Development Mode Selection of Urban Slow Traffic System

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Abstract. Urban slow traffic system is an important part of urban comprehensive system and an important way to prevent and alleviate traffic jam and reduce atmospheric pollution and energy consumption. It concerns the masses’ production and living as well as the cities’ sustainable development. In recent years, the development of slow traffic has drawn attention from more and more cities. In this process, the selection of a development mode for slow traffic system is the basis for sound development.

1. The Basic Situation of China’s Urban Slow Traffic Development
At present, China’s progress of slow traffic relatively lags behind. The scarce capacity of aggregate slow traffic supply, low service quality and general lack of services remain serious problems. Especially under the new situation that cars rapidly enter private households, slow traffic fails to become a priority selection for travel. An efficient, safe, convenient, fast and smooth slow traffic system hasn’t been built yet.

1.1. Bicycle traffic
In the 1980s, after China became a major producer of the bicycle, quantifier licensed increased explosively. In 1995, there were 670 million in China, the maximum throughout history. After that, the bicycles decreased rapidly and declined by 33% during six years by 2001. By the end of 2013, there were only 370 billion left over in China. As the quantity decreases sharply, the ratio of cycling trip also drops by 2% to 5% each year.
1.2. Pedestrian traffic
Sidewalks and non-motor-vehicle lanes have not been paid enough attention in the planning and construction of roads for a long time. The level of supply usually cannot meet the demand, so pedestrians always have to endure great inconveniences and potential traffic dangers. The survey data about the trips of Chinese residents in different cities since 2000 shows that the average ratio of the walking trip to the total trips is 30% or so. Especially in the mountainous and small cities, the ratio is above 40%.

1.3. Public bike system
China is a country in which bike system develops the fastest in the world. As of 2013, there had been over 70 cities in the whole country which rendered public bike rental services to the citizens. In the overall public bike system, there were more than 300 thousand public bikes, 15 cities had more than 10 thousand bikes and 300-odd services sites respectively.

2. Urban slow traffic system development model selection factors
The factors which can influence the development model of urban slow traffic system include: Urban population size, travel distance, urban topography, urban layout, regional and regional factors, etc.

2.1. Urban population size
Small and medium-sized cities are an important part of China's urban system, accounting for more than 80% of the number of cities in china. The size of small and medium-sized city is not big, travel distance of overall citizens is short, mostly by the way of walking and bicycle traffic, the proportion of slow traffic is high which is suitable for the use of "slow traffic development mode walk + bicycle". The construction of slow traffic system of large and medium-sized city, for the city of medium-sized population, the city scale, city morphology and population size are suitable for the development of slow traffic and public transportation and suitable for the use of "walk + bike + bus" balanced development mode and the slow traffic system development model which use “bus” as the main body and use "walk + bike" as the supplement.

2.2. Travel distance
Travel distance is closely related to urban scale. With the development of urbanization and motorization, urban scale is expanding, and people's travel distance is getting bigger and bigger, and the proportion of slow traffic is declining sharply. For the city, in which the resident’s daily travel distance is within 6km, slow traffic should be the main travel mode, and it plays a leading role in the short distance travel, and the slow traffic of “walk + bicycle” should be regard as the main
development mode. While, for the cities, in which the resident’s daily travel distance is bigger than 6km, slow traffic, together with public traffic, is regarded as the main travel activities, which is a supplement to promote the public travel, and it is reasonable to adapt the traffic mode of “walk + bicycle +bus” as the balanced develop mode, and the bus is the main traffic mode, and the “walk + bicycle” is the supplement.

2.3. *Urban landform*

The urban landform is of great influence to the bicycle traffic. Compared with the cities of hills and mountains, the city of plain has higher portion in slow traffic, and the bicycle travel is comparatively balanced with the walking travel. For the cities of hills and mountains, the road condition is poor, and the source for slow traffic is less, and the slow traffic portion, although is lower than that of the cities of other landform, reaches 50%. The slow traffic still occupies an important position, and takes walking as the main travel mode in travel, and the bicycle transportation proportion is less than 10%.

