Optimization Decision of the Location of Shared Car Park
A Study Base on Chongqing

Xiaofeng Yan and Jie Zhao
Foreign trade college, Chongqing Normal University,The No. 9 Xuefu Road of Hechuan Distict, Chongqing, China.
da68da68@163.com

Keywords: Chongqing, Shared vehicle, Multi-objective function, Neural Network prediction.

Abstract: With the development of the shared economy, shared cars have sprung up like bamboo shoots after the rain, providing great convenience for people to travel. How to choose a car park to optimize the use of resources is one of the problems that the managers of all companies pay attention to. This paper through the rolling forecast way to predict the future three years of Chongqing city share total car demand, and then estimate the Chongqing city parking lot demand; then, from the point of view of considering the location factors, to users, operators and government satisfaction as the objective function, the establishment of shop location model; finally, using genetic algorithm to solve the model and in a certain the weight, select the optimal solution. The research results show that the model can provide a more scientific decision-making method for the location of car park in Chongqing.

1 INTRODUCTION

Although there are plenty of problems in the development of shared cars, the market is getting bigger and bigger. We should pay attention to the market and focus on the choice of the way the local people travel. In early studies, most scholars tend to consider the social economic attribute '(age, gender and income) and travel attributes (travel time and cost), with the further study, they found that the traveler's own values and way of life in the inner factors also affect the choice of travel mode.

In addition, there are many research results based on site location. Ben-Akiva (2002) by introducing latent variables, discrete choice model, the subjective psychological factors into the model selection activities; Fatemeh and so on, put forward the factory location model based on fuzzy number to determine the evaluation index weight, and use the simulated annealing algorithm to solve the weight. Xia Jinghong (2005) uses the 0-1 mixed integer programming method to establish the location model. In the analytic hierarchy process, the grey relational analysis is used, and the genetic algorithm is used to solve the model. Gao Taiguang and Chen Peiyou (2011) proposed rough set theory based on Z.Pawlak. Qualitative and quantitative evaluation of location problem was made by decision making feature and method, and the location model that could get the best location plan was established.

The development of shared cars in Chongqing can not only check the flood of black cars, but also create a diversified transportation system for Chongqing citizens, and make Chongqing a resource-saving and environmental protection city. At the same time, it can also promote the transformation and upgrading of the automobile industry in Chongqing. Based on the above research, this paper will use the neural network (BP) rolling prediction in the future three years in Chongqing city car sharing scale, consider three factors of influence, sharing the car parking lot location model of multiple objectives and planning, which is solved by using genetic algorithm, to provide scientific support for the Chongqing City car sharing the popularity of.

Yan, X. and Zhao, J.
Optimization Decision of the Location of Shared Car Park - A Study Base on Chongqing.
In *3rd International Conference on Electromechanical Control Technology and Transportation (ICECTT 2018)*, pages 323-328
ISBN: 978-989-758-312-4

2 THE CURRENT SITUATION OF THE SHARED CAR MARKET IN CHONGQING

2.1 The current situation of the shared car market in Chongqing

At present, Chongqing has two major shared car brand, one is car2go (car2go Dalem subsidiary), the cars with blue and white smart sedan, without a deposit, but to pay 99 ¥ to be registered, the registration fee will not return, take lifelong membership, 1.8 ¥ / km (+0.3 ¥ / minute flameout is 0.1 ¥ / minute), long fee cap price: 128 ¥ / day (every 24 hour journey, the cost of another), if the car is damaged or lost items, will have a special fee. Because it is not electric car, so the endurance is very strong, it is very convenient to use. The other is the PandAuto, the 620EV and 330EV of the Li Fan. Compared with the general car rental, we hope to use the pure electric new energy car, which has no exhaust, low noise, safety and environmental protection. The body has a symbolic panda head. The user needs to pay 1000 ¥ deposit before using the car. Because there are two kinds of cars, so the pricing way is also different: the 620EV car is 26 ¥ / hour, the top price is 179 ¥ per day, and the 330EV2 is 19 ¥ / hour, the top price is ¥ per day, the price is very low in the car rental industry. Lifan in cooperation with Alipay, launched a user-friendly Sesame Credit Car, as long as “sesame” in more than 650, it can be removed 1000 ¥ deposit, if there is illegal activities in the process of using, to deal with illegal activities before deposit refund. Although the cost is lower than impromptu, but because it is an electric vehicle, so the continued route is far less car2go.

