

Study on the Planning of Slow Traffic System in Taiyuan City

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Abstract: Slow traffic is one of the main ways of people travelling in Taiyuan city. This paper discusses the current situation and problems of slow traffic in Taiyuan. It puts forward the strategy of slow traffic development and the countermeasures of constructing low carbon and sustainable slow traffic system approach. This paper aims to achieve the Taiyuan slow traffic system with the goal of safe, comfortable, fast, and healthy.

Keywords: Slow traffic system; Planning strategy; Taiyuan

Introduction

Slow traffic is the main travelling way in Taiyuan city. In recent years with the expansion of the city scale and rapid increase in motor vehicles, slow traffic environment is gradually deteriorating, due to the car-based concept. The government in the traffic planning and urban road construction has the main consideration of the needs of motor vehicles to meet the traffic. The status of slow traffic is not taken seriously and lack of urban road network necessary, fast, safe and slow transport facilities, resulting in motor vehicles and non-motor vehicle mutual interference. This has brought a lot of hidden dangers and slow traffic sharing rate decreased year by year. Over-motorized urban traffic congestion caused by the problem of air pollution has also aroused the concern of the whole society, low-carbon, environmental protection, and green slow traffic travel way to re-attention. The transformation of urban transport development in Taiyuan city brings to comfortable, fast and slow traffic system.

1. Overview of the Spatial Pattern of Taiyuan City

Taiyuan is the capital of Shanxi Province and it is located in the middle of Shanxi Province. It is also the national historical and cultural city, the national garden city, and one of the national energy and heavy industry base. It is the center of political, economic, cultural, science and technology, transportation, and information center of Taiyuan metropolitan core city.

The urban geography of Taiyuan is unique, whereby it is surrounded by mountains, a water flow, and railway barrier. Taiyuan is located in Jinzhong basin, where its east, west and north sides are surrounded by the mountains. It is in the south for the valley plains, the entire terrain north high south was a dustpan shape and northwest vertical distance of about 107 km. The city is divided into three parts: Hexi, Central City and Dongshan. The second largest tributary of the Yellow River - Fenhe, flows from north to south through Taiyuan City with

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territory of about 100 km.



Figure 1. Topographic and geomorphologic map of Taiyuan

2. The status and problems of the slow traffic system of Taiyuan city

2.1 Taiyuan residents travel mode structure

Travel mode of Taiyuan residents includes walking, bicycles, electric bicycles, and private cars. A higher proportion of residents travel through walking, bicycles, and electric bicycles, which constitute the proportion of non-motorized travel accounted for about 64%, while the highest proportion of 15.2% are travelled using private car and the proportion of bus travel was 13.4% [1].

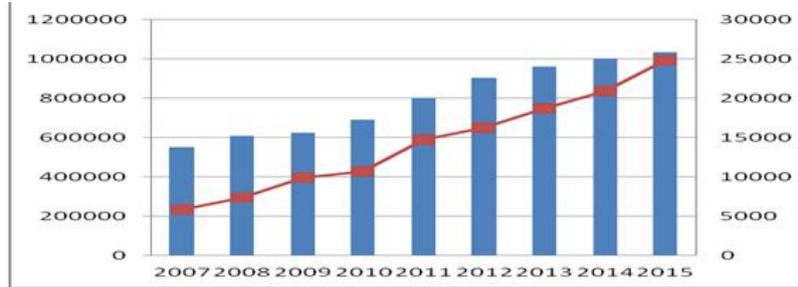
Table 1 The proportion of residents travelling way in Taiyuan urban area over the years.

