

## URBAN TRANSPORT DEVELOPMENT AND ENVIRONMENTAL PROTECTION IN SHANGHAI

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**Abstract:** Generally speaking, there must be advanced transport, perfect infrastructure, rational city layout, good environment, modern service level and moderate density of population in an international metropolis. Among them transport and environmental conditions are particularly outstanding factors to be considered both at the present and in the future. In the paper, firstly, great changes of Shanghai urban transport system in road framework, passenger transport and person trip demand during the past ten years are analyzed. Secondly, based on the evaluation index and Chinese National Code for Urban Transport Planning, the policy, developing direction and contents of the transport in Shanghai urban areas in the 21st century are exposed. Finally, the author puts forward that with the continuous development of urban transport in Shanghai, the environmental pollution gets more and more serious. So besides the generally defined criteria of providing safe, comfortable and convenient transport services at all levels with high quality, environmental protection should be included in the assessment of urban transport plans in Shanghai. Three aspects are especially to be considered: (1) Protection of Culture Environment of the City; (2) Protection of Clean Air; and (3) Elimination of Noise Pollution.

### 1. INTRODUCTION

Shanghai at the 21st century has unprecedented favorable opportunities for development. Yet it also meets with the most severe challenges never met before. It has become the common acknowledgment that Shanghai should be built into an international level metropolis. Generally speaking, there must be advanced transport, rational city layout, good environment, modern service level and moderate density of population in an international metropolis. Since 1949, Shanghai has made great achievements in urban construction. Various infrastructures have been improved. But due to some historical and economical reasons, Shanghai is facing a series of problems including vicious expanding of urban areas, disorderly high buildings, old and obsolete infrastructures, traffic congestion

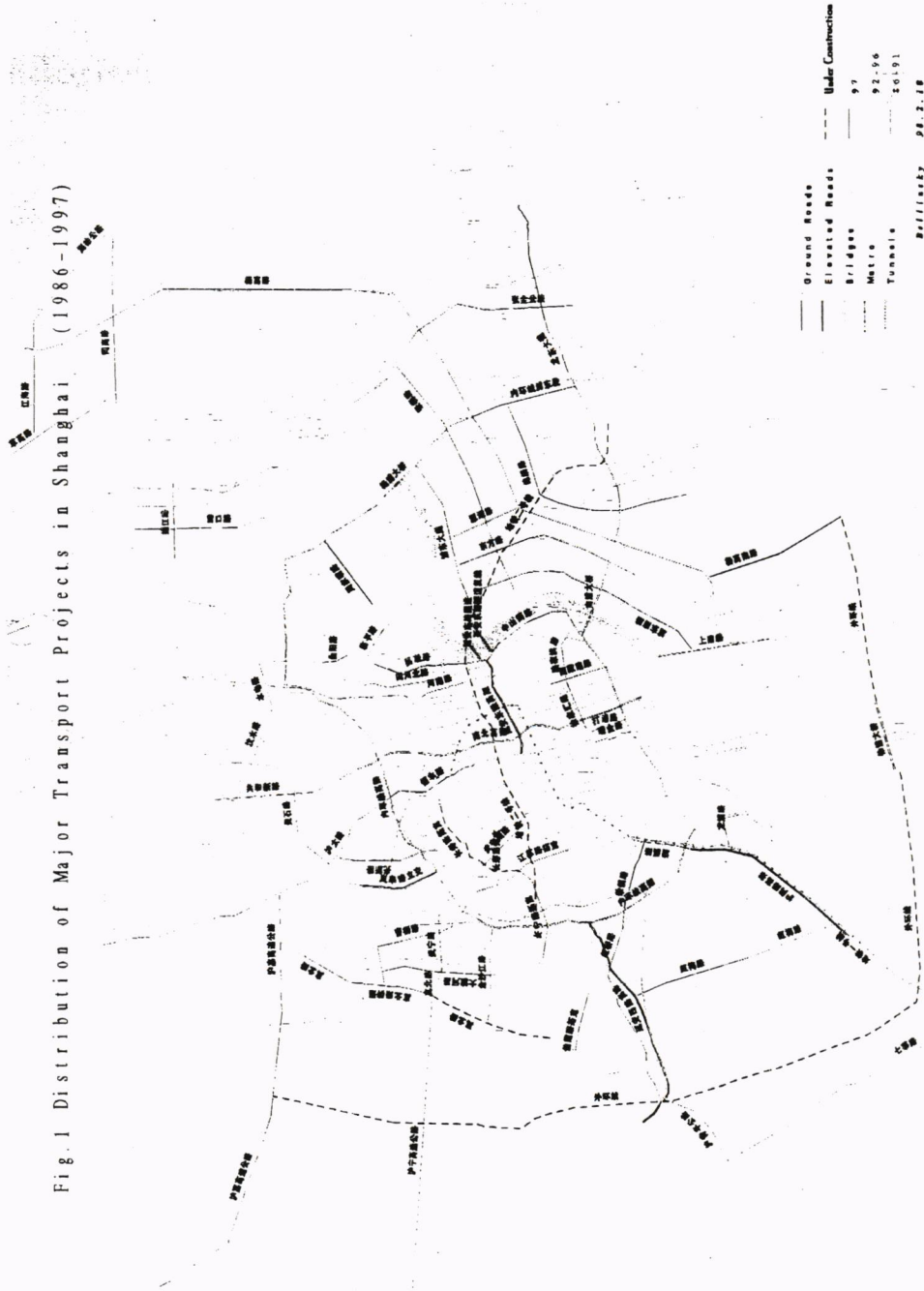
and environmental deterioration. Although they have been improved to some extent in the last 10 years, yet comprehensive functions of the city could not be made full play because of too many outstanding accounts of infrastructure innovation and accumulated problems. Transportation particularly hasn't been correctly understood and treated for a long term. So the contradictions of transportation have become the no. 1 economical and social problem that restrain the further development of Shanghai. To make great leap forward in development, it is quite urgent for Shanghai to formulate various policies for overcoming its own weakness, continuously adjust the structure of land use, improve infrastructure, and especially pay attention to transportation by working out a series of effective short-term and long-term comprehensive transport planning. Meanwhile, environmental protection should be attached great importance to in the process of transport improvement. Only by this way Shanghai might stride into the rank of international level metropolises through long and constant efforts.

