

Analysis of Urban Non-motorized Traffic

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Abstract

Non-motorized traffic is a kind of traffic mode dominated by pedestrian traffic and bicycle traffic. It is also a kind of "human-centered" travel mode that belongs to green traffic. Non-motorized traffic mode has special traffic characteristics. The optimization of road traffic according to these traffic characteristics and the protection of pedestrian traffic and bicycle traffic through various measures provide a theoretical basis for solving urban slow traffic and various traffic problems, which is of great significance to promote and improve urban Non-motorized traffic. This paper mainly expounds the characteristics of urban Non-motorized traffic, obtains qualitative conclusions through studying the urban Non-motorized traffic problems, and puts forward improvement measures for slow traffic in combination with its traffic characteristics.

Keywords

Non-motorized traffic; Pedestrian traffic characteristics; Bicycle traffic characteristics.

1. Introduction

With the continuous development of China's economy and society, urban life is developing in a fast and efficient direction, and the improvement of the level of urban motorization has become an inevitable trend for the improvement of people's living standards. However, the improvement of the level of urban motorization has also brought some unavoidable problems to the residents. Although the development of automobiles has brought a lot of convenience to residents, it has brought about traffic congestion, environmental pollution and other problems, which have greatly affected residents' lives and the construction of cities. In order to avoid the further deterioration of urban traffic problems, the government, urban planning experts and citizens realized the importance of Non-motorized traffic and began to analyze and reflect on the current traffic development model, so as to gradually promote the development of Non-motorized traffic.

The Non-motorized traffic transportation system occupies a very important position in the urban transportation system, and the travel modes of walking and bicycle travel also account for a large proportion of all travel modes. The travel mode of Non-motorized traffic is greener and safer than traditional motor vehicle travel. Therefore, in order to promote the construction of the urban transport system and achieve the sustainable development of urban transport, it is necessary to guide the development of urban transport in the direction of green transport.

To develop Non-motorized traffic, measures need to be taken from multiple levels. Macroscopically, it should be people-oriented, put Non-motorized traffic and motor vehicle traffic on the same position, supplement with motor vehicle traffic and public transport travel modes, and protect the right of pedestrians and non-motor vehicles; on the medium level, strengthen the connection between Non-motorized traffic and public transport, to improve the Non-motorized traffic facilities and Non-motorized traffic travel environment; microscopically design and optimize the Non-motorized traffic system. The development of Non-motorized traffic is also inseparable from the efforts of the government and Non-motorized traffic participants. Urban residents should raise their awareness and

safety awareness of Non-motorized traffic. The government and relevant departments should improve road traffic regulations and strengthen the management.

Based on the relevant theories of Non-motorized traffic, this article expounds the characteristics of Non-motorized traffic from the aspects of pedestrian traffic and bicycle traffic, and conducts a study on Non-motorized traffic strategies in combination with the current situation of Non-motorized traffic.

2. Research status at home and abroad

2.1 Research status abroad

As people and scholars continue to improve their understanding of Non-motorized traffic, what follows is an increase in their understanding of urban Non-motorized traffic systems. In particular, the construction of Non-motorized traffic in many fast-developing countries and cities abroad has developed very rapidly. Many studies have also been carried out on Non-motorized traffic facilities and related improvement measures have been proposed.

Bradessa research analyzes a large number of urban transportation development modes and travel modes, among which Non-motorized traffic is the highest level of green traffic [1]. According to Wright's research and analysis, the road space occupied by non-motor vehicles is the largest, followed by public transportation, while pedestrian traffic takes the least space [2]. According to Amarfm's research, 73% of pedestrians are reluctant to use road facilities to cross the road even if they pass through a higher-risk road. Setting a pedestrian crossing safety island in the middle of the road can avoid the conflict between pedestrians and vehicles to a certain extent, but pedestrians crossing the street are more dangerous [3]. Gail's research shows that most pedestrians have already built underground tunnels and can cross the street from the ground for the second time, and there is also the risk of crossing the road on the street [4]. Studies in Canada have shown that if people are considered first and the transportation facilities and walking environment required for walking are improved, more than half of pedestrians will increase their willingness to increase walking distance [5].

