ISSN: 2688-9323

Quantitative Analysis of Distributed Dispatch and Cost Planning of Shared Cars based on Simulated Annealing Algorithm

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Abstract

With the impact of the epidemic and the acceleration of the iteration of model updates, consumers' desire to use the car gradually escalates, they want to have a lighter and better way to use the car, the "time-sharing rental" model of shared cars has solved this problem very well. However, it makes it very difficult to make a profit by making too many cost controls. In order to ensure the sustainable development of shared cars, it is necessary to use relevant mathematical algorithms, combined with the background of big data, to carry out relevant analysis, and put forward countermeasures.

Keywords

Car Sharing; Simulated Annealing; Cluster Analysis; Hierarchical Analysis; Linear Planning.

1. Introduction

In view of the distribution of shared cars, this paper takes A city as an example, first of all, the A city parking data for descriptive statistical analysis, according to the time of the distribution of parking, through quantitative analysis of the use of shared cars in the city to obtain the distribution characteristics of the use of the city Hierarchical clustering method, get the city's "peak", "medium peak", "low peak" and "low peak" four time intervals to share the frequency distribution of car use, in space using K-means clustering analysis, by dividing the distribution area of shared cars into 11 small areas, study the clustering of vehicles in each region, the distribution area has "K" contouring characteristics and trends.

In view of the scheduling and cost planning problems of shared cars, starting with the regional distribution characteristics of shared cars, the approximate optimal path of 11 planning areas is calculated by using the simulated annealing model and programming through MATLAB code, and the city's shared car planning and scheduling diagram is obtained to reduce the transportation management cost and dispatch cost of shared cars. Then, we use hierarchical analysis to analyze the six main factors affecting enterprise scheduling costs, and these indicators through linear planning to obtain the optimal solution, to achieve more in repair and scheduling to invest more technology and improvements to maximize cost reduction.

2. The Development of Shared Cars

2.1. Development Overview

Since 2015, the shared-car industry has been "in full bloom" with huge financing for a number of projects. But because of the heavy model, operating costs are too high, cannot make a profit and other issues, one after another, there are shared car companies because of the broken capital chain and closed. According to Analysis' 2019 White Paper on Innovation in China's Shared Car Platforms, the shared auto industry in 2019 is a year when small and medium-sized players continue to emerge and the head platform drives the industry to restart growth. The growth rate of shared cars will reach 2.21% in May-October 2019, surpassing the number of cars and online rental cars.

ISSN: 2688-9323

In the past, cars were bought as "big pieces". Now, with the dizzying speed of the model update iteration and the impact of the outbreak, the consumer's decision-making process will take longer. The "time-sharing" model of shared cars solves many problems. However, there are too many cost controls links in this way, making profitability very difficult and requiring optimization.

With the development of science and technology, society has entered modernization, development is becoming more and more rapid, people's living standards are also constantly improving, from walking to cars, from cars to airplanes. Now, this is far from meeting people's needs, when the car should be called into people's lives, convenient, quickly has become synonymous with today's life. But at the same time, sharing cars are also facing a crisis of high costs. Therefore, the cost optimization scheme is very important, and the scheduling problem is also one of the problems faced by the shared car. Costing scheme and scheduling scheme has become people's concern for a while.

2.2. Shared Car Pattern Analysis

(1) On behalf of the enterprise: there is a car

(2) Mode: Guangdong New Co-op Car Rental Service Co., Ltd. launched the "have" car is China's domestic car share pioneer, customers can download the "car" application for free through the client, open this "car" application, the system will automatically give the user a nearby location according to the location of all nearby outlets to provide users with choice, the user can choose a network, the system will automatically recommend a car. Users can see all the information about the car in the app, and of course they can choose to change it. It is worth mentioning that the application does not require a deposit, the vehicle can travel 150 km after each use of the vehicle, the cost is calculated as: the total cost of the vehicle driving kilometers, 1.6 yuan, the vehicle travel time (minutes) x 0.16 yuan.

2.3. The Position of Shared Cars in the Sharing Economy

"Yes" car is China's high-profile in recent years, high utilization rate and in their respective fields have a certain representative of the sharing economy private enterprises, but from the macro environment, the field of travel is currently the most interesting part of the sharing economy, because the transportation travel area of the sharing economy on the optimal allocation of transportation resources needs, and the resource allocation effect is better than other sharing economy.

Among them, the development of shared bike has a certain scale, but it must be mentioned that shared bike in many aspects of travel has great limitations, such as speed limitations, distance limitations. So, in contrast, shared cars make up for the lack of shared bikes in these areas.

