Analysis of The Characteristics of Pedestrian Crossing Behavior Under the Influence of "Give Way to Pedestrians" Policy

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Abstract: In China's road transport system, pedestrians are a vulnerable group and are often injured in traffic accidents. In order to effectively reduce road traffic accidents, Xi'an City has advocated the implementation of the "vehicle transfer" policy since 2017. Based on the intermittent observation of the traffic lights on the streets of Xi'an, this paper captures more than 1500 sets of data, and compares the changes in the proportion of "traffic people" in recent years. The implementation of the "vehicle people" policy is weak, weak, and strong. In the strong three cases, the characteristic factors such as pedestrian crossing mode, waiting time, waiting ratio, and crossing speed are analyzed to analyze the influence of the "vehicle letting people" policy on the behavior of pedestrians crossing the street. The results show that the policy enforcement strength is directly proportional to the yield rate of pedestrians crossing the street, and is inversely proportional to the waiting time, the waiting ratio and the speed of crossing the street. This study can provide a theoretical basis for the implementation of the city's "car letting people" policy, which is helpful to reduce the occurrence of urban traffic accidents.

Keywords: "Give way to pedestrians" policy, traffic management, pedestrian crossing, pedestrian characteristics, waiting time

1 INTRODUCTION

With the increase in the number of motor vehicles in our country and the increasing frequency of use, the problem of urban traffic congestion has become increasingly prominent, the traffic conditions are complex, the conflict points between pedestrians and vehicles have increased, and traffic accidents have occurred frequently. Chinese law clearly stipulates that motor vehicles should slow down and stop and yield to pedestrians when passing through pedestrian crossings. But in fact, crosswalks are often the high-incidence areas of traffic accidents, and the risk of pedestrians being hit by motor vehicles is also extremely high. By analyzing road traffic accidents, it can be found that most accidents are caused by vehicles rushing to speed through intersections. In order to protect the safety of life and property of travelers, the policy of "passing people from vehicles" has been implemented in all parts of the country, and the rectification and punishment have been increased. All changed accordingly. By collecting traffic signal data in Xi'an, the implementation of the "vehicle-to-vehicle" policy in Xi'an is analyzed from the four factors of pedestrian yield rate, waiting time, waiting ratio, and traffic speed. The study found that the stronger the implementation of the policy of "passing people by car", the higher the rate of pedestrians being yielded to crossing the street, the shorter the waiting time, the smaller the

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waiting ratio, and the faster the crossing speed. Exploring the interaction characteristics between pedestrians and vehicles under different policy implementation strengths will help decision makers to better formulate relevant policies, improve road traffic capacity, ensure pedestrian safety, reduce the incidence of traffic accidents, and promote the harmonious coexistence of people and vehicles.

2 LITERATURE REVIEW

Domestic and foreign researchers are relatively mature in the research on which way pedestrians choose to cross the street in various situations, the behavior characteristics and influencing factors of pedestrian crossing, and pedestrian crossing psychology, and mature data models have been established. In terms of the influence of external factors such as traffic facilities on the behavior characteristics of pedestrians crossing the street, Wang Peng[1] and others studied the influence of pedestrian crossing facilities on the psychological characteristics and behavior characteristics of pedestrians crossing the street. Wu Lixin[2] conducted a traffic survey in front of colleges and universities to analyze pedestrians Crossing delays and concluded that the model of pedestrian crossing delays at the entrances and exits of colleges and universities without signal lights is the same as that of urban roads. Mohammed M Hamed[3] analyzed the gender of pedestrians, the frequency of crossing the road, the number of children in the family, the frequency of crossing the street, and the number of children involved. based on the number of traffic accidents, so as to analyze the pedestrian crossing behavior. Cao Ge[4] constructed two types of models for the impact of on-street parking on the traffic capacity of the road section based on the effective lane width reduction and acceptable clearance theory, and studied the impact of on-street parking on dynamic traffic and traffic. The impact of road section capacity and pedestrian crossing safety. In terms of pedestrian crossing behavior decision-making, Yagil[5] found in a study on the factors related to pedestrian crossing at signal control points that women are more sensitive to accidents than men when crossing the street, and they are easily affected by factors other than traffic flow and environmental factors. Peng Chen[6] modeled the interaction between vehicles and pedestrians from the perspective of micro-dynamics, and carried out more detailed analysis of individual behaviors. Zhang Xu[7] collected on-the-spot data of the elderly crossing the street at three signal-controlled intersections in Lanzhou City through the photographic method and manual survey method, and established a dual-factor model of the influence of age and green flashing signal on the crossing time. Effective optimization. Zhao Xuan[8] conducted a survey and analysis on how pedestrians choose street facilities and drivers' attitudes towards various pedestrian crossing methods through questionnaires.