## **2. TRANSPORT EVOLUTION OF SHANGHAI IN THE LAST TEN YEARS**

From 1986 to 1995, the characteristics of transportation system in Shanghai changed dramatically. On one hand, the facilities of traffic supply in the urban areas was greatly improved. The municipality government spent nearly 80 billion Yuan RMB (Chinese Dollars) on the construction of metro, highways and streets. Roads in the urban area increased from 1330 km to 3008 km. Roads in the city rose from 3300 km to 5400 km. In the 10 years, transport construction developed greatly (Shown in Fig. 1). The transportation of Shanghai has gradually formed an integrated multi-level system. On the other hand, traffic volume increased quickly. The ownership of motorized vehicles in Shanghai grow from 160 thousand to 420 thousand (excluding the motorcycles only allowed to operate in the suburban areas).

### **2.1 Road Framework in Shanghai Urban Areas Becomes More Strengthened**

Through several hundred million investment, Shanghai has built large quantities of framework road facilities, which include 90 km expressways, 37.2 km urban elevated roads, 5 bridges and tunnels with 28 motorized vehicles for crossing the Huangpu River and 10 large-scale urban interchanges. The tension of urban transport is relieved to some extent (See Table 1). So the social economical development in Shanghai has been promoted.





**Table 1. Road Transport Facilities in Shanghai**

|                                               | 1985 | 1990 | 1995 |
|-----------------------------------------------|------|------|------|
| Road Length (km)                              | 3300 | 4700 | 5400 |
| Road Area Per Capita (m <sup>2</sup> /person) | -    | 4.5  | 5.7  |
| Road Capacity (10,000 vehicle km/h)           | 200  | -    | 400  |
| Vehicle Flow (10,000 vehicle km/day)          | 1400 | -    | 2000 |
| Motorized Vehicle (10,000)                    | 14   | 21   | 42   |
| Bicycle (10,000)                              | 370  | 545  | 750  |

