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Research on Usage Distribution of Shared Cars Based on Visual Analysis

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Abstract: *With the help of information technology, sharing economy came into being, developed and improved. In order to get the distribution of shared car use in Tel Aviv from the shared car location data set, this paper visually describes all the parking spots in the data set, and then analyzes the distribution of shared car use in Tel Aviv from two dimensions of time and space, and concludes that there are time-sharing differences and regional differences in shared car use in this city. The above research in this paper can provide reference for the service design of shared car parking space distribution, dispatcher distribution and car deployment time.*

Keywords: *Visual Analysis, Time-sharing Differences, Regional Differences, Car-sharing*

1. Introduction

In the era of information intelligence, the industrial development mode of "internet plus" has added some vitality to China's economy, and the sharing economy has been discovered under this background, and has since moved towards the road of rapid development. Sharing economy accelerates the flow of resources with the help of the Internet, and "facilitates" the lives of social members through more efficient resource allocation and lower transaction costs, thus promoting economic development and improving social welfare[1].

As a safe and green means of public travel, shared cars can effectively fill the gap between public transport and private cars[2], thus reducing people's demand for private cars, so as to achieve the purposes of preventing environmental pollution, relieving traffic jams, improving vehicle utilization and improving vehicle management. Due to the different ways of borrowing and returning vehicles, there are two operating modes of shared vehicles: site borrowing and returning and free flowing[3]. In the research of site borrowing and returning formula, Brandstätter et al.[4] solved the optimal location problem of shared car parking spaces under random demand, Zhou Ting[5] chose the improved ant colony algorithm to realize the multi-objective location and adaptive positioning problem of shared car parking areas, Sun Yizhe[6] used the improved TODIM evaluation method to comprehensively analyze multiple alternative parking areas to determine the optimal parking areas of shared cars, and Yao Enjian et al.[7] tried the dynamic discount strategy to guide users. In the research of free flow, Ma Jian[8] combined genetic algorithm and case simulation method to give the shared car scheduling strategy, He et al.[9] gave the optimal service range of shared cars by weighing the benefits of user's order scale and vehicle operating cost, Qing Keyan[10] gave the optimal decision-making model of joint vehicle scheduling and dynamic pricing based on the simulation queuing network model of shared cars, and Weikl et al.[11-12] focused on the human-assisted vehicle scheduling between different regions.

In order to further study the usage distribution of shared cars, this paper will take Tel Aviv, the second largest city in Israel, as an example, and select the data from December 11th, 2018 to January 10th, 2019 to analyze the usage distribution of shared cars in Tel Aviv from two dimensions of time and space, in order to provide reference for the service design of shared car parking space distribution, dispatcher allocation and car deployment time.

2. Analysis of the usage and distribution of shared cars

The data time selected in this paper is from December 11th, 2018 to January 10th, 2019, with a total of 31 days. There are 1,048,575 original data. The data category includes the collection time based on Coordinated Universal Time (UTC), the corresponding latitude and longitude, and the number and

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number of vehicles parked at the parking spot. Because there are various errors and omissions in data collection and transmission, it is necessary to clean the data before analyzing the distribution of shared cars in Tel Aviv.

The data cleaning work in this paper includes data correction and data elimination. In order to ensure the scientific rationality of the analysis results, the data collected less than 20 hours on the same day will be eliminated, and the remaining effective days will be 26 days. In this paper, based on the cleaned Tel Aviv shared car location information data set, the data of the whole sample, each time period and each region will be statistically analyzed from the time dimension and the space dimension respectively.

2.1 Changing trend of parking quantity in parking outlets

2.1.1 Trend of daily parking quantity

During the sample data time, the number of vehicles parked in Tel Aviv's full-time parking spots is basically maintained in a stable range, and the value fluctuates around 24,000, as shown in Figure 1, in which the data on December 18th, 2018 decreased slightly because the sample collection time on that day was more than 20 hours but less than 24 hours. It can be seen that shared cars are frequently used in Tel Aviv, so it is of great significance for shared car operators and Tel Aviv's environmental governance to reasonably schedule shared cars on the premise of considering operating costs and profitability.

