Country Report on Sustainable Urban Transport

Chinese Sustainable Urban Transport System

United Nations ESCAP- KOTI
Chinese Sustainable Urban Transport System
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1. **Introduction**

1.1 **Background and status of urban transport systems**

Since 1900, the urban population and area in Chinese cities has been experienced with rapid expansion. Supply of traffic infrastructure increased significantly. However, the traffic demand grows faster. Basically traced from the time axis, the stages of transportation development could be categorized into following phases:

- **1900-1950:** At the beginning of the last century, towns in China retained the transport form of farming community. Transport was mainly on foot, waterway and horse carriage. After cities opened in China, modern road network appeared.

- **1950-1980:** In this period of time, the development of transport mainly focused on the construction of bicycle system, which acted as the most important mode of transport during the time.

- **1980-1990:** Emphasis in this stage was on the construction of public transit system. Main focus was on the electric buses construction.

- **1990-2000:** Rapid development appeared in this stage. Car based society was in great needs of supporting infrastructures. Road construction had the first priority to adapt the mobility demands.

- **2000-:** In 21st century, the number of private-owned cars exceeded 100 million. Mass transit railway became the priorities of capital construction in major cities. Until recent years, comprehensive transportation has made great progress in China.

The following figures show the evolvement of several urban transportation development indicators in China recently, including urban population, urban area, passenger volume, road length per capita, road area per capita, etc.
1.2 Background and status of public transit systems

Public transit systems play an essential role in building the sustainable urban system. In recent 30 years, China has been adhered to the development of public transport. According to the features of Chinese rapid urbanization and transportation development, public transport development strategy also evolved correspondingly.

In 1985, The State Council first approved the *Urban and Rural Construction and Environmental Protection Department Report* on the city public transportation reform. 2 years later, in 1987, Chinese government stressed the importance to strengthen urban construction work, after which began with the rapid expansion of urban development. Until 2004, the Ministry of construction suggested to give priority to the development of urban public transport. Then in 2005, the General Office of the State Council forwarded the opinions of the Ministry of Construction and other departments on giving priority to the development of urban public transport. In order
to promote the development, a guidance of the State Council on prioritizing urban public transport development was published in 2012. The following table presents the time interval and corresponding relations between urbanization and public transport development.

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Urbanization Development</th>
<th>Transportation Development Features</th>
<th>Public Transport Development Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978–1992</td>
<td>After the reform, eastern coastal cities were the first to enter a period of rapid urban development.</td>
<td>Mainly non-motorized transport, mixed traffic composition.</td>
<td>To solve the difficult drive, a number of operations to meet the needs of the community as the starting point.</td>
</tr>
<tr>
<td>1993–2002</td>
<td>Deep focus on market economic reform, rapid urban development continued.</td>
<td>Rapid motorization, mixed traffic problem becomes serious on the road.</td>
<td>Transit companies are the main public transport providers.</td>
</tr>
<tr>
<td>2003–2013</td>
<td>Urban development has given rise to national strategies.</td>
<td>Easy access to family car causes urban traffic congestion problems.</td>
<td>At the national level, proposed priority development is on public transport policy.</td>
</tr>
<tr>
<td>2013–</td>
<td>Promote human-centered urbanization, emphasis on ecological human development, focus on the quality of urbanization.</td>
<td>Should pay attention to &quot;people-centered&quot; and &quot;ecological human development&quot;.</td>
<td>Bus priority differentiation.</td>
</tr>
</tbody>
</table>

Table 1 Chinese Public Transit Development Stages

Figure 2 shows the trends of public transit infrastructure development from 1980 to 2013, including the number of buses, taxis, and urban rail transit operating mileage.

2. Urban transport policies

2.1 National urban transport policies

2.1.1 Governmental guidance to the direction of urban development

Chinese government has always been placing urban development as an important position. “New National Urbanization Plan” put forward the rapid urbanization and development of China, and has promoted urban agglomeration as its main form of development. Based on the concept of urban agglomeration and node cities, this placed other cities and towns as an important part, in coordination with the development of big, medium-sized and small cities. This concept follows the "two vertical and three horizontal" strategic pattern of urbanization.