## 2.2 Urban Passenger Transport System Is More Modernized

Recent years with the adoption of competition mechanism in urban passenger transport system, passenger transport in urban areas of Shanghai becomes comprehensive. Particularly with the rapid development of special lines (medium size coaches, small coaches and air conditioned buses) and construction of metro, regular transit shrinks and the proportion of transit has reduced year by year. The highest peak of transit volume in Shanghai was in the year 1985 (13.2 million trips/day). In 1992, the trips was reduced to 10.98 million trips per day. With the cancellation of monthly tickets in 1996, the trips further reduced to 5 million trips per day. Instead, other passenger transport modes such as special line coaches and metro take certain proportion.

**Table 2. Passenger Trips Undertaken by Different Transit Modes in Shanghai**

| Modes                        | Daily Transport Volume( x 10,000 persons) |      |      |
|------------------------------|-------------------------------------------|------|------|
|                              | 1986                                      | 1992 | 1995 |
| Urban Area Bus & Trolley-Bus | 1223                                      | 1015 | 696  |
| Shuttle Bus                  | -                                         | 14   | 104  |
| Metro                        | -                                         | -    | 23   |
| Long Distance Suburban Bus   | -                                         | 84   | 66   |

## 2.3 Trip Demand of Shanghai Citizens Becomes Diversified

From 1986 to 1995, motorcycles and taxis in Shanghai developed rapidly. The ownership of motorcycles in the city rose from 20232 to 84761 (4.2 times); The ownership of taxis grew from 7493 to 36991 (4.9 times). So the trip modes of the citizens became diversified. Meanwhile due to the year by year reduction of the transport volume undertaken by regular transit, trip modes of citizens gradually transferred to bicycles and so on.

**Table 3. Percentage of Urban Area Person Trip Modes for Shanghai**

| Year | Walking | Transi | Passenger Vehicl | Taxi | Motorcycle | Bike   | Others | Total |
|------|---------|--------|------------------|------|------------|--------|--------|-------|
| 1986 | 36.6    | 35.2   | 2.41             | 0.2  | 0.08       | 24.9   | 0.6    | 100   |
| 1995 | 36.5    | 22.9*  | 3.1              | 1.5  | 1.4        | 34.4** | 0.2    | 100   |

\* Including metro.

\*\* Including moped.

### 3. TRANSPORT IN SHANGHAI URBAN AREAS IN THE 21ST CENTURY

In the first part of the paper, the fact that in the course of entering urbanization the city of Shanghai developed rapidly, which pushed forward the modernization of society and economy. Yet, transportation problems have always been pestering the urban area of the city. As roads and bridges were constructed considerably, yet motorized vehicles increased greatly and traffic congestion and pollution of emission have got more and more serious. So how to solve transport problems has been hot topics of the society. "Chinese National Code for Urban Transport Planning" was promulgated under such conditions in 1995. The purpose is to guide transport development in Chinese cities by means of legal documents. The contents cover each aspect of urban transport, including bicycles, walking, highways and parking lots. Based on the evaluation index in "Chinese National Code for Urban Transport Planning", the policy, developing direction and contents in Shanghai urban areas in the 21st century is exposed in this part.

#### 3.1 Transport Policies of Shanghai in the 21st Century

In order to solve traffic problems in Shanghai as soon as possible and fundamentally establish essential structure of modern transport facilities, by studying Shanghai has decided a series of policies (Lu Ximing, 1995):

- Strengthening road construction;
- Giving priority to the development of transit system;
- Greatly developing the system of rail passenger transport;
- Appropriately developing truck transport;
- Giving prominence to solving the contradiction of parking in the urban areas;
- Controlling traffic demand and enhancing traffic management;
- Integrating intra transport with inter transport;
- Modernized leading construction of Pudong New Area.

### 3.2 Transport Structure of Shanghai in the 21st Century

The basic requirement of an appropriate traffic structure is that under the guidance of proper transport policies with a series of traffic measures the proportion of transport means in the city reaches the optimal and most stable balance so as to avoid traffic congestion in the urban areas.