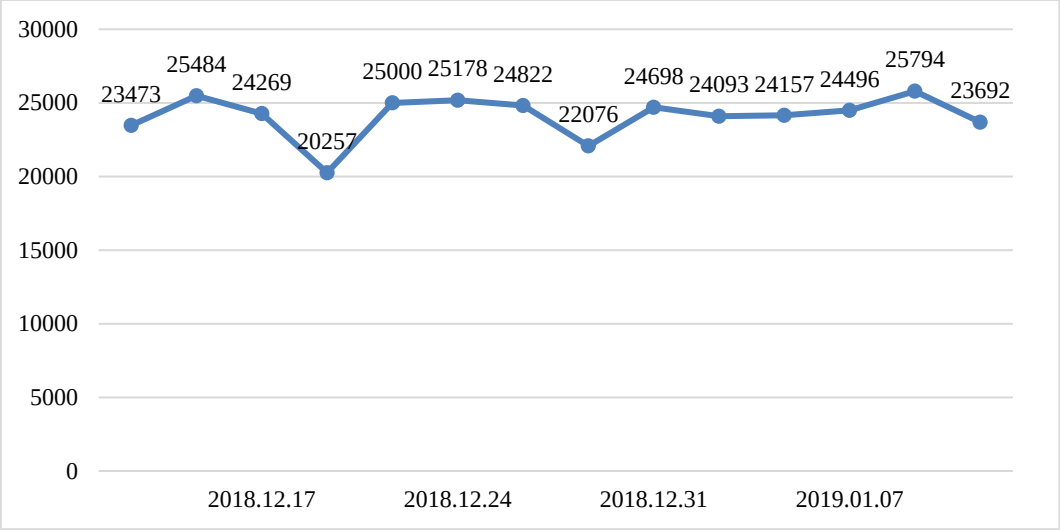

Figure 1: Changes in the number of vehicles parked at daily parking outlets

2.1.2 Weekly trend of the number of vehicles parked

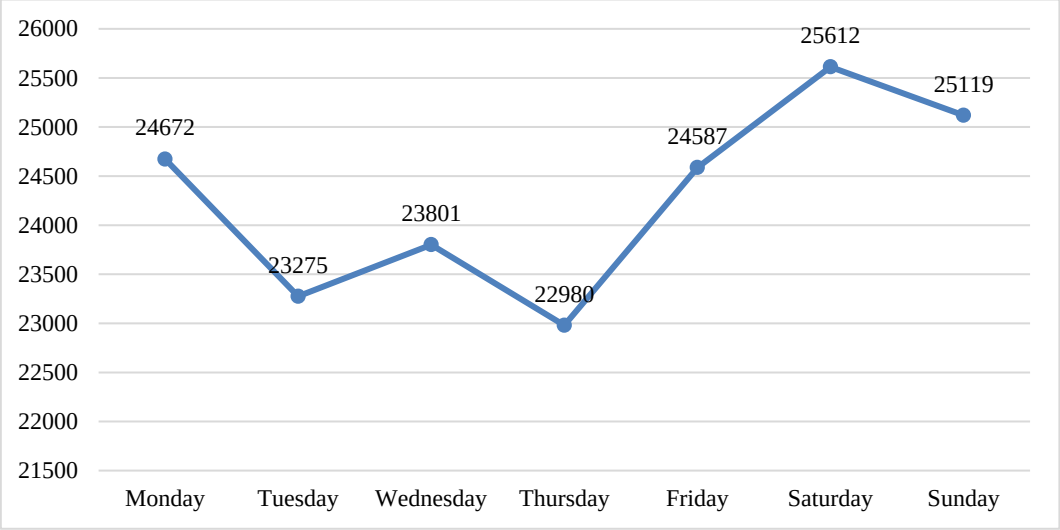

Figure 2: Changes in the number of vehicles parked at parking outlets every week

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Figure 2 shows that the number of parking spots on weekends is obviously higher than that on weekdays, and the average daily parking amount on weekends is 1.1 times that on weekdays. It can be seen that people's demand for shared cars on weekends is higher than that on weekdays, that is, compared with daily commuting, people choose to share cars on weekends more frequently. Combined with the actual analysis, daily commuting is a long-term and persistent activity, so the people who need it usually live not too far from their commuting places, and there is a fixed commuting mode, such as walking, cycling, electric cars, etc. Traveling on weekends is a short-term and accidental activity. Most users who choose to share cars are in a state of no car or inconvenient parking near their destination, such as college students.

