Research on Network Drop Truck Scheduling Based on Dijkstra Algorithm

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Abstract. In view of the important link of vehicle dispatching under the network-type trailer-drop transport strategy of vehicle sharing, this paper uses JAVA to implement the Dijkstra algorithm for the transportation route based on the distance between stations and the demand of freight transportation, so as to find the shortest path, and then through the model of trailer-drop transport, an example is given. The advantages of this vehicle scheduling are analyzed.

1 Introduction

As an advanced organizational mode of hung-and-drop transport, the innovation of its organizational mode is very important. The original "one line, two points" and "circulation mode" can not meet the requirements of today's "smart logistics". In order to pursue higher economic benefits, achieve more efficient hung-and-drop transport mode, network-type hung-and-drop transport mode. As the times require, it is the product of the development of the hang-and-drop transport to a certain stage. On the basis of "one line, two points", it gradually expands the circular hang-and-drop and develops to the network type of hang-and-drop transport mode. Network drop off is a nationwide joint operation cooperation mode.

First of all, it is necessary to divide the distribution tasks of a single yard, integrate the transport functions of different enterprises, and integrate all kinds of logistics resources (including vehicles, personnel, warehousing, etc.), so that the transportation network can realize the saving, high efficiency, rationalization of distribution, and improve the utilization rate of vehicles. Combined with the different characteristics of duty stations, the distribution cluster is formed to simplify the complex distribution problem. In order to realize the reasonable dispatching of goods and the allocation of stations and yards, and to meet the needs of informationization, GPS dispatching management system should be adopted, combined with GPS distribution orders, tractors and trailers should be rationally arranged, and the best driving route should be calculated by Dijkstra algorithm to make a good dispatching plan.

2 Network type drop and pull transport model

2.1 Problem analysis

From the development experience of foreign countries and the current situation in China, the drop-and-hang transport is not the innovation of single enterprise transport mode, but the transformation of the whole industry transport mode. The transport forms, advantages and disadvantages of different drop-and-hang transport modes are different, and their applicable fields are also different. In the process of the development of hung-and-drop transport, we need to pay attention to the inter-regional cooperation between different enterprises, from the single line operation within the enterprise to the inter-regional circulation operation mode and then to the inter-regional network operation, the road freight transport industry in China is constantly innovating the new organization mode of hung-and-drop transport, giving play to different types of hung-and-drop transport. The advantages of transportation mode and its combination characteristics form a new mode of network drop and pull transport. The network-type hung-and-drop transport mode integrates special lines, establishes different station centers according to the distribution of lines and goods, realizes intensive allocation of freight sources of special lines in the same direction, realizes hung-and-drop operation of different stations and lines in the network, makes full use of the economic benefits of the network and reduces the overall transportation cost. On the other hand, the network-type hang-and-drop transport mode needs to strengthen communication with Shipper enterprises, from a single temporary employment relationship to a long-term cooperative partnership, to ensure stable hang-and-drop operation, adequate supply of goods, and through efficient organization to improve the quality of service. This mode is consistent with the requirements of drop and hang transport mode, and is an important manifestation of logistics network. Through the

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intensive arrangement in each yard, the tractor can be dispatched reasonably according to the need in the operation network besides ensuring a stable supply of goods. There are many yards in the network-type trailer-and-drop transportation. The tractor trailer operates between the nodes. If necessary, the branch line can cooperate with the small truck to transport, so as to reduce the logistics cost as much as possible and improve the transport efficiency.

The common layout of network-type hang-and-drop transport mode is that there are S distribution centers in a certain place, and each distribution center area forms a distribution area. Set up S distribution center with K tractors, each tractor maximum load, distribution center I to j transport distance.