2.4. *The layout of the city*

Small and medium-sized city in China mostly belong to the single center centralized mode, its centralized layout features of single center causes the living and working of the city residents is relatively concentrated, the proportion of short distance trips residents is high, the average trip distance is short and already created benefit for the development of walking trips the non-motor vehicle. It is suitable to use the slow traffic development system model which use “walk + bicycle” as the main body. But for plain large-scale type city with multi center group, residents travel between the multi center groups, long distance travel volume is high, the average trip distance is longer, so it is suitable for slow traffic system development mode which use "bus" as the main body and use "walk + bike" as complementary ways. For the large-scale mountainous type city, it generally has multi center groups which as large distance in space between groups, besides the road conditions are relatively tight, so it is suitable for slow traffic system development mode which use "walk + bus" as the main body.

3. Development Mode Selection of Urban Slow Traffic System

Propose five development modes for slow traffic system from the perspective of urban residents’ travel structure, and make a contrastive analysis on them to sum up their respective features and applicability.

3.1. “Walking+ bike-oriented” development mode

In “walking+ bike-oriented” urban slow traffic system, urban residents’ trip mode is centered on walking and bike. The ratio of “walking+ bike” travel to the total travel is above 70%, and travel modes aren’t in the dominant position. It applies to short trip distances in the medium sized and small cities in flat areas and the central business districts in large cities. Its’ feature is green traffic, slow speed and short distance, as shown in Table1.

| Table1. the Cities Which Adopt “Walking+ bike-oriented” Development Mode |
|-----------------------------|------------------|---------------|--------------|
| City                        | Dangyang | Meishan | Shangshu |
| Walking                     | 44.7     | 48.8     | 34.4       |
| Bike                        | 20.5     | 18.5     | 47.8       |
| Public traffic              | 5.6      | 8.3      | 4.2        |
| Private car                 | 21.6     | 18.3     | 10.3       |
| Taxi                        | 3.9      | 3.1      | 0.6        |
| other                       | 3.7      | 3        | 2.7        |
| Urban population            | 20       | 40       | 57         |
| statistical year            | 2006     | 2006     | 2006       |
3.2. “Walking+ bike+ public traffic-balanced” development mode
“Walking+ bike+ public traffic” urban slow traffic system is a balanced mode. Urban residents go for a trip mainly by walking, bike and public traffic. The ratio of “walking+ bike+ public traffic” travel to the total travel is above 75%, and the proportion of these three travel modes is relatively the same. It applies to the medium-sized cities in flat areas where bike riding is convenient. It’s characterized by the balanced development of green travel modes, moderate travel speed and travel distance, as shown in Table2.

Table2. the Cities Which Adopt “Walking+ bike+ public traffic” Development Mode

| City     | Bengbu | Yinchuan | Nanchang |
|----------|--------|----------|----------|
| Waking   | 37.7   | 26.7     | 47       |
| Bike     | 30.9   | 23.3     | 20       |
| Public traffic | 23.1 | 26.9     | 13.5     |
| Private car | 5.8   | 14       | 8        |
| Taxi     | 1      | 2.7      | 1        |
| Other    | 1.5    | 6.4      | 10.5     |
| Urban population | 101 | 133      | 231      |
| Statistical year | 2006 | 2013     | 2012     |

3.3. “Public traffic-oriented and walking+ bike-aided” development mode
In “public traffic-oriented and walking+ bike-aided” urban slow traffic system, public transport is urban residents’ main travel mode. Its ratio to the total travel is above 30%. Walk and bike, as an assistant mode of public transport, assists public transport in expanding the cover area of travel traffic network and improving the traffic travel in the last kilometer. It applies to the large and medium-sized cities in plain hilly areas with good public infrastructures. The characteristic is that urban traffic travel is mainly through rail transit, conventional public traffic, and BRT, slow traffic links up with public traffic efficiently, travel speed is fast, and travel distance is far, as shown in Table3.

