

# Analysis of Traffic Operation State in Xuancheng City

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## Abstract

Accurate analysis of traffic operation status can help traffic management departments to make effective decisions and reduce travel costs. Based on the open source data of Xuancheng downtown provided by open its, this paper uses statistical methods to visually analyze the intersection traffic volume in the central urban area, selects Zhongshan Road, which has the largest traffic volume at the intersection, as the representative to estimate the vehicle speed and average travel time. The results show that: the traffic state of Xuancheng City is the busiest at 7:00 ~ 8:00 and 17:00 ~ 18:00, and the traffic volume at the intersection formed by Zhongshan Road and Zhuangyuan road is the largest; the vehicle speed on Zhongshan road is generally not high, and the vehicle speed and average travel time present inverse function and power function.

## Keywords

Traffic operation state; central city; traffic volume; speed; average travel time; curve estimation.

## 1. Introduction

Accurate analysis of urban traffic flow characteristics, evaluation of traffic operation status and its research and application are the key to the construction of intelligent transportation system. On the one hand, it helps traffic management departments to master the urban traffic operation status, analyze and solve traffic congestion problems, on the other hand, it also helps travelers to understand the urban traffic operation status in time, avoid the congested sections and reduce the travel cost.

The premise of traffic operation state analysis is to obtain traffic data. Xiongmanchu uses the video detection technology of bayou and microwave detection technology to obtain urban road network data, studies the method of obtaining od of urban motor vehicle travel and the method of counting vehicles in transit, and studies the traffic status analysis method based on MFD [2]. In order to improve the matching effect of data map obtained by floating vehicle technology, caketu proposed a map matching algorithm based on the combination of quadratic grid and element weighting, which improved the matching accuracy and matching efficiency. Baihua et al. Put forward a comprehensive evaluation method of traffic operation state of highway network based on point, line and surface level, which can more accurately analyze and improve the traffic operation state. Dai Xuezhen et al. Put forward a method of judging the traffic operation state of urban road based on the coupling of set pair analysis and triangle fuzzy number A-cut set, which more accurately reflects the road operation state than the traditional method.

## 2. Data Description

The data in this paper are from the open its website, which aims to establish a public service platform, provide shared data, analysis software, etc., and create convenience for the majority of scholars to carry out academic research and discuss problems [6]. The traffic data is obtained by the traffic signal installed on the road section and the video detection equipment installed at

the bayonet. As shown in Figure 1, the traffic signal and bayonet point bitmap of Xuancheng central city are shown. The rectangular sign is the signal distribution, the triangle sign is the bayonet point, and the line represents the road within the scope of Shuiyangjiang Avenue in Xuancheng City.

