

Scheme design technique for urban traffic management planning

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Abstract: Management tactics for urban traffic management are presented. The tactics that underlie traffic demand management (TDM) are preferential development tactics, controlled development tactics, prohibited development tactics and economic lever tactics, and those that underlie traffic system management (TSM) are node traffic management tactics, arterial traffic management tactics and area traffic management tactics. The specific contents and design methods of urban traffic total demand control, urban traffic structure optimization, road traffic movement organization based on TDM and intersection traffic management, road signs and markings management, optimized design of traffic signals and management of parking spaces based on TSM are put forward. The urban traffic management planning scheme design method has already been used in the urban traffic management “Smooth Traffic Project” in China.

Key words: traffic demand; traffic system; traffic management

Since China's opening-up to the outside world, demand for urban transport has been growing day by day with the rapid national economic development and there has been a huge pressure on urban road transport. Traffic congestion phenomena have appeared in many cities even causing traffic jams. Following China's entry to the WTO, the entry of small private cars to the household market is an inevitable trend and the demand for traffic will increase with every passing day. There are only two ways to solve or slow down the urban transport problem: the first is to speed up road construction so as to reduce the traffic loads of the roads by increasing the transport capacity of the road network system; the second is to implement scientific traffic management thus reducing traffic demand and increasing the transport efficiency of the existing roads.

It is a usual trend to solve traffic problems through road construction. Transportation (construction) planning has already gotten much attention for better road construction. In the past few years, the solution of urban transportation problems through traffic management has also gotten close attention. Urban traffic management planning has already arisen in middle and large Chinese cities as a newly emerging thing. But few people are concerned with the core content of traffic management planning i. e. scheme design techniques of traffic management planning which cause great

effects on practicality and maneuverability of urban transportation management planning^[1,2]. This paper makes an enquiry of urban transportation management planning emphasizing scheme design techniques.

1 Classification of Urban Traffic Management Methods

Urban traffic management methods can be classified into two types: traffic demand management (TDM) and traffic system management (TSM)^[3,4].

Traffic demand management is the management of traffic sources. It is a policy-type management which influences urban traffic structure and reduces the unnecessary traffic demand, thus reducing the road traffic volume and relaxing the tensed traffic situation.

Traffic system management is the management of the traffic flow. It is a kind of technical-type management, which increases the capacity of transportation facilities, evenly distributes the traffic loads, increases the transport efficiency of road traffic networks and reduces the traffic pressure through the management of basic transportation facilities and control and reasonable guidance of traffic flow.

2 Urban Traffic Management Tactics and Management Measures

Although the traffic management system of a city is very complex, it is composed of the following traffic management tactics and management measures.

2.1 Traffic demand management tactics

2.1.1 Preferential development tactics

Priority is given for the development of travel

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modes having a high road utilization ratio, less pollution and less energy consumption. Each city should plan out implementation measures for preferential development as per its own practical road network conditions, environment controls and energy storage. Urban public transport should be considered for preferential development, as it needs small road space per person, has low pollution parameters per person and consumes less energy per person transported.

2.1.2 Controlled development tactics

When the overall load on the traffic network reaches a certain level, traffic congestion increases. Hence it is necessary to implement controlled (or even restricted) development to some of the transport modes in order to prevent the further deterioration of traffic conditions. The development of transport modes having less transport efficiency, high pollution and high energy consumption should be controlled (or restricted). For example, the development speed of transport modes like small cars, bicycles etc., and the development of motorcycles etc. should all be restricted. Each city should control the total volume of its taxis according to its own specific conditions.

It is worth noting that there will be, to some extent, negative economic effects from using controlled development tactics. Therefore it is necessary to do careful analysis and quantitative evaluation of both positive and negative impacts of these tactics, before they are actually implemented, to effectively deal with the relations between controlled development, restricted development and no development.

2.1.3 Prohibited development tactics

When the overall load on the traffic network of a city is near to saturation or over saturated in partial area, then travel or passage restrictions to some vehicle types should be implemented for some specific time period in a specified area. Generally, travel restriction tactics are temporary-type management tactics.

The generally used travel restriction tactics are as follows:

1) Allowing the vehicles having odd/even number plates to pass when the traffic congestion occurs in some important road sections or areas.

2) Passage restriction to some vehicle types for some specific time period or some specific area.

