
Challenges and Policy Options for Sustainable Urban Transportation Development in China

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Abstract

China's urban transportation system is facing increasing pressures caused by rapid urbanization and motorization. This paper provides an overall analysis on the current status and development trend of China's economy, urbanization, and motorization, and presents the challenges facing sustainable urban transportation development in China. In order to meet the future transportation demands, this paper will discuss strategy and policy recommendations such as integrating transportation and land use planning as well as increasing the priority for and ability to implement both public transportation and travel demand management.

Key words

Sustainable, public transportation, mobility management

1. Introduction

Currently, transportation-related issues in China such as traffic congestion, environmental pollution, energy consumption, and social equity are becoming increasingly problematic. The fast development of China's economy is creating significant excess in demand for transportation (particularly for personal automobiles) and the networks/infrastructure cannot provide enough supply capacity. Rapid increases in traffic volume, congestion, and pollution have resulted, and the public's expectations for personal automobile transportation are only getting higher. These expectations are being fueled by the increased wealth being generated from rapid economic development, particularly in Chinese cities. Therefore, it is becoming increasingly urgent for China to develop and implement an efficient and sustainable urban transport system within the next two decades. The projected increasing pressures from China's immense population and economic development on natural resources and energy supply creates an unsustainable situation that needs to be remedied, particularly with respect to Chinese transportation demands. Both scientific and socially-based strategies and policies will be needed to guide the development of China's urban transportation system which take into full consideration the rapid urbanization and motorization in China.

2. Analysis on the Current Status of China's Urban Transportation Development

Chinese people are moving to the cities at increasing rates, with more than 42% of the nation's population living within China's 660 metropolitan regions in 2004. At that time, there were 11 cities with more than 4 million inhabitants, 22 cities with 2 to 4 million inhabitants, and 141 cities with 1 to 2 million inhabitants. In 2004, urban roads measured 222,000 kilometers, with 10.34 m² road space per capita on average. The length of urban rail transit system was about 400 kilometers. The public transportation vehicle ownership was 8.41 per 10,000 people (City construction year book, 2004). Although the metropolitan transportation infrastructure has been significantly improved throughout many Chinese cities, a huge gap in the metropolitan transportation infrastructure still remains when comparing China to more developed countries.

Along with the rapid urbanization and mobilization in China, a series of issues are severely affecting people's quality of life, such as traffic congestion in urban areas, traffic accidents, environmental pollution, and resources shortages, among countless others.

China currently has five of the ten world's most polluted cities (Fan Bingquan, 2006). Transportation pollution has become the biggest pollutant source for China's urban environment; air quality research in China has determined that 60% of air pollution found in urban areas comes from motorized vehicle emissions. A 2003 survey of traffic noise in 401 Chinese cities shows that the percentage of cities with noise levels exceeding standards is as high as 20.9 percent (CCICED report, 2005).

Petrol consumption in China reached 300 million tons in 2005, with 42% being imported. Vehicles use more than one-third of the overall petrol consumption in China

and that proportion is growing rapidly; it is expected to reach nearly 60% by 2020 (CCICED report, 2005) (see Figure 1).

More frequent traffic accidents and corresponding economic losses are now heavily threatening China's transportation development. There were 540,000 traffic accidents in 2004 with 110,000 deaths, 480,000 casualties, and ¥2.4 billion in losses. The vehicle and accident death rates in China are 10 times that in developed countries (see Figure 2).

Traffic congestion has become the major inhibitor of China's economic development. The economic loss caused by traffic congestion in China's mega-cities (e.g. Beijing, Shanghai, etc.) is estimated at more than several hundred billion Chinese Yuan (30-50 billion U.S. dollars). It is reported that Shanghai suffered a GDP loss of 10% due to traffic congestion. Traffic congestion also results in high logistic costs. China's logistic cost is ten times higher than the U.S., and the percent cost of GDP is double that of the U.S. (see Figure 3).

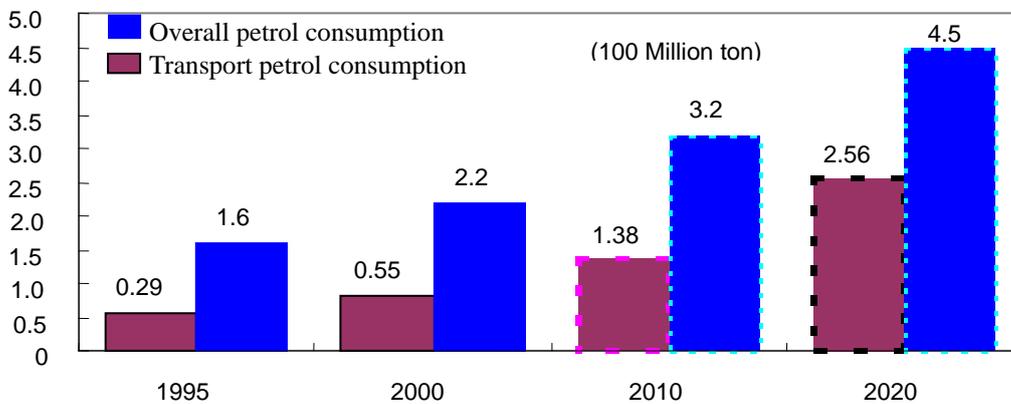


Figure 1 Petrol consumption in China

Source: Sustainable Transportation Development in China: policy Recommendation Draft.