In the early years of various projects on the study of pedestrian traffic characteristics abroad, they were roughly the following aspects: pedestrian speed, pedestrian traffic characteristics, space and collision required for pedestrian walking, pedestrian queuing characteristics, pedestrian start time and delay, based on Different travel behaviors and the relationship between speed-density related theories and speed-density relationships of pedestrian traffic flow under different travel purposes are based on the travel behavior and pedestrian psychology of pedestrians in different transportation facilities.

In recent years, most European and American countries have focused on bicycle traffic research mainly on bicycle traffic safety and environmental protection. Few studies on bicycle traffic flow theory include the following aspects: bicycle start-up time and delay , Bicycle speed and other characteristics of bicycle riding, bicycle service level and evaluation, traffic capacity of non-motorized lanes, traffic flow characteristics of bicycle traffic, design and implementation of bicycle lanes, construction of bicycle traffic, and the correlation of bicycle lane Planning design and methods, planning design and organization management of bicycle transportation system, etc.

2.2 Research state in China.

In China, only a few places, such as Hong Kong and Guangzhou, initially focused on the construction of the slow-moving traffic system. Most other cities have little or no attention to the slow-moving traffic system in their transportation development strategies. At the same time, China's research on the slow-moving traffic system is only preliminary research, and the relevant theoretical knowledge is quite limited. Therefore, the traffic safety problems brought about by the rapid development of urban transportation have attracted the attention of many scholars.

In China, most of the studies on the characteristics of pedestrians are related to the characteristics of pedestrians in road facilities. Yang Lili combined with the characteristics of passenger flow in the passenger transportation hub, using the simulation software Vissim5.1 to simulate the pedestrian

behavior in the passenger transportation hub to simulate [6]. Shi Jiangang conducted a related study on the traffic characteristics of pedestrians around large stadiums during the Olympic Games [7]. Ye Jianhong studied and established the correlation model between flow, speed and density in various traffic environments [8]. Peng Liying studied the correlation of the three elements of traffic flow at signalized intersections [9]. Li Kaibing analyzes the psychology of pedestrians crossing the street illegally, and proposes improvement measures based on these psychology to ensure the safety of pedestrians crossing the street [10]. Zhang Guobin studied the characteristics of pedestrians' space requirements [11].

In recent years, most domestic researches on bicycle traffic have focused on the following three aspects, namely bicycle traffic flow, the connection of other transportation methods with bicycles, and the organization and management of bicycles. On the basis of motor vehicle traffic, combined with the behavior characteristics of bicycle traffic, the relevant parameters of bicycle traffic are studied to establish a correlation model of the three elements of bicycle traffic flow [12].

3. Overview of Slow Traffic

3.1 Slow traffic concept

The so-called slow traffic is a way to guide residents to reduce their dependence on private cars, publicize and guide the development of pedestrian traffic and bicycles, and vigorously develop public transportation, pedestrian traffic and non-motorized vehicle transportation. The connection between "pedestrian traffic and public transportation" and "bicycle traffic and public transportation" will guide urban traffic in a reasonable and orderly direction, and realize the "last mile" green and environmentally friendly transportation method for urban residents. Slow traffic has the following concepts:

(1) Urban development model centered on pedestrians and bicycles

The so-called slow traffic is to promote the development of people-centered and bicycle-centered development methods. Urban planning and design must be people-centered and pedestrian- and bicycle-oriented to create the most suitable transportation development model for pedestrians and cyclists.

(2) Quiet traffic

Tranquility of traffic means that by controlling the speed and flow of vehicles, the adverse impact of motor vehicles on residents is reduced. The method of traffic tranquilization is generally the following two methods: flow control method and speed control method.

(3) Green transportation system

Green transportation is a new concept of sustainable development to solve environmental pollution problems. It advocates the development of urban transportation in a "green" direction, reduces traffic congestion, pollutant emissions and environmental pollution, develops resources appropriately, and reduces waste of resources.

3.2 Characteristics of slow traffic

The characteristics of slow traffic mainly include the following:

(1) Flexibility and freedom. Compared with other modes of travel, slow traffic has greater flexibility and freedom.

(2) High accessibility. Slow traffic is less affected by other modes of transportation on the road, and has fewer requirements on road conditions, and is basically not restricted by road barriers.