Travel restriction tactics similarly have some negative effects; therefore the quantitative analysis of the outcome, before and after its implementation, should be done in advance of its implementation.

2.1.4 Economic lever tactics

Economic lever tactics are relatively flexible type management tactics which fall in between non-management and travel restriction tactics. The principle of adjusting travel distribution or reducing travel demand through economic levers is: charging low for the traffic behavior which is to be encouraged and charging high for the traffic behavior which is to be controlled or restricted.

Measures usually adopted are as follows:

1) High parking fees in city centers (to reduce the traffic volume in the city centers);

2) Provision of additional charges for some transport services (to reduce its travel volume);

3) Congestion pricing when heavy congestion occurs in some important thoroughfare (to regulate traffic volume).

2.2 Traffic system management tactics

2.2.1 Node traffic management tactics

A series of management rules and control of hardware facilities are adopted, taking traffic nodes (intersections) as a management scope, to increase the capacity of traffic nodes by optimal utilization of time and space resources.

The node management methods usually adopted are as follows:

1) Intersection control patterns

- Signalled intersections
- Uncontrolled intersections
- Roundabout intersections
- Grade intersections

2) Intersection management patterns

• Widening of entrances Increase in the number of lanes of entrances at intersections and increase in the capacity of intersections in a unit time.

• Channelization of entrances Setup turning lanes for each directions at the entrance on the basis of traffic volume and turning volume for optimal utilization of time and space resources of intersection.

• Optimization of signal timing Optimize traffic signal timing on the basis of traffic volume and turning volume at intersections to allow as many vehicles as possible to pass in the limited green time.

3) Turning restrictions at intersections

At intersections with relatively high traffic volume, adopt left turn restrictions for some specified time periods (peak hour) or for the whole day (in the whole intersection or some entrance lanes) to increase the capacity of the intersections.

2.2.2 Arterial traffic management tactics

Adopt a series of management measures taking a number of traffic arterials as a management scope to increase transport efficiency by optimal utilization of their time and space resources. Arterial traffic management is different from node traffic management because it has optimal transport efficiency of traffic arterials as its goal. Arterial traffic management should be based on the traffic network arrangement and specific traffic management patterns should be determined according to the function of a road.

The arterial traffic management patterns usually used are as follows:

- One-way street
- Special route for public transportation
- Restricted routes for freight vehicles and bicycles (or special routes for them)
 - “Green wave” route
 - Special transport route etc.

2.2.3 Area traffic management tactics

Area traffic management is the highest level of urban traffic system management. It has the goal of the maximum transport efficiency of all the vehicles in the area (the least total delay, the least number of stoppages, the shortest overall travel time etc.). Area traffic management is a kind of modern traffic managements which should be based on urban traffic information systems with the technical support of communications, controls and computer technologies.

At present, area traffic management has the following two controlling patterns:

- Area signal control system E. g. pre-timed area signal control system (like TRANSYT) and traffic responsive signal control system (like SCOOT, SCATS).
- Intelligent area management system Its important part is ITS with vehicle route guidance system and intelligent vehicle satellite navigation system etc. which are currently being researched and are in the test phase.

3 Urban Traffic Management Scheme Design

The traffic management scheme of a city is usually composed of dozens of traffic management tactics and hundreds or even thousands of traffic management measures related to traffic demand management and traffic system management. Traffic management planning schemes should be drafted reasonably on the basis of thorough analysis of current urban traffic conditions and development trends and should be integrated to the specific conditions of the city.

In formulating an urban traffic management planning scheme, the scheme design should be conducted taking account of three aspects, namely traffic demand management planning, traffic system management planning and an urban road traffic order guarantee system; then coordination, integration, unified evaluation, adjustment, implementation and rolling development^[5].

3.1 Scheme design for urban traffic demand management planning

Traffic demand management is a policy-type management which influences the total travel volume of the whole city by traffic policy formulation and its implementation. In urban traffic management, many traffic management schemes are composed of different management tactics and measures, hence some traffic system management measures are also included in the design of urban traffic demand management schemes. Urban traffic demand management scheme design generally includes the following three aspects: analysis and control of urban traffic total demand, management and optimization of urban traffic structure, and organization of road traffic movement.