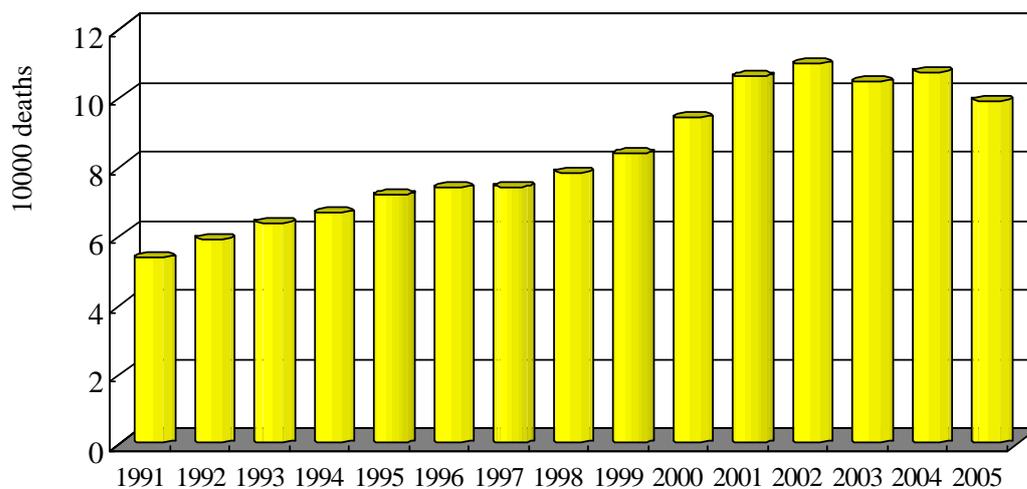


Figure 2 Number of deaths due to traffic accidents

Source: Sustainable Transportation Development in China: policy Recommendation Draft.

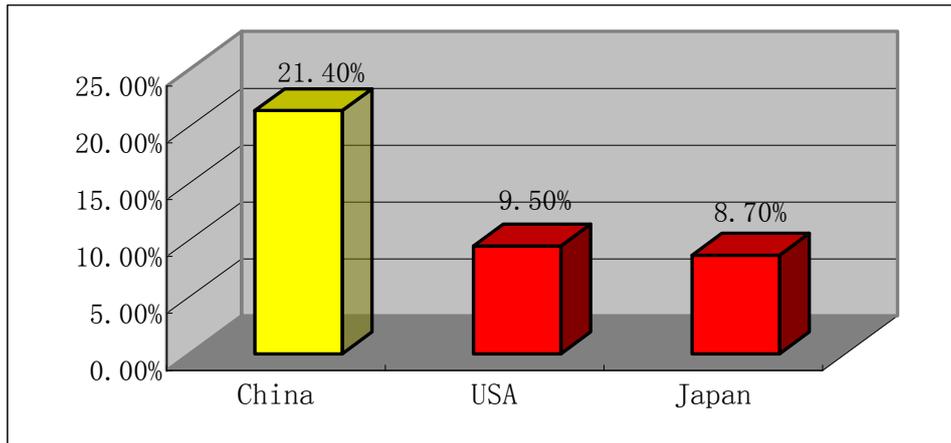


Figure 3 Logistics Cost in China, U.S. and Japan

Source: Sustainable Transportation Development in China: policy Recommendation Draft.

3. Challenges for China Urban Transportation Development

In 1992, the Chinese government promised the United Nations that they would fulfill "Agenda 21st century". In March 1994, the State Council published "China's Agenda for 21st Century", which established the following sustainability objectives for China's cities: rationally distributed and planned, accessible auxiliary facilities, clean, beautiful, and comfortable with a quiet living environment.

In recent years, the central government of China proposed to focus on building an economically prosperous and sustainable society by significantly improving the ecological environment, bringing about harmony between people and nature, and catalyzing the whole society to take a healthy and sustainable development path while improving the standard of people's living quality. This has brought forth many new demands for transportation development in China. The past 20 years has seen a rapid increase in passenger and freight transport accompanied with the GDP growth, and this correlational trend is expected to continue into the coming 20 years. See Figure 4 and Figure 5.