(3) High capacity. Compared with cars, slow traffic only occupies a small amount of road space, reduces the consumption of road resources, and does not have problems such as high emissions and difficult parking, reducing environmental pollution and space resource occupation.

(4) Restrictive. Slow traffic requires a certain amount of physical exertion, so the moving distance is relatively limited. If it exceeds a certain distance, the competitiveness with other modes of transportation will be greatly reduced.

Although slow traffic has many advantages, in today's China, the development of slow traffic is still very slow, mainly for the following reasons: urban transportation construction is centered on motor vehicles; urban construction lacks overall consideration; attention to slow transportation lack of.

4. Slow traffic characteristics

4.1 Pedestrian traffic characteristics

4.1.1 Basic characteristics of pedestrians

(1) Characteristics of pedestrian space demand

The space required by pedestrians when walking is the space requirement of pedestrians. Pedestrian activity space includes walking motion area, walking perception area, reaction area and visual area [11]. The pedestrian activity space is shown in Figure 1 below.

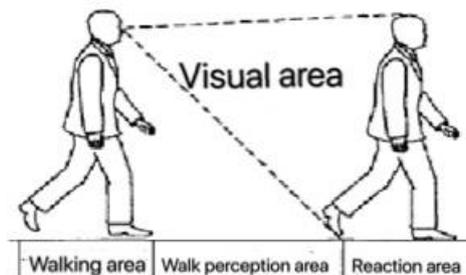


Figure 1. Pedestrian activity space

Pedestrian awareness area refers to a safe distance between pedestrians when they walk comfortably, to prevent pedestrians and other pedestrians from friction or collision when walking on the road, and to reduce pedestrians' psychological and physical discomfort due to collision or friction feel. The comfort safety distance is not a fixed value, but changes with the environment of pedestrians. Generally, in places where pedestrians are dense, the comfort safety distance required for pedestrians to walk is relatively small. Under normal circumstances, pedestrians need a comfortable and safe distance of 1.8m.

(2) Psychological characteristics of pedestrians

The psychological characteristics of pedestrians when walking are generally considered from the following two aspects:

① Pedestrian decision psychology

From a psychological point of view, all the behaviors of the pedestrians occur during the decision-making process and interact with the traffic environment. In this process, the first information obtained by pedestrians includes direct information and indirect information obtained in the external traffic environment. Next, the walker will combine the knowledge and information in the walker's memory to make behavior choices, that is, the reaction selection process. The last process, the execution process of pedestrian behavior, executes the selected behavior after reacting to the selection process. The behavior of general pedestrians differs in their behavior choices due to their different psychological expectations.

② Psychology of pedestrians crossing the street illegally

In the daily road traffic environment, pedestrians cross the street in violation of regulations. Pedestrian violation generally refers to the act of forcibly crossing the road and crossing the street regardless of road traffic regulations. Pedestrians often make different decisions when judging intersections. Many intersections in cities in China are not equipped with right-turn signal lights, so

pedestrians sometimes conflict with right-turn motor vehicles when crossing the street. Therefore, pedestrians who follow the control of signal lights often slowly observe whether there are motor vehicles in the intersection when they reach the intersection. There will be a collision, and under the premise of ensuring that no danger will occur, it will quickly pass through the intersection.

4.1.2 Pedestrian traffic characteristics

The three elements of pedestrian traffic refer to pedestrian traffic volume, pedestrian density, and pedestrian speed.

Pedestrian traffic refers to the number of pedestrians passing a certain point or a certain section of the road in unit time, the unit is person / hour. Pedestrian traffic is generally related to the effective width of the road, that is, the width of pedestrians available on the road section, excluding the space occupied by various other facilities [13]. Most cities have higher pedestrian traffic during morning and evening peaks.

Pedestrian speed refers to, within a certain range, the average value of all pedestrian paces at a time, the unit is meter / minute or meter / second. Pedestrian speed can be divided into time average speed and space average speed [13]. Pedestrian speeds in different time periods are not much different, and the peak pedestrian speed will be slightly higher than the night peak pedestrian speed.

Pedestrian density refers to the number of pedestrians walking or waiting on the road per unit area. The unit is person / square meter. Pedestrian density is generally related to the effective area of the road, that is, the area that pedestrians can use on the road section, excluding the area occupied by various other facilities [13]. In most cities, morning and evening peak hours and peak hours vary greatly in traffic volume. The pedestrian density in the morning and evening peaks is higher, which is much greater than the passenger flow at noon.