A number of suggestions to further strengthen urban planning and construction management work is to put forward the overall goal of urban planning and
construction management: to achieve the orderly construction of the city, moderate development, efficient operation, to build a harmonious and liveable life, a vibrant, distinctive modern city, to make people's lives better.

2.1.2 Public transport priority development policies

As described in the previous section, Chinese public transport development policy went through the following stages: Develop public transport (since the founding of new China) - Develop public transport (1990) - Give priority to the development of public transport (2005) - Public transport priority development (2012-).

For public transit priority development, it has become an essential strategy in urban administrative area. Through the priority allocation of resources, public transit system should be built up and adapt to the market mechanism, government regulation and control, conforming to the local economic and social development stage. At present, Chinese public transport system with equal and efficient public services are provided by various types of enterprises and other business organizations, government have published a series of guidance and plans to lead the traveller choose optimally, to guide the efficient use of land and to save energy, protect and improve the living environment.

Since 2012, China has hold 13 major conferences regarding public transit priority development, in which 7 were plenary meetings and 6 were general topic meetings (see in table 2).

<table>
<thead>
<tr>
<th>Time</th>
<th>Places</th>
<th>Issues</th>
<th>Meeting scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-03-03</td>
<td>Beijing China Urban Planning and Design Institute</td>
<td>Official opening</td>
<td>Total group task</td>
</tr>
<tr>
<td>2012-03-15</td>
<td>Beijing CSCIEAS</td>
<td>General task</td>
<td>Total group task</td>
</tr>
<tr>
<td>2012-04-11</td>
<td>Beijing Beijing Transport Research Center</td>
<td>Urban public transport priority</td>
<td>General group task, public funding authority</td>
</tr>
<tr>
<td>2012-05-13</td>
<td>Beijing Beijing Municipal Commission of Urban Planning</td>
<td>Public service promotion</td>
<td>Total group task</td>
</tr>
<tr>
<td>2012-06-05</td>
<td>Shanghai Tongji University</td>
<td>Preliminary report on outcomes of the subtopics</td>
<td>General group task, public funding authority</td>
</tr>
<tr>
<td>2012-07-07</td>
<td>Beijing Beijing Transport Research Center</td>
<td>General task</td>
<td>Total group task</td>
</tr>
<tr>
<td>2012-08-04</td>
<td>Nanjing Nanjing Business of City and Transport Planning Co., Ltd</td>
<td>Report on outcomes of the subtopics</td>
<td>General group task, public funding authority</td>
</tr>
<tr>
<td>2012-09-02</td>
<td>Beijing Beijing Municipal Commission of Urban Planning</td>
<td>Review and preparation in the subtopics</td>
<td>Total group task</td>
</tr>
<tr>
<td>2012-09-19</td>
<td>Beijing Foshan Jinyu Spa Resort</td>
<td>Midterm review</td>
<td>General group task, public funding authority</td>
</tr>
<tr>
<td>2012-10-01</td>
<td>Guangzhou International Meditainment Hotel</td>
<td>Total topic discussion</td>
<td>Total group task</td>
</tr>
<tr>
<td>2012-10-22</td>
<td>Hangzhou West Lake Hillview Int’l Hotel</td>
<td>Preparation of summary</td>
<td>General group task, public funding authority</td>
</tr>
<tr>
<td>2013-01-25</td>
<td>Beijing Beijing Municipal Commission of Urban Planning</td>
<td>General topic</td>
<td>Total group task</td>
</tr>
</tbody>
</table>

Regarding specific measures to promote the development of public transit in urban area. Chinese government launched “Transit Metropolis” projects, which is one
of the urban transportation strategies in order to cope with the rapid growth of private vehicles and traffic congestion. It represents a transit oriented urban development structure, in which motorized mobility mainly focused on public transit. Transit Metropolis is an optimal urban development status subject to resources, environment and safety. Ministry of Transport has enacted an indicators system to evaluate the performance of public transit system in urban area.

2.1.3 Traffic demand management policies

Demand management is an important theoretical concept in urban traffic. Not limited to management measures, it includes the evaluation of existing policy effects, analysis of the differences in domestic policy environment, and guide the construction of facilities, paying more attention to the internal coordination and effectiveness of the transportation system, while ensuring good balance with the urban space.

