

Traffic Volume Forecast of Parking Lot Entrance and Exit Roads

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Abstract: As people's living standards improve, commercial plaza development also more and more quickly, commercial plaza and the surrounding areas of transport vehicles, in the parking lot entrances and exits of highway road traffic conditions, the parking lot entrances and exits of low traffic capacity and traffic organization chaos (motor vehicles, electric vehicles and the status of the bicycle traffic complex). It is necessary to predict the traffic volume of the entrance and exit roads of the parking lot. In ningyang county lingyun building as an example, through direct observation records investigation parking lot parking condition and facilities, analysis of traffic organization form of the parking lot entrances, investigate the status of the parking lot entrance road and surrounding roads, using artificial paper counting method to collect parking entrance road traffic flow, speed and other data, The time series moving average and exponential smoothing are used to predict the traffic volume at the entrance and exit of the parking lot. The prediction results show that the two methods are suitable for the parking lot entrance traffic volume prediction, and the moving average method is more accurate than the exponential smoothing method, which is closer to the actual value.

Keywords: Parking lot entrance and exit, Traffic, Traffic organization.

1. Introduction

Now people's living standard is gradually improved, the number of urban vehicles is growing more and more rapidly. The surge in the number of vehicles on the city's road congestion has also produced a serious challenge, making the car in some roads or some periods of time driving is more difficult. In addition, the domestic commercial square is also growing rapidly, commercial square also has its own particularity, particularity is that it is closely with the surrounding area of traffic vehicles, and the entrance and exit of the parking lot has a great impact on the road traffic conditions, so to solve the congestion problem for vehicle driving and parking supporting measures have a high demand, in this study of the commercial square parking lot entrance and exit traffic situation, predict the traffic flow of the road. The key to traffic flow prediction is to build an appropriate prediction model and select an appropriate prediction variable.

Traffic flow prediction algorithms can be divided into traditional prediction methods based on mathematical analysis, intelligent prediction methods appearing after the development of artificial intelligence, and combination prediction methods that integrate different prediction methods. The prediction model based on mathematical analysis uses mathematical analysis to process historical traffic data, such as traffic flow, traffic speed, vehicle density and other data information, and uses the processed data for traffic prediction. Generally speaking, the prediction model based on mathematical analysis uses historical data for prediction, and its premise is that the data of future prediction have the same characteristics as the data of the past. Time series method is one of the commonly used prediction methods based on mathematical analysis. Time series method, according to the statistical characteristics of traffic flow time series, adopts a parameterized model to characterize the time series characteristics of traffic flow, and based on the statistical law of the model, uses the current and past observation values to predict its future value [1]. Here, linear model prediction

methods are mainly used, which mainly include moving average method, exponential smoothing method, time series method (based on AR model, MA model, ARMA model, ARIMA model, etc.) and Kalman filtering method [2]. Two simple moving average methods and exponential smoothing methods are used here.

As for the study of moving average method, Xu et al.[3] pointed out that the short-term prediction of traffic flow parameters can be realized by moving average method. When the step size parameter is 2, the overall effect is relatively good and it is more suitable for short-term traffic flow prediction. This method can not only eliminate the influence of random components, but also reflect the change of traffic flow sequence trend. There are a lot of researches on exponential smoothing, most of which are applied between big cities with a lot of data. For example, Ma et al.[4] used the triple exponential smoothing method to study the special line of Dalian New Airport rail transit, which can provide a good basis for the operation of the special line. In addition, Jia et al.[5] put forward a segmented quadratic exponential smoothing model that is in line with current traffic information. Through the quadratic exponential smoothing model, short-term prediction of traffic information is made, which fully takes into account the actual situation of traffic road information and improves the rationality of short-term prediction of traffic information.

In order to predict the traffic volume of the road at the entrance and exit of the parking lot, the two methods of moving average and exponential smoothing are used to smooth the time series respectively to describe the trend of the series, and the method that is more suitable for the area with small traffic volume is selected by comparison.