3.1.1 Analysis and control of urban traffic total demand

With the increase in the level of urbanization and income of people, the urban traffic total demand and motor vehicle ownership will also increase. But as there are limited urban land resources, roads cannot be extended infinitely. The contradiction between the traffic supply and demand should be dealt with from the following two aspects: ① Taking into account of interior structure, function and characteristics of the urban transport system, analyzing the traffic demand that is suitable for a specific urban road network system (including basic transportation facilities like roads, parking spaces, etc.); ② Taking into account of characteristics of the exterior environment of the urban transport development, analyzing the probable development extent and allowable motor vehicle ownership of the urban transport system under the condition of limited resource restraint and environmental protection goals. After this, the development extent of urban vehicles is drafted on the basis of total traffic volume that the city can adapt to.

3.1.2 Management and optimization of urban traffic structure

On the basis of the current condition of urban passenger traffic structure obtained from the traffic survey and the forecast development of future urban

traffic demand, scientific use of urban traffic demand management tactics and management measures should be made and policy implementation measures and development strategies for reasonable guidance of current traffic structure and optimization of the future traffic structure should be worked out.

In the process of management and optimization of urban traffic structure, we should have a farsighted consciousness. The extent of ownership control of each vehicle type in each year and the control value of ownership development speed of each vehicle type at every stage should be pointed out taking into account urban socio-economic development speed, urban road traffic facilities construction speed, vehicle ownership development speed and changing conditions of vehicle structure. More emphasis should be given to policy development and total volume control tactics of bicycles, motorcycles, taxis, official vehicles, private cars etc. and to preferential development tactics of urban public transportation.

3.1.3 Road traffic movement organization planning

Organizing road traffic management is one of the main parts of urban transportation management planning. It is related to the two aspects of management measures: traffic demand management and traffic system management. The traffic movement organization scheme should be worked out by the unified use of traffic demand management and traffic system management tactics and measures combining the specific road network and traffic volume, flow directions etc. so as to reasonably organize the traffic flow, evenly distribute the traffic load and increase the network transport efficiency. Some examples are travel (or passage) restrictions to certain vehicle types on the roads of some partial areas, one-way streets, special routes for public transportation, various kinds of travel restricted routes and turning restrictions at the intersections.

3.2 Scheme design for urban traffic system management planning

Urban traffic system management is a kind of technical-type management, which increases the capacity of transportation facilities and balances the traffic load through the construction of hardware facilities for traffic management and the implementation of corresponding technical measures.

Road traffic management facilities are the foundation for the implementation of urban traffic management schemes. In working out urban transportation

system management planning schemes, the construction-planning scheme of the management facilities should be formulated according to the requirements of the planning scheme and construction conditions of management facilities at that time.

The contents of urban traffic system management planning mainly includes design and management of cross sectional traffic, design and management of intersection traffic, design and management of road signs and markings, optimized design of traffic signals, planning and management of parking spaces, development planning of traffic police command and control systems and development planning of urban intelligent transportation systems.

3.2.1 Design and management of road cross-sectional traffic

A road intersection is composed of vehicle travel lanes, pedestrian lanes, green belts, traffic separators, etc. For road intersections with current serious traffic congestion at the network or the road sections that may have serious traffic congestion in future (based on forecasting), the functional design of intersectional traffic should be done. The main responsibilities of functional design of cross sectional traffic are to determine the width of each component parts and make their reasonable arrangement to gain the maximum utilization of road resources by taking account of grading, characteristics and right of way and other related road data.

3.2.2 Design and management of intersection traffic

For intersections which currently have serious network traffic congestion or are likely to have serious traffic congestion in future (based on forecasting), special traffic designs, including geometrical design of the intersection, channelization design, design of pedestrian crossings, etc., should be conducted to increase the capacity of the traffic-congested areas and relax the tensed traffic conditions of the city.

In traffic system management planning, the type-choice and construction scheme of traffic control pattern (Signalized intersection, uncontrolled intersection, roundabout intersection, grade intersection and stop-or-yield intersection etc.) of each intersection in the network should be pointed out according to the present or forecasted traffic volume.

3.2.3 Design and management of road traffic signs and road markings

Traffic signs and road markings provide explicit passage rights and accurate traffic information to the

road users. By the proper and reasonable placement of traffic signs and road markings, the road capacity can be increased; order of traffic movement can be adjusted to meet the target of making roads safe, smooth, less polluted and energy efficient.

In urban traffic management planning, short-term and long-term targets and construction planning of road traffic signs and road markings should be worked out on the basis of city size and the current installation conditions of traffic signs and road markings.

