

INFLUENCING FACTORS, CHALLENGES AND APPROACH FOR SUSTAINABLE URBAN MOBILITY IN CHINA

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ABSTRACT

The paper is intended to lay a foundation to explore integrated solutions to sustainable development of urban mobility through investigating the Chinese connotation of sustainable mobility, current situation and challenges of sustainable mobility and the influencing factors of sustainable urban mobility in China while giving consideration to various aspects such as strategy, planning and policies etc. from an interdisciplinary perspective. Then, the approach to realize the urban sustainable mobility is discussed.

1. DEFINITION AND CONNOTATION OF SUSTAINABLE URBAN MOBILITY IN CHINA

The report of the Sustainable Mobility Project of World Business Council for Sustainable Development has put forth the definition and the seven major goals of sustainable mobility.

Definition: The ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values today or in the future.

- Reduce Conventional Emissions from Transport
- Reduce GHG Emissions from Transport
- Reduce Transport-Related Deaths and Injuries
- Reduce Transport-Related Noise
- Mitigate Traffic Congestion
- Narrow the Mobility Divide
- Preserve and Improve Mobility Opportunities

The aforesaid goals have given a good description of the connotation of sustainable urban mobility, and have provided an important guidance and reference for research on solving the issues on sustainable development of urban mobility in China. However, due to different national conditions, different development stages of economy and mobility, different characteristics of demands for mobility and the different major problems and challenges confronting urban mobility at present, the definition and connotation of sustainable urban mobility in China are not the same as those mentioned above. According to the actual situation of cities in China, the definition and connotation of sustainable urban mobility put forth in the study are as follows:

Definition: Sustainable urban mobility system is a comprehensive mobility system that can meet the demands for mobility out of social and economic development and the improvement of living quality of the people to the utmost extent at a relatively small resource and environmental cost. The system shall have the following major characteristics: safe, smooth, highly efficient, comfortable, environment-friendly, energy-efficient, highly efficient and highly accessible. The high efficiency and high accessibility are key to guaranteeing the continuing and rapid development of the nation's economy, improving the living standards of people and safeguarding the security of the country. The high efficiency mentioned here means reasonable shares for different transport modes, seamless connection, small amount of void trips and short trip time. A highly efficient mobility system can greatly reduce production cost, promote the development strategy of regional economic circle and corridor, lower the logistic cost and improve international competitiveness. The high accessibility refers to the high coverage, convenient use and provision of options, which demonstrates the principle of equality.

China is undergoing a period of continuing and rapid economic development, rapid urbanization and motorization. And the core challenge is to make out the development strategies, planning and policies on urban mobility beforehand by making reference to

experience at home and abroad from the strategic point of view in order to ensure the healthy development of the society and economy in urban areas, avoid mistakes in and waste out of decision-making, avoid heavy costs for the development of motorization, and establish sustainable urban mobility system.

Therefore, the connotation of sustainable urban mobility system in China is to meet the current demands for mobility while keeping the capacity to meet the ever developing demand for mobility in the future and realize the sustainable development of the economy, society and environment and the mobility system itself through properly balancing between the use of land and mobility system, among different modes of transport, between planning and construction of transport infrastructure and its management, between development of mobility and environmental protection, and between the development of mobility and use of resources by means of mobility strategies, planning, policies and regulations etc.. That is to say the overall objective of sustainable urban mobility system is to meet the demand for mobility, optimize use of resources, improve environmental quality, promote social harmony, and increase level of safety so as to realize the virtuous development cycle of society, economy, mobility and environment. Specifically speaking, it shall contain the following objectives:

- Meeting the demand for mobility out of social and economic development

The basic objective of urban mobility system is to meet the ever increasing demand for mobility, support the urban development, meet the demand for transport of people or goods, improve operation of transport and reduce traffic jams.

- Optimizing use of resources and improving efficiency in using resources

It is necessary to encourage means of transport with low consumption of energy and land to guarantee sustainable development of economy, environment and society.

- Reducing environmental pollution and promoting virtuous cycle of ecosystem

Urban mobility system shall become part of urban ecosystem of good ecological features, and it is necessary to encourage means of transport with low pollution.

