.25 | 0.2 |
| Policy measures | 4 | 1 | 0.3333 |
| convenient transportation | 5 | 3 | 1 |

The results of the AHP hierarchical analysis and consistency test of satisfaction with the direct development environment are shown in Table 3.

**Table 3.** Results of the direct development environment (B1) analysis

| Results of the direct development environment (B1) analysis | | | | |
|---|---|---|---|---|
| | eigenvector | weighting | Maximum characteristic root | CI value |
| Institutional mechanisms | 0.3684 | 0.0936 | 3.0858 | 0.0429 |
| Policy measures | 1.1006 | 0.2797 | | |
| convenient transportation | 2.4662 | 0.6267 | | |

A hierarchical approach was carried out for the 3rd order judgment matrix, and the eigenvectors of institutional mechanism, policy measures, and facilitating transportation were derived as (0.3684, 1.1006, and 2.4662), and their corresponding weight values were:, 9.36%,27.97%, and 62.67%, respectively. By calculating the eigenvectors the maximum eigenroot is 3.0858, and finally the CI value (0.0429), RI value (0.525) is calculated and consistency test is carried out. if the CR value is less than 0.1, the judgment matrix satisfies the consistency test; if the CR value is greater than 0.1, it means that it does not have consistency. This time the CI value is 0.0429, CR value is 0.0817, CR value is 0.0817 < 0.1, then the judgment matrix passes the consistency test.Satisfaction analysis was conducted as shown in Table 4

**Table 4.** Results of direct facility equipment satisfaction analysis

| | | | |
|---|---|---|---|
| infrastructure | 1 | 0.5 | 0.2 |
| Logistics equipment | 2 | 1 | 0.25 |
| Transportation equipment | 5 | 4 | 1 |

**Table 5.** AHP hierarchical analysis and consistency test for direct facility equipment satisfaction

| | eigenvector | weighting | Maximum characteristic root | CI value |
|---|---|---|---|---|
| infrastructure | 0.4642 | 0.1168 | 3.0246 | 0.0123 |
| Logistics equipment | 0.7937 | 0.1998 | | |
| Transportation equipment | 2.7144 | 0.6833 | | |

As shown in Table 5,Hierarchical method analysis was performed for the judgment matrix, and the eigenvectors of infrastructure, logistics equipment, and transportation equipment were obtained as (0.4642, 0.7937, and 2.7144), and their corresponding weight values were: 11.68%,19.98%, and 68.33%, respectively. By calculating the eigenvectors the maximum eigenroot is 3.0246 and finally the CI value (0.0123) is calculated and consistency test is performed.The CR value (0.0234) is similarly consistent with the above and the judgment matrix passes the consistency test.

(3) Results of analysis of satisfaction with direct logistics operations

The results of AHP hierarchical analysis and consistency test of direct logistics operation satisfaction are shown in Table 6

**Table 6.** AHP hierarchical analysis results

| | eigenvecto | weighting | Maximum characteristic | CI value |
|---|---|---|---|---|
| Innovative organizational models | 0.3684 | 0.0989 | 3.094 | 0.047 |
| Direct packaging development | 1.3572 | 0.3643 | | |
| Packaging Recycling System | 2 | 0.5368 | | |

Hierarchical method analysis was carried out for the judgment matrix, and finally the eigenvectors of innovative organizational model, direct packaging development, and packaging recycling system were (0.3684, 1.3572, and 2), and their corresponding weight values were: 9.89%,36.43%, and 53.68%, respectively. The maximum eigenroot of 3.094 was obtained by calculating the eigenvectors, and the final CI value (0.047) was calculated and tested for consistency. The judgment matrix passes the consistency test since the CR value is 0.0895 this time and the CR value is 0.0895<0.1.

(4) Overall analysis results of direct logistics system satisfaction

**Table 7.** Overall analysis of direct logistics system satisfaction

| norm | Direct development environment | Direct facility equipment | Direct logistics operations |
|---|---|---|---|
| Direct development environment | 1 | 1/2 | 1/4 |
| Direct facility equipment | 2 | 1 | 1/3 |
| Direct logistics operations | 4 | 3 | 1 |

The results of the overall analysis of satisfaction with direct logistics operations are shown in Table 7.

Hierarchical method analysis was performed for the judgment matrix, and the eigenvectors of direct development environment, direct facilities and equipment, and direct logistics operation were derived as (0.5, 0.8736, and 2.2894), and their corresponding weight values were: 13.65%,23.85%, and 62.5%, respectively. By utilizing the eigenvectors the maximum eigenroot was calculated as 3.0183 and finally the CI value (0.0091) was calculated and consistency test was performed. Since the CR value (0.0174) is less than 0.1, the judgment matrix satisfies the consistency test; the judgment matrix passes the consistency test.