3.2.4 Optimized design of traffic signals

In urban traffic management planning, the effect of current intersection signal timing should be checked and then the short-term improvement scheme for signal control patterns and timing schemes should be put forward in accordance with the acute problem of intersection channelization to maintain the status quo of traffic at the intersection. Coordinated arterial signal control ideology, based on the result of urban road network construction planning, should be put forward. The long-term construction target of the urban traffic signal control system and its phase wise implementation plan should also be put forward.

3.2.5 Panning and management of urban parking places

On the basis of the survey of present conditions and the parking demand forecast, the adaptation level of the urban parking capacity and parking demand should be checked; the parking space arrangement planning and parking management methods (including the draft for collecting parking fees) should be formulated with good handling of the design of the transport interchange systems near the parking spaces^[6].

3.2.6 Development planning of traffic police command and control system

The traffic police command and control system is the basis for achieving the modernization of urban traffic management, so its development planning should be conducted in cities with a population of more than a half million. It includes structural design of the system, functional design of each sub-system, construction planning, and methods of raising capital^[7].

3.2.7 Development planning of urban intelligent transportation system

Urban ITS planning is conducted only in large cities, in big metropolises and in cities with prerequisites. ITS deals with a very wide range of aspects, and urban traffic management (including urban public transport management, urban traffic control systems

etc.) is a part of it. The development planning of ITS, including the description of ITS characteristics and its current research conditions in different countries, should be worked out jointly with the help of scientific personnel from other sectors too. The study of ITS contents related to road traffic management, its function and development goals should be conducted on the same fashion^[8].

3.3 Urban road traffic order guarantee system

The urban road traffic order guarantee system is an important part of urban traffic management planning which provides the guarantee of specific implementation of the latter with respect to traffic safety, traffic management teams, setting up traffic laws and regulations, traffic management education, enforcing traffic laws and regulations and vehicle management, etc.

The contents included in an urban road traffic order guarantee system are guarantee of traffic safety, planning for building traffic management teams, planning for setting up traffic laws and regulations, traffic management education, enforcement of traffic laws and regulations and vehicle management, etc. The contents in planning of a traffic management guarantee system are the important aspects in urban traffic management, which are the key parts in making sure of successful implementation of ideology and achievement of goals of traffic management planning.

The principle and guiding ideology of an urban road traffic order guarantee system is to fulfill the requirements of urban socio-economic development related to traffic management to the maximum possible extent by working out corresponding measures and development plans from the aspects of traffic safety policy and guarantee, team building and traffic safety publicity, etc. on the basis of local socio-economic development with traffic safety and management teams, etc. as a basis, with safety, order, efficiency, fairness and convenience as goals, and with urban traffic planning as its core part.

4 Conclusion

After the preliminary completion of urban land development and basic completion of a road network, there will be increasingly little effect of solving traffic congestion problems through road construction and its cost will be increasingly higher. On the contrary, the results of solving traffic congestion problems through road traffic management will get better and better. But the traffic management level in China is very low. To

make changes to the current condition, the Ministry of Public Security and Ministry of Construction have jointly implemented road traffic management “Smooth Traffic Projects” throughout the country. As urban traffic management planning is one of the main evaluation parameters in conducting the national checking of “Smooth Traffic Projects” in each city, most of the middle and large cities have worked out urban traffic management planning. But as there are no norms and standards to work out urban traffic management planning and design, there exist some problems in planning goals, contents, depth and scope of traffic management planning prepared by different cities, which affects the forwardness, usefulness and workability of these plans. This paper has done a substantial job on standardizing the scheme design work of urban traffic management planning.

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城市交通管理规划的方案设计技术

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摘要:为提高交通管理的科学性,构建了城市交通管理的管理策略体系,包括交通需求管理模式下的优先发展策略、控制发展策略、禁止出行策略、经济杠杆策略,及交通系统管理模式下的节点交通管理策略、干线交通管理策略、区域交通管理策略.并提出了基于城市交通需求管理模式的城市交通需求总量控制、城市交通结构优化、道路交通运行组织方法,及基于城市交通系统管理模式的道路交叉口交通管理、道路交通标志标线管理、交通信号灯优化设计、城市停车场规划与管理等方法.提出的城市交通管理规划方案设计方法已经在全国城市交通管理“畅通工程”中推广应用.

关键词:交通需求;交通系统;交通管理

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