- Promoting the harmonious development of mobility and use of land

The harmonious development of mobility and use of land is the basis of the healthy development of cities. Mobility system shall provide support for the spatial development strategies in urban areas, and the use of land shall be rationally allocated in such a way that urban layout generates small load of transport and the characteristics of demand for transport can be adjusted.

- Providing more options of mobility

Consideration shall be given to investment capacity for the construction and management of mobility system with emphasis on economic benefits and means of transportation compatible with the affordability and preferences of different users in selecting such means are provided.

- Putting on top agenda the development of urban public transport

In view of the current actual situation of China, priority shall be given to developing urban public transport and guidance shall be provided for the rational development of private transport.

- Improving transport efficiency and alleviating traffic jams

Traffic jams have become a widespread serious problem in urban areas and a bottleneck for the constant and rapid economic development. It is an important task in the field of mobility to improve transport efficiency and promote the constant and rapid development of the society and economy.

- Promoting social equality and safeguarding social harmony

Planning of urban mobility shall not become “planning of automobile transport” or “planning for motorized transport”, and it shall enable all the various participants in mobility to fully share suitable space and provide convenience for those people having difficulties in mobility as well as meet the demand for transportation of those without private means of transportation and pedestrians. Meanwhile, it shall reduce pollution and impact of transport pollution to people who do not produce mobility pollution.

- Improving Safety

It shall provide safer and more comfortable means of mobility and traveling conditions for travelers as well as reduce traffic accidents and fatality in traffic accidents.

- Integrating the urban transport system

An integrated comprehensive urban mobility system shall be established. The subsidiary systems of urban mobility shall be well coordinated and connected, and the local benefits and overall benefits, current benefits and long-term benefits individual benefits and social benefits shall be aligned.

- Establishing assurance system for sustainable urban mobility

It is necessary to establish an assurance system to realize sustainable urban mobility, including various factors such as management systems, mechanisms, policies, regulations, funds, management and technology etc.

2. CURRENT STATUS AND CHALLENGES OF SUSTAINABLE URBAN MOBILITY IN CHINA

- The rapid development of cities has brought great impact on the existing urban transportation structure

Configuration and adjustment of urban function zones has changed the primary passenger and freight distribution and travel characteristics. The transportation network and public transit lines settings need corresponding adjustment. The enlargement of urban space and the extending of trip distance require enhancing the transit speed of transportation tools. Land use exploitation of high intensity causes passenger and freight travel flow exceeding the road capacity. And the improvement of residents’ living standard also requires higher transportation initiative authority and service level. Great increase of motor vehicle amount requires enhancement of technical standard and traffic capacity of current roads. And travel demand of multi-levels requires constructing urban transportation combination structure of a new type.

- The spatial expansion of cities and the development of transportation lack alignment with transportation development lagging behind.

The correlation between urban transportation and urban dynamic development has not been built due to the lack of effective policy guarantee, which making the effect of

central area assembling continues intensifying in many big cities. The function of urban central is too concentrated. Population and employment density are becoming higher and higher. Central agglomerations are continuously breaching the former planning magnitude, leading to the unchanged situation of transportation deteriorating, population and industry conglomerating in urban central areas.

The highway corridor which is mainly for the cars has stimulated the rapidly increase of car traffic. Centripetal transportation characteristics and traffic of tide pattern are apparent. Transportation situation is getting worse. For example: The travel volume attracted within "The Third Circle" road in Beijing takes a proportion of 60% of the total travel volume in the city area. And travel amount generated in the old city area within "The Second Circle" road takes a proportion of 47%. The motor vehicle travel intensity in the city area is 3.6 times as much as that in the suburb area. In the past eight years, vehicle travel intensity in the old city area has increased for 1.6 times.

- Traffic congestion in the main metropolises in China is serious, restricting the development of urban economy and society.

Recent years, although the big cities all accelerate the constructing speed of urban roads, the contradiction between transportation supply and demand is still serious. The phenomenon of congestion presents a trend the getting worse. And the travel speed in the central of metropolis is only more or less than twenty kilometers per hour. Traffic congestion presents the extending trend both in the scale of time and space. For example, the average saturation rate in the trunk network of Shanghai reaches 0.9 and the trunk roads in Guangzhou where the travel speed is less than twenty five kilometers per hour take a proportion of 12.5%. Investigation and measurement in Beijing indicate that when the average travel speed of buses descends for one kilometer per hour, the loss is equal to the carrying power of 200 buses which is as high as 100,000,000 Yuan. The losing of efficiency caused by transportation congestion has increase the cost of management, while restricting the healthy development of urban economic society seriously.

