Study on the midway docking mode of the regional trunk transportation network

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Abstract. This paper presents a new form of trunk transport network to improve the loading rate and reduce the vehicle stopping through the distribution centre. The article first compares the empty waste of vehicles between point to point direct mode and midway stop mode, obtains the applicable conditions of regional trunk logistics transportation network and midway docking transportation mode, and analyzes the feasibility of trunk logistics vehicles.

1. Introduction
With the continuous improvement of Chinese economy and the rapid development of logistics industry, logistics plays an increasingly prominent role in the national economy development of electricity. With the rapid development of logistics industry, a large number of logistics companies competing, the rapid development of logistics industry also prompted the competition. So how to build reasonable transportation networks in the competitive industry, especially the transportation path to reduce the logistics cost has become an urgent problem for logistics companies. This paper focuses on studying the transport mode of the trunk line logistics in the region. In order to ensure the balance of the trunk transportation resources, the logistics enterprises generally require the transport vehicles to return to the departure and distribution after completing the transportation task, so as to facilitate the next phase of the transportation operation. In the whole logistics and transportation process, most logistics enterprises are faced with the problems of irregular operation process, unreasonable vehicle scheduling and low degree of line optimization, which is a great waste of trunk transportation resources.

Regional logistics refers to the logistics activity system established to adapt to regional environmental characteristics supporting the overall goal of regional sustainable development, provide regional logistics functions, meet the needs of regional economic, political, natural and military development, have reasonable spatial structure and service scale, and achieve effective organization and management. Regional logistics is mainly composed of regional logistics network system, regional logistics information support system and regional logistics organization and operation system. Direct transportation refers to the direct transportation of goods from the origin to the desired goods unit, and the middle does not need to pass through the warehouses of wholesale enterprises at all levels. Direct-line transportation refers to the transportation that reduces the circulation link of goods and adopts the shortest transportation distance. Direct transportation is consistent with the rationality of straight-line transportation, commonly known as direct transportation.

2. Analysis of the operation process of the regional trunk transportation network
With the construction of national logistics network and the rapid growth of business, the demand for standardized operation is increasingly obvious. Facing the fierce competition in the industry, logistics
enterprises are establishing a relatively perfect operation system to realize the commitment to timeliness and quality. After the deployment of recent years, most express enterprises have initially completed the development and implementation of information management system, routing vehicle system and operating system, and realized the multi-node process systematization and have the conditions to build a relatively perfect operation system. Through the sorting and optimization of the operation process and management process, form a standard operation system, guide and standardize the site operation, and finally through the systematic process, to realize the whole process nodes monitoring, and create a healthy and sustainable operation system. Through the sorting and optimization of the operation process and management process, form a standard operation system, guide and standardize the site operation, and finally through the systematic process, to realize the whole process nodes monitoring, and create a healthy and sustainable operation system. The freight flow of the logistics and transportation network is shown in Figure 1 below.

Fig. 1. Schematic diagram of the freight flow of the logistics and transportation network.

The logistics transportation network is mainly divided into trunk transportation network and branch transportation network. Due to the whole transportation network system that is relatively complex, this paper mainly introduces the trunk transportation network, and the trunk transportation network is not introduced too much. The operation process of the trunk transportation network mainly includes distribution to distribution goods delivery, goods in transit, distribution to distribution goods collection. The process of distribution and distribution includes: system dispatch, inspection, redispatch and delivery. The process of distribution and distribution includes: vehicle waiting on the port, port confirmation, berth distribution, guide and the port. Distribution and delivery and departure process includes: vehicle sealing, document handover, departure attendance, departure bar distribution, and departure distribution. The process of distribution and collection includes road tracking, attendance, departure and departure of distribution and collection.

The above introduction of the operation process of the trunk transportation network is universal, and many enterprises have adopted this standardized operation process. However, there are still a series of problems in the trunk logistics network, including low vehicle load rate and high trunk transportation costs.

3. Structure analysis of the regional trunk line transportation network

Different transport network structures can be used to meet different transport needs, and different transport network forms can operate effectively under different transport needs. Transportation network is divided into: direct type, HS network, multi-point serial type, mixed mode, midway docking and other forms. According to the characteristics of transportation network in the logistics system, the appropriate transportation network is selected to maximize the load loading rate and reduce logistics costs. Whether direct transport mode, HS network, midway transport mode is used to stop at, or other transportation forms. Whether direct transport mode, HS network, midway transport mode is used to stop at, or other transportation forms. Similarly, both problems belong to the transport network optimization problem.
3.1 Point-to-point direct access mode
The trunk transport network based on the direct transport mode means that all vehicles only travel back and forth between the two distribution centers and are only responsible for the transport of goods between the two distribution centers.