Travel mode	Travel ratio of 2009	Travel ratio of 2015
Walk	32.0%	36.26%
Bicycle	28.6%	10.57%
Public bicycle	—	3.82%
Electric bicycle	10.2%	13.49%
Bus	15.4%	13.40%
Taxi	1.2%	2.85%
Unit car	2.4%	—
Private car	6.8%	15.20%
Unit bus	1.7%	1.21%
Motorcycle	0.8%	0.28%
Others	0.9%	2.92%
Total	100.00%	100.00%

Source: Literature (1)

2.2 The status of development of motor vehicles of Taiyuan City

From 2007 to 2015, there is rapid increase of motor vehicles in Taiyuan. The personal car ownership increased from 234,400 to 99.2 million, an increase of 275%; urban residents’ disposable income from 13745 yuan to 25,768 yuan, an increase of 90%. Relative to disposable income, urban residents reduce the cost of car rental year by year. In the end of 2015, Taiyuan City, thousands of motor vehicle ownership reached 264 cars per thousand people, with an average annual growth rate of 13%, thousands of private cars reached 230 cars per thousand people, with an average annual growth of 18%. Compared with other provincial capitals, Taiyuan is a city with a low per capita disposable income but a high private car ownership [2].

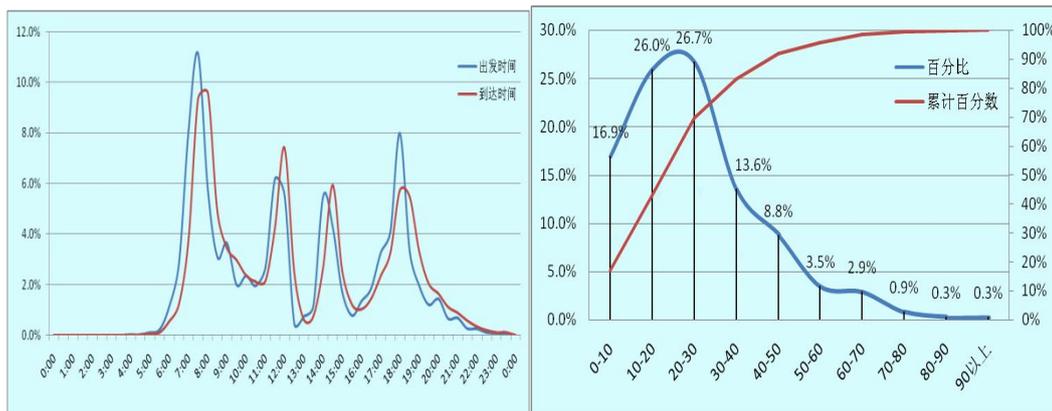


Source: Taiyuan Yearbook

Figure 2. Disposable income (blue) and individual car ownership (red line) of Taiyuan Urban residents over the years.

2.3 Travel time consumption of Taiyuan residents

According to the existing survey, the central city traffic travel average consumption was 26.6 minutes, the majority travel time was from 10 to 30 minutes, of which consumption within 30 minutes reached 70% of total demand, and travel time that more than 40 minutes only reached 36.7%. The peak travel time of residents are early, middle and late. The average travel distance of Taiyuan central city residents was 6.8 km. This indicates that Taiyuan city space expansion and travel distance of residents are limited [2].



Source: Document (2)

Figure 3. Travel time distribution and time consumption scale map of Taiyuan city residents

2.4 The status of slow traffic of Taiyuan City

2.4.1 Walking system

Walking system is the walking space of city road for the people. Taiyuan city roads are basically built sidewalks, due to the historical tradition and the layout of urban space. Walking is still one of the main ways of travelling of the residents of Taiyuan. The roadside parking and business operations accounted result in poor continuity of the walking system. Therefore, the motor vehicles and pedestrians were mixed and caused traffic chaos.

2.4.2 Public bicycle system

In order to meet the needs of people travel and to solve the problem of public transport, Taiyuan City learnt from the domestic public bicycle project in Beijing, Hangzhou, Wuhan, Zhuzhou and other city experience in 2012. In

June of the same year, the public bicycle project was launched Taiyuan. Taiyuan City Public Bicycle Co., Ltd. is responsible for daily operation and maintenance. After several years of operation, the Taiyuan Municipal Public Bicycle Co., Ltd. is responsible for the operation and maintenance of the public bicycle in Taiyuan City. Rate, turnover rate, rental rate, construction speed and other aspects in Taiyuan city was the first in China with significant effect.