Based on accurate understanding of transport demand characteristics, demand management could facilitate the evaluation on different aspects of traffic demand management measures, to explore alternative ways to manage urban traffic demand under changing country conditions. It pays more attention to the time effectiveness of each measure, public acceptance and financial capacity of the government.

Information age has brought emerging opportunities for urban traffic demand management, using information technology to understand perception on individual behaviour and travel demand became a new method. Based on the aim, principle and the elements of traffic demand management, we could establish and evaluate the methods and mechanism of transportation policy formulation and evaluation, constructing urban traffic demand management policy system framework by big data.

2.2 Ongoing and planned major urban transportation projects

2.2.1 Guangzhou BRT

Guangzhou BRT started to build in 2008 and operate in 2010. The total length of the route is 22.9 km. As Asia’s busiest BRT system, the maximum transect volume exceeds 2.69 million people/one direction/hour. The project was awarded the “Beacon Award” by the Secretariat of the United Nations Framework Convention on Climate Change.

BRT system could help solve “the last mile” issues and improve public choice of public transport trips. At present, more than 20 Chinese cities have built BRT systems, including Beijing, Guangzhou, Lanzhou, Hefei, Changzhou, Yichang, Yiwu, etc. While in the project construction, cities should avoid blindly copying and relying
on rail transit priority development models without taking into consideration the local economic and social development, and to fully integrate, renovate and transform, and make full use of existing facilities to complement ecological urban renewal.

2.2.2 Hangzhou public bicycle sharing system

In 2010, Ministry of Housing and Urban-Rural Development launched “China's urban pedestrian and bicycle traffic system demonstration project”. Hangzhou public bicycle sharing system developed as the model in China. By the end 2015, Hangzhou has built 3504 service points, 84,100 vehicles. Total number of bike rental has reached 114.5 Million bike share users, frequency of bike rental per day has reached 313,600 bike share users. Daily maximum rental reached about 44.86 Million users.

In October 2013, American newspaper “USA Today” reported that Hangzhou public bicycle scheme is the world's 16th best public bicycle sharing scheme. In
2015, it won the 2nd Tehran Golden Adobe Award presented by the Tehran municipal government and UN-HABITAT during the World Cities Day and the 2015 National Golden Card Project.

The project makes the best use of the local conditions to meet people's demand for urban transport services and fully reflects the differences in "public transport priority development". Public bicycle sharing system complements public transport capacity in large cities and megacities in China. It is an important measure and model to improve the quality of urban travel in small and medium-sized cities. At present, more than 120 cities provide public bicycle service to promote urban green transport revival.

3. Data availability on urban transport indicators

Public transit priority development is one of the most significant policy for Chinese sustainable transportation development. In order to guide the establishment of Chinese Transit Metropolis, identify the performance measurement objectives in each city, and scientifically evaluate the performance of Transit Metropolis development, Ministry of Transport enacted the indicators system of performance measurement for Transit Metropolis. The indicators system contains a series of measurement data related to public transit development. Data mainly derives from resident trip survey, transport administration authorities, urban planning authorities, statistical yearbook, questionnaire, police department, and other third parties.

The following table shows 11 indicators used to evaluate the public transit system in one particular city. Measurement Indicators have direct effect on the performance of public transit system, while reference indicators could be used to support the evaluation result.
Table 3  Transit Metropolis indicators

<table>
<thead>
<tr>
<th>No.</th>
<th>Indicator Name</th>
<th>Indicator Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motorized modal share of public transit</td>
<td>Measurement</td>
</tr>
<tr>
<td>2</td>
<td>500-meter coverage ratio of public transit stations</td>
<td>Measurement</td>
</tr>
<tr>
<td>3</td>
<td>Public transit vehicle ownership 10 thousand per capita</td>
<td>Measurement</td>
</tr>
<tr>
<td>4</td>
<td>Public transit on-schedule rate</td>
<td>Measurement</td>
</tr>
<tr>
<td>5</td>
<td>Average speed of public transit vehicle in peak hours</td>
<td>Measurement</td>
</tr>
<tr>
<td>6</td>
<td>Degree of satisfaction of public transit passengers</td>
<td>Measurement</td>
</tr>
<tr>
<td>7</td>
<td>Utilization rate of public transit smart card</td>
<td>Measurement</td>
</tr>
<tr>
<td>8</td>
<td>Number of daily public transit trips per capita</td>
<td>Reference</td>
</tr>
<tr>
<td>9</td>
<td>Average age of public transit vehicles</td>
<td>Reference</td>
</tr>
<tr>
<td>10</td>
<td>Income level of public transit employees</td>
<td>Reference</td>
</tr>
<tr>
<td>11</td>
<td>Energy consumption intensity</td>
<td>Reference</td>
</tr>
</tbody>
</table>