In summary, most of the existing studies focus on the impact of external transportation facilities on pedestrian crossing behavior, and there is a lack of research on the characteristics of pedestrian crossing behavior under the influence of policies. This paper studies the changes of pedestrian crossing characteristics in Xi'an under different policy implementation strengths. The conclusions obtained will help policy executors to better understand the interaction between pedestrians and vehicles, so as to formulate effective policies to reduce pedestrians and vehicles. conflict and improve pedestrian safety.

3 PARAMETER SELECTION UNDER DIFFERENT "GIVE WAY TO PEDESTRIANS" POLICY IMPLEMENTATION

The main parameters studied in this paper include pedestrian yielding rate, pedestrian waiting time, pedestrian waiting ratio, and pedestrian speed. The specific definitions are as follows.

Pedestrian yielded rate (%) is the ratio between the total number of pedestrians yielded and the total number of pedestrians when they cross the street.

Pedestrian waiting time (s) is the time duration from the moment a pedestrian arrives at the curb to the moment a pedestrian starts to show movement to cross the street.

Pedestrian Waiting Ratio (%) is the ratio of the total number of pedestrians waiting at the curb to the total number of pedestrians.

Pedestrian passing speed (km/h) is the average pedestrian crossing speed when there is an effective interaction between pedestrians and vehicles.

4 ANALYSIS OF PEDESTRIAN CROSSING CHARACTERISTICS UNDER DIFFERENT "YIELD TO PEDESTRIANS" POLICY ENFORCEMENT LEVELS

In this experiment, SPSS statistical analysis software was used to conduct an ANOVA to investigate whether there is a significant effect on the mean value of the distribution of pedestrian crossing characteristics under a certain policy enforcement level at the 0.05 level of significance. When $\rho < 0.05$, the original hypothesis H_0 is rejected and the parameter is considered to be significantly different.

5 RESULTS OF THE ANALYSIS OF PEDESTRIAN CROSSING CHARACTERISTICS UNDER DIFFERENT "GIVE WAY" POLICIES

5.1 Pedestrian yielding rate

Counting the percentages of pedestrians who are given way under different implementation strengths of the "vehicle-asking" policy, it is found that: when the "vehicle-assignment" policy implementation is no (2017), the percentage of pedestrians who are yielded is 6.42%. When the implementation of the "vehicle-asking" policy was strong (2018), the percentage of pedestrians who were yielded was 25.56%. when the implementation of the "vehicle-asking" policy became weaker (2019), the percentage of pedestrians who were yielded was 22.83%. Intuitively, there is a big difference in the rate of pedestrians being given up under different "vehicles" policies. It can be seen that there is a strong correlation between the implementation of the policy and the rate of pedestrians being given up.

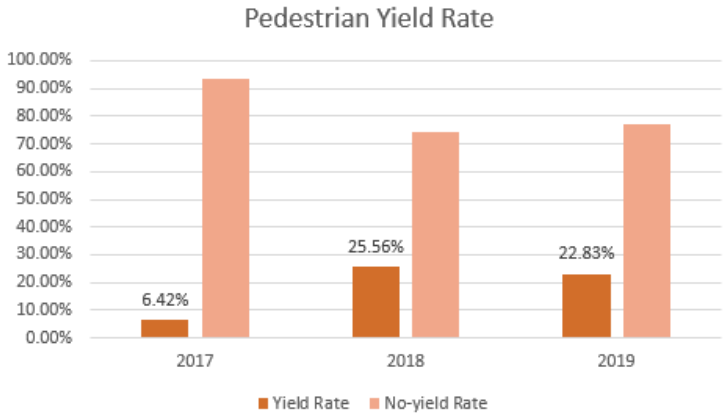

Figure 1. Pedestrian yielding rate diagram

The chi-square test showed that there was a statistically significant difference in the yielding rate of pedestrians under different "give way to pedestrians" policies ($\chi^2 = 191.85, \rho < 0.001$). Post hoc two-by-two tests showed that there was a statistically significant difference in the yielded rate of pedestrians when policy enforcement was none versus strong ($\chi^2(2) = 180.35, \rho < 0.0125$). there was also a significant difference in the yielded rate of pedestrians when policy enforcement was none versus weak ($\chi^2 = 78.96, \rho < 0.0125$). and there was a statistically significant difference in the yielded rate of pedestrians when policy enforcement was strong versus There is also a significant difference between the yielded rate of pedestrians when policy enforcement is strong and weak ($\chi^2 = 93.45, \rho < 0.0125$).