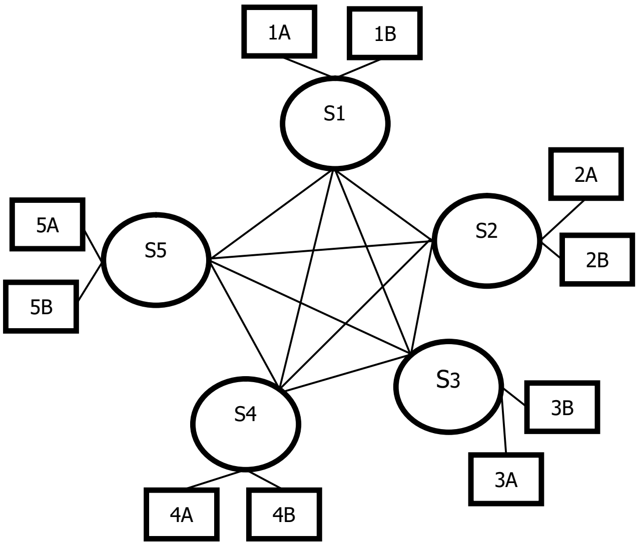

Figure 1. Network-type hang-and-drop transport diagram

The network transportation scheduling problem can be described as starting from several distribution centers and using multiple tractors to send goods to other distribution centers. It is assumed that the location of each distribution center and the quantity of goods required by customers are predetermined, the number of tractors in the distribution center and the number of tractors in each distribution center are determined. The number of trailers can meet the maximum demand for freight transportation. The goal is to make the total cost smaller and larger. The total cost here consists mainly of the following two parts: (1) Travel cost, which is related to the distance of transportation and the fuel consumption per unit distance. (2) Fixed costs, mainly including vehicle depreciation fee, insurance fee, annual inspection fee, vehicle maintenance fee, artificial salary and so on.

2.2 Basic assumptions

1. Distribution centers have sufficient supply of goods, regardless of the transfer of goods or other supplementary supply between the distribution centers.

2. The number of trailers reserved by the distribution center is sufficient, and the transportation cost is only related to the transportation distance, without considering other specific transportation details.

3. Does not consider the storage cost of goods in distribution centers.

4. Each trailer is loaded with cargo and will not be empty, not full load.

5. The capacity of each yard can meet the demand of freight forwarding and temporary storage, and charge a fixed management fee.

2.3 Variables and symbols

Q_a: Fuel consumption per 100 km

d_{ij} : The distance between task nodes i and j

C_2: Unit Trailer price of truck trailers

W_a: Tractor loading condition

q_k: The load of the k tractor

Q_{ij}: Yard i transport to station j freight volume

2.4 Establishment of models

1. According to the mode of transportation, the target value of the model is considered as two parts: the least cost and the maximum benefit.

It has been assumed that the running cost of the trailer is only related to the driving distance and fuel consumption of the K vehicle. It is easy to write down the running cost of a trailer for transporting goods at one time without considering the non-full load state of the trailer $\sum_{a=0}^{a}\sum_{i=0}^{i}\sum_{j=1}^{j}\sum_{k=1}^{k} Q_a d_{ij} x_{sk}(i,j)$, that is, the K tractor of Distribution S will be the cost of travelling from i trailers to j. And in the actual transportation process, not only the driving cost, but also the vehicle depreciation fee, toll, labor wages, maintenance costs, management costs and so on, these fixed costs are analyzed, Then select the appropriate coefficient C1 to express comprehensively, $\sum_{k=1}^{k}\sum_{i=0}^{i}\sum_{j=1}^{j} C_1 x_k(i,j)$, The K vehicle runs from task node i to task node j. In summary, the model with the lowest cost is $\sum_{a=0}^{a}\sum_{i=0}^{i}\sum_{j=1}^{j}\sum_{k=1}^{k} Q_a d_{ij} x_{sk}(i,j)+\sum_{k=1}^{k}\sum_{i=0}^{i}\sum_{j=1}^{j} C_1 x_k(i,j)$.

2. In the process of trailer-drop transportation dispatching, there are certain constraints for distribution centers and trailer-drop vehicles. The number of tractors from all stations does not exceed the total number of tractors reserved in the station yard $\sum_{s=1}^{s}\sum_{k=1}^{k}\sum_{j=1}^{j} x_{sk}(0,j)\le k$, the number of tractors from all stations does not exceed the total number of tractors reserved in the station yard $W_a \le C_w$, tractor trailer capacity limitation $\sum_{s=1}^{s}\sum_{k=1}^{k} q_k x_{sk}(i,j)=Q_{ij}$

The sum of all tractor loads traveling from any station to complete a task equals the total freight demand for the task.

3. Design of network drop and pull transport

algorithm

$$r_1\sum_{i\in V}\sum_{j\in V}\sum_{k\in K}C_{ij}X_{ijk}+r_2\sum_{i\in V}\sum_{j\in V}\sum_{k\in K}r_2c_{ij}x_{ijk}+\sum_{j\in V}F_jz_j+P(t_{ik})$$

r_1 : Loading cost coefficient

Tractor fuel consumption on Trailer laden semitrailer on Section (i,j)

r_2 : Empty car running coefficient

Fuel consumption of tractor when traveling alone on Road (i,j)

$X_{ijk}=1, x_{ijk}=0$： Tractor k Trailer laden semitraile r driving

$X_{ijk}=0, x_{ijk}=1$: Tractor k no load driving

F_j : Fixed costs of j freight stations

z_j = 1（ Freight station selected ）;