Since 2014, when shared cars came into the public eye as "network cars", the number of users of online booking cars has exceeded 300 million. As a representative service of the shared economy, the network car has played an important role in invigorating vehicle resources and meeting the travel needs of users, and with the introduction of relevant policies, the network contract vehicle model in the field of transportation has entered a standardized development period.

2.4. Sharing the History of Car Development

Car sharing is a new type of transportation, distributed in residential communities, commercial office centers, universities and other places.

Ownership of the car is replaced by the right to use the car to meet the short-term travel needs of the residents. Consumers use mobile apps on their phones that share car platforms, allow users to book orders online and find their cars offline for green travel at a lower cost than taxis. Car sharing predates the advent of shared bicycles. As early as 1940, Switzerland had its first

ISSN: 2688-9323

platform to operate shared cars as a primary means of profitability, the Self-Driving Co-operative.

Later, it slowly became popular in Germany, Italy, the Netherlands, the United States, Australia, Japan and many other countries or regions, and now it has gradually developed into one of the main ways and means of urban transportation and passenger transportation systems.

For the first time in history, car-sharing is a "car-sharing" in Bremen, a city in northern Germany, which was officially exhibited and implemented as an imported product at the 2010 Shanghai World Expo as an imported product. Then, with the emergence of business opportunities, China gradually appeared EVCARD, Gofun car sharing, car ur-car and other private car-sharing enterprises, and in the domestic first-tier cities and some second-tier cities developed, but has not been able to achieve the desired national popularity.

2.5. Shared Environmental Analysis of the Automotive Industry

Nowadays, the road of first- and second-tier cities in China is more and more vehicle blockage phenomenon, a large number of vehicles excrete exhaust gas pollution to the environment is serious day by day, for the prevention and control of environmental pollution, shared cars as a safe and green public transport means and ways can effectively fill the gap between urban public transport (such as buses, buses, etc.) and private cars, and in the future has a good application space and market prospects. In addition, the National Information Center further predicted in a study after the survey that people could effectively reduce waste of buying 13 cars in the future by sharing a car every day. More research and statistical analysis show that at this stage the average private car is on the road for about 1.5 hours a day, the rest of the time will be parked in a public car park, and the " car sharing " approach can make each shared car used for more than 6to9 hours a day, which also changes to solve the current parking space is difficult to find and expensive, parking management quality is low, and even vehicle parking traffic management phenomenon.

Therefore, Xu Heyi, chairman of BAIC Group Co., Ltd., and executive representative of the National People's Congress, has publicly stated that although there are many new shortcomings in sharing cars, it will be difficult to develop, but it meets the travel needs of contemporary people well, and conforms to the low-energy environmental protection plans of the times, with great potential for development and room for improvement.

3. Shared Car Distribution Feature Analysis

3.1. Research Ideas

First, we analyze the distribution of shared car use in the city by collecting location data sets for shared cars in an area, including location information such as time, latitude and longitude, and a list of vehicles parked at parking spots, but the data is too large and cluttered to observe the inherent laws and characteristics. Therefore, it is necessary to make descriptive statistics on the data, classify the distribution of parking by time, and make quantitative analysis.

To more intuitively see the overall distribution of shared cars in the city, you can import longitude and latitude from the dataset into ArcMap10.8 to visualize the data to clearly see the distribution characteristics of shared cars at a given time. Looking at the data, it is not difficult to find some differences in the use of cars on weekdays and weekends, thus discussing the use of shared cars separately on weekdays and weekends. Because there are obvious differences in the use of vehicles in each time period of each day, it is classified by hierarchical clustering, which divides the daily traffic flow into four stages.

Hierarchical clustering has played a good role in dividing the time distribution of shared bikes, and the visualization of longitude and latitude coordinates also allows the location distribution of shared bikes to be intuitively displayed, which is conducive to our understanding of the use of shared bikes in the city.

3.2. Shared Car Distribution Descriptive Statistical Analysis

Descriptive statistics are primarily used for descriptive studies of data, where data sets are disassembled and combined to depict the relative relationship between parking volumes in different regions at different times, as shown in Figure 1. As can be seen from the figure, the parking rate is low in the morning, noon and evening periods, i.e., these three time periods are peak points for the use of cars, and the frequency of users' cars is higher. Parking is higher in the early hours of the morning and users use their cars less frequently. In addition, the working days and There are also differences in how often users use shared cars over the weekend. It is clear that parking is higher during the day than during the working day on weekends and higher at night, indicating that there is a lower demand for shared cars and higher demand for cars at night during the weekend, which may be due to the habits of the public, who generally do not need to work on weekends and most people do not need to work during the day stay at home, and at night go out hanging out. As a result, not only do the different points in time of day vary greatly, but so do the use of shared cars during weekdays and weekends.