2. Moving Average and Exponential Smoothing

The moving average method is a common method for predicting future values of time series using a set of recent

actual data values. It uses a step-by-step method to calculate a series of moving ordinal averages respectively, forming a new derived ordinal average time series. In this derived time series, changes caused by short-term accidental factors are weakened, thus presenting the basic development trend of phenomena in a longer period of time. Here, the simple moving average method is mainly used, and its calculation formula is as follows:

$$M_{t+1} = \frac{1}{N} \sum_{j=1}^N A_{t-j+1}$$

Where, N is the number of periods;
 A_{t-j+1} is the actual value of (t-j+1) period;
 M_{t+1} is the predicted value of (t+1) period.

Exponential smoothing method eliminates the influence of random factors by smoothing historical time series layer by layer, identifies the basic trend of phenomenon, and predicts the future. Among all forecasting methods, exponential smoothing is the most widely used one. Its basic formula is as follows:

$$S_t = aY_t + (1 - a)S_{t-1}$$

Where, S_t is the predicted value at time t
 Y_t is the actual value at time t
 S_{t-1} is the predicted value at time t-1
 a is a smooth constant with a value range of [0,1]
 S_t initial value $S_1 = Y_1$

3. Traffic Condition of Entrance and Exit Road of Parking Lot

3.1. Classification of traffic organization forms

According to the survey, the existing traffic organization forms of the main parking lot entrances and exits mainly have two forms: left in left out and right in right out. The left-in and left-out traffic organization form has a great impact on the traffic capacity of connected roads, and the entrance and exit of the parking lot of this traffic organization form is often set on the road with small traffic capacity or low grade. There are four interfering traffic flows in this form, two of which need to pass through the normal traffic flow on the connected road, so it has a great impact on the road traffic capacity. The right-in and right-out traffic organization form has little impact on the traffic capacity of connected roads, and is often used as the traffic organization form of the entrance and exit of the external parking lot with larger traffic capacity or higher road grade. There are only two interfering traffic flows in this way, including the inbound diverting traffic flow and the outbound

combined traffic flow, which can reduce the passing time of the traffic flow on connected roads. As a result, the capacity of connected roads can be reduced.

3.2. A commercial square parking lot entrance road organization form

As shown in Figure 1, traffic flow 1 indicates the traffic flow that will turn right to enter the parking lot on this road. When the vehicles in this traffic flow enter the parking lot, they need to slow down and turn right to enter. Therefore, the vehicles running straight behind the traffic flow must slow down or change to the lane opposite the cars, which greatly reduces the efficiency of the vehicles running straight. Traffic flow 2 refers to the vehicles that will merge into the main road flow A after turning right out of the parking lot. Subject to the priority level of right-turning vehicles that should give way to the vehicles going straight, this traffic flow can only merge during the gap between the main road flow A passing or when the main road flow A has fewer vehicles. Therefore, it will greatly affect the traffic flow in this direction, that is, the passing time of the main road flow A. In actual circumstances, some vehicles do not comply with traffic rules and forcibly merge into the main traffic flow, causing the main traffic flow to slow down or change lanes, traffic order disorder, and the capacity of the road section is reduced. Traffic flow 3 represents the traffic flow that is about to turn left into the parking lot. This traffic flow still needs to slow down when entering the parking lot and then turn left to enter, which will still hinder the main traffic flow B in this direction and reduce the efficiency of the vehicles in the direction of the main traffic flow B. When turning left, traffic flow 3 needs to pass the main road where the main traffic flow A is located in the other direction. It is necessary to use the travel gap of the vehicles of the main road flow A (do not need to consider when the traffic flow is small), thus affecting the normal running of the vehicles of the main road flow A, resulting in traffic congestion. Traffic flow 4 represents the vehicle that needs to turn left to leave the parking lot and will join the main road flow B. To leave the parking lot, traffic flow 4 must first pass through the main road flow A, which reduces the traffic efficiency of the main road flow A and increases the traffic time. Then it must take advantage of the gap between the main road flow B (which is still not considered when the traffic flow is small) to smoothly join the main road flow B. In turn, it will have a great impact on the main road traffic flow B. In general, it will have a great impact on the traffic capacity of the carpark section of this Building.