**Table 8.** Schematic table of weights

| target level | standardized layer | weights | indicator layer | weights | |
|---|---|---|---|---|---|
| Satisfaction with the city's direct logistics operation system | Direct development environment | 0.1365 | Institutional mechanisms | 0.0128 | 9 |
| | | | Policy measures | 0.0382 | 7 |

| | | | | | |
|---|---|---|---|---|---|
| | | | Convenient transportation | 0.0856 | 4 |
| | Direct facility equipment | 0.2385 | infrastructure | 0.0279 | 8 |
| | | | Logistics equipment | 0.0477 | 6 |
| | | | Transportation equipment | 0.1630 | 3 |
| | Direct logistics operations | 0.625 | Innovative organizational models | 0.0618 | 5 |
| | | | Direct packaging development | 0.2277 | 2 |
| | | | Packaging Recycling System | 0.3356 | 1 |

From Table 8, it can be seen that the size of the evaluation value of the guideline layer is ranked as direct logistics operation (0.625) > direct facilities and equipment (0.2385) > direct development environment (0.1365). Then it can reflect the customer's satisfaction level. It is most satisfied with the direct logistics operation, which also reflects the importance of the direct logistics operation from the side.

In addition, the nine indicators from the indicator layer are analyzed. The top three in terms of weight share are packaging recycling system (33.56%), direct packaging development (22.77%), and creation of transportation equipment (16.30%). The above data can be seen that the development of direct packaging is particularly important for the development of enterprises. And direct packaging is in line with the international trend of environmental protection needs, not only can reduce environmental pollution, maintain ecological balance, but also to provide customers with a diversified choice. Realization of direct packaging we can from the direct packaging materials, packaging design and vigorously develop the direct packaging industry and other aspects of the beginning, from the root to solve the problem of direct packaging and other issues.

The last three are policy measures (3.82%), infrastructure (2.79%) and institutional mechanisms (1.28). We can see that these three items are indicators of low satisfaction or low impact, and they are also indicators that we cannot ignore and most need to strengthen to make up for.

## 5 MATHEMATICAL FUZZY EVALUATION METHOD PROCESS

Determine the set of indicators for evaluation as A={B1,B2,B3,B4}, each indicator within this indicator set corresponds to this study in the previous section to determine the construction of logistics system risk factors, such as direct development environment, direct facilities and equipment, direct logistics operations. Then the impact evaluation level set is V={V1,V2,V3,V4}={Low, Lower, Higher, Higher}, in addition, the corresponding fuzzy relationship matrix is to be established after specifying the degree of affiliation. In this paper, according to {Low, Lower, Higher, Higher]

evaluation level. Three different dimensions of the construction of the direct logistics operation system was evaluated, and the data and information collected from the experts were statistically analyzed. After calculating the ratio of the number of experts in each level of evaluation to the overall number, the affiliation relationship was determined. In addition, this paper introduces an evaluation level scale to derive a score about building a direct logistics system. Set V={V1,V2,V3,V4}={10,20,30,40}
As shown in Table 9.

**Table 9.** Indicator affiliations corresponding to evaluation levels

| Consolidated target level Aj | Guideline layer Bj | Indicator layer Cj | lower | relatiely low | high | your |
|---|---|---|---|---|---|---|
| Urban direct logistics operation system | Direct Development Environment B1 | Institutional mechanism C1 | 0 | 0.2 | 0.3 | 0.5 |
| | | Policy Measure C2 | 0.1 | 0.2 | 0.4 | 0.3 |
| | | Facilitated Transportation C3 | 0.2 | 0.2 | 0.3 | 0.3 |
| | Direct facility equipment B2 | Infrastructure C4 | 0 | 0.25 | 0.4 | 0.35 |
| | | Logistics equipment C5 | 0 | 0.25 | 0.35 | 0.4 |
| | | Transportation equipment C6 | 0.1 | 0..4 | 0.3 | 0.2 |
| | Direct logistics operations B3 | Innovative organizational model C7 | 0 | 0.25 | 0.45 | 0.3 |
| | | Direct Packaging Development C8 | 0.15 | 0.25 | 0.3 | 0.3 |
| | | Packaging Recycling System C9 | 0 | 0.15 | 0.35 | 0.5 |

$$R1=\begin{bmatrix}0 & 0.2 & 0.3 & 0.5\\ 0.1 & 0.2 & 0.4 & 0.3\\ 0.2 & 0.2 & 0.3 & 0.3\end{bmatrix} \quad R2=\begin{bmatrix}0 & 0.25 & 0.4 & 0.35\\ 0 & 0.25 & 0.35 & 0.4\\ 0.1 & 0.4 & 0.3 & 0.2\end{bmatrix} R3=\begin{bmatrix}0 & 0.25 & 0.45 & 0.3\\ 0.15 & 0.25 & 0.3 & 0.3\\ 0 & 0.15 & 0.35 & 0.5\end{bmatrix}$$