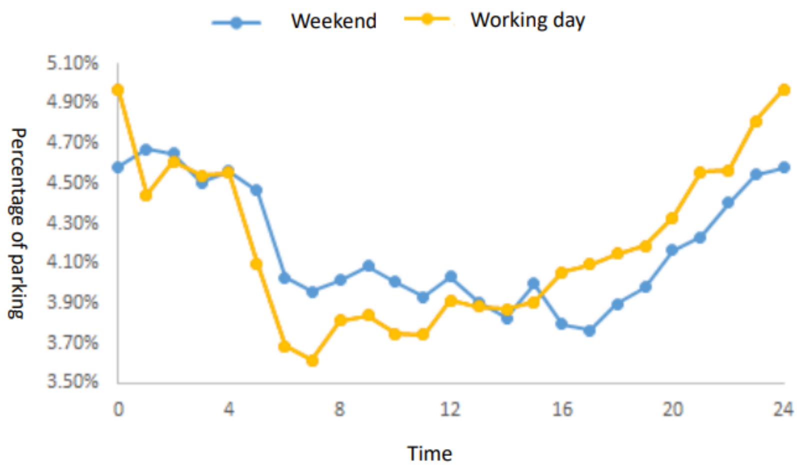

Figure 1. Parking distribution time change chart

Table 1. Share the distribution of car usage

variable	n	minimum	maximum	mean
date	1048575	2018/12/11	2019/01/10	2018/12/26
Time	1048575	0:00:04.31	23:59:55.28	12:01:27.99
Latitude	1048575	31.952230	32.145650	32.0838
Longitude	1048575	34.729980	34.951420	34.7893
Parking	1048575	0	9	0.65
Number of valid cases	1048575			

ISSN: 2688-9323

Analysis of the data by SPSS gives an overall distribution of the use of shared cars in the city, as shown in Table 1. The table shows that this is the data distribution of cars in the data set from 11 December 2018 to 10 January 2019, with an overall span of one month, while the lowest latitude and maximum values of the parking points are 31.952230 and 32.145, respectively 650; The minimum and maximum longitudes are 34.729980 and 34.951420, respectively, with a minimum parking value of 0, a maximum of 9, an average parking capacity of 0.65, and a cumulative total of 1048575 parking's. Based on these data, the distribution of shared car use in the city can be analyzed.

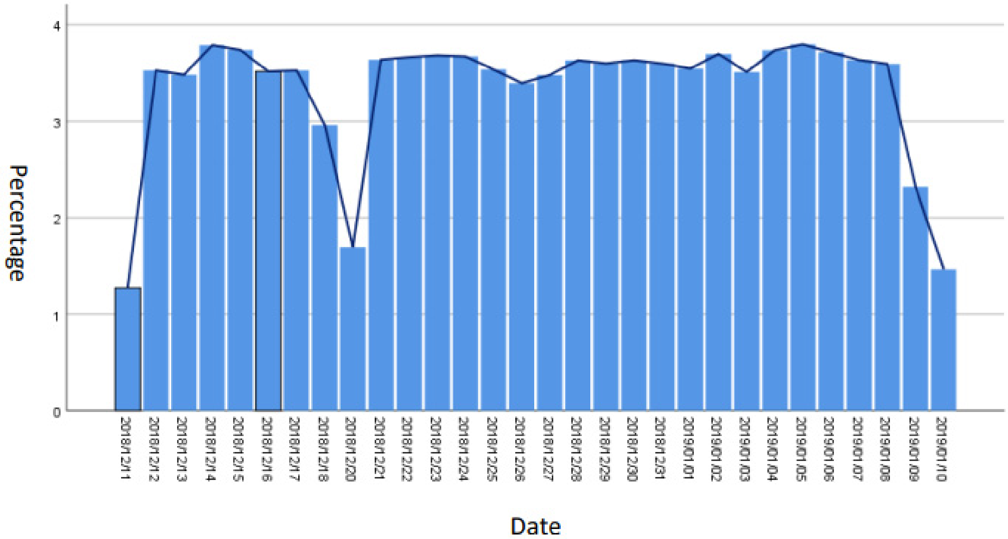

Figure 2. Parking date map

Second, we add up the daily parking volume and get a bar chart for the month, as shown in Figure 2, and it's not hard to see that the overall use of shared cars is relatively even except for individual days (e.g., December 11, December 20, and January 10).