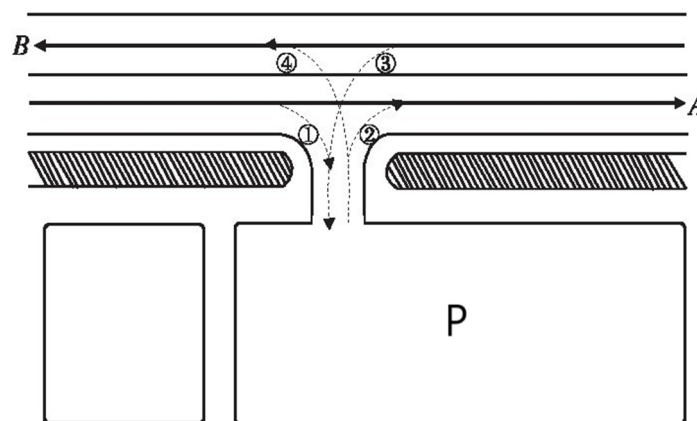


Figure 1. left-in and left-out traffic organization

3.3. Parking lot Condition

The condition of parking lot was investigated by direct observation and record survey. The direct observation and record survey method is applicable to the centralized storage area of vehicle parking such as commercial square, which has large parking attraction, short parking time and high turnover rate. If the method of inquiry survey or distribution of forms survey is adopted, traffic jams may be caused. According to the investigation, the road at the entrance and exit of the parking lot of this Building is a two-lane road, and a major feature of the road is that the overtaking vehicles pass through the opposite lane in the process of overtaking, so the vehicles on the road in the process of driving not only have to be affected by their own vehicles, but also may be affected by the opposite vehicle. The parking lot can park a maximum of about 300 vehicles, that is, the parking facility capacity is 300 vehicles, which is a medium-sized parking lot. Parking is mainly used for work and shopping activities. The vehicle

parking form is a combination of oblique and vertical, mainly oblique. From 2pm to 5pm, the number of vehicles parked is about 85 / hour, and it fluctuates on this basis. There are two intersections at either end of the road near the parking lot.

4. Data Acquisition and Prediction

4.1. Data acquisition

The traffic volume at the entrance of Lingyun Building parking lot was investigated by manual counting method. Due to the limited conditions of the investigation, the time for the investigation of the entrance and exit of the parking lot is not much, and the traffic volume of the parking lot entrance and exit of the building is investigated on a random day to reflect the actual traffic volume of the parking lot. Choose 1h as the unit to calculate the change of traffic volume. The following table 1 shows the change of road traffic volume at the entrance and exit of the car park of Lingwan Building during a survey on a certain day.

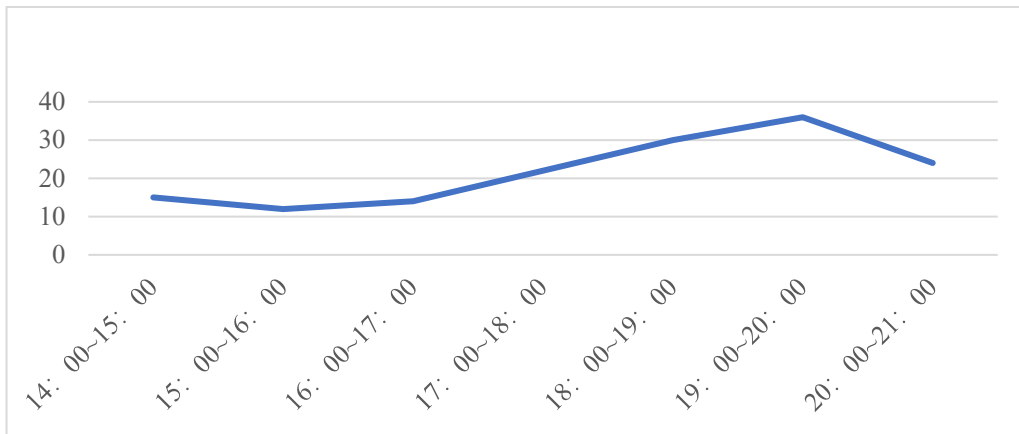


Table 1. Hourly Traffic volume of parking lot entrance and exit roads (except holidays)

According to the line chart above, it can be seen that in the region, the traffic flow before five o'clock in the afternoon does not change much, the traffic volume per hour is maintained at about 14 vehicles/hour, and then as time goes on, the traffic flow gradually increases, plus after five o'clock for the rush hour, the area is the business center, so it reaches the peak at about eight o'clock in the evening, when the traffic flow is the most. At this time, the traffic capacity of the

parking lot entrance and exit of this Building is 40 vehicles per hour.

