Urban Transport Investigation on Shared Vehicles

National Urban Transportation Mobility Innovation Competition

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Type
Academic/ Team work

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Role in Team
field investigation
data statistics
strategy analysis

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Transportation, as a reflection of the dynamics of the city, is directly related to the operation of the city. IWith the sparking aura of "shared economy" and "new energy automobile", the time-sharing rent, which relies on the internet, of sharing cars has achieved explosive development. Result from the ability to record the travel path and geographical location, the activities of sharing automobiles continue to accumulate a rich amount of information and database, which can **help us better understand traffic problems in contemporary urban context**.

In order to solve urban traffic problem and improve people's commuting efficiency , we decided to do a research on Shared Vehicles in Wuhan. **In the research process, we operated principle components analysis with SPSS to discover the relations between shared vehicles usage frequency and the types of supporting facilities situated in the immediate catchment. Consolidating the analysis, we summarized the key location factors that affect shared vehicles usage the most and promoted a strategic plan for allocating shared vehicles' parking locations based on users' usage pattern.** This report was awarded the Third Prize in the National Urban Transportation Mobility Innovation Competition.

references
[1] Wuhan Electric Vehicle Promotion and Application Action Plan
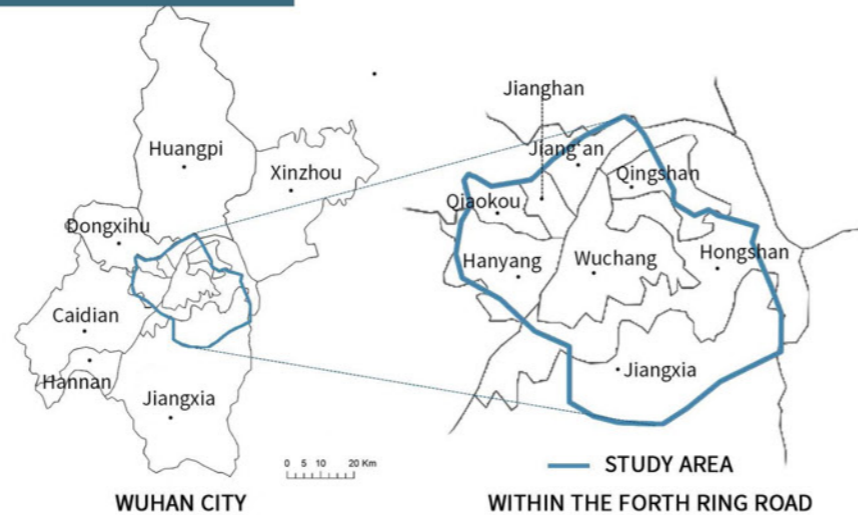[2] Yin xin, "Sharing the car" to explore a new model of urban traffic construction   "China Economic Weekly"
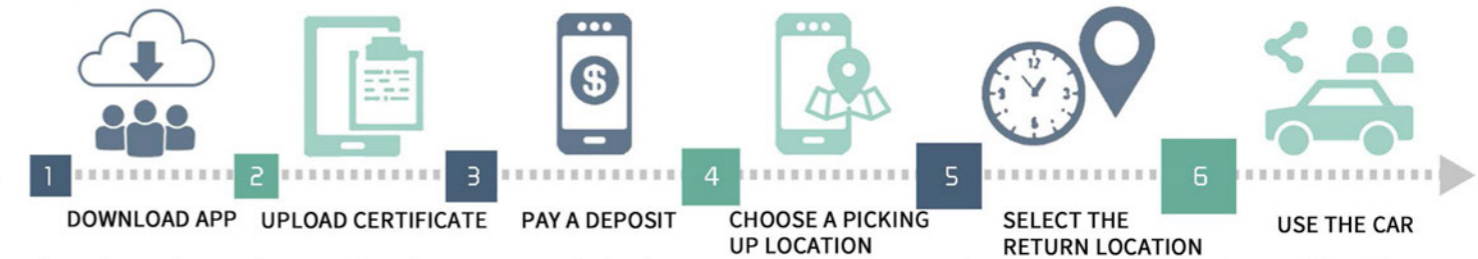
1 INTRODUCTION

1.1 STUDY BACKGROUND

In recent years, it has become a common phenomenon that the problems of traffic congestion , expensive parking fees and exhaust pollution have become more and more serious in many cities, such as Beijing, Shanghai, and Guangzhou.