3.3. Hierarchical Clustering Model Clustering of Vehicle Time

3.3.1. The Principle of Hierarchical Clustering Models

Hierarchical clustering is the first to treat each sample of a dataset as an initial cluster, and then to find the two closest to each other in each step of running the algorithm to merge, repeating the process until the number of cluster clusters is reached.

(1) The basic elements of hierarchical clustering

You need to enter a sample $D=\{x_1,x_2,\ldots,x_m\}$ set, cluster distance measurement function is d, cluster clusters are k, and the output results in cluster division.

(2) hierarchical clustering algorithm

Methods such as minimum distance, longest distance, average distance, and weighted distance are commonly used, but each cluster is a sample collection, so only one algorithm of the collection needs to be taken.

1) The shortest distance method

$$d_{\min}(C_i,C_j)=\min{}_x \in C_i, z \in C_j\, dist(x,z) \tag{1}$$

2) The maximum distance method

$$d_{\max}(C_{i,C_j})=\max{}_x \in Ci, z \in C_j\, dist(x,z) \tag{2}$$

3) Average distance method

$$d_{avg}(C_i, C_j) = \frac{1}{|C_i|\,|C_j|} \sum_{x \in C_i} \sum_{z \in C_j} dist(x, z) \tag{3}$$

4) Weighted distance

$$d_{weight}(C_i, C_j) = (d(C_k, C_j) + d(C_l, C_j))/2 \tag{4}$$

3.3.2. Hierarchical Clustering Model Establish

The clustering method used in this paper is intergroup join, the distance measurement method is square European distance, through literature review and competition data, we cluster the data for weekdays and weekends, considering the percentage of parking (P), through SPSS operation, the clustering genealogy map is shown in Figure 3:

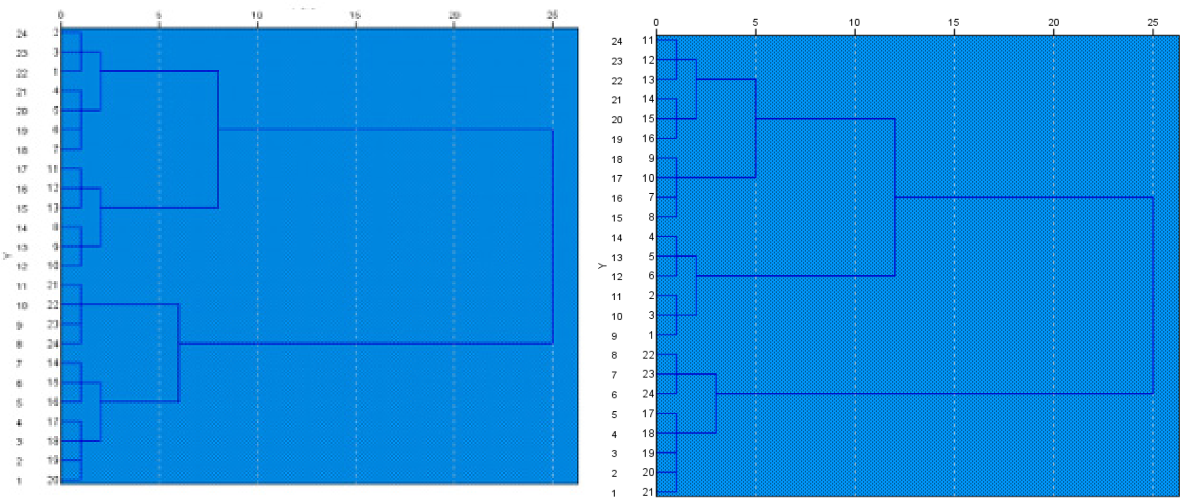

Figure 3. Genealogy

As can be seen from Table 2, 24 cases are first divided into two categories, and then each category is subdivided into two categories, and finally formed four categories, we according to its characteristics are different, the four time periods are named "peak", "medium peak", "low peak" and "low peak", respectively, indicating the distribution of the frequency of users in each interval. For example, the peak time zone for a weekday consists of 6,7,8,9 points in time, indicating that the traffic of the shared car is relatively high at each of these four hours.