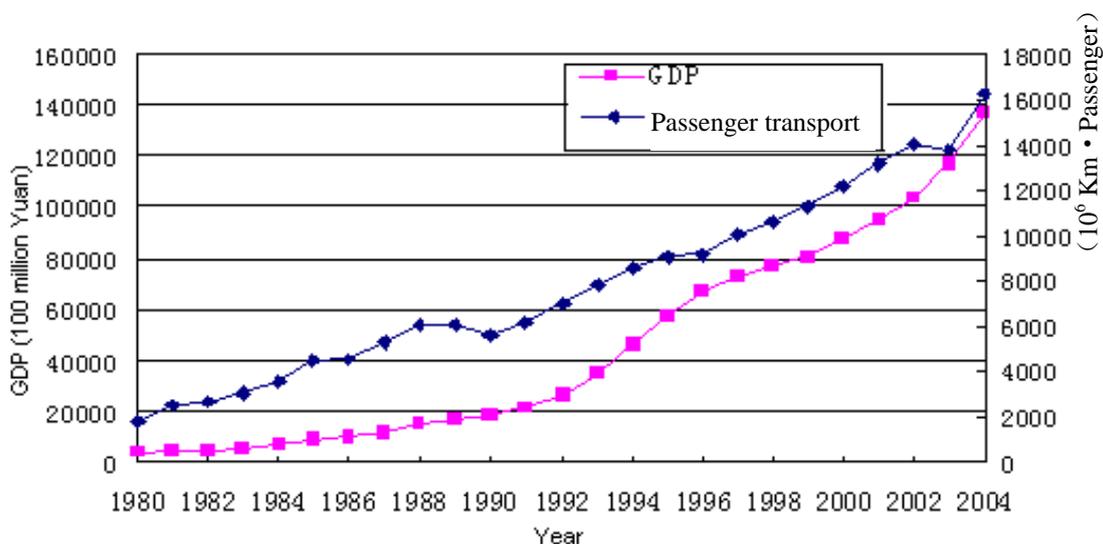


Figure 4 Passenger Turnover Volume Per Capita GDP

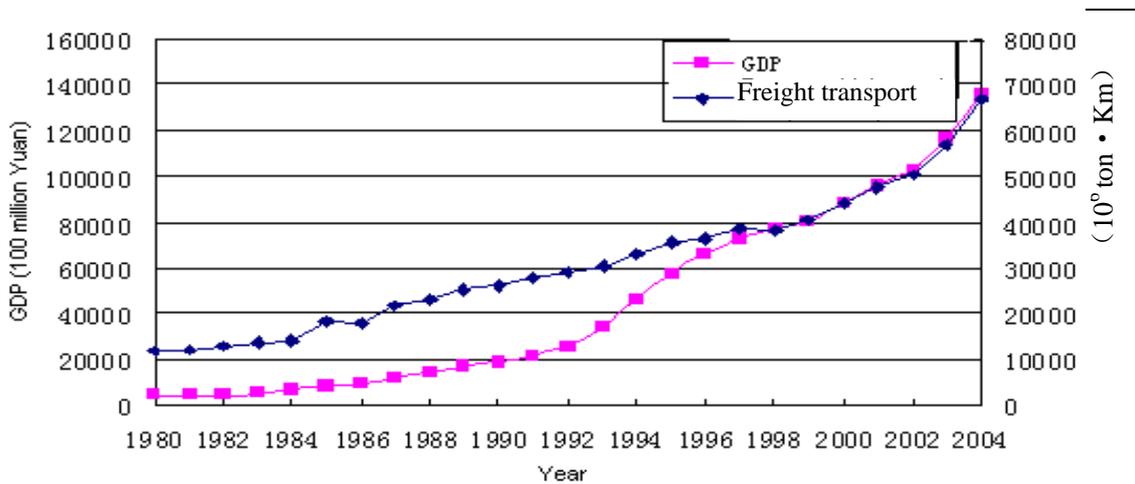


Figure 5 Freight Turnover Volume Per Capita GDP

Sources of Figure 4 and Figure 5: China Statistical Yearbook 2003 and International Statistical Bureau website of People's Republic of China.

In the first twenty years of this century, China's annual economic growth rate is projected to remain above 7.2 percent. Total gross national product will reach two important stages of US\$2 trillion in 2010 and US\$4 trillion in 2020. Passenger and freight transport will keep increasing simultaneously with GDP in this period. The estimated passenger transportation demand in 2020 will be three times the demand level experienced in the year 2000; freight transportation demand will be twice that of the year 2000. The projected growth rate of passenger transportation will be faster than that of freight transportation (see Figure 6).

The 11th Five Year Plan sets the goal for China's GDP per capita to double between 2000 to 2010, while also requiring a 20% decrease in resource consumption per unit GDP as referred to in the 10th Five Year Plan. Not only would transportation have to stop the increase in oil and natural resource consumption, it would actually have to decrease consumption by 20% as well as stay ahead of demand from other sectors to maximize the efficiency of the entire economic system.

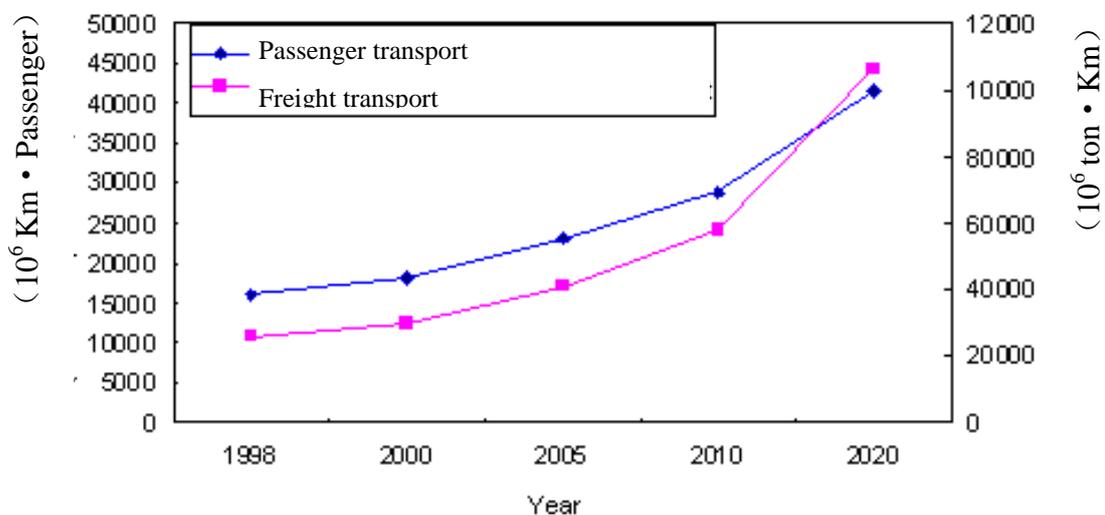


Figure 6 Projections for Passenger and Freight Transportation Demand in China

Source: Sustainable Transportation Development in China: policy Recommendation Draft.

China has experienced rapid development and urbanization since the opening and reform policy being carried out in 1978 (see Figure 7). As previously mentioned, the urbanization rate was 42% in 2004, and is expected to reach 57% in 2020, with the current urban population of 830 million continuing to grow by approximately 80 million each year as rural residents relocate to urban areas. This level of urbanization brings huge transportation demand between urban and rural areas and requires much more transportation capacity, both on the inter-city and intra-city level. Therefore, it is wise to design the transportation structure to accommodate an integrated transportation system connecting urban and rural areas.