0（ Other ）

4. The penalty cost of tractor k arriving at the starting point of i.

$P(t_{ik})=a(s_1-t_{ik}), t_{ik}<s_1$; Waiting cost

0, $s_1\le t_{ik}\le s_2$;

$b(t_{ik}-s_2), t_{ik}>s_2$ Late cost

3 Design of network drop and pull transport algorithm

1. According to the model of network-type hung-and-drop transportation, the cost is closely related to the transportation distance in the process of hung-and-drop dispatching, so the shortest route should be chosen as far as possible, and then the lowest cost of hung-and-drop transportation should be considered comprehensively to adjust, which becomes the shortest path problem. The shortest path problem is usually abstracted as a network problem in the sense of graph theory. The core of the problem becomes the shortest path problem in network graph (the implementation of fast Dijkstra shortest path optimization algorithm). According to the freight demand of each service point, it is connected into a directed graph, and then the information of the graph is stored by matrix.

2. Algorithm steps:

Step 1: initialize, update the freight demand of each service point and the number of trailers and tractors.

Step 2: Connect the service points into a directed graph in matrix form, and the distance between the service points is the transportation distance.

Step 3: mark the v[0], vis[0] = 1 (VIS initialize 0 at the beginning);

Step 4: Find the nearest point v [k] adjacent to V [0], record the V [k] point, and mark the distance between V [k] and V [0] as min.

Step 5: mark v[k], vis[k]=1;

Step 6: Compare dis [j] with min + W [k] [j] to determine whether the direct V [0] connection V [j] is shorter or the connection V [j] through V [k] is shorter, that is, dis [j] = MIN (dis [j], min + W [k] [j]);

Step 7: continue to repeat steps three and five.

The JAVA implementation code is as follows:

```
public class Dijkstra {
static int MAX=10000;
public static void main(String[] args) {
   String l=null;
   Conutil con=new Conutil();
    l=con.getConnection();
   System.out.println(l);
   int[][] weight = {
         {0,210,80,45,90,170,220,65,120,135},
         {210,0,135,155,200,75,90,55,270,50},
         {80,135,0,85,110,40,200,280,95,115},
         {45,155,85,0,240,270,70,120,75,100},
         {90,200,110,240,0,130,50,85,30,95},
         {170,75,40,270,130,0,110,90,100,180},
         {220,90,200,70,50,110,0,40,45,100},
         {65,55,280,120,85,90,40,0,160,200},
         {120,270,95,75,30,100,45,160,0,70},
         {135,50,115,100,95,180,100,200,70,0}
   };
   int start=0;
   int[] shortPath = Dijsktra(weight,start);
   for(int i = 0;i < shortPath.length;i++)
   {
      System.out.println("The shortest distance
from"+start+"to"+i+"is:"+shortPath[i]);
   }
}
public static int[] Dijsktra(int[][] weight,int start){

   int n = weight.length;
   int[] shortPath = new int[n];
      String[] path=new String[n];
   for(int i=0;i<n;i++)
   {
      path[i] = start + "-->" + i;
         }
       int[] visited = new int[n];
   shortPath[start] = 0;
   visited[start] = 1;
   for(int count = 1;count <= n - 1;count++)
   {
      int k = -1;
      int dmin = Integer.MAX_VALUE;
      for(int i = 0;i < n;i++)
      {
         if(visited[i] == 0 && weight[start][i] < dmin)
         {
            dmin = weight[start][i];
            k = i;
         }
      }
      shortPath[k] = dmin;
      visited[k] = 1;
      for(int i = 0;i < n;i++)
      {
         if(visited[i] == 0 && weight[start][k] +
weight[k][i] < weight[start][i])
         {
            weight[start][i] = weight[start][k] +
weight[k][i];
            path[i]=path[k]+"-->"+i;
         }
      }
```

```
        }
        for(int i=0;i<n;i++)
        {
          System.out.println("The          shortest          path
from"+start+"to"+i+"is:"+path[i]);
        }

System.out.println("=========================
===========");
        return shortPath;
    }
}
```

4 Example analysis

To simplify the calculation, it is assumed that the management cost of the station is the same; the transport speed of the trailer is 60 km/h; the cost of the tractor is 0.8 yuan/km with a load and 0.45 yuan/km with no load; the driver's salary is determined by the working time and the environment; and the maximum working time is 24 hours per day, the traditional transport party will be provided. The formula is calculated with Dijkstra algorithm and the result is compared.