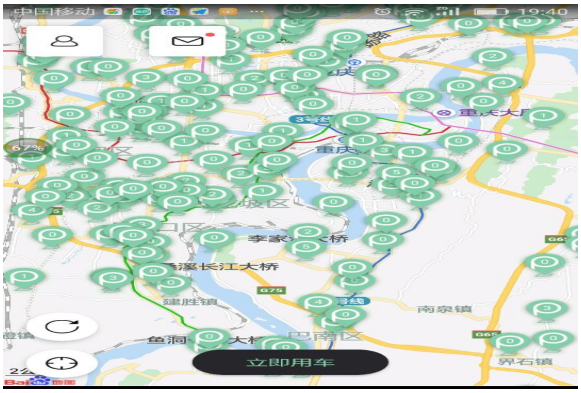

Figure 1: PandAuto parking spots in Chongqing (about 400).

In addition to sharing brands above, There are EVPOP, Chang An, EVCARD line trip , Chi road travel and so on several operating platforms. In addition to the free flow of car2go car rental model, the rest of the platform take a fixed point to take back, return to the parking lot themselves.

The Car sharing strong competitors is the local rental car industry in Chongqing City, the car rental industry entrenched for many years, the biggest advantage is that there are rich models, automatic and manual, and various brands, different cars are more able to meet the needs of car rental. The deposit of car rental generally fluctuates around 2000 ¥, and the charging mode of different vehicles is different. The basic vehicle type is about 100 ¥, and the entrust cost is at least 50 ¥. There is no need to compensate vehicle damage after the accident. Although Chongqing is a good car rental business, it needs to sign a contract on the face, and the formalities and materials are more. It's a lot of trouble compared to the shared car. The deposit of car rental generally fluctuates around 2000 ¥, and the charging mode of different vehicles is different. The basic vehicle type is about 100 ¥, and the entrust cost is at least 50 ¥. There is no need to compensate vehicle damage after the accident. Although Chongqing is a good car rental business, it needs to sign a contract on the face, and there are formalities and materials. It's a lot of trouble compared to the shared car.

2.2 The forecast of the development scale of the shared automobile in Chongqing

The development of most industries will experience germination, growth and maturity. Sharing automobile industry is no exception. Its development is influenced by urban population and government policies. Up to now, about 8000 vehicles have been launched in Chongqing, covering most of the main urban areas and a small number of remote counties. According to the data of China's sixth (2010) national population census, a neural network model is used to predict the total population of Chongqing in the next three years.

Table 1: The total population of the city of Chongqing for 2010-2016 years

year	2010	2011	2012	2013	2014	2015	2016
TPTPC	2885	2919	2945	2970	2991	3017	3048

TPC: Total population of Chongqing (10000)

This paper will use the prediction neural network (BP) forecast model: a way to forecast the number of population of fourth years in the first three years of the total population, the number of the total population of Chongqing as 2010, 2011, 2012 in Chongqing City, the total population as input to predict in 2013, so repeated until it meets the accuracy requirement so far. First, the data in the above table is normalized, that is, to keep all values between (0,1) (using MatlabR2013a).

$$Z = R + j\omega L = R(j\omega L / R)$$

Combined with Chongqing

$$P=\begin{bmatrix} 0.1389 & 0.1405 & 0.1418 \\ 0.1405 & 0.1418 & 0.1430 \\ 0.1418 & 0.1430 & 0.1440 \\ 0.1430 & 0.1440 & 0.1452 \\ 0.1440 & 0.1452 & 0.1467 \end{bmatrix}$$

$$T=\begin{bmatrix} 0.1430 & 0.144 & 0.1452 & 0.1467 \end{bmatrix}$$

The total number of the population every three years after normalization as input, with a total population of fourth years the number of normalized as the target vector, create a BP neural network, each input vector range, the hidden layer activation function was Tansig, activation function of the output layer is logsig, the training function as the gradient descent function, namely the standard learning algorithm, setting learning rate is 0.1, the simulation and comparison results.

According to the population travel and the choice of travel mode in Chongqing, the total volume of automobile in 2020 is calculated in Chongqing. The following formula is as follows:

$$Q=10^{4}*\frac{(\frac{M*C*N}{p})*D}{\delta*t*v}$$

Table 2: The meaning of each symbol in the upper formula

Symbol	Meaning
Q	Estimated number of shared cars
M	Total population of urban residents (10000 people)
C	Daily average travel times per person (day / time / person)
N	The ratio of citizens to choose to share car trips
D	Average driving distance (km / times) of one trip for a shared car
δ	Percentage of the normal operation of a shared car
P	Passenger volume of a shared car trip (person / time)
t	Travel time (hours) of one trip for a shared car
V	The speed of one trip for a shared car (km / hour)

Through the above population forecast, combined with the statistical yearbook of China and the comprehensive transportation planning data of Chongqing, we can get the results.

$$M=3200,\ C=2.65, N=2\%,\ D=11,$$

$$P=3.25, t=4, V=24.8, \delta=90\%.$$

By bringing these data into the top, the total number of shared cars in Chongqing in 2020 was 64296.