3.4. K-means Clustering Model Clustering of Vehicle Areas

3.4.1. The Principle of the K-means Clustering Model

K-means clustering is an unsupervised learning, the basic idea of which is to find the clusters through iterations, then make the data generated by clustering the data to achieve the lowest loss, and then cluster the remaining samples, then classify the corresponding samples, and repeat the process over and over again, thereby calculating the best category attribution and labeling them accordingly. Its basic steps are as follows:

(1) Randomly select k samples, each representing a cluster center

(2) The remaining samples are divided into the closest clusters according to the distance from the center value of the cluster

(3) Recalculate the average of each cluster, updated to cluster center

(4) Repeat the steps (2) (3) until the constraint or termination value is reached

ISSN: 2688-9323

Common K-means clustering methods include elbow and contour factor methods as follows:

1) Elbow method

Defines the sum of the error squares of clustering

$$SSE = \sum_{i=1}^{k} \sum_{x \epsilon c_i} ||x - u_i||^2 \tag{5}$$

2) The contour coefficient method

$a(i) = average$ (The distance of the i vector to the other points in all the clusters that belong) Calculated, called intra-cluster incoma not similarity

$b(i) = \min$ (The average distance of the i vector to all points in the cluster closest to it) Calculating, called inter-cluster non-similarity, the contour coefficient of the i vector is:

$$S(i) = \frac{b(i) - a(i)}{\max(a(i), b(i))} \tag{6}$$

3.4.2. K-means Clustering Model is Established

In this paper, when the data is clustered with K-means, SPSS software is still used, using longitude, latitude, and parking volume, respectively. Cases are still parking data arrangement number, according to these three variables clustered, the results, as shown in Table 2, we divide these cases into 13 categories, observation table, easy to find category 2 and category 5 sample capacity is low, it is not difficult to find it is outliers, we discard it, can get the remaining 11 categories. These eleven categories indicate that the location distribution area of the city's shared car is divided into 11 zones, and the longitude and latitude represent the central area of each interval, basically containing all the parking spots, and a good description of the distribution of shared cars in the city.

Table 2. Cluster results

method	category	Number of cases	latitude	longitude	vehicle
	1	238.000	32.115957	34.951348	1
clustering	2	3.000	32.103400	34.805900	8
	3	69.000	32.079454	34.791452	7
	4	26460.000	32.113966	34.809834	2
	5	4.000	32.103400	34.805900	9
	6	894.000	32.105729	34.830558	5
	7	10042.000	32.084150	34.791270	3
	8	55909.000	32.069493	34.775559	2
	9	1966.000	32.090097	34.798980	4
	10	484204.000	32.083706	34.787850	0
	11	351.000	32.103917	34.828115	6
	12	198303.000	32.116047	34.811865	1
	13	270132.000	32.059995	34.775725	1

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3.5. Share Car Distribution Troys

According to the statistical description of the distribution of user vehicles, in the time interval to the percentage of user parking as an evaluation index, the use of hierarchical clustering method, the time interval is divided into four periods, each for "peak", "medium peak", "low peak" and "low peak", respectively, to represent the distribution of the frequency of user vehicles in each interval, and K-means clustering method was adopted in space, the city's shared car distribution area was divided into 11 small areas, indicating the aggregation of vehicle distribution in each region.

4. Share Car Scheduling Issues and Cost Planning

4.1. Research Ideas

The city's vehicle-using areas are divided into different categories through K-means clustering, which are analyzed at the latitude and longitude levels and traffic flow levels. Based on the results of the analysis, we develop a car-sharing scheduling scheme that is most beneficial to the enterprise, so we can use the simulated annealing model to analyze the optimal path based on the classification results in the shared car distribution in the optimal path optimization to reduce scheduling and transportation costs.

For the overall scheduling scheme of the enterprise, the hierarchical analysis method is selected to determine the weight that affects the cost of the enterprise, and then the cumulative rate is selected according to the weight to represent the whole cost index for analysis. The linear planning model is used to determine the combination of the lowest cost of the enterprise, to choose the best scheduling scheme.

4.2. Simulated Annealing Model Solves the Optimal Scheduling Path

4.2.1. The Principle of Simulating the Annealing Model

The simulated annealing algorithm uses the similarity between the annealing process of solid substances in physics and the general optimization problem from an initial temperature, and randomly looks for the global optimal solution in the solution space by combining the probability burst characteristics with the decreasing temperature. There are n states (limited, discrete) in thermodynamic system S, and the energy of state i is E_i at temperature T_k, and the probability of thermal equilibrium reaching over time is:

$$P_i(T_k)=C_k\exp\left(-\frac{E_i}{T_k}\right) \tag{7}$$

There is a relationship as follows:

$$E_i\downarrow\rightarrow P_i\uparrow,T_k\downarrow\rightarrow P_i\downarrow$$

According to the Bolzman equation, you can get:

$$P_i(T_k)=\frac{\exp\left(-\frac{E_i}{T_k}\right)}{\sum_{i=1}^{n}\exp\left(-\frac{E_i}{T_k}\right)} \tag{8}$$

visible $\begin{array}{l} E_i\uparrow\Rightarrow P_i(T_k)\downarrow \\ T_k\downarrow\Rightarrow P_{i^*}(T_k)\rightarrow 1, i^*\ \textit{represents}\ E_i\textit{'s smallest one}\end{array}$