The point-to-point direct mode allows direct goods to destination distribution, which is the fastest way. Express enterprises can take advantage of the point-to-point high-speed direct access to deliver the goods to the destination within the operation period. At present, most express enterprises adopt the direct transport mode. The main advantage of the direct transport mode is the need for transit, reduce the transit cost, and it is simple and easy to operate. The use of self-operated vehicles can improve the cargo transport efficiency to a large extent. Direct transport mode is feasible if vehicle maximum load rate is achieved. The direct transport network structure is shown in Figure 2 below.

![Direct network structure](image)

The connection in Figure 2 shows that the direct transport line, and there is no direct transport between some distribution centres, so the direct transport mode does not cover the entire transport network. At the same time, the point-to-point direct access mode is not the most cost-effective. Because in the direct transport mode, for the restrictions of geographical conditions, some distribution goods are too small, resulting in the high no-load rate of the vehicle, the vehicle cannot reach the maximum load, there is a certain degree of no-load.

3.2 Midway point stop mode
To overcome the defects of direct transport mode, the transit stop transport mode for non-loaded vehicles, but there will be multiple transport paths available. In order to ensure the timeliness of logistics transportation, under the principle of meeting the limitation of goods transportation, choose a halfway point to choose the best transportation route for cargo transportation, so that the lowest transportation cost.

The choice of stop distribution and the division principle of the main logistics and transportation network in the region: the lines are generally in a straight line or from the beginning to the destination distribution. Timeliness generally give priority, do not meet the conditions may stop the cumulative departure.

The vehicle route arrangement breaks through the traditional transportation network form. The traditional vehicle transportation is only responsible for goods transportation between the two distribution centres, and the improved transportation mode can be responsible for goods transportation between the three distribution centres. Although the improved transport mode increases the cost of detour to some extent, this transport mode improves the loading rate of the vehicle and reduces the transport cost of unit cargo, so it is better than the vehicle route arrangement from point to point to point.

This paper aims the total goal of minimum trunk logistics transportation cost. The model decision variable studied in this paper is the selection and loading of each vehicle between the distribution center and the distribution center, which can be defined as 0-1 variables and thus constructed as an integer planning model for solution. In order to overcome the defects of direct transportation, the trunk transport
network is improved by increasing the midway docking transport mode, which greatly improves the loading rate of the vehicle.

4. Structure analysis of the regional trunk line transportation network

One of the main functions of logistics is transportation, the transportation network can be divided into branch logistics cargo transportation research and trunk logistics cargo transportation research. A large part of the cost during transportation comes from trunk transportation, with point-to-point direct delivery directly to destination distribution, which is the fastest way. But in most cases, the point-to-point direct access mode is not the most cost-effective. Because in direct mode, vehicles often have a half-empty load, which greatly increases the cost of idling. The direct mode requires the goods to load greater than or equal to a whole vehicle, but generally the goods must be surplus and cannot become an integral number of the vehicle, or many vehicles due to the imbalance of cargo traffic between regions.

4.1 Feasibility analysis

In the trunk logistics network, the cargo loading mode in each distribution centre has an important influence on the benefit of the whole network. According to different loading and unloading modes, the amount of empty waste (ton / km), analyzing the feasibility of regional trunk logistics transport vehicles stopping at the halfway point.

The symbol PQ (U, x₁, x₂, d) is introduced, where U indicates the rated load weight of the vehicle between the P, Q, in: ton; x₁, x₂ indicates the return load rate; d indicates the distance between the two distribution centres in km.

Direct vehicles between distribution centre S and S of distribution centre, namely S double (A, α₁, α₂,a). Now insert a stop point Q, to discuss the feasibility of the stopping mode of regional trunk logistics transport vehicles at the halfway point:

① Now insert a stop point Q, to discuss the feasibility of the stopping mode of regional trunk logistics transport vehicles at the halfway point:

② Direct hair vehicles exist in both Q and S, T.

4.1.1 Only Unloading (only) mode

In the logistics and transportation network, the quantity of delivery and arrival at each point is basically unbalanced. At this time, the empty driving and waste amount of vehicles (ton / km) under two round-trip two-trip direct mode and midway point stop (non-direct) mode should be compared.