2.4.3 Non-motor vehicle parking facilities

Taiyuan non-motor vehicle parking facilities are lacking of scientific and reasonable planning. Non-motorized parking are basically free parking in the unauthorized place, which causing the road occupation and resulting in increased traffic accidents. It not only brings a lot of inconvenience to pedestrians and motor vehicles, but also brings adverse effects to the urban landscape.

2.4.4 Pedestrian crossing facilities

Overall, the Taiyuan city road is lack of three-dimensional crossing facilities, while the pedestrians crossing the street through the form of street. In recent years, large-scale urban road construction is conducted for pedestrian bridge and underground channel in three-dimensional way to optimize the slow traffic environment. In the Binhe East Road, Changfeng Street, there are constructions of a number of bridges for people to pass. The underground channel is mainly arranged in Changfeng Avenue.

2.5 Slow traffic problems of Taiyuan City

The status quo Taiyuan City is lack of safe, comfortable, and humane slow traffic system. The city center area does not form pedestrian street along the Fen River on both sides of the quasi-expressway layout of the Binhe East and West Road and out of the river park traffic warnings prominent. In recent years, the new and rebuilt a number of urban roads and sidewalks are mostly used in the form of non-board, where people do not mixed with a large security risks. The parking spaces are seriously inadequate, thus, the motor vehicles often park at the non-motor vehicle lanes and sidewalks, resulting in slow traffic space compression and poor slow traffic travel environment.

3. Slow traffic system development strategy of Taiyuan City

The natural environment of Taiyuan provides a good ecological background. The public also retains the slow travel habits. There is a rapid increasing of private cars with a high proportion of 64% indicating that the future slow traffic will continue to travel one of the main ways. The main development strategies are as follows:

Slow traffic is a part of the integrated transport system that improving the slow traffic network at the macro level, strengthening the construction of slow space and network system, building a safe and comfortable slow traffic network, and further developing public bicycles and electric bicycles. Development of the situation makes best use and relying on the city traffic backbone. The rational distribution of public bicycle rental and non-motor vehicle parking point achieves slow traffic and public transport system, good convergence, and guide the public travel in walking and bus.

The implementation of different measures in different regions of the city. Central area slow traffic should be based on recovery through the road to the motor vehicle and slow traffic diversion to clear the slow traffic space boundaries and to create a safe and comfortable slow traffic system. The residential area slow traffic should use the district internal road and combination of public green space and public buildings and other nodes, in series superposition to form a network system. The residential area slow network system should pay attention to the convergence of public transport and guide people to travel more choices of public transport. The efficiency of the traffic hub leisure traffic should be improved and accessibility should be increased in space shaping to reflect the

people-oriented concept and to create a Taiyuan landscape characteristics of the space environment.

The policy-making and urban construction should ensure that the quality of slow travel traffic space and environmental. The alteration of urban roads should protect the slow traffic rights to ensure comfort, safety and continuity and enhance the attractiveness of slow-moving systems.

Taiyuan natural landscape resources endowment prominent, east, west and north on three sides around the mountains. In the south of the valley plains, the entire terrain north high south was dustpan shape; eastern mountain known as Dongshan, western mountain for the Luliangshan east wing, north Department of Zhoushan, is Xin set. The two basins of the mountain between the East and West mountains is Taiyuan Basin, 800 m above sea level, flat, Fenhe from north to south through the city. The southern part of the urban area has the largest artificial lake in North China - Jinyang Lake. The national key cultural relics protection units 13, 32 provincial cultural relics protection units, tourism resources are extremely rich. Combined with the natural historical landscape of Taiyuan City to Jinyang Lake, Jinci, Tianlongshan, Rise and Mountains and other natural historical and cultural landscape as a node, with the Fenhe Park Green Road will be the organic node in series to create local characteristics of Taiyuan slow system. In the Fenhe Park area, the slow traffic system should be combined with waterfront landscape highlights the characteristics of landscape, strengthen the human space environment design, along the slow road nodes and the layout of the seat, marking, landscape sketches and trash, to facilitate people to leisure, fitness, communication, entertainment and other activities.