The average energy of T_k is:

$$\bar{E}(T_k)=\sum_{i=1}^{n}E_i\cdot P_i(T_k) \tag{9}$$

So, $T_k\downarrow\Rightarrow\bar{E}\rightarrow E_{i^*}$

The effect of this temperature T_k on P_i (T_k) is as follows:

When T_k is large, $\frac{E_i}{T_k} \to 0$

$P_i(T_k) \approx \frac{1}{n}$, the probability of each state is almost equal

As the temperature decreases the P_i (T_k) difference widens

When T_k is small and tends to be 0, $\frac{E_i}{T_k} \to \infty$

The simulated annealing calculation steps are:

1) Initialization, optional initial solution, given the initial temperature $Ti \in S_0$, the termination temperature T_f, makes the iteration indicator ks0, T_ksT_0. (T_0 should be high enough to make). $E_i/T_k \to 0$.

2) randomly produce a domain solution, $j \epsilon N(i), (N(i)$ *represents the domain of* $i)$. Calculate the target value increment $\triangle f = f(j) - f(i)$.

3) If, step $\Delta f < 0$, $let\ i = j$ (4) (j is better than i, unconditional transfer), otherwise it will occur, so that i $\xi \epsilon U(0,1), if\ \exp\left(-\frac{\Delta f}{T_k}\right) > \xi$ -j (j is better than i, unconditional transfer).

Note: Wands search when T_k is high;

4) If the thermal balance is reached (the number of inner cycles is greater than n(T(k), the rotation step (5), otherwise the rotation step (2)).

5) ks k1, lower T_k, if T_k< T_f, stop, otherwise turn (2).

4.2.2. The Solution to Simulate the Annealing Model

By simulating annealing algorithm, the travel business problem (TSP) can be solved better, and the path problem of car dispatch in this city is well suited to the TSP problem, and the path can be better planned by simulating annealing algorithm to reduce operating costs. In view of the above-mentioned automobile distribution problem, we have planned it as a different area, now with the central point of each area as the coordinate point, through MATLAB code programming, to arrive at the city shared car planning and scheduling map, as shown in Figure 4, the planning route is an approximation of the shortest route, the shortest distance is 0.46293, the approximate optimal path is

$$1 \to 3 \to 10 \to 9 \to 11 \to 6 \to 7 \to 8 \to 2 \to 5 \to 4$$

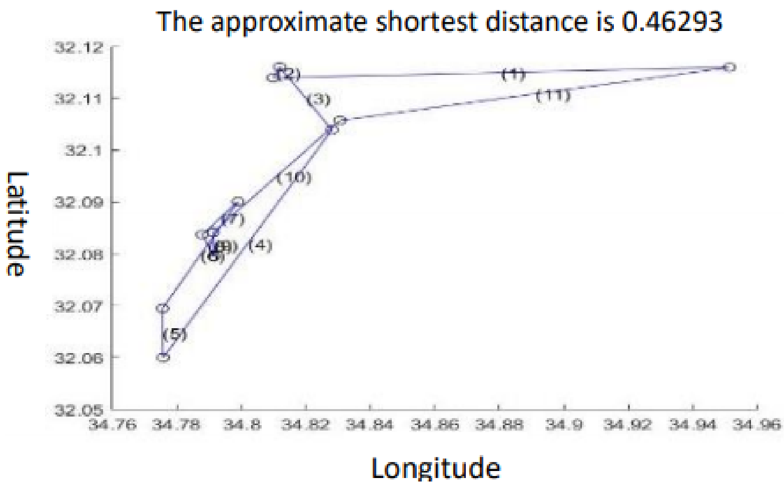

Figure 4. Shortest path map

Therefore, in order to better manage and reduce transportation costs, the shared car company needs to divide the city into 11 administrative planning areas, and vehicle transportation between planning areas should also operate according to the optimal route.