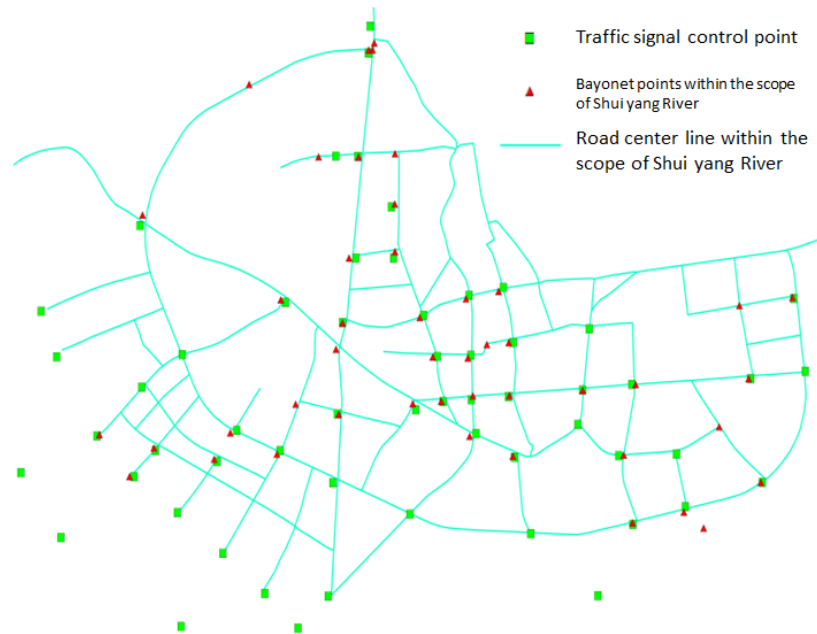


**Figure 1.** Location map of traffic signal and bayonet in central Xuancheng City

In addition to the published traffic signal control data, bayonet data and road network data, it also publishes three types of data, namely road travel time, speed and intersection traffic volume, with a statistical granularity of 5 minutes. Table 1 shows the attribute columns of travel time and speed data of Xuancheng central city section, including the section name, road always node and statistical time.

**Table 1.** Attribute columns of travel time and speed data of Xuancheng downtown section

| Field name | data type | field description     |
|------------|-----------|-----------------------|
| ROADID     | NUMBER    | Road center line      |
| FROMNODE   | NUMBER    | Road start node       |
| TONODE     | NUMBER    | Road termination node |
| BEGINTIME  | DATA      | Statistics start time |
| ENDTIME    | DATA      | Statistics end time   |
| SPEED      | NUMBER    | speed                 |
| TRANELTIME | NUMBER    | Travel time           |

Table 2 shows the attribute column of traffic volume data of intersection in central Xuancheng City, and the data statistics is also 5 minutes, including the information of bayonet ID, lane number and statistical time, among which the bayonet number is consistent with the road network information.

**Table 2.** Attributes of intersection traffic volume in Xuancheng Downtown

| Field name | data type | field description                          |
|------------|-----------|--------------------------------------------|
| SSID       | NUMBER    | Bayonet ID                                 |
| CDBH       | NUMBER    | Lane number                                |
| BEGINTIME  | DATA      | Statistics start time                      |
| ENDTIME    | DATA      | Statistics end time                        |
| FLOW       | NUMBER    | Number of vehicles counted in five minutes |

### 3. Analysis of Traffic Operation in Central Urban Area

The research area of this paper is Xuancheng central city (within the scope of Shuiyangjiang Avenue), with Xuancheng municipal government as the center, surrounded by schools, communities, hospitals and other building facilities. The provincial highway 322 and the Anhui Jiangxi railway line pass through the central urban area and the urban roads cross through the central urban area. As shown in Figure 2, it is Xuancheng downtown area (within the scope of Shuiyangjiang Avenue), and the blue road mark is Shuiyangjiang Avenue.

**Figure 2.** Xuancheng downtown area (within the scope of Shuiyangjiang Avenue)

#### 3.1. Analysis of Intersection Flow in Central Urban Area

Figure 3 shows the change of traffic time series in the central area of Xuancheng City. Starting from zero, the traffic volume is collected every other hour for a total of 24 hours. It can be seen from the figure that the traffic volume decreases slowly from 0:00 to 4:00, and the traffic growth from 4:00 to 8:00 is more and more intense, among which the traffic volume from 7:00 to 8:00 is 106053 veh / h, which is in the early peak period of the central city; the traffic volume from 8:00 to 13:00 begins to decrease, and then increases continuously from 18:00 to 18:00, and the maximum traffic volume from 17:00 to 18:00 is 109328 veh / h in the afternoon, which is in the late peak period of the central city.