(1) Motorized modal share of public transit
- Definition: In the statistical period, the percentage of resident trips using public transit in total motorized trips (unit: %)
- Computing method:

\[
\text{Motorized modal share of public transit} = \frac{\text{public transit trips}}{\text{total motorized trips}} \times 100\%
\]

Public transit trips include buses, mass transit railway, ferry, etc. (not including public bicycles and taxis). Total motorized trips indicate number of all kinds of trips made by power-driven vehicles, including bus, mass transit railway, ferry, private car, taxi, motorcycle, commuting car, business car, school bus, etc.

(2) 500-meter coverage ratio of public transit stations
- Definition: In the statistical period, the ratio of the area of 500-meter coverage by public transit stations to the area of built-up area in the city centre. (unit: %)
- Computing method:

\[
\text{500-meter coverage ratio of public transit stations} = \frac{\text{area of 500-meter coverage by public transit stations}}{\text{area of built-up area in the city centre}} \times 100\%
\]

Public transit stations include bus stops and metro stations. Locations of the metro
stations are identified as the passenger entrance and exit.

(3) Public transit vehicle ownership 10 thousand per capita
- Definition: In the statistical period, the equivalent number of public transit vehicle ownership per 10 thousand people, calculated by the urban population. (unit: veh/10 thousand people)
- Computing method:
  \[
  \text{public transit vehicle ownership per 10 thousand people} = \frac{\text{public transit vehicle ownership}}{\text{urban population}} \times 100\%
  \]

(4) Public transit on-schedule rate
- Definition: In the statistical period, the average on-schedule rate of buses and mass transit railway. (unit: %)
- Computing method:
  \[
  \text{bus on-schedule rate} = \frac{\sum (\text{on-schedule departure runs} + \text{on-schedule arrival runs})}{\sum (\text{total planned runs} \times 2)}
  \]
  \[
  \text{mass transit railway on-schedule rate} = \frac{\sum (\text{on-schedule departure trains} + \text{on-schedule arrival trains})}{\sum (\text{total planned trains} \times 2)}
  \]

(5) Average speed of public transit vehicles in peak hours
- Definition: In the statistical period, the average annual speed of buses carrying passengers. (unit: km/hr)
- Computing method:
  \[
  \text{average speed of public transit vehicles in peak hours} = \frac{\sum \text{average speed of public transit runs in peak hours}}{\text{total number of runs in peak hours}}
  \]
  \[
  \text{average speed of public transit runs in peak hours} = \frac{\text{operational distance of public transit runs in peak hours}}{\text{operational time of public transit runs in peak hours}}
  \]
(6) Degree of satisfaction of public transit passengers

- Definition: In the statistical period, the average rates of valid questionnaire on performance investigation for the level of service of public transit. (unit: %)
- Computing method:
  \[ \text{degree of satisfaction of public transit passengers} = \frac{\sum \text{score of single valid questionnaire}}{\text{total number of valid questionnaire}} \times 100\% \]

Details in questionnaire contain the duration of waiting, convenience of transfer, attitude of service, travel information service, degree of comfort, waiting environment and environment in buses.