4.3. Hierarchical Analysis Determines the Metrics that Affect Scheduling Costs

4.3.1. The Principle of Hierarchical Analysis

A business needs to consider several factors if it wants to calculate the best cost. To do this, the factors that affect costs are analyzed by hierarchical analysis. By constructing a systematic and structured hierarchical model and using a small amount of quantitative data, we can solve the complex problem of multi-objective. This method does not require the quantity and precision of quantitative data, and can be applied to the study of shared car cost.

Before calculating the minimum cost of a shared car, we need to consider the cost of the shared car in many ways, if there is an impact on the cost of the shared car, then it can be used as an indicator to calculate the lowest cost of the shared car. When selecting indicators, follow these principles:

(1) Comprehensive principles

(2) The principle of data availability

(3) The principle of comparability

(4) The principle of combining applicability with operability

4.3.2. The Solution of Hierarchical Analysis

Considering that the depreciation, dispatching, advertising, maintenance, electricity and insurance of the shared car have a great impact on the cost, the cost of the shared car is basically covered.

Combined with the basic theory of hierarchical analysis, it is necessary to evaluate the importance of the indicator, construct the importance scale matrix, analyze the degree of six factors affecting the cost, and its importance scale is shown in the table3 Shown:

Table 3. Scale method

The scale of importance	meaning
1	represents the same importance as two elements
3	Represents that the former is slightly more important than the latter than the two elements
5	Represents the apparent importance of the former over the latter compared to the two elements
7	Represents the stronger importance of the former than the latter compared to two elements
9	Represents the extreme importance of the former over the latter compared to the two elements
2,4,6,8	Represents the median value of the above judgment
reciprocal	If the ratio of the importance of element i to element j is a_{ij}, the ratio of element j to element i is $a_{ji}=1/a$

According to Table 4, we looked for a large amount of literature and consulted experts in the field to draw up the table.

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Table 4. Compares the matrix in pairs

Z	A1 Advertising fees	A2 Depreciation	A3 Maintenance costs	A4 insurance	A5 Electricity	A6 Scheduling fee
A1 Advertising fees	1	1/8	1/6	1/3	1/5	1/7
A2 depreciation	8	1	5	7	6	2
A3 Maintenance costs	6	1/5	1	4	3	1/3
A4 insurance premiums	3	1/7	1/4	1	1/2	1/6
A5 Electricity	5	1/6	1/3	2	1	1/5
A6 scheduling fees	7	1/2	3	6	5	1

We import the data into MATLAB for consistency testing and calculate the appropriate weights. WhereA1, A2, A3, A4, A5, A6 to Z weight is: 0.0275, 0.4253, 0.1425, 0.0489, 0.0761, 0.2797; CI=0.0775.

Check the table to determine the corresponding average random consistency indicator RI (random index). For example, for the 6th order judgment matrix, the check table gets RI=1.26.

Calculate the consistency ratio CR and make a judgment.

$$CR = \frac{CI}{RI} = \frac{0.0775}{1.26} = 0.06150790.0615 < 0.1 \tag{10}$$

Because the combination of depreciation, maintenance, electricity, scheduling costs and four weights is more than 90%, that is, depreciation, maintenance, electricity, scheduling costs have a greater impact on costs, and advertising fees, insurance costs on the cost of less impact, cannot enter the analysis. Therefore, the depreciation, maintenance, electricity, scheduling costs for linear specification analysis, to calculate the optimal cost.

4.4. The Establishment and Solution of Linear Planning Model

(1) Car sharing: operating vehicles are pure electric vehicles, 1 electric vehicle at any time can only meet 1 order demand, all vehicles have no grade difference.

(2) Site aspect: each site parking space is equipped with the same model of charging pile, any two stations between the distance must not be greater than 3/4 of the vehicle's maximum range, there is a shared bike around the site, but whether the user is willing to use this method to pick up, return the car is affected by preferential prices.

(3) Service cycle: During historical data analysis, vehicle maintenance time is from 1 a.m. to 7 a.m. every morning, vehicle opening hours from 8 a.m. to 12 p.m., and order data collection is set at half an hour to 1 cycle based on the allocation of actual orders and service hours.

(1) The first step is to assume that the decision variables, such as X_1, X_2, ..., X_n

(2) The second step is to establish a target function, such as the target function: $\min X = C_1X_1 + C_2X_2 + \ldots + C_nX_n$

(3) Step 3, look for constraints. (According to the actual situation, it is assumed that depreciation fee shall not exceed 40% of the total cost, the sum of maintenance and dispatch expenses shall not be less than 10W yuan, the sum of maintenance and electricity charges shall not be less than the dispatch fee, and the electricity bill shall not be higher than 10% of the total cost).