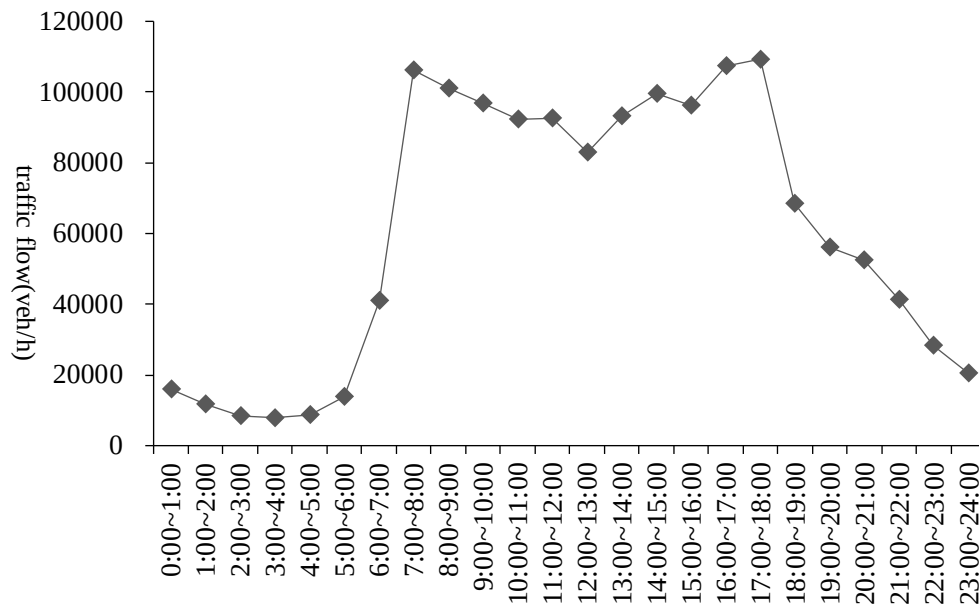


**Figure 3.** Time series of traffic volume in central Xuancheng City

Figure 4 shows the traffic volume of each intersection in the central city of Xuancheng City. The intersections are marked with a combination of English letters and numbers. According to the radar chart, the traffic volume of each intersection in the central urban area is listed from big to small. It can be seen that the traffic volume of intersections represented by hk-104, hk-90 and hk-95 is the largest, which are Zhongshan Road and Zhuangyuan Road (33007 veh / day), Meixi Road and Aofeng Road (32085 veh / day) and diezhang road and Zhuangyuan Road (31243 veh / day).

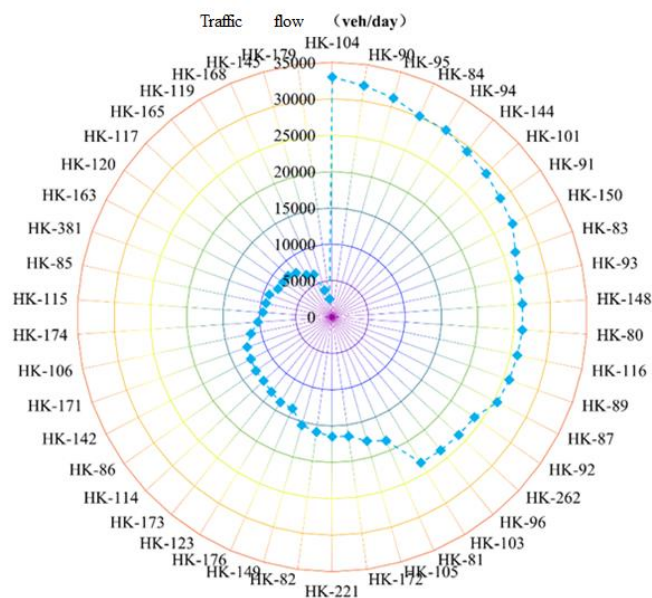


**Figure 4.** Traffic volume at intersection of Xuancheng Downtown

In order to further observe the intersection distribution and traffic volume in the central urban area, a three-dimensional thermal map of the intersection traffic volume in the central urban area is drawn through the map lab [7] of Gaode open platform. As shown in Figure 5, the three-dimensional distribution of intersection traffic volume in Xuancheng downtown area reflects not only the traffic volume of the intersection, but also the geographical location of the

intersection. As can be seen from the figure, the traffic volume around the commercial center and the hospital is relatively large, followed by the traffic volume around the community.