From the fuzzy system evaluation calculation equation B=A*R, the details are as follows:

$$B1 = A1 * R1 = (0.0936\ 0.2797\ 0.6267) * \begin{bmatrix}0 & 0.2 & 0.3 & 0.5\\ 0.1 & 0.2 & 0.4 & 0.3\\ 0.2 & 0.2 & 0.3 & 0.3\end{bmatrix}$$

$$=(0.153,0.2,0.328,0.319)$$

$$B2 = A2 * R2 = (0.1168\ 0.1998\ 0.6833) * \begin{bmatrix}0 & 0.25 & 0.4 & 0.35\\ 0 & 0.25 & 0.35 & 0.4\\ 0.1 & 0.4 & 0.3 & 0.2\end{bmatrix}$$

$$=(0.068,0.352,0.322,0.258)$$

$$B3 = A3 * R3 = (0.0989\ ,0.3643\ ,0.5368) * \begin{bmatrix}0 & 0.25 & 0.45 & 0.3\\ 0.15 & 0.25 & 0.3 & 0.3\\ 0 & 0.15 & 0.35 & 0.5\end{bmatrix}$$

=(0.055,0.196,0.342,0.407)

Determine the effectiveness of the evaluation of the direct logistics operation system: A = Bsum * Rsum

where Bsum = (0.1365, 0.2385, 0.625)

$$R = sum \begin{bmatrix} 0.153 & 0.2 & 0.328 & 0.319 \\ 0.068 & 0.352 & 0.322 & 0.258 \\ 0.055 & 0.196 & 0.342 & 0.407 \end{bmatrix}$$

A=(0.041,0.234,0.335,0.359)

As a result of the judgment matrix, it was determined that the value of B is 0.359, which indicates that there is a high risk of building a direct logistics system. 4.1% of the experts evaluated the system of building a risky logistics operation as low, 23.4% of the experts thought that the risk of building a logistics operation was average, 33.5% thought that the risk of building a system of logistics operation was high, and 41.76% thought that the risk of building a system of logistics operation was high. risk is high.

Already evaluate the set V= [10,20,30,40], and reduce the evaluation results to an integer: P=V*A

P=[10,20,30,40]* (0.041,0.234,0.335,0.359)=29.5

Based on the hierarchical analysis method - fuzzy comprehensive evaluation method, the final result of the quantitative evaluation results after factor analysis is 29.5 points, according to the results of the evaluation of the specific values represented by the risk level between the lower risk and higher risk, favoring higher risk[8]. Therefore, the comprehensive evaluation of the risk level of building logistics operation system is higher.

# 6 CONCLUSION

The factors in each guideline layer were weighted, and the weights of the indicators were finally obtained. By observing the weights of the factors and analyzing them, several indicators that are the most critical to building a direct logistics system were identified. In the establishment of the urban direct logistics system, the direct logistics operation in the guideline layer has the greatest influence on it, and its weight accounts for 62.5%. Among them, the packaging recycling system has the greatest impact on it, 33.56%, followed by the development of direct packaging is the impact on it, 22.77%, and the innovative organizational model has a smaller impact on it, 6.18%. It can be seen that in the construction of direct logistics system, direct logistics related technology plays a big role in it[9].

Secondly, more important to the construction of the direct logistics system is the direct logistics facilities and equipment, which accounted for 23.85%, of which the transportation equipment can be seen to have the greatest impact on it, 16.3%.

The choice of transportation equipment will reduce the generation of transportation costs, thus greatly improving the cost of logistics. As the environmental protection problem becomes more and more serious, the national requirements for environmental protection are also higher and higher, so the development of direct logistics is inevitable, and the logistics company should pay more attention to the environmental protection status of the enterprise. The article proposed for the first time to establish the evaluation system of urban direct logistics and distribution system, and gave the corresponding evaluation criteria and evaluation content. Therefore, it is necessary to follow the specific weight of each index to make it more scientific and scientific to promote the reality, it is not to compare each index, but to make the direct logistics of the city have a clearer development direction and goal toward the development of direct logistics, and then improve the environmental protection of the logistics distribution, and better realize the direct operation of each logistics enterprise, so that the logistics development and the natural environment coexist[10].

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