3 MODEL CONSTRUCTION

3.1 The basic principles and influencing factors of the site selection

(1) Practicality: in accordance with the characteristics of the population distribution in Chongqing, it can provide convenient travel for the citizens.

(2) Rationality: it can not only meet the needs of urban residents but also guarantee the agreement with the urban planning management of Chongqing.

(3) Sustainability: the principle is mainly for the sharing of vehicle operation platform, to ensure that the platform has certain benefits, and to support the healthy operation of shared cars.

The Car sharing development mainly by users, operators, government, three party effect, from the user point of view, they want to take the car also more locations and reasonable cost, so the car sharing outlets generally focus on the larger flow of people in commercial areas, residential areas, near the school; while operators want to share vehicle operation and management to maximize the minimum cost and benefits, so they tend to be more

users and outlets located in places built on cheap prices; compared to the two, the government pay more attention to the city environment and traffic management, sharing the selected automobile outlets must not impede the operation of public transport, and will not cause the public the complaint is.

3.2 Model hypothesis

Since the problem of shared vehicle location involves many uncertain and unquantifiable elements, the following assumptions are put forward for the location model.

Hypothesis one: the service range of each shared car node is fixed to 2 km, and the total demand for shared vehicles within two thousand meters is divided by 100, that is, network coverage.

Hypothesis two: Based on population factors, the candidates for sharing cars are restricted only in schools, commercial areas, residential areas, tourist attractions, and public transport stations.

Hypothesis three: the distance between each node does not consider various terrain and is represented by only two points.

Hypothesis four: the area of all shared cars is 100 square meters, and the population density and the land unit price of the net shop are positively related to the pollution index of the land.

3.3 The establishment of a mathematical model

Based on the above principles and assumptions, under certain constraints, we select m preferred demand nodes ($n > m$) from the n shared vehicle candidate nodes, aiming at the largest user demand, the lowest cost of operators and the highest level of government satisfaction, and set up the following objective functions:

The shortest distance between the supply and demand of the shared vehicle is the maximum user demand

$$\max f1 = \sum_{n\in N}\sum_{q\in Q} y_n \bullet x_{nq} \bullet p_n$$

$$\min f2 = \sum_{n\in N}\sum_{q\in Q} y_n \bullet d_{nq}$$

$$\max f3 = 0.01\sum_{n\in N}\sum_{q\in Q} y_q \bullet x_{nq}$$

Shared car parked point is the least expensive

$$\min f4 = \sum_{n\in N} y_n \bullet h_n$$

The greatest degree of government satisfaction

$$\max f5 = \sum_{n\in N} y_n \bullet (\alpha_1 \bullet p_n + \alpha_2 \bullet \sum_{n\in N, q\in Q} 0.01 x_{nq} + \alpha_3 \bullet c_n)$$

Constraints:

The total cost of the scheme should not be higher than Z (million ¥)

$$\sum_{n\subset N} y_n \bullet h_n \le Z$$

The scope of the total number of the car parking points shared

$$M_{\max\min} \le \sum_{n\subset N} y_n \le M_{\max}$$

No less than a certain distance between two shared cars

$$y_m \bullet y_n \bullet d_{\min} \le d_{\max}$$

$$y_n = \begin{cases} 1 \text{When n is a parking spot} \\ 0 \text{When n isn't a parking spot} \end{cases} \quad \forall n \in N$$

$$x_{nq} = \begin{cases} 1 \text{When } d_{nq} \le d_0 \\ 0 \text{When } d_{nq} > d_0 \end{cases}$$

Table 3: The meanings of symbolic

Symbol	Meaning
N	Candidate set
Q	Demand point set
$d_{\min}$	The distance between any two nodes
p_n	Population density between demand points
α	Factors that account for the weight coefficient of government satisfaction
c_n	Urban environment
h_n	Share car park construction capital

4 MODEL SOLUTION

4.1 Genetic algorithm solving model

The model of this paper is a complex problem of multivariate programming, which is usually solved by particle swarm optimization, firefly algorithm, genetic algorithm and simulated annealing algorithm. Due to the large number of candidate nodes and complex objective functions, In order to simplify the solution, a genetic algorithm with the non-dominated sorting is using to solve the location model. At present, the algorithm is mostly used in the actual optimization and scheduling engineering, and is rarely applied to the location problem. At present, the algorithm is mostly used in the actual optimization and scheduling engineering, and is rarely applied to the location problem.