At the same time, the emergence of "shared-car" powered by new energy has improved the convenience of people's travel and provided a new way of thinking for solving urban traffic problems. In Wuhan, however, there are many problems such as frequent demolition and construction of parking spots, low usage rate of some parking spots, and insufficient battery life of charging piles. In order to solve these problems, we decided to conduct an in-depth investigation on shared-cars.

Since the shared-car parking lots are mainly concentrated in the Forth Ring Road in Wuhan, **we decided to choose the area within the Third Ring Road as study area.**

WUHAN CITY

WITHIN THE FORTH RING ROAD

— STUDY AREA

1.2 INTRODUCTION OF GOFUN SHARE-CARS IN WUHAN

1	2	3	4	5	6
DOWNLOAD APP	UPLOAD CERTIFICATE	PAY A DEPOSIT	CHOOSE A PICKING UP LOCATION	SELECT THE RETURN LOCATION	USE THE CAR

Shared car refers to the provision of new energy vehicle sharing services on campus, subway stations, bus stations, residential areas, commercial areas, public service areas, etc. It is a time-sharing lease model. People only need to download the app, register their real name and pay a small deposit, then they can use the car at the shared car parking spot. In addition, after the vehicle is used, the driver needs to drive it back to the designated parking location. We selected the Gofun shared car in Wuhan as our survey subject .
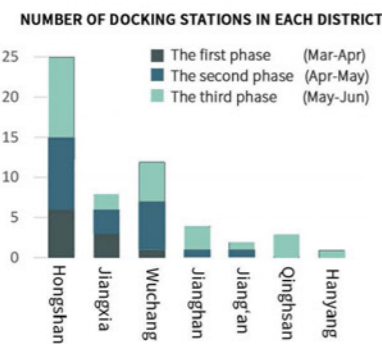
1.3 METHODOLOGY

In the research process, we conducted a questionnaire survey and operated principle components analysis to discover the relations between shared vehicles usage frequency and the types of supporting facilities situated in the immediate catchment. Consolidating the analysis, we summarized **the key location factors** that affect shared vehicles usage the most, and promoted **a strategic plan for allocating shared vehicles' parking locations based on users' usage pattern.**

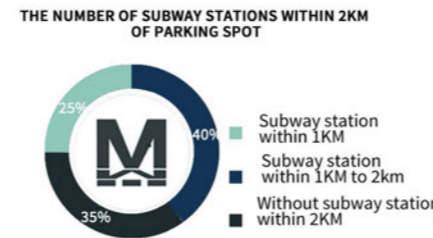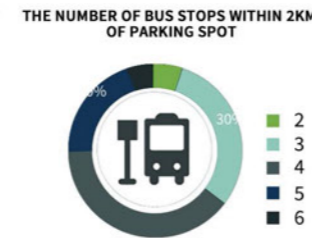# 2 CURRENT SITUATION OF SHARED-CARS PARKING SPOTS

2.1 STATISTICS OF SHARED-CARS PARKING LOTS

Gofun shared-cars were first placed in three districts in Wuchang, and gradually developed to Hankou in the second phase. In the third phase, they were mainly invested in the Qinghai ,Hanyang,Jiang'an District.

Most of the parking spots have 10-15 share-cars. Only P and R have fewer than 10 vehicles. Only 6 of the 21 parking spots have charging posts, accounting for only 28.6% of the total

NUMBER OF DOCKING STATIONS IN EACH DISTRICT

- The first phase (Mar-Apr)
- The second phase (Apr-May)
- The third phase (May-Jun)

2.2 TRAFFIC SITUATION AROUND PARKING LOTS

THE NUMBER OF BUS STOPS WITHIN 2KM OF PARKING SPOT

THE NUMBER OF SUBWAY STATIONS WITHIN 2KM OF PARKING SPOT

- 2
- 3
- 4
- 5
- 6

- Subway station within 1KM
- Subway station within 1KM to 2km
- Without subway station within 2KM

Most of the shared-cars' parking spots are located around the main road of the city and are close to the intersection of the roads. In terms of transportation hub , many parking spots are built near the four main train stations in Wuhan(within 2KM), and some of them can also serve nearby subway station.