Table3. the Cities Which Adopt “Public traffic-oriented and walking+ bike-aided” Development Mode

| City     | Shenyang | Beijing | Xi’an |
|----------|----------|---------|-------|
| Walking  | 25       | 8.6     | 21.2  |
| Bike     | 17.5     | 17.9    | 7.2   |
| Public traffic | 32.8 | 39.3    | 33.3  |
| Sedan car | 22.1 | 34.2    | 18.8  |
| Taxi     | 2.6      | -       | 6.6   |
| Other    | 0        | 0       | 12.9  |
| Urban population | 510 | 2115    | 855   |
| Statistical year | 2012 | 2010    | 2008  |

3.4. “Walking+ public traffic-oriented” development mode
In “walking+ public traffic-oriented” urban slow traffic system, walking trip and transit trip are in the dominant position, accounting for over 70% of the total trip, while cycling trip accounts for a lower proportion, below 10%. Walking traffic, as an assistant mode of public transportation, assists public
traffic in expanding the cover area of travel traffic network and finishing it in the last stage of a journey. It applies to the cities in hilly and mountainous areas where bike riding is inconvenient. The feature is that cycling trip accounts for a low percentage, as shown in Table 4.

| City      | Anning | Qingdao | Guiyang |
|-----------|--------|---------|---------|
| Walking   | 45.8   | 37.7    | 51      |
| Bike      | 2.9    | 0.9     | 1       |
| Public traffic | 29.2   | 29.3    | 28      |
| Private car | 16.7   | 13.1    | 9       |
| Taxi      | 1.3    | 6.3     | 5       |
| Others    | 1.1    | 12.8    | 6       |
| Urban population | 34    | 279      | 224     |
| Statistical year | 2009 | 2010     | 2011    |

3.5. “Private car-oriented and walking + bike-aided” development mode
In “private car-oriented and walking + bike-aided” urban slow traffic system, a private car is a major urban travel mode, accounting for over 30%. Walking and bike are the assistant way for the car travel, and transit trip’s ratio is lower than others’. Public traffic is not yet uncompetitive, and slow traffic competes with car traffic, so this development has not been recommended.

3.6. Development mode selection of urban slow traffic system
The selection of development mode of urban slow traffic system is mainly based on a city’s inherent properties. The influencing factors for the selection of development mode of urban slow traffic system mainly include the size of the urban population, trip distance, urban terrain and urban layout form, etc. as shown in Table 5.

| Slow development mode  | Proportion of travel | Travel characteristics | Suitable for | Characteristic city |
|------------------------|----------------------|------------------------|--------------|-------------------|
| Walking+ bike-oriented | The proportion of walking and bike travel is over 70% | Short travel distance and Small cities and plain cities | Changshu and Qinhuangdao |
| Walking+ bike+ public traffic-balanced | The proportion of “walking+ bike+ public traffic” travel is over 75% | Moderate travel distance and speed | Medium-sized cities and plain cities | Bengbu and Yinchuan |
| Public traffic-oriented and walking+ bike-aided | The proportion of public traffic travel is over 30% | Far travel distance and fast speed | Megacities, big cities and hilly and plain cities | Shenyang, Beijing and Xi’an |
| Walking+ public traffic-oriented | The proportion of urban walking travel and public traffic travel is over 70%, and the proportion of bike travel is below 10% | Moderate travel speed and far travel distance | Hilly and mountainous cities | Qingdao, Guiyang and Zunyi |
| Private car-oriented and walking+ bike-aided | The proportion of car travel is over 30% | Moderate travel speed and far travel distance | - | - |

4. Conclusion
This paper makes a preliminary study on five urban slow traffic development modes, and compares the features and applicability of different slow traffic development modes, to provide references and suggestions for the development of different types of urban slow traffics. This paper just regards the cities as a whole. In the following research, it’s necessary to analyze further the different requirements of different regions for slow traffic systems, to provide references for guiding urban slow traffic development regionally.

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