4.2 Bicycle traffic characteristics

4.2.1 basic features of bicycle

The basic characteristics of bicycles (including electric bicycles) mainly include size and mass, territorial space and lateral clearance, age characteristics of cyclists, characteristics of arrival time period, speed characteristics and other aspects.

(1) size and quality

Different bicycle quality is different, the size is generally different, mainly in the long, wide, wheel radius and other aspects. The common size of the bicycle is generally about 1.7 meters long, about 0.6 meters wide, the mass is generally 10-20 kilograms.

(2) territorial space and lateral clearance

The territorial space refers to the space that belongs to one's own. If an external object enters this area, it will have a repulsion reaction. In 1994, Navin first proposed the theory and structure diagram of the territorial space surrounding the bicycle, as shown in figure 2 below.

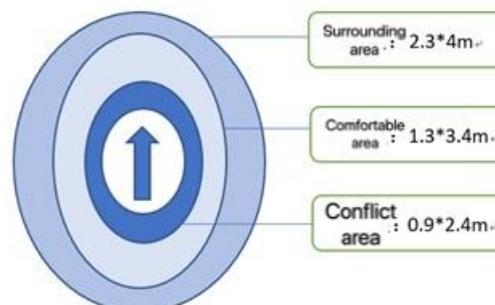


Figure 2. Ownership space around the bicycle

The white part in the center of the picture is a bicycle, and the dark blue area is a conflict zone. When other bikes enter the conflict zone, the bike slows down to avoid it. The light blue area is the surrounding area. If there is another bike in this area, the bike will not react at all. The area between

the circle and the conflict zone is the comfort zone, and the bike will not slow down significantly. In this structure diagram, the territorial space is the dark blue part of the diagram. The size of the possession space is related to the speed of cycling. The faster the cycling speed is, the larger the scope of the possession space is.

(3) age characteristics of cyclists

The main cycling groups in the city are young and middle-aged people, and the main purpose of travel is to commute. To be on the safe side, cyclists for the elderly and children are cautious and in small Numbers.

(4) bicycle speed characteristics

Bicycle is a low-speed means of transportation. The speed of bicycle is mainly affected by age, gender, road facilities, traffic conditions, weather and many other factors, among which age and gender are the main factors.

4.2.2 Bicycle traffic flow characteristics

Bike traffic flow characteristics mainly include bike traffic volume, speed and density:

Bicycle traffic refers to the number of bicycles per hour that pass through a certain point or section of a road in a unit of time. The distribution law of urban bicycle traffic volume is similar to that of pedestrians.

Bicycle traffic speed refers to the average of all bicycle speeds at a given time in meters per minute or meters per second. Similar to the distribution law of pedestrian traffic flow speed, bicycle speed in each time period has little difference.

Bike traffic density refers to the number of bicycles that travel or stop on the road per unit area. The units are people per square meter. Similar to the pedestrian traffic flow, the bicycle density in morning and evening peak is obviously higher than that in afternoon peak.

5. Study on countermeasures of slow traffic

5.1 Current situation of slow traffic

There are still many deficiencies in the slow traffic mode in most cities today, including the following problems:

(1) traffic order at intersections is chaotic and traffic organization flow lines are not smooth

The mixing of non-motor vehicle and pedestrian is serious, especially the non-motor vehicle. Under mixed traffic conditions, motor vehicles and non-motor vehicles run in a mixed way, causing disorder and cutting off the road. Cars speeding; Non-motor vehicles and pedestrians do not abide by the road traffic laws and regulations, are not controlled by the signal lights, and cross the road strongly; Motor vehicles parked randomly; Pedestrian violations emerge in endlessly and other problems will lead to traffic congestion to a certain extent, and even lead to traffic accidents.

(2) the road structure is not scientific enough and the travel mode is not reasonable enough

Nowadays, cities lack reasonable ideas to guide the development of road traffic. The design of urban roads puts motor vehicles in the first place, which further leads to the rapid growth of the number of motor vehicles, the neglect of public transport and slow travel, and the lack of scientific road planning.