(7) Utilization rate of public transit smart card

- Definition: In the statistical period, the percentage of passenger volume using smart card in total public transit passenger volume. (unit: %)
- Computing method:
  \[ \text{utilization rate of public transit smart card} = \frac{\text{passenger volume using smart card}}{\text{total public transit passenger volume}} \times 100\% \]

(8) Number of daily public transit trips per capita

- Definition: In the statistical period, number of daily public transit trips per capita made by residents in urban area. (unit: times)
- Computing method:
  \[ \text{number of daily public transit trips per capita} = \frac{\text{annual public transit passenger volume}}{365 \times \text{transfer coefficient} \times \text{urban population}} \]

(9) Average age of public transit vehicles

- Definition: In the statistical period, average applicable age of public transit vehicles in urban area. (unit: year)
- Computing method:
  \[ \text{average age of public transit vehicles} = \frac{\sum \text{total applicable age of single public transit vehicle}}{\text{total number of public transit fleets}} \]
Income level of public transit employees

- **Definition:** In the statistical period, the ratio of average salary of public transit employees to all local employees. (unit: %)

- **Computing method:**

\[
\text{Income level of public transit employees} = \frac{\text{average salary of public transit employees}}{\text{average salary of all local employees}} \times 100\%
\]

Energy consumption intensity

- **Definition:** In the statistical period, tons of standard coal equivalent energy consumed by 10 thousand person-time. (unit: ton/10 thousand person-time)

- **Computing method:**

\[
\text{Energy consumption intensity} = \frac{\text{total tons of standard coal equivalent energy consumed by vehicles}}{\text{total passenger volume}}
\]

4. **Issues and challenges faced by the urban transport systems**

4.1 Urban traffic congestion

“Traffic congestion becomes an urban disease”, is a reflection of, to a large extent, a flaw in theory and method of urban transportation system in China. Urban traffic congestion problems in megacities, particularly in big cities, become more and more serious in central area, and extend to the periphery, increasing travel time and traffic congestion to small and medium sized cities.

![Sanya](image1) (population: 586.6 thousand)  ![Hohhot](image2) (population: 5600 thousand)  ![Lanzhou](image3) (population: 3688.4 thousand)

Figure 5 Population and Congestion in Chinese Big Cities
4.2 Traffic pollution

Transportation section has always been a big source contributed to local air pollution. The focus of the discussion on traffic pollution is on the ownership of the city car and its oil and emission standards. Urban traffic scholars suggest that we should not only pay attention to transport emissions, but also to the overall operational efficiency of the urban transport system, optimizing the traffic structure and improve operational efficiency.

Beijing PM2.5 shows that regional transport accounts for about 28-36%, local pollution sources accounted for 64-72%. Local pollution sources, motor vehicles, coal-fired, industrial production, dust accounted for respectively, 31.1%, 22.4%, 18.1% and 14.3%, catering and other emissions account for about 14.1%.
4.3 Parking management problems

Along with the rapid urbanization and motorization, parking becomes an urgent problem in city management. Design of old neighbourhoods cannot cope with motorization, new residential parking needs of residents are underestimated. Serious shortage of public parking spaces in old public buildings; underground parking garage in new public buildings are not fully being used. Parking management studies did not consider local requirements, particularly in new street parking development. Parking information processing is still in its initial stage, dynamic parking systems still require further studies.

![Figure 8 Parking Shortage Condition in Beijing](image)

4.4 Green transport development

As the concept of green transport development started to guide the sustainable urban planning. Urban traffic scholars should concentrate on the problems brought about by motorization to bicycling and walking and propose green transport ideas (including walking and bicycling) to better adapt to the city.

![Figure 9 Green Transport Development](image)

5. Way Forward

5.1 Research on urban transportation science
Theory of transportation planning and management is based on the “engineering” perspective, hence it is difficult to cope with urban traffic problem. Urban transportation should solve practical problems with a vision and strategy based on sustainable urban transport development, innovating on theory and method.

Under the background of information technology, big data, cloud computing and other rapid development in science and technology, Engineering and Technology must continue to improve the urban transportation theory and propose the need to adapt to international, social and economic development and trends.

![Figure 10 Global Rate of Urbanization](image)

Purpose of the research is to serve the needs of the people, and organize an effective, safe and sustainable city (low energy consumption and low pollution). Human needs is the demand for employment and the demand for living. The essence of employment demand is the essence of industrial development and employment, including logistics. The demand for living refers to the basic needs of life and education, health care, leisure and other services.