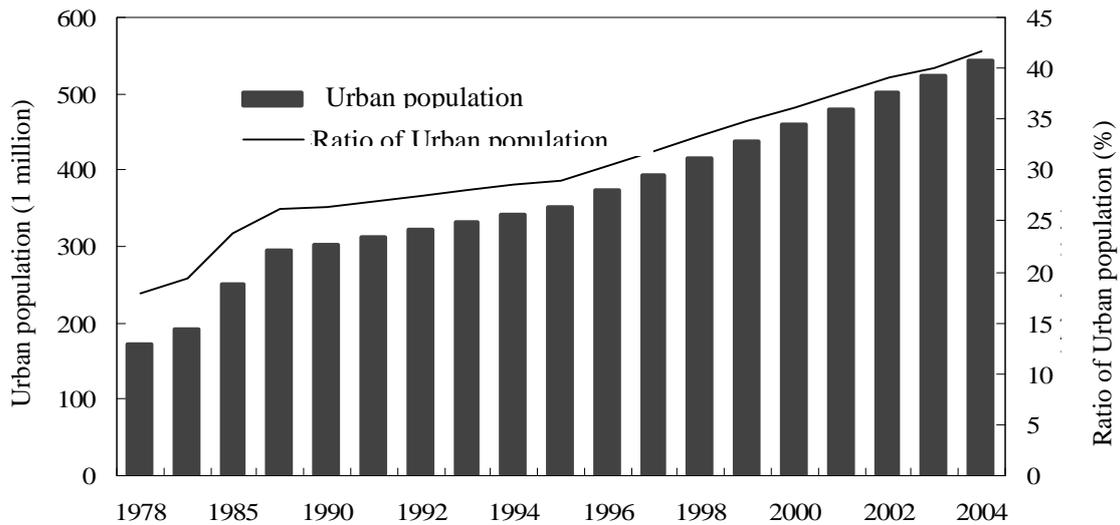


Figure 7 Urbanization Percentages in China

Source: *China Population Statistics Yearbook*

The motorization level continues to increase and the growth in private car ownership far exceeds the growth in GDP for the same time period. In 2004, the number of commercial vehicles (taxis, trucks, etc.) was 27.1 million, and there were over 10 million private cars (CCICED report, 2005) (see Figure 8). By 2020, the motorized vehicle population is expected to reach 130 million. With rapid motorization come many significant challenges for urban transport planning and construction.

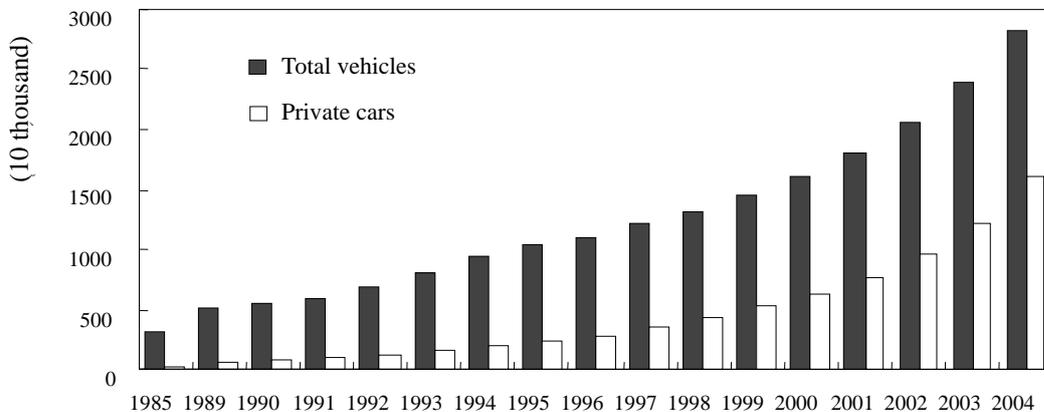


Figure 8 Possession of private vehicles from 1950 to 2001 in China

Source: *China Population Statistics Yearbook*

Along with the economic development and improvement of China's standard of living, the transportation system must not only meet the travel demand, but also must accommodate the increasing expectations for better service quality such as accessibility, safety, and efficiency, all at a lower cost.

It is estimated that there are roughly 500 million "disadvantaged" people in China, including: 60 million disabled, 88.1 million elderly, and 45 million poor people. Disadvantaged groups have special transportation needs and since social equity is of increasing concern, more convenient, economical, and safe transportation conditions should be provided in order to reduce the gap between transportation service quality for the "advantaged" and "disadvantaged" groups.

4. Goals for Sustainable Urban Transportation Development in China

The current urban transportation system in China is unable to meet the demand of social and economic development. Furthermore, the conflict between economic and transportation planning institutions and the open-market system inhibits sustainable development. The upcoming 20 years is a crucial phase for sustainable urban transportation development in China. China needs to take strong strides toward implementing a sustainable and practical development strategy before motorization problems become too difficult to manage or mitigate. China has a history of repeating transportation mistakes that other development countries have made, so new development strategies must incorporate international knowledge and learning experiences in order to be most effective for achieving sustainability. China's overarching goal for developing sustainable urban transport will adapt some more universal international definition and value statement to China's current status (a developing country with rapidly expanding urban transportation systems). This will help China to build transportation systems that meet the safety, efficiency, economic, coordination, and environmental needs to create socially and economically sustainable cities. In other words, policymakers must keep transportation's use of resources and impacts on the environment within nationally- and internationally-acceptable levels while keeping in mind their required duty to provide a safe, high quality service, not only for the benefit of citizens, but also for the economy and environment.

5. Policy options for sustainable urban transportation development in China

China's current urban transportation policies must be reviewed using social, financial, environmental, and institutional sustainability as the primary topics for analysis. The main aspects needed for policy to support and complement China's development of sustainable urban transportation are as follows:

(1) Promote institutional integration of urban transportation management

Fragmented institutional management of urban transportation has been a main obstacle for China's sustainable urban transportation development for a long time. Currently, there is no standardized system for managing urban transportation. Different departments within government and industry manage different aspects of transportation. The task of managing transportation system is divided among various governing

institutions according to the different transportation modes. This management system was formed during the planned economy era and was considered practical at that time. The management is typically handled by several departments and here are two main forms: first, the authorities jointly manage urban construction, transportation, public affairs, and public safety, etc; second, there is a single transportation authority that manages both the urban and rural roads, which often includes public transportation. Without a standardized and ordered management system, urban transportation management will continue to be divided among different regions and authorities, and therefore is destined to remain inefficient. Forming a unified, effective management system is imperative.