Taking college students as an example, according to the 2012 college students' consumption survey of Zero Market Research Company, 14.9% of college students have obtained their driver's licenses, 10.2% are taking their driver's licenses, and 31.6% plan to get their driver's licenses before graduation, which means that most college students will get their driver's licenses before graduation, and they are in a state of "having a license without a car", which shows the hidden demand for sharing cars. To sum up, shared car operators and related institutions can carefully analyze the user groups who travel on weekends, and add shared car parking spots near the gathering places of user groups to facilitate their travel and increase the utilization rate of shared cars.

2.2 Analysis of space-time usage characteristics of shared cars

2.2.1 Time characteristic analysis

1) Vehicle parking at parking outlets in different time periods

As can be seen from Figure 3, the usage of shared cars in the morning rush hour in this city is significantly higher than that at noon and at night, and the increase is huge in a short time, which is 25.5% higher than that in the previous interval. In view of the morning rush hour, the shared car operators and relevant institutions should complete the dispatching and distribution of vehicles during the peak hours on the premise of ensuring the normal use of vehicles, and appropriately transfer vehicles from a long distance to meet the high-demand routes.

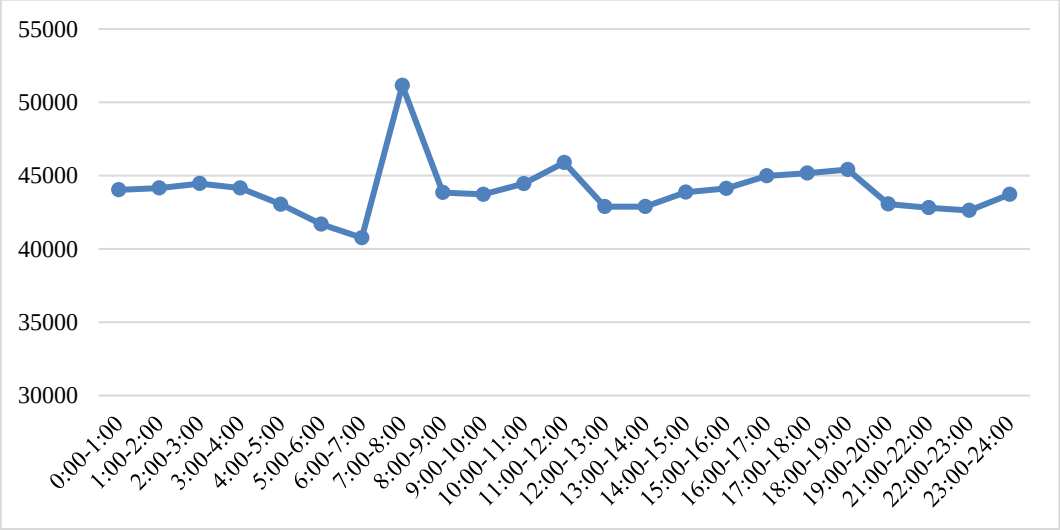

Figure 3: Usage of shared cars in different time periods of the day

For the small peak hours at noon and night, shared car operators and related institutions can appropriately increase car dispatchers in various regions, or encourage users to change their travel routes by providing discounts and subsidies to reduce the imbalance between supply and demand of parking spots; In view of the continuous decline in the use of shared cars at night, a "package night discount package" can be launched to better absorb the demand for night peak and night travel and increase the frequency of users' use.

2) Distribution of car use time within 24h hours

The usage time of shared car can reflect the user's usage pattern to a certain extent, that is, whether the user rents the car all day or for a short time. This paper mainly explores whether the shared car usage pattern in Tel Aviv belongs to short-term rental. According to the integrity of the data, select the shared

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car location data from 0:00 on December 30th, 2018 to 0:00 on December 31st, 2018, and calculate the car use time of each car according to the time interval when each car appears at the same parking spot. After filtering out the data with an interval of less than 5 minutes, take 10 minutes as the duration interval, and draw the distribution map of the car duration of the sample within 24 hours.