The planned transport structure of Shanghai in the 21st century (Chen Xiaoyan, 1996) is as follows:

- **Closed Busway:** Within the area of the inner ring road a closed busway transit system will be built, which stresses on relieving the difficulty of taking buses in the central city and strives by every means to gain benefit in three or four years. The system consists of six lines with a total length of 60 km and 43 stations.
- **Freight Transport:** Outside the inner ring road, there is an outer ring road. The two ring roads basically are the dividing line of old and new areas of Shanghai urban areas. The layout of the street network within the inner ring road is basically orthogonal. While the roads outside the inner ring road are radial (Except for the roads in the developed zones of this area, which are still orthogonal). And thus a combined road system is formed.  
The freight transport will mainly be moved out of the inner ring road through gradual adjustment of land use (In the central city, passenger transport will be mainly developed).
- **Rail Transport:** Shanghai has a high density of population and its social characteristics possess great power of traffic attraction. Thus transport sources is rather strong while land use is limited. For this reason, urban passenger transport will persist in giving priority to development of public transport, especially develop rail transport into an framework of urban public transport system.  
The total length of rail transport in Shanghai will be 415 km, of which metro accounts for 284 km, light rail accounts for 131 km.
- The layout of rail transport network will be annular radial, which supplements the ground orthogonal network so as to raise the accessibility of medium and long distance journey. Most metro lines are diametrical lines passing through the whole urban area of the city or circular ring in the middle part of the urban area. The metro lines are all surpasses 30 km, responsible for medium and long distance passenger transport in Shanghai. Light rails, acting as complement of metro, principally distribute in the central city (There the traffic demand is rather high but it is difficult to build metro.) and are responsible for medium distance passenger transport.

### 3.3 Criteria for Evaluating Transport of Shanghai in the 21st Century

Generally the criteria for evaluating transport level in Shanghai is to provide safe, comfortable and efficient transport service with high quality in all directions at multi-levels.



“Safety” has two meanings: One refers to safe journey for passengers on the vehicle; The other is that on the journey collision among pedestrians, bicycles and other traffic means should be avoided, which has close relation to vehicle structure, roads conditions, transport facilities, traffic regulations and other relevant countermeasures.

“Comfortable” refers to creating good traffic environment. The specific measures include building mall and reducing the density of passengers in buses or trolley-buses from the existing 11 persons/m<sup>2</sup> to 5~6 persons/m<sup>2</sup> by increasing the vehicle frequency of similar passenger transport volume.

For different classes of urban roads, “accessibility” has different requirements:

Express and rapid arterial roads: The design vehicle speed is 80~120 km/hour. The width of red lines is 50~100 m. They are mainly two ring roads and peripheral express highways that heading for the main city.

Major arterial roads: The design vehicle speed is 50~60 km/hour. The width of red lines is 40~80 m. They are mainly three west-east and three north-south arterials (within the inner ring road), supplementary lines in some areas and part of radials (outside the arterial road) extending from the urban area to suburban areas.

Sub arterial roads: The design vehicle speed is 40~50 km/hour. The width of the roads is 24~40 m. They are mainly for local connecting.

Local roads: The design vehicle speed is 25 km/hour. The width of the road is below 24 m. They all distribute in the urban area extending to each place to serve people's daily life and other activities.

#### **4. ENVIRONMENTAL PROTECTION**

With the continuous development of the urban transport in Shanghai, the impacts of transport on environment become more severe. No matter what the urban natural environment (geography, layout, climate and vegetation) or human geographical environment (history, culture, folk custom, important policies and regulations), all greatly get affected by some aspects from transportation. Hence, in the gradual formation of future modern transport structure, environmental protection should be paid great attention to and the elements of environment should be listed in the index of the 21st century transport of Shanghai.

#### 4.1 Protection of Urban Cultural Environment

Urban cultural environment has meanings in three aspects (Huang Chengyuan et al., 1998): (1) urban cultural environment is the psychological environment of the personality of urban citizens; (2) urban cultural environment is the common cultural and intellectual system of urban citizens; and (3) urban cultural environment is the medium and means for urban citizens adapting themselves to ecological circumstances. Only by considering personality characteristics and psychological needs can transport planning create good urban environment. For instances: The overpass of East Ya'an Road at the Bund in Shanghai doesn't leave a good impression on citizens. The beautiful landscape of the Bund is one of the "symbol" of Shanghai, which attracts thousands and millions of residents and visitors from other cities and provinces. But the external form of the overpass is dull and its color is grey, which is uncoordinated with the style of architectures at the Bund and thus affects the architectural culture of Shanghai urban areas and the personality psychology of residents.