The constantly changing government responsibility and functions make it beneficial to form an integrated transportation administrative organization to manage all aspects of urban transportation in the quest for sustainability (through simplification, integration, efficiency, etc.). Institutional transformations have occurred during the implementation of the “One City and One Transportation Administration” vision in several Chinese cities, including economic hubs such as Beijing, Shanghai, Chongqing, Shenzhen, and Chengdu, etc. The newly formed administrative organizations integrate relevant departments from the city council, communications departments, public security, and other various transportation administrations. The newly formed conglomerate transportation authority in each of these cities has pursued the management strategy that deals with urban transportation as an integrated, dynamic, and interrelated system. The new Bureau of Communications in Chengdu is shown in Figure 9. The “One City and One Transportation Administration” vision consists of a series of features: consistency of strategy and policy, establishing standards in integrated transportation planning, enhanced supervision and evaluation, encouraging new solutions and resources sharing, integrated administration of urban transportation including regulation, infrastructure, traffic control, public transportation operation, and so on.

Building databases for sharing urban transportation information is another important institutional task. A special administrative department should be set up based on formulating the transportation survey system and uniform survey standard. It can wholly manage the survey work and publishes survey outcomes to planning, research and administration organizations to ensure the maximum effectiveness of resource using. Moreover, an evaluation system should be developed beyond existing systems to better analyze the impacts of major construction projects on transportation.

(2) Policy for integrated development of transportation and land use

Urban transportation planning in China was handled initially by a separate institutional section. There are different departments in charge of land use, transportation and city planning in Chinese cities. Therefore, there is little coordination between transportation and urban planning, and thus, the systems are not effectively or efficiently integrated. This institutional organizational structure does not allow for consideration of the impacts of urban layout on transportation, nor the feedback of the transportation system to urban development. Planning for new transportation infrastructure also does not take into account of the need for integrating old districts into the developing system,

which further aggravates traffic, noise, and general transportation inefficiencies and undesirables.

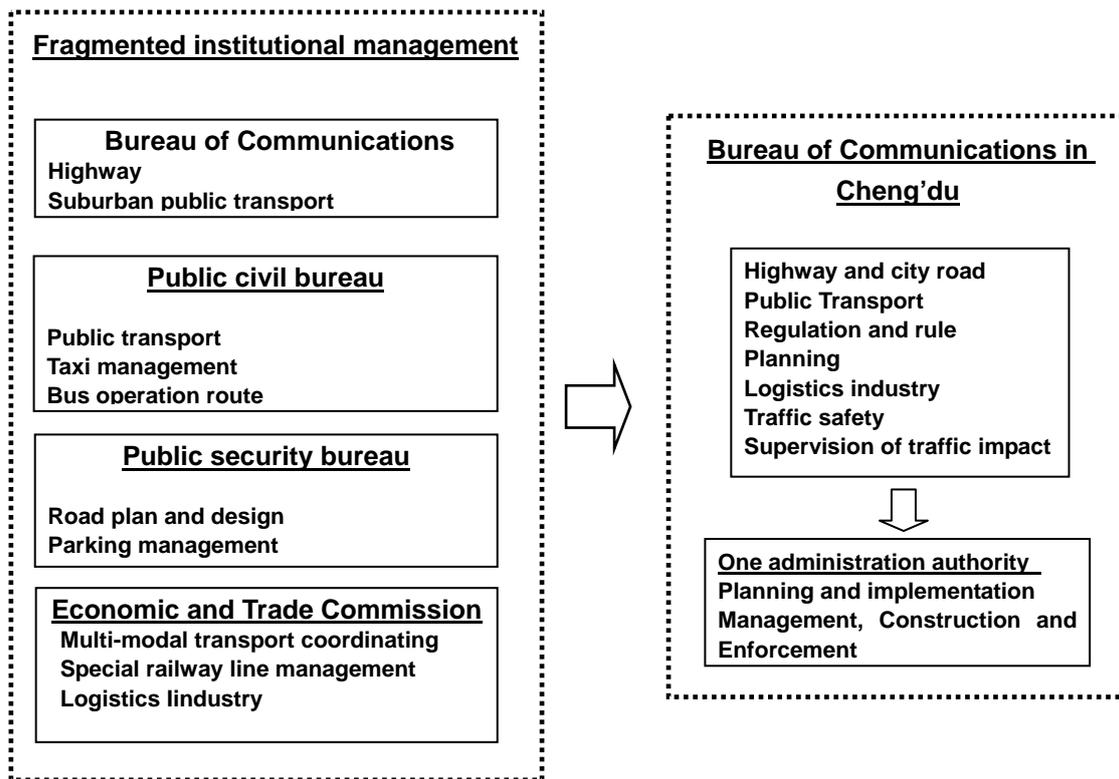


Figure 9 Integrated Transportation Administration Structure in Chengdu

Many cities in China have not used an integrated planning model for urban transportation, and have not even begun to factor in the effects of important transportation areas on future projects. Transfer between different transport modes in many cities is extremely inconvenient. In China on average, half of the trip time is spent outside the vehicle (walking to stations, waiting for vehicles, transferring, etc.). Development occurring in these key transportation areas (particularly multi-modal areas) continues to lack coordination with the development of the city's overall road capacity which has exacerbated the transportation transfer problem. For instance, the airport road and the areas near Guangzhou Railway Station and Guangzhou East Railway Station suffer from heavy congestion resulting from lack of planning for intermodal traffic. In addition, additional negative outcomes result from both the perceived and real inconveniences of transferring between different modes that encourages passenger vehicle travel leading to further overcrowding of city roads. The need for transfer was not considered in designing city's highway entrances and exits, and parking lots and interchanges were not designed to promote car traffic to switch to/from public transportation, nor is traffic or driving in general currently being controlled or regulated (e.g. no fuel taxes, few tolls, etc.). In consequence, city traffic coming from outside the urban core has extended its impact along the entire traveled route connecting to the city's internal transportation infrastructure. Insufficient opportunities for transfer also provide a big market for illegal transportation operators, which further deteriorating traffic and even causing public security problems.