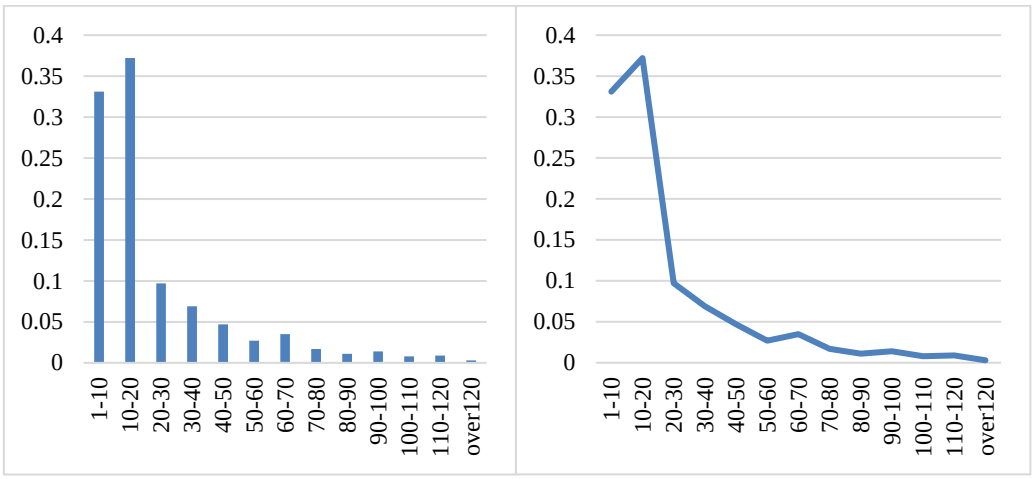

Figure 4: Frequency distribution of vehicle duration within 24 hours

As can be seen from the figure 4, the car use time of the sample is mainly within 60 minutes, indicating that the shared car use in Tel Aviv is more inclined to short-term rental. Similar to Tel Aviv, domestic car sharing projects are mostly limited to short-term leasing, with slow large-scale commercialization and low profitability and penetration. In order to break the ice of short-term lease, shared car operators and related institutions can control and optimize operating costs on the one hand based on the same model; On the other hand, we can diversify the leasing mode, increase the preferential intensity to guide users to change their travel modes, and improve the profitability and ability by providing users with new ideas to share.

2.2.2 Analysis of spatial characteristics

1) Parking situation of vehicles during peak hours in each region

Through the analysis of the above time characteristics, it can be seen that there are time-sharing differences in the use of shared cars in Tel Aviv, that is, there are three use peaks in the morning, middle and evening. In order to further study the regional differences of the usage frequency of shared cars in the peak hours of this city, this paper makes ARCGIS visual analysis of the usage data of shared cars in the three peak hours of 7:00-8:00, 11:00-12:00 and 18:00-19:00, as shown in Figure 5.

Figure 5: Parking situation in the morning (left), middle (middle) and evening (right) peak hours

By analyzing the heat map obtained in the early, middle and late peak hours, it can be found that the parking situation basically conforms to the distribution characteristics of Tel Aviv urban buildings. There are a large number of medical centers, shopping centers, squares, flea markets, museums, halls and other buildings in the middle of Tel Aviv, which belongs to the center of Tel Aviv. The density of people is high and the flow of people is frequent, so the frequency of sharing cars in this area is high. With the passage of time, the use frequency of shared cars in the northern and southern marginal areas of the city has been increasing, which further infers that these two areas belong to residential areas, and the flow of people

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from the city center to the surrounding areas has led to the increase of the use rate of shared cars in the northern and southern marginal areas.

Due to the regional differences in the use of shared cars at different times, shared car operators and related institutions can add outlets in areas with high personnel density, appropriately reduce or remove outlets with low frequency of use, predict the use of shared cars based on demand, and assign grades to each area according to the frequency of use to rationally dispatch personnel. In addition, when dispatching vehicles, the staff can also dispatch the shared cars in the city center to the marginal late peak areas in the afternoon during the peak hours to meet the travel needs of residents in residential areas.