#### 4.2 Protection of Urban Air

The existence of human beings needs air. Clean air usually consists of nitrogen (78%), oxygen (21%) and argon (1%). Yet because of human activities, many harmful elements add in the air. They impair human health and harm plants. The emission of vehicles is the main air pollution source, which has been paid great attention to by some developed countries. For example: America has established "Clean Air Act" to standardize transport planning. In recent years at many intersections of Shanghai the average daily concentration of CO and NO<sub>x</sub> surpasses the 2nd class standard of atmospheric quality. So the diseases such as chronic bronchitis, bronchial asthma and pulmonary emphysema increase dramatically.

The phenomenon mentioned above arouses the concern of Shanghai citizens as well as other relevant agencies. Since 1997, Shanghai Environmental Monitoring Center has started to release "Weekly Report on Shanghai Air Quality" in one of the most popular newspapers, Wenhui Daily. From the beginning of 1998, the weekly report has been changed to daily report. Table 4 is the English version of "Daily Report on Shanghai Air Quality" issued on Wenhui Daily on Sept. 10, 1998.

**Table 4. Daily Report on Shanghai Air Quality**

| September 10, 1998                        |                    |                 |                 |
|-------------------------------------------|--------------------|-----------------|-----------------|
| Index                                     | General Suspension | SO <sub>2</sub> | NO <sub>x</sub> |
| Pollution Index (API)                     | 51                 | 23              | 66              |
| Classes of Air Quality<br>(GB3095---1996) | II                 | I               | II              |
| Description of Air Quality                | Good               | Excellent       | Good            |



### 4.3 Elimination of Noise Pollution

Many countries in the world have worked out environment noise standards. America, Japan, Germany and Swiss have made similar environment noise standards. China issued Noise Standards for Motorized Vehicles in 1997 and promulgated environment noise standards for urban areas in 1981. Shanghai is the most serious noise polluted city in China and at the present it is difficult to implement the national standards. Hence, interim standards have been worked out. The main contents (Zhou Shangwu et al., 1988) are as follows:

**Table 5. Environment Noise Standards for Shanghai Urban Areas**

Unit: Classes of Noise Levels  $Leq$  dB(A)

| Areas                              | Daytime<br>(7:00~19:00) | Morning & Evening<br>(5:00~7:00) and (9:00~23:00) | Night<br>(23:00~5:00) |
|------------------------------------|-------------------------|---------------------------------------------------|-----------------------|
| Special Residential Quarters       | 50                      | 45                                                | 40                    |
| Residential Quarters & Schools     | 55                      | 50                                                | 45                    |
| Commercial Residential Quarters    | 60                      | 55                                                | 50                    |
| Residential Quarters for Factories | 65                      | 60                                                | 55                    |
| Both Sides of Arterial Roads       | 75                      | 65                                                | 55                    |

The serious transport problems in Shanghai urban areas result in strong noise pollution, which is greatly harmful to citizens both physically and psychologically. People who are under conditions of high dB noise for a long period of time are likely to have heart disease, to become agitated in mood and weak in nerve, and thus normal work and living are influenced. The monitored results of traffic noise in 1992 showed that the average level of noise by road transportation in the urban areas of Shanghai reached 75.2 dB(A), and on the arterials the level of noise was higher than the standard of 70 dB(A) set in the GB 3096 (Xia Ming et al., 1993).

## 5. CONCLUSIONS

Urban transport in Shanghai has made rapid progress in the recent ten years and surely will be developed much more in the future. Yet with the continuous development of urban transport, its impacts on environment will get serious. So besides "safety", "comfortable" and "accessibility", some important index for environmental protection should be considered in the evaluation of the 21st century urban transport so that the city of Shanghai might enter the ranks of international level metropolis stably and healthily.

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