With the aim of achieving urban-rural integration and overall comprehensive transportation integration, the mechanism of integrated urban transportation planning should be established to complement urban community development. It is necessary to establish a comprehensive and coordinated integration system for land use and transportation planning and implementation in China. The government should guide urban development by creating a regional development plan which balances transportation, land use, etc. in a sustainable manner, while perhaps encouraging strategies like multi-center urban layouts if deemed sustainable. Spatial design should be of particular importance with the various urban functions being inter-accessible (housing, employment, commercial, etc). The planning process itself needs to be fully developed with established protocols to make sure that development commences only when the majority of stakeholders (developers, residents, environmentalists, etc.) have agreed on the project or design plan.

It is of great value for Chinese large cities to build transportation corridors that are flexible and compatible with multiple modes of transportation (both presently and projected for the future) and promoting public transportation-oriented urban development. The primary concern in urban road planning and design is the demand and function of public transportation. Public transportation needs to be granted with enough road space and right-of-way. During the planning process, the mutual feedback and interaction between urban public transportation and land use should be paid more attention, so as to achieve the goal of public transportation-oriented urban development.

(3) Implementation of policies that give priority to public transportation

China currently has no official legislation on public transportation development and the structure of travel modes in urban transportation generally has little rationale. The significant challenge for the Chinese urban transportation system is the decreasing percentage of travel by public transportation. This is exacerbated by the traveling conditions for most modes worsening while passenger car travel is rapidly increasing. The travel by public transportation in Chinese mega-cities normally has a mode-share of 15% to 35%, which is much lower than cities with similar scale in foreign countries. Some cases in China are demonstrated in Figure 10. Moreover, the water transportation is one of the most sustainable modes of transportation, but the inner city ferry is greatly shrinking in China, even in some cities that have very good resources for ferry service. Meanwhile, the government supplies a huge amount of funding to public transportation every year, yet is not able to recover the costs. For example, in 2005, the government gave totally ¥ 1.8 billion subsidy for Beijing public transportation system, in Hangzhou, ¥ 270 million. The poor public transportation system aggravates the finance burden of Chinese government.

In 2005, Premier Wen Jiabao of the State Council made comments on giving priority to the development of urban public transport. In October 2005, General Office of the State Council issued "Suggestions on giving priority to developing urban public transport" made by Ministry of Construction and other departments. It requires local governments and relevant departments to deepen the understanding further, establish

the preferential position of urban public transport, define the guiding theory and goal task and take effective measures to quicken the steps of development. As for city level, policies that favor increasing development and use of public transportation should be encouraged in order to slow or reverse the trend of increasingly unsustainable private automobile use.

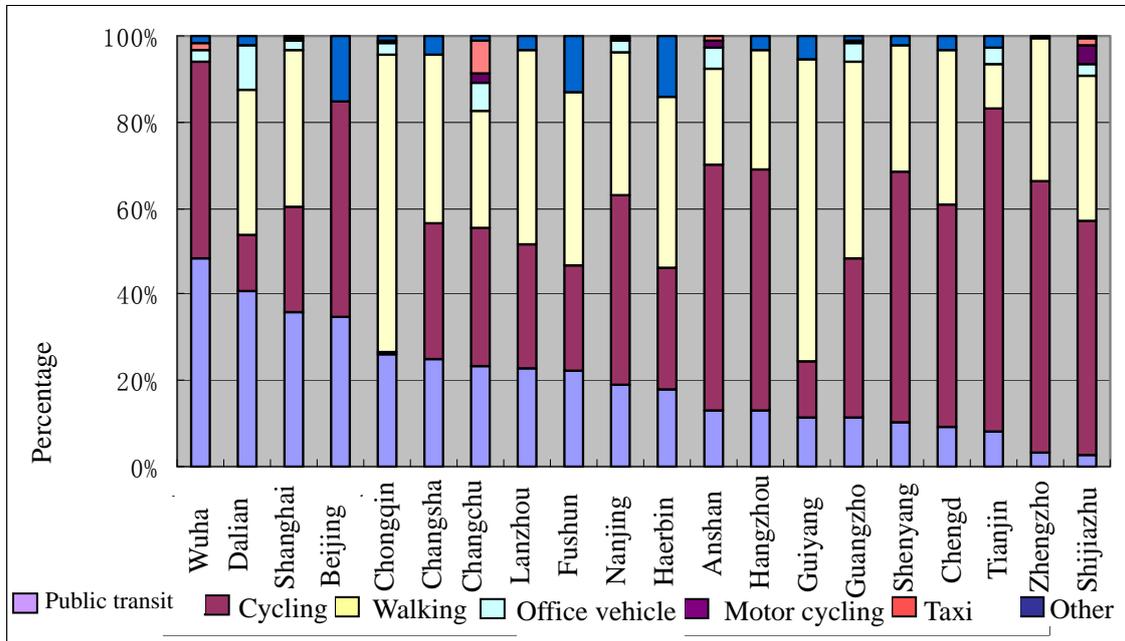


Figure 10 Percentage of travel by different transportation modes in Chinese cities

Source: Sustainable Urban Mobility Project- Supported by BP

According to the current developing trend, the travel percentage of public transportation is expected to go up for 15% in many large cities in the future 15 years, it will more significantly help Chinese cities towards the sustainable transportation development. In the case of Beijing, the percentage of travel by public transportation was 27% in 2000, and it is expected to be 40% in 2010, and over 50% in 2020 (Beijing transportation development program, 2003). In order to support the increase in public transportation mode-share, reforms on the current administration system for public transportation are needed and the capacity and quality of public transportation must be improved.