**Figure 5.** Three dimensional distribution of intersection traffic volume in Xuancheng City

### 3.2. Correlation Analysis of Speed and Travel Time on Zhongshan Road

In order to further study the traffic operation of Xuancheng central city road, because the intersection traffic volume formed by Zhongshan Road and Zhuangyuan road is the largest, Zhongshan road is taken as the research object, and vehicle speed and average travel time are selected as indicators to analyze the traffic operation status of Zhongshan Road.

**Table 3.** Description of traffic flow speed on Zhongshan Road

| average | skewness | kurtosis | minimum value | Maximum | 25%     | 50%     | 75%     |
|---------|----------|----------|---------------|---------|---------|---------|---------|
| 21.3861 | .533     | .027     | 5.27          | 58.317  | 16.5450 | 19.9100 | 26.0225 |

Note: the last three columns are percentile

Figure 6 shows the histogram of vehicle speed on Zhongshan Road. The red curve is a normal distribution curve, with skewness of 0.533 greater than 0, it is positive deviation, i.e. right skew, indicating that vehicle speed is generally small, while kurtosis of 0.027 is greater than 0, which is close to normal distribution, indicating less extreme values.

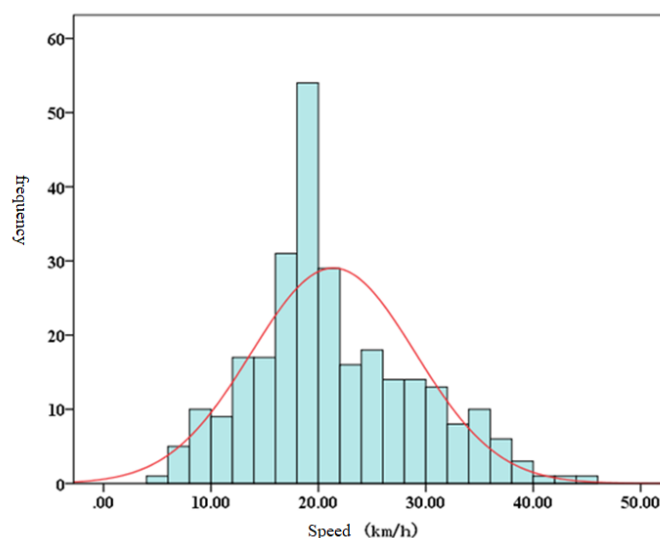


**Figure 6.** histogram of vehicle speed of Zhongshan Road

Figure 7 shows the scatter relationship between vehicle speed and average travel time on Zhongshan Road. It can be seen that with the increase of speed, the average travel time decreases, and there is a certain nonlinear relationship between them. In order to further understand the correlation between vehicle speed and average travel time, Pearson correlation coefficient is used to judge.

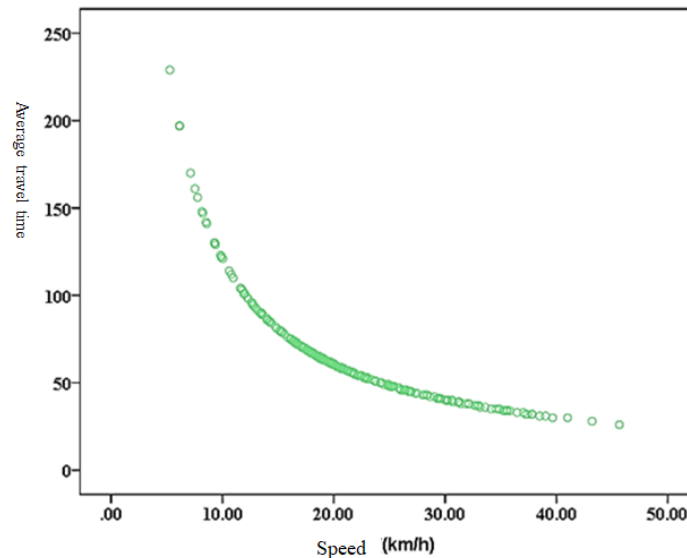


**Figure 7.**

Figure 7. Scatter distribution of vehicle speed and average travel time on Zhongshan Road. Pearson correlation coefficient, It is also called Pearson product moment correlation coefficient, which is used to measure the correlation between two variables, The formula is as follows:

$$r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}} \quad (1)$$

In the formula: X is the speed; y is the average travel time;  $R_{XY}$  is the correlation coefficient. If  $0 < |R_{XY}| < 1$ , the closer  $|R_{XY}|$  is to 1, the higher the correlation between X and Y. The closer  $|R_{XY}|$  is to 0, the lower the correlation between X and y.

Table 4 shows the correlation between vehicle speed and average travel time on Zhongshan Road. It can be seen that Pearson correlation coefficient is 0.851, which indicates that there is a great correlation between vehicle speed and average travel time. The results of bilateral test are less than 0.05, indicating that vehicle speed has significant correlation with average travel time.

**Table 4.** Correlation between vehicle speed and average travel time on Zhongshan Road

|                         |                            | Speed(km/h) | Average travel time (s) |
|-------------------------|----------------------------|-------------|-------------------------|
| Speed(km/h)             | Pearson correlation        | 1           | -.851**                 |
|                         | Significance (double tail) |             | .000                    |
| Average travel time (s) | Pearson correlation        | -.851**     | 1                       |
|                         | Significance (double tail) | .000        |                         |

\*\*. At 0.01 level (double tail), the correlation was significant.

### 3.3. Regression Analysis of Vehicle Speed and Average Travel Time on Zhongshan Road

It is known from figure 7 that there is a nonlinear relationship between vehicle speed and average travel time on Zhongshan Road, so curve estimation is used to establish the specific relationship between speed and average travel time

$$y_i = f(x, \theta) + e_i \quad (2)$$

Where  $f(x, \theta)$  is the expected function, which can be in any form or even has no explicit expression in some cases. Since it is uncertain which model is closer to the sample data, five models, logarithmic, inverse, power, s and growth, are selected to fit the sample data. For example, table 5 shows the five models and regression methods. When SPSS completes the parameter estimation, the optimal model is determined by the output regression equation p value and the determination coefficient R.

**Table 5.** Representation of different models

| Model name            | regression equation              | symbol description                            |
|-----------------------|----------------------------------|-----------------------------------------------|
| Logarithmic           | $y = \beta + \beta_1 \ln(x)$     |                                               |
| Inverse               |                                  |                                               |
| Power                 | $y = \beta(x^{\beta_1})$         | $\beta, \beta_1$ : Parameters to be estimated |
| S curve (S)           | $y = e\beta + \frac{\beta_1}{x}$ | X: Vehicle speed<br>Y: Average travel time    |
| Growth curve (Growth) | $y = e^\beta + \beta_1^x$        |                                               |

Figure 8 shows the effect of five regression models fitting. It can be clearly seen that only inverse function and power function have better fitting effect. In order to further observe the fitting effect of the regression model, it is determined by comparing the determination coefficient R.