(3) unreasonable channelization of roads and unscientific timing of signals

To solve traffic congestion, not only from to improve road traffic facilities, and also means to use the traffic management and control, optimize the signal timing, development and reasonable utilization of resources, the existing road in the road traffic flow channel, ease traffic congestion problems, further improve the traffic capacity of road network.

(4) insufficient attention is paid to the slow traffic system

Nowadays, the development of urban traffic is mainly centered on motor vehicles, so the construction of urban traffic is mainly around cars. However, slow traffic lacks attention, and pedestrians and

bicycles only get a small part of attention. Urban road design mainly around roadway and some facilities related to the motor vehicle to unfold, rarely considering the pedestrians and non-motor vehicles, slow traffic is not guaranteed, urban road construction development faster and faster, more and more infringement to the way of pedestrians and non-motor vehicles, including sidewalks, non-motor vehicle road is compressed, pedestrians and non-motor vehicles crossing the distance is longer, and so on and so forth, will result in car situation.

(5) security issues

The slow traffic system is in a weak position in the urban traffic system and its safety cannot be guaranteed. Under the condition of the mixed traffic, accidents, even more vulnerable pedestrians and non-motor vehicles, one reason is that the protection of pedestrians and non-motor vehicles measures is less, the second is road traffic regulations less regulations on pedestrians and non-motor vehicles, pedestrians and non-motor vehicles violation behavior is more, crossing the increased the risks of its own.

5.2 Improvement measures

Based on the situation of slow traffic disorder and frequent accidents, the following improvement measures are proposed:

(1) optimize the slow traffic system

Urban transportation planning and design needs to perfect the slow traffic system construction standard, comprehensive analysis was carried out on the slow traffic, in accordance with the relevant standards to slow traffic system design and optimization, improve the pedestrian crossing signs marking, add bridge or tunnel crossing the street, to combine slow traffic facilities and road infrastructure, slow traffic system to fully mix up with the urban traffic system, the traffic demand and traffic development into account, learn lessons from the current road traffic and better to provide services for pedestrians and non-motor vehicles, reduce car conflict, to ensure the safety of pedestrians in urban development play a positive role in promoting.

(2) properly handle the relationship between slow traffic and motor vehicle traffic

At present, urban road traffic is developing towards the direction of safety, speed and efficiency. Reasonable street crossing facilities and management and control facilities should be set at intersections to effectively guide the behavior of pedestrians. For example, barriers and signs should be set up to separate people and vehicles from each other so that they can go their own way without interfering with each other. This not only improves the efficiency, but also alleviates traffic congestion and reduces the occurrence of road traffic accidents. Slow traffic plays a complementary role to motor vehicle traffic in the urban traffic system. Slow traffic and motor vehicle traffic are not mutually exclusive. In the process of developing slow traffic, motor vehicle traffic is developing constantly, which does not mean that motor vehicle traffic is regressing or slowing down. Slow traffic and motor vehicle traffic are complementary to each other, coordinated development.

(3) integrated design of slow traffic

In the design and optimization of slow traffic system, slow traffic should be considered as a whole, and the interests of pedestrians and non-motor vehicles should be fully considered, so as to provide a green and safe slow space for pedestrians and non-motor vehicles. The integrated design of slow traffic makes pedestrians and non-motor vehicles move on the same road, which greatly improves the traffic disorder at intersections. Every pedestrian and every bicycle has the right of way. The integrated design of slow traffic is to make full use of the limited road resources to guarantee the right of way for pedestrians and bicycles.

(4) strengthen the organization and management of bike-sharing facilities

At present, the facilities of bicycle parking and the measures of organization and management are not perfect in many cities, resulting in the chaos of urban traffic order. Especially with the large-scale investment of Shared bikes, the optimization and development of slow traffic system and the

construction of urban slow traffic facilities are extremely urgent. It is far from enough to grant more road rights to bicycles. We should organize and manage bicycles to make urban traffic more efficient and orderly and save more road resources. At the same time, we should also promote the construction of bicycle parking lots in view of the phenomenon of random parking.