2.3 LAND USE AROUND SHARED-CARS PARKING LOTS

RESIDENTIAL	B D G H J K M N O P Q R
COMMERCIAL	A D E I
EDUCATIONAL	C F I R
OFFICE AREA	A C J T
SCENIC SPOTS	E F G H K Q
TRANSPORTATION	I M S T

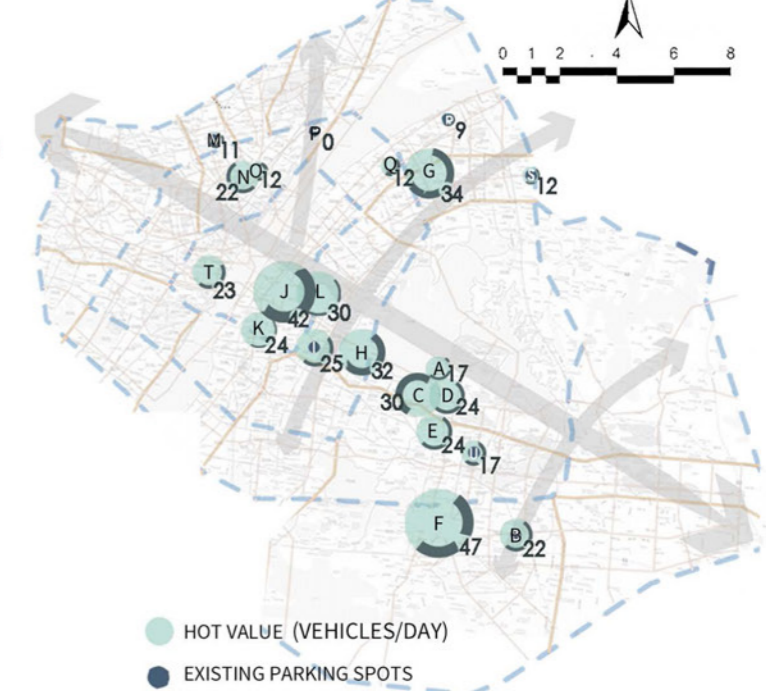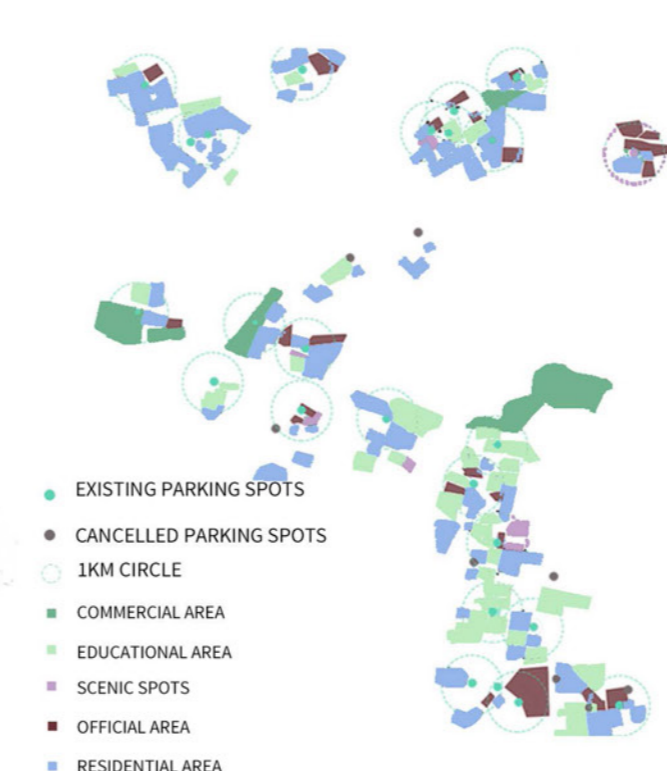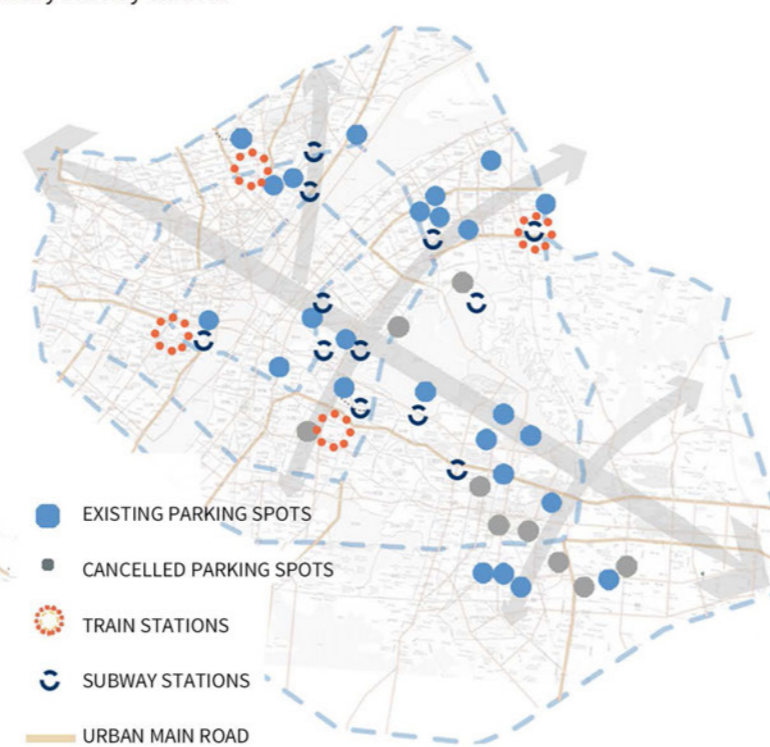THE NUMBER OF PARKING LOTS IN DIFFERENT TYPES OF LAND USE
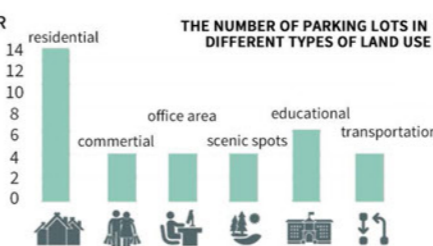
It can be seen that most of the parking lots are built in residential areas and educational areas. A small number of parking lots serve the office areas because of the needs for commuting . Some of shared-cars parking spots relies on hotels that are close to the scenic spots .