To cater for the special travel of the elderly, children and people with disabilities, consider setting up blind roads, reminders and three-dimensional street facilities in the design of the road, reflecting the city's humanistic care [4].

4. Slow traffic system practice of Taiyuan City

4.1 Slow traffic development ideas in Taiyuan City

After several years of exploration in Taiyuan City, slow traffic development ideas are to follow the principle of sustainable development, taking into account the fair and efficient. With the development of economy, the rapid growth of motor vehicles in Taiyuan City, the resulting traffic congestion, air pollution is increasingly serious, especially in many cities recently appeared haze caused people to low carbon, green, and environmentally friendly slow traffic concerns. The slow traffic in line with urban sustainable development requirements plays an important role in reducing vehicle emissions and energy conservation. In the diversity of economic activities today, travel way is not the same, the use of public transport and slow traffic are mostly elderly and urban low-income groups. Urban traffic should focus on vulnerable group travel, to ensure that each traffic participants equal road right, to create a safe, comfortable, fast and healthy slow traffic system. (5)

4.2 Slow traffic system model of Taiyuan City

Taiyuan city terrain, topography and climatic conditions are suitable for the development of slow traffic in a variety of modes of travel. The slow travel traffic ratio is higher. Taiyuan residents travel average time consumption was 33.95 minutes, the average travel distance was 6.80 km [1], which are suitable for the use of "walking + bus" and "bike + bus" mode of travel.

4.3 Slow traffic system network of Taiyuan City

According to the characteristics of Taiyuan, to the district, shopping malls and transportation hub as the core, a people-oriented slow traffic system network is built to ensure the continuity of the slow traffic network and integrity. The road construction takes measures to ensure that slow traffic space is not compressed, improve the slow traffic capacity, and ease the pressure on urban road traffic.

4.4 Implementation of slow traffic system in Taiyuan City

In recent years, Taiyuan City has carried out a large-scale urban infrastructure construction, new and rebuilt a number of urban trunk roads and slip roads. In addition, Metro Line 2 also started construction on March 15, 2016, which is optimized for Taiyuan City Space layout to improve the quality of the city, improve the living environment and improve the comprehensive carrying capacity of the city. In the urban transformation, we will note that the accessibility and cross-street facilities of the slow-moving transport system will facilitate the use of children, the elderly and the disabled. We will take into account the overall layout of the slow traffic system and combine the surrounding parks, squares and community. The formation of slow traffic system convenient way improves the slow traffic microcirculation system. The construction of microcirculation road ensures the smooth passage of fire channel and earthquake evacuation channel. The minimum width of the road is not less than 4 meters, and the road at the end not less than 12 × 12 meters of the parking lot.

4.5 Public Bicycle System of Taiyuan City

The public bicycle project in Taiyuan city starts from June 2012. Since the start of the development, public bicycle development in Taiyuan has become one of the best cities in China. The public bike uses government-led and state-owned enterprises operating model, which is good for public. In order to ensure the safety of public facilities and to prevent human damage, Taiyuan public bike implements real-name system, where the public need to submit their identity cards. The card storage costs of 230 yuan, where 1 to 2 hours costs 1 yuan; 2 to 3 hours costs 2 yuan; more than 3 hours costs 3 yuan per hour; and 24 hours up to 66 yuan. At the end of 2015, a total of 41,000 public bicycles were covering most of the main urban areas in the Taiyuan City.

Table 2. The charge situation of Taiyuan public bicycles

1 hour	1—2 hour/s	2—3 hours	3—24 hours	24 hours later
0 yuan	1 yuan	2 yuan	3 yuan/hour	30 yuan/hour

Source: Taiyuan Public Bicycle Co. Ltd

5. Conclusions

Slow traffic cannot be ignored as an important part of the urban transport system as it can ease the traffic congestion in urban areas. The construction of slow traffic system should be paid with attention to fair and efficient, and follow the principle of sustainable development of urban transport. Besides, measures should be taken to optimize the slow traffic and public transport connections, and guide the public to use “slow traffic + public transport” travel way to enhance the quality of the city.

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