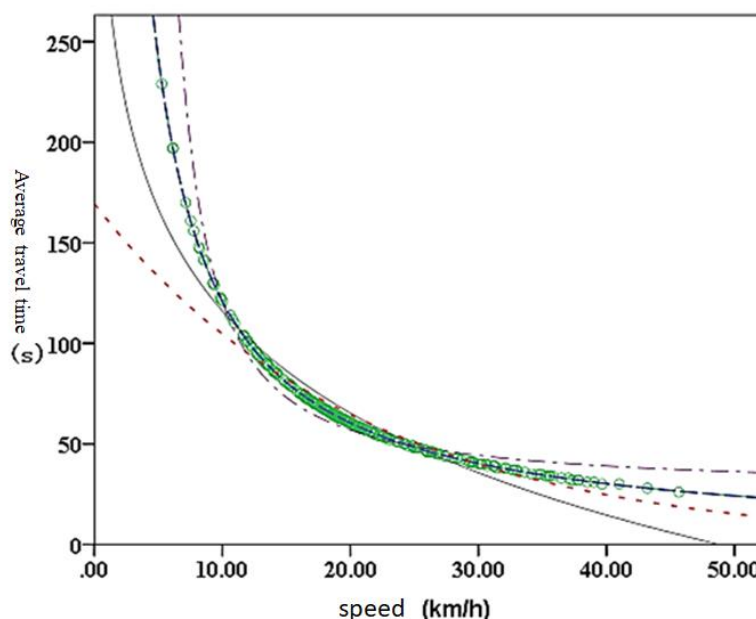


**Figure 8.** Fitting effect of curve regression model

For example, table 6 is a summary of the five regression models. It can be seen that the correlation coefficient R and the determination coefficient r of the inverse function and power function are both 1, indicating that the inverse function and power function can well fit the relationship between the speed of traffic flow and the average travel time on Zhongshan Road.

**Table 6.** Summary of different regression models

| Model name  | R     | R2    | After adjustment of R2 |
|-------------|-------|-------|------------------------|
| Logarithmic | .955  | .912  | .912                   |
| Inverse     | 1.000 | 1.000 | 1.000                  |
| Power       | 1.000 | 1.000 | 1.000                  |
| S           | .955  | .912  | .911                   |
| Growth      | .966  | .934  | .934                   |

Table 7 shows the regression coefficients and P values of inverse function and power function output by SPSS. It can be seen that the P values of the two models are less than 0.05, indicating that the fitting effect of the regression model is very good, while table 8 is the final representation of the inverse function and power function.

**Table 7.** Regression coefficients of inverse function and power function

|                  |                 | Non standardized coefficient |                | Standardization coefficient | t        | Significance |
|------------------|-----------------|------------------------------|----------------|-----------------------------|----------|--------------|
|                  |                 | B                            | Standard error | Beta                        |          |              |
| Inverse function | 1/Speed(km/h)   | 1209.438                     | .716           | 1.000                       | 1689.772 | .000         |
|                  | (constant)      | -.003                        | .042           |                             | -.073    | .942         |
| power function   | ln(Speed(km/h)) | -1.0003                      | .001           | -1.000                      | 1166.715 | .000         |
|                  | (constant)      | 1210.736                     | 3.134          |                             | 386.275  | .000         |

**Table 8.** Inverse function and power function regression model

| Model Name       | expression                       |
|------------------|----------------------------------|
| Inverse function | $y = -0.003 + 1209.438/x$        |
| power function   | $y = 1210.736 \cdot x^{-1.0003}$ |

#### 4. Conclusion

Based on the open its website, this paper obtains the open source data of the central urban area of Xuancheng, Anhui Province (within the scope of Shuiyangjiang Avenue), makes a visual analysis of the traffic volume in the central city area, estimates the vehicle speed and average travel time on Zhongshan Road by curve, and draws the following conclusions:

(1) The traffic volume of Xuancheng downtown is the largest at 7:00-8:00 a.m. and 17:00-18:00 p.m., and the traffic is relatively busy. Among all the intersections in the central city, the traffic volume at the intersection formed by Zhongshan Road and Zhuangyuan Road (33007 veh / day) is the largest, followed by Meixi Road and Aofeng Road (32085 veh / day) and diezhang road and Zhuangyuan Road (31243 veh / day).

(2) The average speed of vehicles on Zhongshan road is 21.3861 km / h, and the speed of 75% percentile is 26.0225 km / h, which indicates that the speed of vehicles on Zhongshan road is not large, and the average travel time decreases with the increase of vehicle speed. Through curve estimation, the relationship between vehicle speed and average travel time on Zhongshan road can be expressed by inverse function and power function regression model.

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