2.4 HEAT VALUE OF SHARED-CARS PARKING LOTS

HEAT VALUE MEASUREMENT

The net change number of shared-cars in the unit time (12 hours) at the parking lot is used as a measure of the heat value.

DATA STATISTICS AND PROCESSING

According to the above criteria, we randomly selected 7 days for testing in a month, and averaged the recorded data (vehicles/day).

HEAT MAP CREATION AND SORTING RESULTS

According to the average value obtained, the heat of each parking lot is proportionally expressed by the area of the circle. The heat value of each parking lot is from high to low: F>J>G>H>L>C>I>E>K>D >T>B>N>A>Q>O>S>M>R>P

STUDY AREA

- TOTAL NUMBER OF CHARGING PILES
- TOTAL NUMBER OF SHARE-CARS
- CONSTRUCTION OF PARKING SPOTS IN FIRST PHASE
- CONSTRUCTION IN SECOND PHASE
- CONSTRUCTION IN THIRD PHASE
- CANCELLATION OF PARKING SPOTS IN SECOND PHASE
- CANCELLATION IN THIRD PHASE

- EXISTING PARKING SPOTS
- CANCELLED PARKING SPOTS
- TRAIN STATIONS
- SUBWAY STATIONS
- URBAN MAIN ROAD

- EXISTING PARKING SPOTS
- CANCELLED PARKING SPOTS
- 1KM CIRCLE
- COMMERCIAL AREA
- EDUCATIONAL AREA
- SCENIC SPOTS
- OFFICIAL AREA
- RESIDENTIAL AREA

- HOT VALUE (VEHICLES/DAY)
- EXISTING PARKING SPOTS

3 DILEMMA OF SHARED-CAR PARKING LOTS NETWORK OPERATION

3.1 INADEQUATE INFRASTRUCTURE

LOW RECOGNITION

Most shared-cars parking lots are attached to the existing parking lot, and **there are no obvious signs** such as "shared car" parking when the parking lots are set up.

LIMITATION OF CHARGING PILES

The configuration of the **charging pile is relatively low**, and the charging depends on the staff.

3.2 UNSYSTEMATIC PARKING LOTS DISTRIBUTION

The setting of the shared-cars parking lots does not form an overall network system, and the performance is mostly **a block-like centralized distribution setting.**
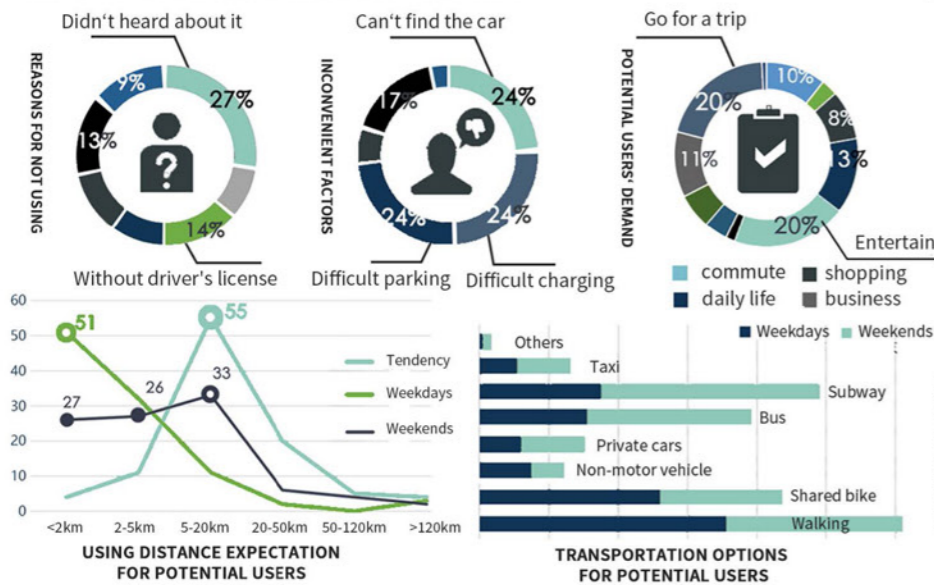
3.3 UNCOORDINATED DEMAND AND SUPPLY