Step 1: Analyze variablesA1, A2, A3, A4, A5, A6

Step 2: By the hierarchical analysis method to calculate the proportion of the know, A2 depreciation, A3 maintenance, A5 electricity, A6 scheduling costs for decision-making variables. Record as x1, x2, x3, x4, respectively

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Step 3: Establish the objective function, whereas $C=a_1X_1+a_2X_2+a_3X_3+a_4X_4$ 1, a2, a3, a4 is the ratio of indicators (a1s0.51, a2s0.13, a3s0.06, a4s0.30).
Its constraints are:

$$(0.1)\min(a_1X_1+a_2X_2+a_3X_3+a_4X_4)$$
$$X_1\geqslant 0, X_2\geqslant 0, X_3\geqslant 0, X_4\geqslant 0$$
$$a_1X_1<(a_1X_1+a_2X_2+a_3X_3+a_4X_4)*40\%$$
$$100000\leqslant a_2X_2+a_4X_4\leqslant 400000$$
$$a_2X_2+a_3X_3\geqslant a_4X_4$$
$$a_3X_3\leqslant(a_1X_1+a_2X_2+a_3X_3+a_4X_4)*10\%$$
$$s.t.C \quad \min(a_1X_1+a_2X_2+a_3X_3+a_4X_4)$$

Substitute lingo learned that minC is 180,000

4.5. Cost Analysis and Adjustment Scenarios

4.5.1. Cost Analysis

As can be seen from the linear planning process, any increase or decrease in depreciation, scheduling, electricity, and maintenance costs has an impact on the total cost. Among them, depreciation and scheduling costs have a large impact on its total cost, electricity costs on the total cost of the impact are small, electricity costs increase, can be appropriate to reduce maintenance costs. Combined with the actual situation of life, depreciation and electricity costs change factors more, the impact is slightly greater than the other two factors. The scheduling and maintenance costs are stable and basically unchanged. Consider investing more technology in repair and scheduling to maximize cost reduction.

4.5.2. A Cost-cutting Solution

(1) Appropriately reduce scheduling costs and increase the site. Reduce electricity bills and expand production efficiency.

(2) Establish a corresponding management system, especially the financial system, from the system to eliminate all unnecessary costs. After the system is formulated, it is necessary to study within a certain scope, to better promote the implementation of the system.

(3) Invest more technology in maintenance and scheduling, reduce maintenance costs.

(4) Depreciation changes, easy to be affected by a variety of natural (human) factors, so can increase the intensity of punishment, the establishment of a punishment mechanism, 1000 to 50,000 yuan punishment.

(5) Enterprises can customize targeted preferential pricing strategies to improve user satisfaction while achieving optimal vehicle scheduling costs. Enterprises can adjust according to their own circumstances and related practices to achieve the balance between corporate profits and user satisfaction.

4.5.3. The Best Scenario for Scheduling Schemes

(1) Set up multiple stations in the high-traffic area, each two sites between the establishment of an extra charging pile. With Beidou navigation and positioning system, the path of shared cars can be optimally planned, which can avoid the peak traffic area and get to the destination quickly and easily.

(2) Establish a sound vehicle information file, timely grasp of vehicle dynamics, to ensure safety on the way, the first time to provide vehicle location and maintenance services, reduce unnecessary waiting time.

ISSN: 2688-9323

(3) Provide scheduling time and dispatch operator history, post-service analysis of the cause of failure, summary, reduce such accidents, and timely upload relevant documents and data, to provide quality services.

(4) During the rainy season, reduce vehicles and increase temporary stations, and appropriately reduce car fares and electricity bills. Increase vehicles and temporary stations in winter, raise electricity bills appropriately, and reduce car fares appropriately. Special periods (rain, snow, holidays, etc.), limiting maximum speeds and reducing fares.

(5) Reasonable arrangements within the scope of the number of shared cars, so that traffic control is appropriate, while appropriately increasing traffic management, to prevent traffic problems. Secondly, emergency systems can be developed to prepare for sudden accidents and ensure user safety.

5. Summary

The above models are tested by the relevant software in the modeling process, which has some rationality. In the analysis of the characteristics of the distribution of shared cars, the distribution characteristics of shared cars are obtained by descriptive statistics, then the time and space are clustered separately, the shared planning area is set up, and the optimal path is calculated by simulated annealing algorithm, which provides convenience for the dispatch of shared cars through the combination of hierarchical analysis and linear planning. At the same time, this paper combines with practice to make the model closer to reality, reduce the scheduling cost, and lay the foundation for the development of shared cars.

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