5.2 Pedestrian waiting time

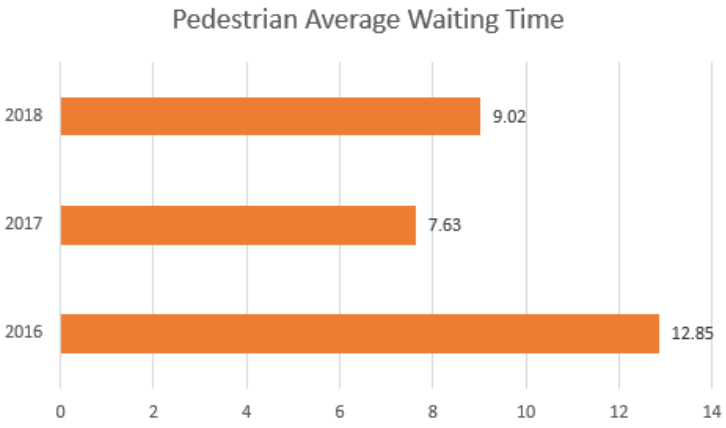

Figure 2. Pedestrian average waiting time diagram

When the implementation of the "passenger" policy is no, the average waiting time of pedestrians is 12.85s. when the implementation of the "passenger" policy is strong, the average

waiting time of pedestrians is 7.63s. When the policy enforcement is weak, the average waiting time of pedestrians is 9.02s. it can be seen that with the enhancement of policy enforcement, the waiting time of pedestrians is significantly shortened, which may be due to the policy enforcement has given pedestrians greater confidence in crossing the street. Take on higher risks.

The results of the one-way ANOVA show that there are statistically significant differences in the waiting time of pedestrians under different implementations of the "car letting people" policy. The results of the post-event two-by-two test found that there was a significant difference in the waiting time of pedestrians when the "car-to-man" policy was not implemented strongly and the "car-to-man" policy was strongly implemented ($\rho < 0.001$). There is a significant difference ($\rho < 0.001$) in the waiting time of pedestrians when the implementation of the "vehicle person" policy is weak. the waiting time of pedestrians exists when the implementation of the "vehicle person" policy is strong and the "vehicle person" policy is weak Significantly different ($\rho < 0.001$).

5.3 Pedestrian waiting ratio

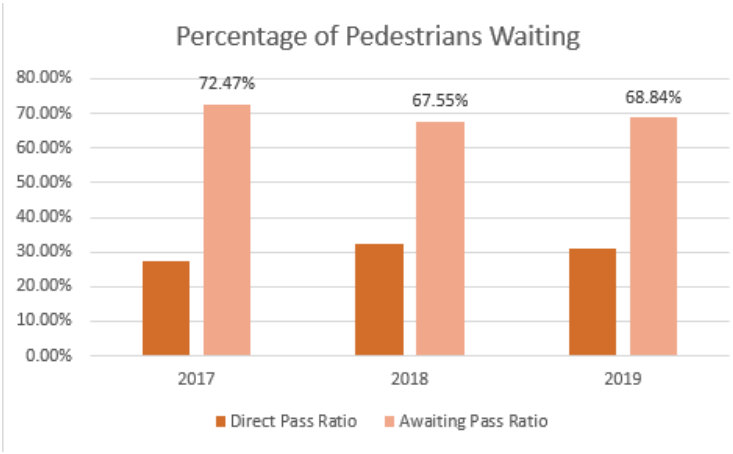

Figure 3. Pedestrian waiting ratio and Pedestrian speed diagram

Statistical results show that when the policy enforcement is no, the proportion of pedestrians waiting to cross the street is 72.47%. when the policy implementation is strong, the pedestrian waiting to cross the street is 67.55%. when the policy implementation is weak, the pedestrians waiting to cross the street. The ratio is 68.84%. It can be seen that the proportion of pedestrians waiting to cross the street has a certain correlation with the implementation of the policy. But it should be pointed out that with the gradual weakening of the policy implementation, the proportion of pedestrians waiting to cross the street has still declined, which may be dangerous. As can be seen from Figure 3, when the policy enforcement is gradually weakened, the percentage of pedestrians who are given way decreases. There is a certain conflict between these two situations, which may increase the danger of pedestrians crossing the street.