As shown on the right, the shared vehicle configuration is relatively average while **the charging piles are not evenly configured.** Sites with higher heat, vehicle and charging pile configurations may be insufficient.

- TRAFFIC STATISTICS (VEHICLES/DAY)
- NUMBER OF SHARED-CARS
- NUMBER OF CHARGING PILES

4 ANALYSIS OF THE INFLUENCE MECHANISM OF SHARED-CAR PARKING LOTS HEAT VALUE

4.1 POTENTIAL USER DEMAND ANALYSIS

REASONS FOR NOT USING

Didn't heard about it — 27%
7%
13%
14%
Without driver's license

INCONVENIENT FACTORS

Can't find the car — 24%
17%
24%
24%
Difficult parking   Difficult charging

POTENTIAL USERS' DEMAND

Go for a trip
20%
11%
20%
10%
8%
3%
Entertainments

commute   shopping
daily life   business

USING DISTANCE EXPECTATION FOR POTENTIAL USERS
51   55
27   26   33
Tendency
Weekdays
Weekends
<2km 2-5km 5-20km 20-50km 50-120km >120km

TRANSPORTATION OPTIONS FOR POTENTIAL USERS
Others
Taxi
Subway
Bus
Private cars
Non-motor vehicle
Shared bike
Walking
Weekdays   Weekends

4.2 SHARED-CAR USER DEMAND ANALYSIS

Male 26% / 74%
GENDER
Male
Female

18-25 — 44%
5%
15%
36%
Female
AGE
18~25   26~30
31~40   41~50

5k-10k — 47%
5%
34%
14%
INCOME
5K-10K   2K-5K
<2K   >10K

ENTERPRISE STAFFS 49%
11%
29%
OCCUPATION
CIVIL SERVANTS   STUDENTS
BUSINESSMEN   OTHERS

TRAVEL PURPOSE
Exercise
Leisure activities
Shopping
Cultural events
Family trips
Hospital
Business trips
Commute

TRAVEL TIME
EARLY PEAK   6:00-9:00
9:00-11:30
NOON PEAK   11:30-14:00
14:00-17:00
EVENING PEAK   17:00-20:00
20:00-22:00
22:00-24:00

CROSS-ANALYSIS OF VEHICLE DURATION AND TRAVEL PURPOSE AND DISTANCE

<20km   20-50km   50-120km   >120km

go to work   go to school   daily life   shopping
culture   education   sports   doctior
park   business   go home   others

59.38%
48.00%
40.00%
18.75%   18.75%   12.00%   14.29%   11.11%
12.50%
0.00%   3.13%   0.00%   0.00%   0.00%

<0.5H   0.5H-1H   1H-2H   2H-3H   >3H

A total of 540 valid questionnaires were used in this questionnaire, of which 243 were valid questionnaires for shared cars. Most people have not used a shared car because they have not heard of it, used to choosing other modes of travel or have no driver's license. The inconvenience is that the number of shared-car is small,and it is hard to find a place to park or charge. Compared with the working day, the number of people who chose walking or non-motorized vehicles decreased at weekend, and more people tend to use public transportation and cars for relatively long distance travel. The "weekend mode" and "entertainment" keywords are more suitable for potential shared-car users

People generally choose to use shared-car when they are engaged in entertainment activities. Shared cars are more popular when it comes to group activities, followed by commuting. In terms of travel time, the usage rates of the three peak hours are high at 6:00-9:00, 11:30-14:00, and 17:00-20:00, especially at night peaks.The top two educational areas and the Jiyuqiao parking lot were used to analyze the characteristics of the users. It can be concluded that the basic characteristics of the users are 20 to 30-year-old undergraduate students with a monthly salary of around 5,000 yuan, and the average car is less than 1 hour.