According to the average resident population of 38 districts and counties in Chongqing, the average number of 781 thousand and 900 people, In combination with the concentration of tourist attractions and the large population flow, the area of 15 people with concentrated population is selected.

Table 4: Partial candidate attribute.

Chongqing City	Permanent population (10000)	Requirement	Population density (man/per km)	Land price $10000/m^2$	Government satisfaction
Jiang Bei	84.98	1126.45	3845	1.89	5.44
Jiu Long Po	118.69	1530.43	2754	1.41	5.01
Yu Bei	155.09	1248.19	1064	1.32	5.07
Yu Zhong	64.95	893.57	28239	0.89	5.73
Ba Nan	100.58	792.70	552	0.75	5.08
Sha Ping Ba	112.83	1462.29	2849	1.13	5.18
Nan An	85.81	841.50	3275	1.09	5.21
Fu Ling	114.08	927.01	388	0.80	5.24
Zuan Jiang	107.84	889.65	393	0.61	3.46
Jiang Jin	133.19	1064.18	414	0.76	4.57
He Chuan	136.06	914.87	581	0.72	3.78
Yong Chuan	109.61	873.04	694	0.64	4.61
Wan Zhou	160.74	1130.21	466	0.88	4.98
Yun Yang	89.66	438.46	247	0.69	3.02
Kai Xian	117.07	601.37	295	0.64	3.53

To realize the genetic algorithm of the non - dominated sorting by MatlabR2013a programming. The algorithm sets the population size $N = 200$, the genetic algebra $Z = 300$, the cross probability $P_1 = 0.8$, and the compilation probability $p_2 = 0.1$. The 7 sets of solutions are calculated through the software code, and the node number of each group of optimal solutions is derived.

Table 5: The optimal solution of each group calculated by Matlab

Scheme number	Dot number	Total cost (million ¥)	Total distance (km)	Government satisfaction
4	88	121	66239	91
53	76	119	70105	85
9	60	110	71229	74
78	64	105	71062	79
94	83	108	64148	82

According to the above data, the comprehensive score of Plan 9 is 85.7, and the highest score is in all the programs. Therefore, the final location plan of the shared car in Chongqing is 9, and the number of outlets is 60.

4.2 Analysis of site selection of parking point

Please For the above results, we need to select the final location plan from the above. The selection-criteria is the largest user demand, the lowest operator cost and the highest government satisfaction.

Table 6: Comprehensive score of the scheme.

Scheme number	Indicator1 Score	Indicator2 Score	Indicator3 Score	Comprehensive score
4	89	72	82.5	81.2
53	83	76	80.9	80
9	86	80	81.1	85.7
78	82	81	79.2	80.7
94	80.9	79	74.9	78.3
32	81	84	82.3	82.4
66	70	99	86	85

5 RESEARCH CONCLUSIONS

Based on the actual survey data of Chongqing, this paper analyse the problem of the location of shared vehicles in Chongqing from three angles of users, operators and government. According to the topography and demographic characteristics of Chongqing, the development prospect of shared cars is more promising than the popularization of shared bicycles. Moreover, people will travel more or more depending on the long distance and convenient way to travel. The research done in this article is for the development of the shared car in Chongqing to be more smoothly, and to contribute to the construction of green traffic and civilized cities in Chongqing.

Moreover, a scientific and reasonable location plan can not only reduce operators' management costs, but also improve user satisfaction, which is extremely important for the long-term development of new shared automotive industry.

REFERENCES

Ju Peng, Zhou Jing, Xu Hongli, Zhang Junting, Research on the behavior of car sharing selection based on mixed selection model. Transportation system engineering and information [J].2017 (04).

Cheng Yuan, A game study on the mode of urban traffic travel under car sharing. Harbin Institute of Technology (06) (06).

Lu Ting, Huang Jing, Jiang Wen, Construction of the location model of shared car network shop -- Taking Hongshan District of Wuhan as an example, [J]. "Transportation Research" 2017 (10)

Xia Jinghong, Logistics center and its location model study [J]. Nanjing University of Information Science and Technology.2005 (05).

Yearbook of the China Statistics Bureau -

Jiang Bujian, Research on the matching of automobile supply and demand under the shared lease model [D]. HeFei University of Technology.2017.