- The development of private cars lacks in guidance and urban transportation structure is getting worse.

With the enhancement of residents' living standard and the increase of travel distance, the citizens pursue more comfortable, flexible and convenient private trip modes. The ownership of private cars is increasing sharply. Compared to the rapid development of cars, the development of public passenger transportation is relative slow. The construction of rail in the past 40 years has not reached 100 kilometer. In 2000, the total subway passenger traffic volume was 440,000,000 person-times, only taking a proportion of 3.6% of the daily trip in the downtown area. And electrical buses only take a proportion of 22.9%. The trip mode proportion of cars has already increased to 23.3% from 6% in 1986. The proportion of public trip mode declined from 35% in the past to 26.5%. How to expedite the development of public transit, to turn the users of private traffic tools to public transit, making the transportation structure of urban integrated transportation system more reasonable, is a serious task in front of us.

- The urban transportation infrastructure status is far behind the requirement of sustainable development

At present the mix of urban traffic tools is at a low lever, the road situation is bad, the management level is low and the technology is very draggled, while easily causing

traffic congestion and safety accidents, effecting the life and work of citizens and restricting the rapid development of urban social economy.

- The investment into transport infrastructure is irrational and the development of public transportation is rather slow.

The ratio of investment on road, including highway to the investment on public transportation, including subway in the period of “Eighth Five-Year” reached 8.2:1.8. Because of the extreme lack of fund for public transit, the service level of public transportation infrastructure in the city is very low.

- The transportation system lacks in integration and the existing resource has not been utilized fully.

The transportation planning and urban spatial layout planning are lack of coordination. And planning of various trip modes also lack coordination.

Construction of various transportation equipments lacks integration and match.

The operation management of various transportation systems lack integration.

The management departments of transportation lack communication and coordination.

- Travel demand management is weak, resulting in unnecessary burden on the transportation infrastructure.

Travel demand management is management of the origin, relating to land use distribution, transportation mode and transportation management, travel guidance and so forth. Inadequate management of trip demand will result in the disequilibrium of road transportation both in the scale of time and space, enlarging ineffective transportation load. For example, the running taxies without passengers form ineffective transportation of huge amount. The existing time of taxies is as long as ten to twelve hours, taking a proportion of 35% of the road section volume in the city area. At present the empty ratio of taxies is nearly 50%, much higher than the proper ratio 25%, resulting 10% of the ineffective transportation load. If managing properly, it is quite possible to reduce the load of 5% without too much investment. Comparably, if using the method of enlarging current roads to deal with 5% of the traffic load, at least 0.01 billion to 0.02 billion Yuan is needed. Taking another example of parking, the parking equipment construction and management have not paid high attention as an effective method to adjust dynamic trip demand. Impersonally, the united parking match standard has encouraged the excess use of cars.

- The contradiction between supply and demand of parking facilities has aggravated.

With the increase in the number of motor vehicles in urban areas, it has been generally rather difficult to park vehicles in large cities. According to the experience of developed countries, the parking demands can only be met to provide 1.2 to 1.5 parking spaces for each vehicle on average, and in general, the parking standard in open parking lots is 25 to 30 square meters per vehicle, and 30 to 35 square meters per vehicle for indoor garages. However, there are less than 35 parking slots for every 100 vehicles in urban districts in China; Therefore, the phenomenon that vehicles are parked on the roads is rather serious. For example, there are few parking slots in most urban centers in the 10 big cities that have been investigated, which can only meet on half of the actual demand, and even one fourth to one sixth in some cities. The amount of motorized vehicles possessed in Beijing has exceeded 2.4 million, while the number of parking spaces is less than 0.7 million; The amount of motorized vehicles possessed in Guangzhou is 0.8 million, while the number of parking spaces is less than 0.18 million;

And nearly one third of vehicles are parked by the roads, which has greatly affected the normal mobility of the roads and has destroyed the overall environment of the cities.

- The land resources are limited in urban areas, worsening the contradiction between demand and supply of mobility.