![Figure 11 Spatial Scope of Urban Traffic Theory Research](image)

The scope of the study of urban transportation includes the internal traffic within
the urban administrative region, connection point with the external urban traffic and the inter city traffic within the metropolitan area (See figure 11). Urban transport network consists of six major systems as well as walking and cycling. Urban traffic network should strengthen the integration of the six systems and the connection of the organization of the bicycle and people, process urban internal traffic system and convergence of city's traffic and metropolitan transit station, emphasizing the overall system as “whole is greater than the sum of the parts”. (See figure 12)

5.2 Research on urban transportation policy

Research on urban transportation policy is the implementation of urban transportation theory study. The focus is on the satisfaction of the reasonable demand of urban residents and the improvement of the overall effectiveness of urban operations. It emphasizes that the policy of urban traffic is based on the method of multi criteria thinking and systems theory. It pays attention not only to engineering technology, but also between the legal, economic, fiscal and taxation relations.
Urban traffic is different from general traffic, the basic reason is that urban transportation involves different laws and regulations, standard system, information system, public funds, fare policy, etc. (See figure 14)

### Figure 14 Urban Transportation Policy System

#### Regulations:

<table>
<thead>
<tr>
<th>Urban traffic laws and regulations</th>
<th>Long-distance transport regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Town and Country Planning</td>
<td>Road Traffic Safety Law</td>
</tr>
<tr>
<td>Urban Road Management Ordinance</td>
<td>Highway Law, road regulations, toll</td>
</tr>
<tr>
<td></td>
<td>road management regulations</td>
</tr>
<tr>
<td>City Bus and tram passenger</td>
<td>Railway Law, railway safety</td>
</tr>
<tr>
<td>management approach</td>
<td>regulations, Railway Transport</td>
</tr>
<tr>
<td></td>
<td>Safety Protection Ordinance</td>
</tr>
<tr>
<td></td>
<td>Maritime Traffic Safety Law</td>
</tr>
<tr>
<td></td>
<td>domestic waterway transport</td>
</tr>
<tr>
<td></td>
<td>regulations</td>
</tr>
<tr>
<td></td>
<td>Civil Aviation Civil Aviation of</td>
</tr>
<tr>
<td></td>
<td>China International Carriage of</td>
</tr>
<tr>
<td></td>
<td>Goods</td>
</tr>
</tbody>
</table>

#### For example, the financial system

<table>
<thead>
<tr>
<th>Urban road construction financial system</th>
<th>Road construction financial system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban construction and maintenance tax</td>
<td>Construction loan</td>
</tr>
<tr>
<td>Land transfer</td>
<td>repayment charges</td>
</tr>
<tr>
<td>- By the city government</td>
<td>Gasoline tax (the original road</td>
</tr>
<tr>
<td>finances, Local government</td>
<td>maintenance)</td>
</tr>
<tr>
<td>financing platform</td>
<td>- By the company or by a</td>
</tr>
<tr>
<td></td>
<td>higher traffic department</td>
</tr>
<tr>
<td></td>
<td>in charge of finance</td>
</tr>
</tbody>
</table>

#### For example, fare policy

<table>
<thead>
<tr>
<th>Public transport fares policy</th>
<th>Road transport fare policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combining government finance (subsidies) and corporate finance</td>
<td>Enterprise -based costing</td>
</tr>
</tbody>
</table>

5.3 Research on big data of urban transportation

The aim of urban transport information cannot stop for the purpose of advancing intelligent transportation technology, but it should be consistent with the overall development goals of the city in order to study the combination of information technology and urban traffic. During the process, we should comprehensively consider public, private, civil society, and other different requirements, generally, to establish information sharing mechanism, promote research development directions and development policy concerning transportation information technology. The key is to establish the information service system of open city traffic network as an important part of urban traffic, and consider the concept of an “open, sharing, collaborative” platform as the key link to complete the above-mentioned objectives.
Collaborative optimization method for construction and operation of urban traffic network of mega and large central city or metropolitan area, under information environment is also a promising area. Relying on mobile internet, big data, cloud computing and other emerging information technology, the method is to integrating all kinds of data resources. Around the city circle formed by the central city, the urban core area and the urban and regional transportation connection, the focus is on proposing a collaborative optimization approach to the construction and operation of urban traffic network in the metropolitan area of mega and large central cities.