The current situation calls for legislation on urban public transportation to specify the status, investment guarantee system, road-right, and operations management of public transportation. Mega-cities should build a comprehensive transportation system consisting of large capacity transit modes as the foundation, normal public transportation modes as majority, and mini buses and taxis as supplementary and complementary to the main system components. Small cities should actively develop smaller, more flexible and scaleable public transit systems (e.g. minibuses) to meet travel demand.

Urban transportation development should guarantee financing for public transportation

development first and foremost. A specific fund for urban public transportation can be set up which accumulates funds from fees and taxes, such as land sale revenue, fuel tax, fixed asset tax, land appreciation tax, parking fee, congestion charges, etc.

In the public transportation administration system, it is suggested to set competing mechanisms, accelerate marketization, and relieve the government’s financing burden. In the past, the government was in charge of construction, management, and administration of public transportation systems in China’s “Planned Economy Era”. Now, the government role should change with respect to public transit by separating the operations (daily operations management, pricing, etc.) and administrative entities (policy-makers, overseers, etc.) role. By allowing the public transportation operating company or organization to be wholly responsible for operations, urban public transportation management can be made compatible with the market economy system, resulting in improved efficiency. The possible management structures for public transportation in China are shown in Figure 11.

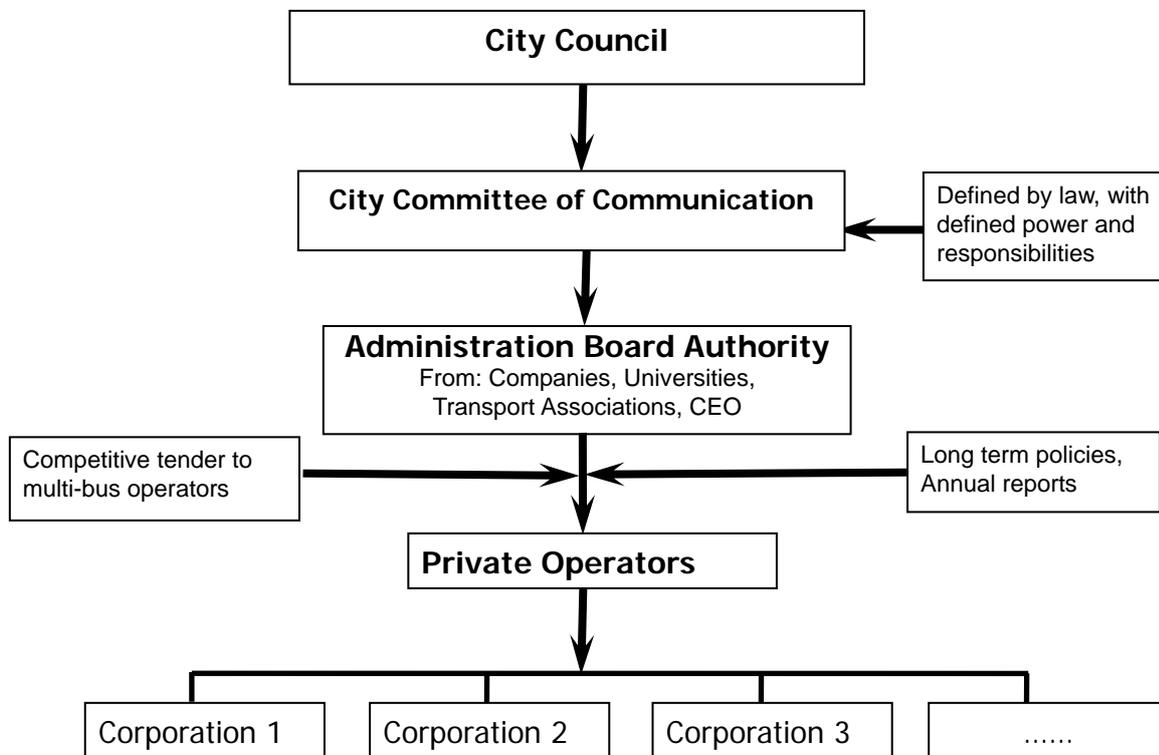


Figure 11 Possible management schemes for public transportation operation in China

(4) Implement travel demand management policy

Chinese city authorities have focused on construction and supplying material support to build their way out of metropolitan transportation problems for many years, while ignoring the potential benefits of strategies beyond basic construction efforts (strategies such as new management approaches and mode integration). Current utilization efficiency of road resources is poor because of ineffective management. Without explicit, well-planned strategies for managing the rate of private car ownership growth and use, automobile use will continue to increase. It is reported that the frequency of trips for every Chinese car is five times higher than the US. More cars create more

congestion with more pollution, and require significant investments in new road infrastructure, which inevitably cannot keep up with increasing car population, as has been the case in every other city throughout the world.

The development of the automotive industry in China has only worsened urban transportation problems. People have become more cognizant of and obsessed with car travel, and have begun to overlook walking and cycling as alternatives to car travel. Even at the beginning of the shift from two wheels to four, the growth of mixed-speed traffic (bikes vs. cars) lacked proper management and policy guidance. Whether in road building or traffic management, discrepancies between bicycles and cars were not dealt with, and their respective advantages were not accommodated on the road. The practice of expanding motorways while shrinking non-motorized paths deteriorates the non-motorized travel environment. Safety and convenience is reduced and various travel modes experience further unjustifiable imbalances in development.