2) Distance distribution of vehicles within 24h

Through the above analysis, it is concluded that the use time of shared cars in Tel Aviv is generally less than 1 hour within 24 hours. In order to further analyze the distance of users' cars within 24 hours, this paper screened out the 20 cars with the highest frequency within 24 hours, and based on the 50 km/h speed limit of Israeli urban roads, made a statistical description of the distance distribution after calculating the driving distance of each car. As shown in figure 6, the abscissa represents the driving distance class of vehicles and the ordinate represents the vehicle number.

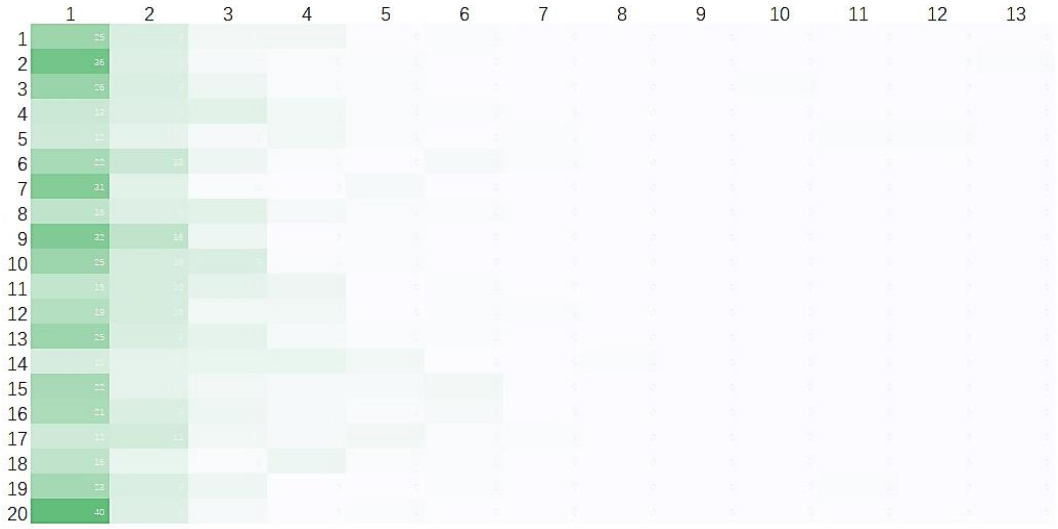

Figure 6: Vehicle distance distribution within 24 hours

Judging from the colors of the color scale in Figure 6, the shared car belongs to the travel mode with short distance of 5-25 km and high freedom of route in the city map, which is close to the travel scenes of taxis, network cars and private cars and forms a complementary pattern. From this, it can be seen that the use distance of urban shared cars is short and the frequency is high, so a reasonable scheduling scheme is needed to solve the imbalance caused by tidal effect and avoid the situation of saturated supply or insufficient demand.

3. Conclusions

In order to further study the usage distribution of shared cars, this paper takes Tel Aviv, the second largest city in Israel, as an example. Firstly, it studies the daily and weekly change trend of shared car usage in this city in the data interval. Secondly, from the time dimension, it compares the usage of shared cars in different time periods of a day and the time interval of users using shared cars every time; Finally, based on the usage characteristics of time dimension, three peak periods are selected to observe the regional differences in the usage of shared cars, and the distance distribution of users using shared cars is shown in the form of color scale diagram.

Through the analysis, we can know that the usage frequency of shared cars in Tel Aviv is high, and the usage of shared cars on weekends has increased in a few weeks. At the same time, there are obvious time-sharing differences and regional differences in the use of shared cars in Tel Aviv. The use of shared cars in Tel Aviv is more frequent in the morning, middle and late peaks, among which 7:00-8:00 am is the highest time interval of the three commuting peaks in a day. With the passage of time, there is no obvious difference in the usage of shared cars in the central part of the city, but the usage in the northern and southern fringe areas of the city has increased. In addition, according to the 24-hour data randomly

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selected on December 30th, Tel Aviv users mostly rent shared cars for a short time, with the use time concentrated within 60 minutes and the driving distance generally within the short and medium range of 5-25 km. Based on the above analysis, shared car operators and related institutions can build a shared car network more specifically, and further optimize the distribution of shared car parking spaces, the allocation of dispatchers and the car deployment scheme by excavating data value, strengthening credit system and expanding car service, so as to reduce operating costs, traffic jams and environmental pollution and help build a harmonious society.

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