It can be seen that most people who use the shared-car for less than half an hour drive 0-20 km, mainly for shopping and leisure activities; most users who use more than half an hour drive 20-50km, mainly for entertain shopping, sports activities and business. Only a small number of users use shared-car for commuting or medical treatment, which is a time-critical event. Overall, the shared car is mainly aimed at 20-50km travel (mainly for leisure activities).

4.3 PARKING LOCATION OF SHARED-CAR FACTOR

In order to study the impact of commercial facilities, transportation sites, residential facilities, universities, scenic spots, and office facilities on the heat value of share-cars parking spots. We use the heat value as the dependent variable, and the number of facilities within 2km around the parking lots as independent variable. Firstly, using SPSS software to carry out principal component analysis of variables, it is concluded that the number of office facilities, attractions and traffic stations have a significant impact on the heat of the outlets. After the multiple regression analysis of the above three variables, the magnitude of the influence of each variable on the heat of the parking lots can be seen by the p value.

SPSS ANALYSIS RESULTS

MODEL	NON-STANDARDIZED COEFFICIENT	STANDARDIZED COEFFICIENT		T	P VALUE	SIGNIFICANCE
	B	STANDARD ERROR	BETA			
1 (CONSTANT)	-7.12	5.995		-1.188	.280	1.720
TRANSPORTATION SITES	.694	.238	.432	2.909	.270	1.730
SCENIC SPOTS	2.019	.865	.350	2.334	.058	1.942
OFFICE FACILITIES	.730	.147	.677	4.969	.003	1.997
COMMERCIAL FACILITIES	-	-	-	-	-	NULL
RESIDENTIAL FACILITIES	-	-	-	-	-	NULL
UNIVERSITIES	-	-	-	-	-	NULL

According to the analysis results, among the above six spatial location factors, office facilities have the greatest impact on the heat of parking spots, and the second and third are the number of scenic spots and traffic stations. The remaining factors have no significant impact on the operation of the outlets. Therefore, it is important to consider setting up parking spots in areas with more office facilities, classics, and convenient transportation.

5 REPRESENTATIVE OF HIGH HEAT VALUE SHARED-CARS PARKING SPOT

INDUSTRIAL PARK-TYPE
There are intensive workplaces around the parking spots, and the shared-car users are accurately positioned mainly for company employees.

COMMERCIAL CENTER-TYPE
It is mainly based on the city's commercial center.The distance between the parking lot and commercial center is relatively close, and it is alsoclosely related to other transportation sites.
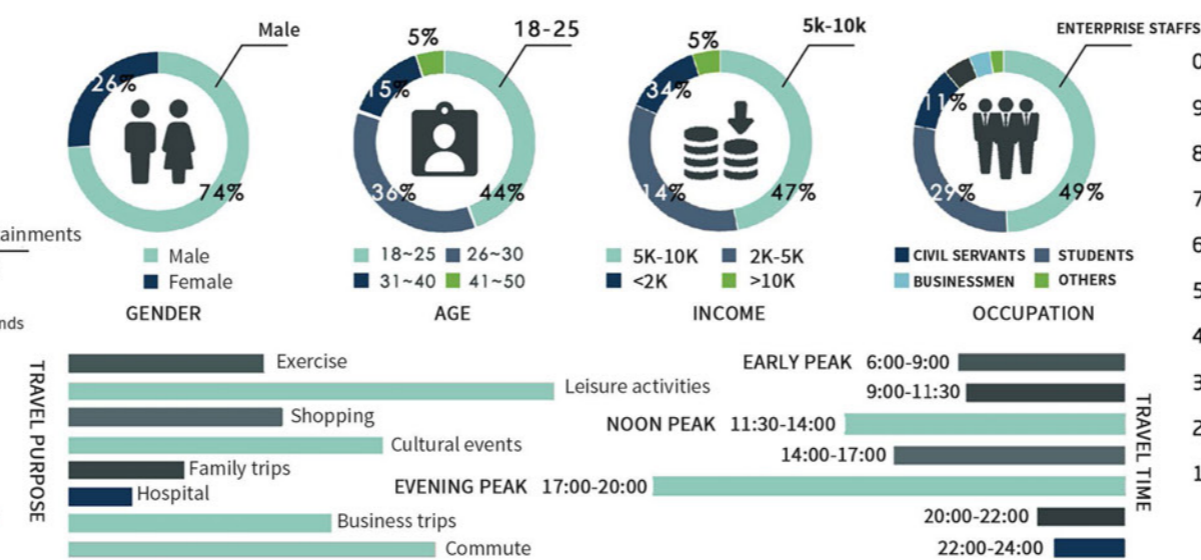
TOURISM SERVICE-TYPE
Tourism service parking lots are mainly located around the scenic spots. Serving tourists who want to travel freely in Wuhan.
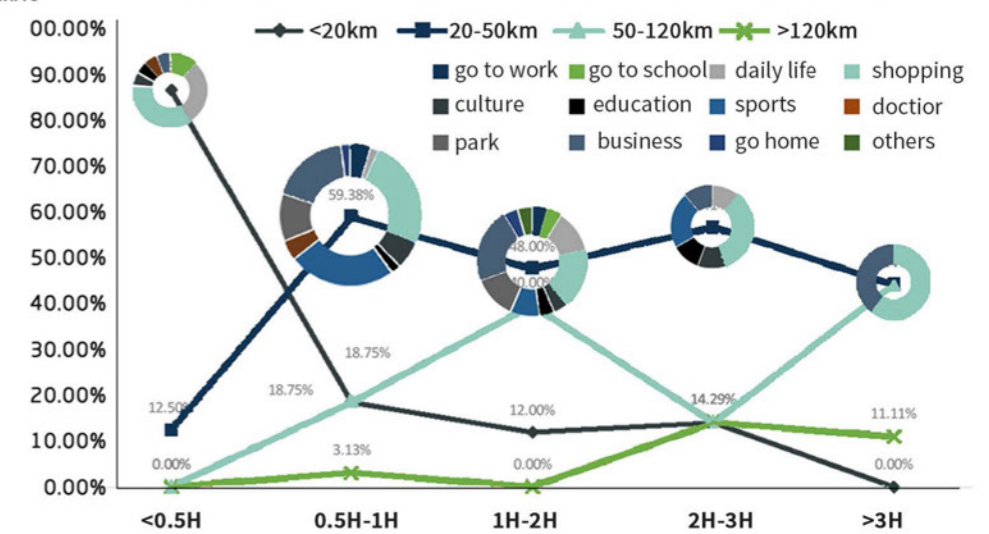
TRANSPORTATION HUB-TYPE
Transportation hub-type parking lots are usually set on important transportation nodes , in order to serve transportation transfer.