(5) other detailed measures

- ① In view of the traffic disorder in the intersection, traffic organization flow line is not free, can carry on the channelization design again;
- ② For non-motor vehicles to disrupt the intersection traffic order, can be added in the intersection of the non-motorized lane, non-motor vehicles to cross the street waiting zone for the second time;
- ③ in view of the conflict between right-turning motor vehicles and pedestrians, non-motor vehicles, to make the traffic organization more orderly, can be added to the "let people", "do not cross the line" ground signs, to protect the slow.
- ④ in view of some roads no more than the motor vehicle lane and lead to motor vehicles and non-motor vehicles mixed more serious problems, if there is available space around the intersection, can be added to the sidewalk and non-motorized lane, and set the barrier.

6. Conclusion

Slow traffic is one of the core components of urban traffic system, which is also an indispensable complement to motor vehicle traffic. The traffic development strategy of the whole city should, on the basis of clarifying the location of slow traffic and combining the current situation of urban traffic and the relevant theories of slow traffic, put forward relevant measures to optimize and construct the slow traffic system, so as to realize the sustainable development of slow traffic system and urban traffic system. Therefore, based on the study of the current situation at home and abroad, this paper expounds the characteristics of urban slow traffic, and proposes measures to improve the slow traffic based on its traffic characteristics. However, due to the limitations of my research level and time, there are still some deficiencies, which still need to be improved through continuous research. The following can be further studied:

- (1) this paper only studies the general rules of most cities in three time periods, which is not comprehensive enough. More time periods should be selected for the study, and there is a lack of accurate data support, so as to obtain the common characteristics of slow traffic in cities.
- (2) this paper only studies the slow traffic system and does not take it into consideration in the whole urban traffic system. The optimization and design of the slow traffic system should fully consider the connection with the whole urban traffic system.

Acknowledgements

In the research and writing process of my graduation thesis, I thank my tutor, Mr. Li Gang, for her instruction and guidance. She has devoted a lot of energy to the selection of the subject, the collection of materials, the writing and modification of the thesis, etc., which made me finish the writing of the thesis at last. In the course of research, I was deeply impressed by my tutor's knowledge, rigorous attitude towards study and high enthusiasm for work, which benefited me a lot. I would like to extend my heartfelt thanks to the distinguished tutor.

References

- [1] Governance of Environmental Health and Transportation Decisions: The Case of New York City[J]. O.A.Elrahman,Case Studies on Transport Policy,2019.
- [2] Exploring the utility of Analytic Hierarchy Process (AHP) in ranking livelihood activities for effective and sustainable rural development interventions in developing countries[J].Gideon Baffoe,Evaluation and Program Planning,2018.

- [3] Study on Green Transportation System of International Metropolises[J].Hanru Li,Procedia Engineering, 2016.
- [4] Blending Individual Tenacity with Government's Responsibility in the Implementation of US Non-motorized Transportation Planning (NMT)[J].Carlos Balsas,Planning Practice & Research,2017(2)..
- [5] Statistical analysis of pedestrian perceptions of sidewalk level of service in the presence of bicycles[J].Lei Kang,Yingge Xiong,Fred L,Mannering,Transportation Research Part A,2013.
- [6] Lei Ouyang. Green traffic research in Changsha Based on BRT and slow traffic system [D]. Changsha: Central South University, 2012.
- [7] Zhang Dongming, Li Youwen. Current situation analysis and optimization suggestions of domestic urban slow traffic system [J]. Value engineering, 2016 (23).
- [8] Shen Chan, Liu Minglin. Overview and application of slow traffic system at home and abroad [J]. China Municipal Engineering, 2015 (04).
- [9] Cheng Liqin. Study on the development strategy of slow traffic in Dalian [J]. Transportation technology and economy, 2019 (01).
- [10] Zhao Xiaolong, Xu Jingran, Zhang Bo. Study on the use of slow traffic system in Guangdong greenway from the perspective of news [J]. Landscape architecture, 2019 (01).
- [11] Hou Haijing, Mo Shaoqing, Du Haixing, Liu Xinchao, Li Qi. Research on shared bicycle scheduling scheme based on fluctuating travel demand [J]. Think tank era, 2018 (52).
- [12] Sun Yixuan, Zhou Yushan, Cong Yuxi, Liu Ming. Research on Simulation Based Scheduling Optimization of shared bicycles [J]. Logistics technology, 2018 (10).
- [13] Zhou Longyu, Chang Xingjia, Tian Bo. Optimization of shared bicycle scheduling based on BP neural network [J]. China strategic emerging industry, 2017 (24).