When point to point direct transport is shown in Figure 3, the total empty waste of direct vehicles can be expressed as:

\[ a*A(1-\alpha_1)+b*B(1-\beta_1)+a*A(1-\alpha_2)+b*B(1-\beta_2) = a*A(2-\alpha_1-\alpha_2)+b*B(2-\beta_1-\beta_2) \] (1)

Fig. 3. Direct transport.

When using "midway stop" (non-direct) transport, the vehicle stops at point Q, as shown in Figure 4, order \( X_1 > A \alpha_1 + B \beta_1, \) \( X_2 > A \alpha_2 + B \beta_2, \) then the X> max \{X1, XZ\}. Empty waste of vehicles rated at X tons may be expressed as:

\[ c*X-c*A \alpha_1+bX-b*A \alpha_1-b*B \beta_1+bX-b*A \alpha_2-b*B \beta_2 + cX-a*A \alpha_3 \] (2)
Compare (1) (2) of the differences by: \[ \Delta = (2b+2c)X - 2aA - 2bB + (a-b-c)A \alpha_1 + (a-b-c)A \alpha_2 \]
For \( \Delta < 0 \), you must have
\[ X < \frac{[2aA + 2bB - (a-b-c)A \alpha_1 - (a-b-c)A \alpha_2]}{2(b+c)} \] \tag{3}
Midpoint stop transport mode is higher and less expensive than point-to-point direct mode.
Since \( X \geq \max\{X_1, X_2\} \), the rated load of the parked vehicle is met \( \max\{X_1, X_2\} \leq X < \frac{[2aA + 2bB - (a-b-c)A \alpha_1 - (a-b-c)A \alpha_2]}{2(b+c)} \). At this time, the vehicle transport form compared with the point-to-point direct transport form.

4.1.2 Remove first before loading mode
In the logistics and transportation network, the quantity of delivery and arrival at each point is basically unbalanced. At this time, the empty driving and waste amount of vehicles (ton / km) under two round-trip two-trip direct mode and midway point stop (non-direct) mode should be compared.
By calculation, the no-load rate can be reduced compared with the point-to-point direct vehicle organization mode.

4.2 Empirical analysis
This paper takes the trunk transportation organization of S Logistics Company as the object, and demonstrates the feasibility and practical value of the regional trunk logistics combined with the midway point docking mode.
With the rapid growth of national network construction and business, the demand for standardized operation is increasingly obvious. Facing the fierce competition in the industry, the logistics enterprises are establishing a relatively perfect operation system to realize the commitment to the transportation time limit and service quality. Through the sorting and optimization of the operation process and management process, a standard operation system is formed to guide and standardize the site operation, and finally systematic the process, the whole process node monitoring, to create a healthy and sustainable operation system. Logistics and transportation network can be divided into trunk transportation network and branch transportation network. With the complex transportation network system, this paper mainly studies the trunk transportation network. The organization form of trunk logistics and transportation is shown in Figure 5 below.

![Figure 5. Organization form of trunk line logistics and transportation.](image-url)
customers, outlets and the distribution center. As can be seen from the figure above, there are not direct vehicles between all distribution centers. At this time, the appropriate transportation network form is selected according to the characteristics of the transportation network in the logistics system.

5. Conclusion
Aiming at the practical problems faced by most logistics enterprises in the transportation process, this paper optimizes the current trunk transportation network, and puts forward the one-way full-load vehicle docking mode to improve the loading rate to reduce the logistics transportation cost and improve the competitiveness of enterprises. This paper proposes the transportation form of "midway stop" to improve the regional trunk logistics and transportation network, and compares the idling and waste amount of vehicles in the two transport mode with different loading and unloading modes.

At present, due to the unbalanced China's economic development, the flow of goods is extremely unbalanced. Many one-way fully loaded vehicles' load rate in the return process is not high and more empty return, which greatly waste the transportation resources and makes the transportation cost of logistics enterprises high, which is not conducive to the improvement of the core competitiveness of enterprises. The research of this paper is mainly to improve the vehicle loading rate and reduce the logistics and transportation costs. Firstly, this paper analyzes the current situation of Chinese trunk logistics and transportation network for the practical problems facing enterprises, and understands the current academic research situation and solutions. For the different loading and unloading modes of trunk logistics transport vehicles, we propose the midway point stop mode, compare the empty driving waste amount of vehicles under the point to point stop mode, and analyze the feasibility of regional trunk logistics transport vehicles stopping at the halfway point. The resulting data shows that in most cases, the midway transport mode can avoid some empty vehicle waste than the point-to-point direct mode, which proves the feasibility of improving the trunk transport network in most cases.

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