Table 1. Distance between stations in network transportation (unit: km)

	0	2	3	4	5	6	7	8	9
0	0	80	45	90	170	220	65	120	135
1	210	135	155	200	75	90	55	270	50
2	80	0	85	110	40	200	280	95	115
3	45	85	0	240	270	70	120	75	100
4	90	110	240	0	130	50	85	30	95
5	170	40	270	130	0	110	90	100	180
6	220	200	70	50	110	0	40	45	100
7	65	280	120	85	90	40	0	160	200
8	120	95	75	30	100	45	160	0	70
9	135	115	100	95	180	100	200	70	0

The above table describes the distances between the stations. For example, the second row in the first column indicates that the distance between the No. 1 and No. 0 stations is 210 km, and the distance between the station and the station itself is 0.

The demand for goods between each station is shown in the following table:

Table 2. Transport demand between stations (unit: Trailer)

	0	1	2	3	4	5	6	7	8	9
0	0	2	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0	0	0
2	0	0	0	1	0	0	0	0	0	0
3	0	0	2	0	0	0	0	0	0	0
4	0	0	0	0	0	0	3	0	0	0
5	0	0	0	0	0	0	2	0	0	0
6	0	0	0	0	0	0	0	0	4	0
7	0	0	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	1	0

The above table forms a transport demand relationship table according to the demand for goods between stations. For example, the fourth row in the second column indicates that two trailers need to be transported from station 1 to station 2.

Traditional path of hanging and hanging transportation:

$$0 \longrightarrow 1 \longrightarrow 3 \longrightarrow 2$$

$$7 \longrightarrow 2$$

$$4 \longrightarrow 6$$

$$5 \longrightarrow 6 \longrightarrow 8$$

$$9 \longrightarrow 8$$

The Dijkstra algorithm is calculated by JAVA, and the best transport path is obtained, as shown in the following figure.

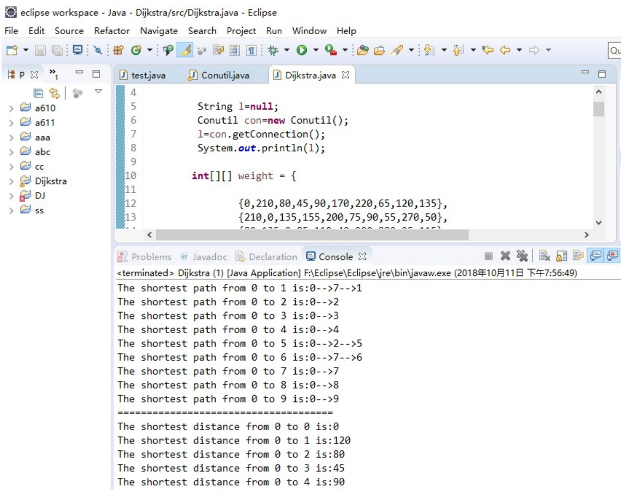

Figure 2. Dijkstra algorithm

Dijkstra algorithm is used to adjust the transport path to:

The shortest path from 0 to 1 is 0-->7-->1, and the shortest distance is 120.

The shortest path from 1 to 3 is 1-->9-->3, and the shortest distance is 150.

The shortest path from 3 to 2 is 3-->2, and the shortest distance is 85.

The shortest path from 7 to 2 is 7-->5-->2, and the shortest distance is 130.

The shortest path from 4 to 6 is 4-->6, and the shortest distance is 50.

The shortest path from 5 to 6 is 5-->6, and the shortest distance is 110.

The shortest path from 6 to 8 is 6-->8, and the shortest distance is 45.

The shortest path from 9 to 8 is 9-->8, and the shortest distance is 70.

$0 \longrightarrow 7 \longrightarrow 1 \longrightarrow 9 \longrightarrow 3 \longrightarrow 2$
$7 \longrightarrow 5 \longrightarrow 2$
$4 \longrightarrow 6$
$5 \longrightarrow 6 \longrightarrow 8$
$9 \longrightarrow 8$

Table 2. Comparison of results

	Stroke (load)	Journey (no load)	Total travel	Cost
Traditional hanging transport	1005km	100km	1050km	1149
Dijkstra algorithm for drop and pull transport	760km	100km	860km	953

5 Conclusion

As an efficient transportation mode, the drop-and-drop transportation has been widely used at home and abroad. Using Dijkstra to study the vehicle scheduling problem can better reduce the logistics cost, promote energy conservation and emission reduction, and improve economic efficiency. In this paper, a preliminary study on the network-type trailer-and-drop transport mode is carried out, and it is necessary to continue to study the multi-trailer and dynamic situation of a vehicle.

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