The use of land for construction per capita in large cities in China has been strictly controlled around 100 square meters, and the land available for road mobility is in short supply. Though the average road area per capita in urban areas in China has reached 10.3 square meters in 2004 with an increase of 0.99 square meters over compared with that in 2003, there is a gap over one fold compared with foreign cities with high levels of motorization. For example, the average road area per capita in cities with a population of over 0.25 million is 24.5 square meters, and 21.7 square meters in Berlin. The insufficient land for the use of urban construction has made it rather difficult to expand the capacity of road mobility, and has made the plot ratio of the development and construction in megalopolises such as Beijing, Shanghai and Guangzhou etc. remain at high levels, and the density of population in urban centers has reached as high as 20, 000 persons per square kilometers. Moreover, the intensive and high-density urban development mode will still be maintained in the future 20 years, and the intensive demands for mobility will further deteriorate the contradictions between supply and demand for mobility. It There is an urgent need to introduce new concepts, new chain of thoughts, new technology to find out new solutions to solving problems.

- The traffic accident rate remains high

Because of the situation of too many vehicles and very few road in the cities of our country, plus the laggard traffic management, the seriously lack of traffic management and transportation engineering equipments ensuring traffic safety and the mixed traffic on the urban road network, lead to the increase of traffic accidents.

- Transport pollution has been increasingly serious.

With the constant and rapid economic development and the gradually sped-up progress of urbanization in China in recent years, the demands for mobility of the residents in urban areas have increased drastically within several years, and the amount of motorized vehicles possessed there has increased drastically. The photochemical smoke pollution characteristic of pollution discharged by motorized vehicles has been gradually more serious in several big cities such as Beijing, Guangzhou and Shanghai, and the amount of NOX and O3 representing the characteristics of air pollution by motorized vehicles has seriously exceeded the standards. Moreover, the concentration of NO2 in Guangzhou, Beijing, Ningbo, Wuhan and Shanghai is rather high and has exceeded the state standard. The air quality has been seriously deteriorated and blended pollution of smokes and exhaust of motorized vehicles has emerged.

As for mobility noises, though the average figure of the noises on urban roads can reach the state standard, the rate of the noises on arteries of the most cities exceeding the standard is rather high.

- With the development of urban economy and society, transport energy demand is increasing sharply

With the development of urban economy, social development and income enhancement, the city passenger and freight traffic demand increase sharply. Traffic demand level and traffic demand type will be more remarkable. The commute traffic demand will reduce gradually, and the demand for life, leisure, entertainment and so on

will have a large scale increase, the city freight traffic demand type will be changed from the scattered to the intensified. At the same time, with the city advancement, the city layout shape expansion and the city functions gather all inevitably, and the total trip amount, the trip density and the trip length of city daily life will have a large scale growth. Under such development background, the city has an urgent need to establish the comprehensive transportation system whose main body is public transportation to meet the traffic demand which grows day by day.

- Traffic management model and traffic policy fail to satisfy the requirement of market-oriented system.

In a long time, the procedures as decision, planning, construction, management, operation and maintenance etc. of urban traffic system in China are under the administration of different departments respectively. Such management system was established in order to adapt to the past highly centrally planned economic mode. Along with the economic restructuring, and diversification of beneficiary parts, the former mode is no longer adaptable to the government public service management under market-oriented system. The traffic system is in need of an effective organization to be responsible for traffic development strategy, preparation of policy, construction, operation of urban traffic system, design of urban traffic facilities, traffic organization, maintenance of urban road, clearance of road occupation, and the unified coordination among them. Currently the planning, construction, operation and maintenance are disjointed. There is no effective coordination or mobility among the relevant department, which results in repeat construction, unsmooth order, shifting responsibility to others, but jostling for benefit. Along with the in-depth development of market economy, it is pressing to break down the current situation of department separation and doing things in its own way, and make the sub-systems of urban traffic system link up each other effectively and enhance the efficiency of urban traffic by establishing an unified and harmonious management system and policy measures.