6 SHARED-CAR PARKING LOTS LAYOUT OPTIMIZATION STRATEGIES

6.1 SPATIAL LAYOUT OPTIMIZATION STRATEGY OF SHARED-CAR PARKING LOTS

MAIN IDEA
By dismantling, adding, and optimizing existing shared-car parking lots, we will build a network of parking lots to further expand the use of shared cars and provide better services for people.

STRATEGIES
The adjustments of the shared-car parking lots are mainly divided into two categories: adding layout points and dismantling outlets.

URBAN CENTERS
Since the land use function of urban center is complicated,the stratetie is aiming to increase the density of parking spots.

OUTER DEVELOPMENT AREA
Add new parking spots in potential plots with comprehensive functions.

INCREASE THE DENSITY OF CHARGING PILES
Add charging piles from the city center parking lots, achieving the goal that every 3 parking lots are able to share a set of charging facility .

NEW-CONSTRUCTED PARKING SPOTS
Industrial Park (B)
scenic area (A C D)
downtown business district (C D)
transportation hub (E)
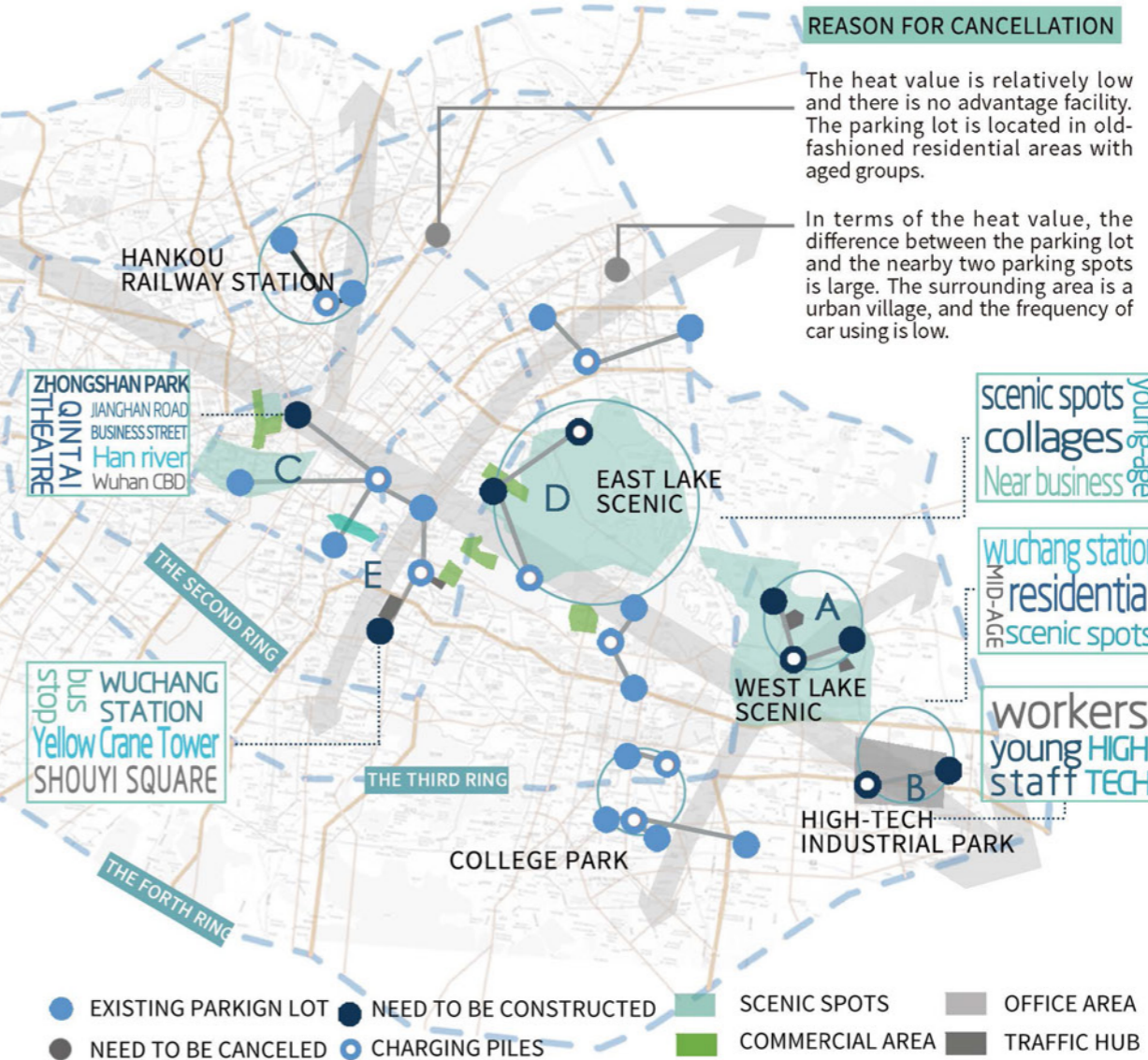
REASON FOR CANCELLATION
The heat value is relatively low and there is no advantage facility. The parking lot is located in old-fashioned residential areas with aged groups.

In terms of the heat value, the difference between the parking lot and the nearby two parking spots is large. The surrounding area is a urban village, and the frequency of car using is low.

6.2 SELF-OPTIMIZATION

PARKING FACILITY