Congestion charges can be imposed in the central area in mega-cities in order to guide more rational and sustainable car use. Further policies that can be tested include encouraging/incentivizing different work schedules in order to minimize the peak/ (spread out demand across a longer period of time). Setting up travel demand management systems to provide travelers with instant traffic information using ITS techniques and adopting fluctuating ticket fees according to route congestion (charge less for using less utilized routes, and vice versa) are two strategies that could also assist in managing travel choices in China. Furthermore, park'n'ride lots can help facilitate the transfer between modes. Overall, basic concepts like using existing transportation resources more optimally, better integrating different transportation systems, sharing transportation information, and improving the efficiency of operation should be pursued. The goal of all these activities is to guide people's travel behavior to be more rational and sustainable by introducing measures like controlled access.

(5) Improve walking and cycling

Walk and cycling are most energy saving and environmentally friendly means of travel. They are crucial for making China's urban transportation systems sustainable. Both modes are ideal for short trips and can be used as the primary mode for the "last-mile" (distance between transit station and destination) of public transportation trips. Most Chinese cities are suitable for bicycle use when considering land use, trip length, topography, and climates, and a large portion of the Chinese population has traditionally used bicycles for most of their daily travel. However, the development of walking and bicycle travel has been neglected and travel conditions have become worse in terms of safety and convenience, leading to the decreasing percentage of travel by walking and cycling. The footpaths are often overcrowded, and the accommodations for crossing streets are poor.

In the urban transportation planning process, the relevant regulations, project examination/analysis, and road space use, etc. should be given the utmost consideration. A possible recommendation would be to encourage bicycle travel by providing road space and park & ride services, etc. Meanwhile, it is important to build walking environment that is safe and comfortable with continuity in order to ensure a

sound pedestrian-friendly roadway system.

(6) Policy recommendations for sustainable transportation energy development

It is high time for China to establish fuel economy standards for motor vehicles. The fuel economy standards for commercial light trucks, heavy-duty vehicles, and motorcycles should be established as early as possible. China fuel economy standards should follow an incentive-based, manufacturer-specific structure so that annual incremental improvements in fuel economy are mandated and allow each of the manufacturers to meet the standards independently. For example, a mandated 1% fuel economy improvement for an entire manufacturer's fleet that is sold during that fiscal year. If standards aren't met, then penalties/fines are imposed and if standards are exceeded, then rewards/incentives are offered.

The government should create policies to promote the demonstration, production, and the use of hybrid-electric vehicle (HEV) technologies, especially in passenger cars such as taxis (taxis account for significant resource consumption and would be the best candidates for benefiting from the advantages that come with hybrid drive-trains).. Incentives should be established to encourage car manufacturers to provide HEV technologies in order to achieve the mandated energy efficiency levels for their vehicle products.

Comprehensive evaluations must be developed in order to accurately analyse the impacts of vehicle technology and alternative fuels on product performance, oil saving potential, life-cycle cost, the environment, energy, and the economy. Because coal is the main energy source in China, we should strengthen the analysis and evaluation of coal-based alternative fuels in particular by investigating environmental, energy, and economic impacts of coal-based methanol, DME, and coal-based liquid fuels in both near term and long term scenarios.

(7) Policy recommendations for transport-related environmental protection

To deal with increasingly serious transport-related air pollution in cities, pollution control levels of conventional gasoline and diesel vehicles should further improve by continuing to follow the path of existing emissions regulations in developed nations such as the European Union. Implementation of the strict standards on new vehicles will have a good long-term effect to reduce pollution of the Chinese transportation sector, although short-term benefits will be negligible.

Some special vehicle types, such as buses and fleet vehicles, should increase their use of clean alternative fuels. Meanwhile, alternative fuel vehicle technologies and fuel production should be incentivized in order to promote and stimulate the rapid development of alternative fuels in China.

Effective environmental protection regulations and management systems need to be established, and inspection and maintenance systems for motor vehicle emission controls need to be strengthened and centralized so that a single administrative agency is in charge of the inspection administrative programs; both the agency and the programs still need to be fully established.

Fiscal policies should be created to reflect environmental impacts of different transportation modes. That is, external costs of different transportation modes in terms of their environmental pollution should be reflected in the form of taxes or prices to ensure social equity and the most efficient and equitable allocation of transportation resources. China should set up tax reduction or exemption system for vehicles with low emissions and energy use. Meanwhile, it is suggested that environmental tax policy tailored to China's development needs (transportation capacity growth while mitigating environmental impacts, etc.) should be formulated to control vehicles with heavy pollution.

(8) Strengthening international cooperation and exchange

Sustainable transportation development covers a wide range of stakeholders including government officials, transportation engineers and the public. Capacity building is essential in promoting sustainable urban transportation in China. Regional and international collaborations for giving advice and exchanging knowledge and experience for institutional structuring, research, legislation, public/NGO participation, training, etc. will be very helpful to China. It is very necessary to learn international experiences and lessons during the development and implementation of sustainable urban transportation in China. It helps avoid mistakes that had been made by developed countries and bring in tried-and-true techniques and management experiences through international communication and cooperation. Under this context, the China Academy of Transportation Sciences (CATS, which is a part of the Ministry of Communications, or MOC) founded the China Urban Sustainable Transportation Research Center (CUSTReC) in 2006. As one of the ten Centers of Excellence funded by Volvo Research and Educational Foundation, the center aims to thoroughly research the key problems concerning China's urban transportation development and make recommendations for improvement. The Center has already established close partnerships with a number of distinguished international transportation research organizations from the EU, U.S., and other regions. The government overall should follow the example set by CUSTReC and take active measures to promote international cooperation in urban transportation development.

6. Conclusions

The first few decades of this century is a crucial phase for China's urban transportation development. Transportation development continues to focus on building more roads as a means for expanding capacity; this approach needs to be seriously re-evaluated. China's future transportation development must make changes such as enhancing the coordination between development of the economy, environment, energy, and society, etc. The realization of sustainable urban transportation development in China requires collective input from various fields beyond transportation itself in order to effectively integrate systems and use integrated measures in the path towards sustainable development.

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