3. COUNTERMEASURES FOR REALIZING URBAN SUSTAINABLE MOBILITY

- To build an organizational and management system with comprehensive coordination capability that can ensure the scientific decision making and implementation of plans

Solving urban transport problems starts from the system. The problems can not be solved thoroughly if any of the “three arrangements and two sides” mentioned above is overlooked. Even if one considers such road traffic as expanding the road and rebuilding the crossing, he should not only consider a single crossing or a single section of road. Instead, he should analyze the whole road network and avoid the decision mistake of relaxing the local traffic while expanding the jam area.

To solve the problems from whichever of the 3 arrangements, people should think out various feasible solutions according to the transport planning theory, the system engineering theory, the traffic engineering theory and the transport economy theory, and compare and analyze them in advance, as well as forecast and evaluate their effectiveness.

For the sake of ensuring the scientific decision and implementation of the planning, and of coordinating effectively such steps as planning, construction, management,

operation and maintenance as well as such departments as urban construction, transport and management, an urban transport comprehensive coordination organization should be established that is led by the mayor and is attended by relevant departments. This organization solves the urban transport problems by an integrated approach.

- To well coordinate the transport and land use plan

Transport and land use interact and influence each other. Transport development and land use promote each other. From the point of view of transport planning, different land use layouts determine the producing and attracting traffic counts. They also decide the transport distributing layout, thus decide the transport structure to some extent. The improper land use or land over-exploitation will lead to the traffic capacity being unable to meet the traffic demand. From the point of view of land use, transport development changes the urban structure and land use layout. It plays a leading role for land use and urban development. Such relationship between land use and transport demonstrates the importance of the coordinated planning of transportation and land use.

Practices in developed countries show that attention should be paid to decentralizing urban functions in order to form the urban structure with low traffic load. Strong measures should be taken to manage the urban development.

A feedback mechanism should be introduced into the process of urban planning and urban transport planning, and planning should be integrated and quantitative analysis should be conducted so as to change the current practice that transport planning is only one subject planning of the overall urban planning. Without the powerful support of transport planning, the urban functions could hardly realize. Therefore, the overall urban planning should fix the urban development mode, the industry layout, the differences of land function and function design based on sufficient qualitative and quantitative analysis. A coordinated planning for both transport and land use can be achieved by conducting the comprehensive transport system at the same time as land use planning.

- To make out the strategic plan of urban transportation development

Making out the strategic plan of urban transportation development is the key step to solving urban transportation problem and the important assurance to realize best allocation of resource. The suburb railway, subway, light rail, new transportation system, normal public transportation system and road network should be planned as a whole. The reasonable transportation mode split and priority of their implementation should be made based on both qualitative analysis and quantitative analysis. Long term planning and projects in the near future should also be combined. The actions in the near future should be consistent with the strategic plan of urban transportation development and be taken as a step to implementing the strategic plan.

- To introduce transportation impact analysis when developing cities

As learned from the experience of developed countries such as USA, to avoid excessive exploitation of land and drop in transportation service level out of new exploitation, transportation impact analysis system should be introduced as the precondition to approving exploitation projects. The introduction of this system and policy has not only important realistic meaning, but also long term influence to the development of the city.

- To land the policies and measures for developing public transportation preferentially

Developing public transportation preferentially is a common concept of countries over the world to deal with the urban transportation problem. The countermeasure to develop public transportation preferentially should be actualized in various aspects such as system, policy, construction, management and so forth.

- Integrated transportation planning is the key point to promoting transportation efficiency.

Integrated transportation planning is necessary to promote transportation efficiency. For example: Railway transportation should become the skeleton transportation of the integrated transportation system in big cities. But the covering range of railway transportation is limited. The function of railway transportation hangs on the support and cooperation of normal transit. In the range that railway transportation can cover, the passengers of railway also depend on the distributing capability of normal transit. While in the region that railway cannot cover, normal transit should become the skeleton transportation. The key point to realizing concept above is to plan the railway transportation and transit jointly. Railway transportation planning without consideration of normal transit and normal transit planning without consideration of railway transportation planning are hard to realize the planning goal.

In the process of integrated transportation hub planning, travel demand characteristic analysis is the most important. The transportation establishment magnitude and transportation organization management should be planned and constructed according to the total volume of traffic participants using the transportation hub, the characteristics of quantity and direction of the traffic flow, and trip characteristics. The design of transportation hub should be physically integrated, making the transfer distance as short as possible. The operation should also be managed in an incorporate way for the most convenient use by traffic participants.