Divide independent shared car parking spaces and add guidance signs. Differentiate shared cars and general private cars to improve the recognizability of shared-cars. Add charging piles to share a cttharging pile for every 2 parking spaces.

ACCESSIBILITY
The shared-car parking lot is selected in the ground parking lot with better conditions and avoid to be located inside the community or hotel.

When setting up parking lots in the city center, try to choose a public parking lot located in the branch road, and optimize the situation where the entrance and exit of the parking lot and the road relationship are not convenient.

TRANSIT SYSTEM
Enhance the connection between parking lots and public transportation stations. considering the connection with bus stations and subway stations.

Enhance the connection between parking lots and shared bike parking spots. Link the shared car to the use of shared bikes, and take into account the accessibility of shared bike parking spots.

HANKOU RAILWAY STATION
ZHONGSHAN PARK
QINTAI THEATRE   JIANGHAN ROAD   BUSINESS STREET   Han river   Wuhan CBD
bus stop   WUCHANG STATION   Yellow Crane Tower   SHOUYI SQUARE
C   E   D   EAST LAKE SCENIC
A   WEST LAKE SCENIC
B   HIGH-TECH INDUSTRIAL PARK
COLLEGE PARK
THE SECOND RING   THE THIRD RING   THE FORTH RING

scenic spots collages Near business   young-age
wuchang station residential scenic spots   MID-AGE
workers young staff   HIGH TECH

EXISTING PARKIGN LOT   NEED TO BE CONSTRUCTED   SCENIC SPOTS   OFFICE AREA
NEED TO BE CANCELED   CHARGING PILES   COMMERCIAL AREA   TRAFFIC HUB