The results of the chi-square test showed that there was a statistically significant difference in the percentage of pedestrians waiting to cross the street under the different implementation of the "car letting people" policy ($\chi^2(2) = 35.46, \rho < 0.001$). The post-hoc test results show that

there is a significant difference between the percentage of pedestrians waiting to cross the street when the "car-to-man" policy is not implemented strongly and the "car-to-man" policy is strongly implemented ($\chi^2(1) = 25.33, \rho < 0.001$). there is a significant difference in the percentage of pedestrians waiting to cross the street when the implementation of the "vehicle person" policy is not strong and when the "vehicle person" policy is weakly implemented ($\chi^2(1) = 15.2, \rho < 0.001$). There is also a significant difference in the percentage of pedestrians waiting to cross the street when the implementation of the "let people" policy is strong and when the "car to let people" policy is weakly implemented ($\chi^2(1) = 26.85, \rho < 0.001$).

5.4 Pedestrian speed

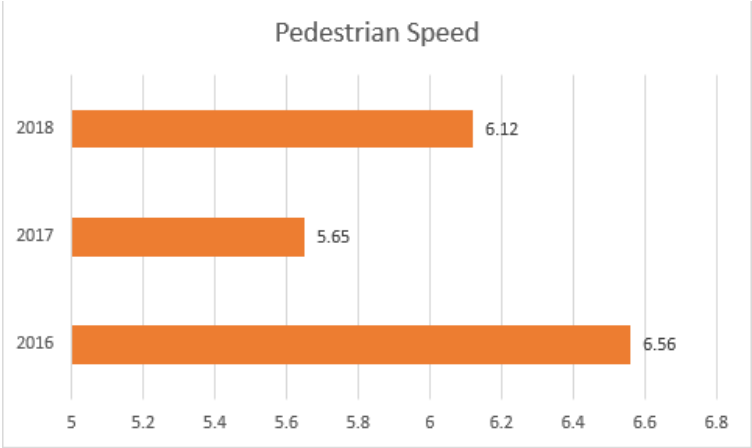

Figure 4. Pedestrian waiting ratio and Pedestrian speed diagram

Statistical analysis results show that when the implementation of the "vehicle-in-person" policy is weak, the pedestrian's crossing speed is about 6.56km/h. when the "vehicle-in-person" policy is strongly implemented, the pedestrian's crossing speed is about 5.65km/h. h. When the implementation of the policy of "car letting people" is weak, the pedestrian crossing speed is about 6.12km/h. From a psychological point of view, when pedestrians perceive danger, their walking speed increases. When the policy enforcement is not stronger than the policy implementation, the pedestrian crossing speed increases by about 13.8%. when the policy implementation is stronger than the policy implementation, the pedestrian crossing speed drops by about 8.3%.

Intuitively through statistical data, there are certain differences in pedestrian crossing speeds under different policy implementation efforts. The results of one-way analysis of variance show that there are statistically significant differences in the speed of pedestrians crossing the street under different policy implementation efforts. The post-hoc test results show that there is a significant difference in the pedestrian speed when the policy implementation is weak and the policy implementation is strong ($\rho < 0.001$). when the policy implementation is weak and the policy implementation is weak, the pedestrian speed is significantly different ($\rho < 0.001$). when the policy enforcement is strong and the policy enforcement is weak, there is a significant difference in pedestrian speed ($\rho < 0.001$).

6 CONCLUSIONS AND RECOMMENDATIONS

By collecting traffic signal data at intersections in Xi'an, and analyzing the implementation of Xi'an's "vehicle-to-vehicle" policy from four factors: pedestrian yield rate, waiting time, waiting ratio, and traffic speed, the following conclusions are drawn: First of all, when the policy implementation is weak, the proportion of pedestrians waiting to cross the street is 4.92% higher than that when the policy implementation is strong, and 3.63% higher than that when the policy implementation is weak. In the absence of policy enforcement, pedestrians lack confidence when crossing the street, and their psychological ability to take risks is relatively low. They are worried about conflict with vehicles, so more pedestrians choose to wait. Second, the average waiting time of pedestrians varies widely in different policy implementation stages. When the policy implementation is strong, the waiting time is reduced by about 40.6% compared with the non-periodic policy implementation, and the waiting time is reduced by about 18.22% when the policy implementation is strong than when the policy implementation is weak. Finally, there is an inverse relationship between the strength of policy enforcement and the speed of pedestrians crossing the street. Pedestrians believe that when the enforcement of the policy is strong, vehicles will choose to give way under the pressure of punishment from the traffic control department or the deduction of points from the driver's license, so it is safer to cross the street at the intersection. Discussing the interaction characteristics between pedestrians and vehicles under the implementation of the policy of "car letting people" will help government departments to formulate policies and improve road traffic capacity. This paper only discusses the implementation of different policies based on the four factors of pedestrian yield rate, waiting time, waiting ratio, and traffic speed. Further research is necessary.

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