- Constructing a road network with reasonable hierarchy

The size, class and function design of urban road networks has a significant influence on the efficiency of transportation systems, the scheduling of traffic organization and management schemes, and the economic development as well as the convenience of trip users.

In view of road stratifications, the number of collector roads should be larger than that of arteries, and the number of branch roads larger than that of collector roads. In the view of road connection, branch roads should connect to collector roads, and collector roads should be linked with arteries. In the meantime, the road planning and design, as well as the scheduling of traffic organization and management schemes, should conform to road functions.

As a whole, Chinese cities mainly pay more attention on the construction of arteries and wider roads whereas overlook the road network density indicators, resulting in a small density of arteries and collector roads. Excessive wide roads not only lead to exceeding vehicle interweaving, but also render pedestrians unsafe at crosses.

- Advancing scientific and modern road traffic management

The improvement of the utilization efficiency of the current transportation infrastructure is an important part for solving urban traffic problems. The advancement of scientific and modern traffic management is the fundamental procedure to promote such efficiency. Scientific management means the implementation of traffic education and regulation based on the principle of transportation engineering; work such as channelization, signal control, traffic signing, road-crossing facilities, parking facilities should also be included. Modern management contains the adoption of various new concepts, technologies, and mechanism for enhancing the effectiveness of transportation infrastructure utilization and traffic safety level, as well as the public's awareness of relevant regulations. In addition, it can also improve management efficiency and the construction of human-oriented transportation system.

- Implementing travel demand management (TDM)

From a broader spectrum, travel demand management means the alteration of travel choice of traffic participants by means of regulating travel policies and measures to reduce motorized trip volume and mitigate or eliminate traffic congestion. In a narrow sense it corresponds with comprehensive travel policies and measures aiming at cutting single-passenger car volumes during peak hours. TDM contains staggered commuter traffic and flexible working schedule, which flats travel demand in the scale of time; it also includes providing drivers with traffic information such as congestion and accidents in order to spatially disperse travel demand; by improving the service level of public transportation, TDM also encourages the public to use mass transit; by implementing various procedures, it helps promote the effective use of cars; the adjustment of traffic origins can also be attained through urban and transportation planning.

Practical and effective TDM planning should be made and corresponding measures should be implemented based on the level of urban development, motorization as well as the unbalance between demand and supply.

- Carrying out pertinent studies on intelligent transportation system (ITS)

ITS, a new transportation system, was first developed in the United States, Japan and Europe in order to solve traffic related problems such as congestion, accident, energy and environmental issues, and to build a highly effective and safe transportation system. ITS, in essence, is to apply modern technologies for solving transportation problems in a comprehensive way. As a result, it provides an important means for settling China's urban transportation problems, and several suggestions are proposed as follows:

- Enhancing parking planning and management

The parking issue plays a significant role in controlling the total vehicle trips. An excessive number of parking lots would encourage the use of cars; whereas the deficiency of urban parking lots results in an increase of illegal parking, therefore intruding upon the limited urban space. Related studies should thus be undertaken to obtain the optimal parking volume, to assess the impact of relevant regulations on travel demand, and to integrate parking planning and management with public transportation development and TDM implementation. In addition, legislation should be enforced in order to maximize parking capacity, thus solving parking problems.

Park and Bus Ride (P&BR) is a key factor in promoting public transportation use and increasing transportation system efficiency, and should be strengthened in terms of facility planning and comprehensive information guidance. European countries such as Germany provide both real-time road congestion information and corresponding alternative travel mode information, therefore not only the overall efficiency of the system is boosted, but conveniences for the travel mode changes are provided also.

Based on the characteristics of each city, large-size P&BR facilities should be constructed in the suburb areas, helping form a public transportation-dominated traffic pattern in downtown areas.

- Improving urban road traffic facilities

A road network with adequate structure and functions is the premise of solving contemporary urban traffic problems. Starting from the connection and function structure, as well as the proportion of roads with different functions, efforts should be put into augmenting the overall traffic volume and service level, meanwhile bettering traffic management, safety facilities, and channelization. Those measures will definitely contribute to improving traffic capacity, diminishing accident rates, cultivating the law awareness of trip makers, and creating a new city image.

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