4.2. Prediction

According to the data obtained from the survey, the moving average method and exponential smoothing method were used to make predictions through Excel and compared with the actual values.

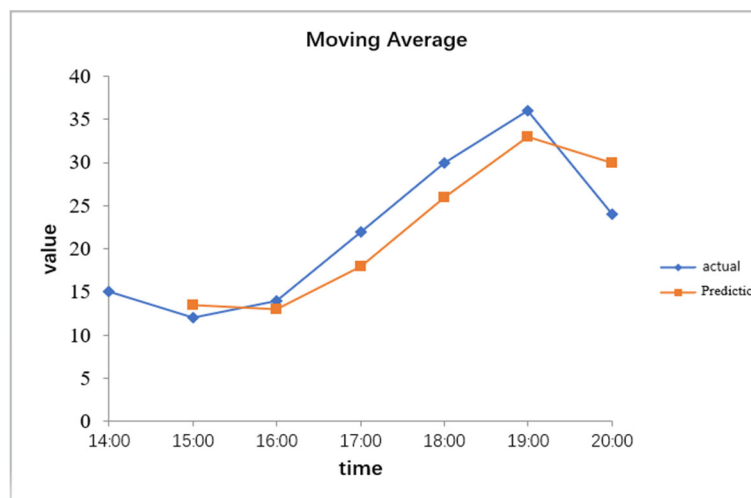


Table 2. Moving Average

As can be seen from the table 2, the time series prediction results obtained by the moving average method have smaller error compared with the actual traffic volume and are more in line with the expected situation, both of which can be achieved at time 19:00. The peak is reached around 00, mainly because this time is just after the rush hour, and people

are more willing to go shopping and other activities in the commercial square after work, so the traffic volume at the entrance and exit of the parking lot is the highest at this time, and then because the time is gradually getting late, it gradually shows a downward trend.

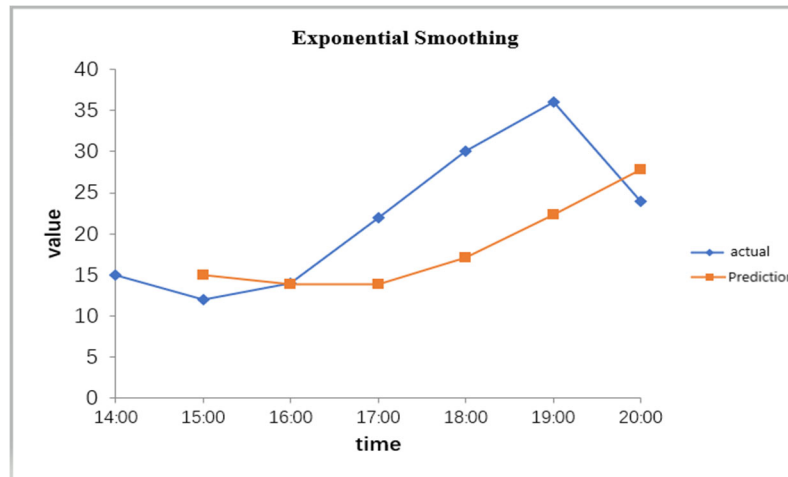


Table 3. Exponential Smoothing

It can be seen from the figure that the prediction results obtained by the exponential smoothing method show that the predicted value has a small error at 16:00 time, and the error in other time periods is larger than the actual value, and is still in an upward trend after 19:00, which is not quite consistent with the actual traffic situation.

As can be seen from the above two figures, compared with the moving average method and the exponential smoothing method, the moving average method predicts the actual traffic volume of the parking lot more closely, with relatively small errors, and is more in line with the actual situation of the entrance and exit sections of the parking lot.

5. Conclusion

The above analysis shows that it is feasible to use the time series smoothing and forecasting method to predict the traffic volume, because the data of the selected area come from the county area with low economic level. In this kind of area, the moving average method is better than the exponential smoothing method to predict the traffic volume of the road at the entrance and exit of the commercial square parking lot, and the error is smaller, which can better reflect the real situation. When traveling, try not to choose to pass this section at 7 PM to avoid road congestion. The forecast can lay some foundations for the expansion of parking lots and roads in the area, and provide direction for the future development of the area.

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