STUDY ON GREEN PARKING PLANNING AND MANAGEMENT

Xin Li
Master pursuing
Institute of Transportation Engineering
Tsinghua University
Beijing, China
PH: 13581684843
Fax: (010)62795339
E-mail: zrmuy@163.com

Huapu Lu
Professor
Institute of Transportation Engineering
Tsinghua University
Beijing, China
Fax: (010)62795339
E-mail: luhp@mail.tsinghua.edu.cn

Abstract: Sustainable development is an important goal for cities in the world. Green planning has attracted a lot of attention. Parking planning is a part of city traffic planning. Traditional parking planning’ aim is to well satisfy citizen’s demand, which performs as a following type planning. While green parking planning is quite different. It controls and guides people’s parking demand to realize high efficiency and low pollution. In this paper, we first make a study of advanced experiences both in home and abroad. At the same time, we absorb some excellent concepts and methods. Then a specific process of parking planning and management is proposed with a case study of Caofeidian ecological city. The characteristic of this planning is green, guiding and easy executable. We hope this paper is able to give some inspiration to researchers working on parking planning.

Key Words: green transport, parking planning and management, guiding type planning, Caofeidian ecological city

1. INTRODUCTION

Nowadays, people pay more and more attention to environment and resource problems. The exhaust and dust generated from traffic has seriously affected urban environment and caused a kind of “city diseases”. In the context of this, the concept of “green transport” is raised, which means that we encourage people to use clean and suitable vehicle to complete social activities. The goal of this concept can be concluded as reduce traffic congestion, reduce environment pollution, promote social equity and use resources properly. The green transport system level diagram is shown in Figure 1. Walking and bicycle are both encouraged because of non-pollution. Bus and pool-car are on a lower level because of high utilization and low pollution. The worst vehicle for green transport is private car.

Figure 1 green transport system level diagram
To improve the status of “city disease”, transport planning and management can play an important role, especially for a new city. “Parking is the vital but often ignored transportation policy issue. Parking policy decisions shape the form of cities, their density, travel patterns and the quality of the environment” (U.S. department of transportation, 1992). In this paper, we focus on one of the most significant parts of transport planning: parking planning. How to integrate the concept of green transport and parking planning is the major problem we are going to discuss.

Many researchers have done a lot of studies on parking planning and management to solve traffic problems in different cities (Miao Lixin etl, 1999). LI Changbo etl (2010) introduce a process of parking planning in Wenzhou which considers implementation and public participation. It is helpful to propel a specialized parking planning. WANG Rui etl (2009) advance some suggestions on the planning of residential areas considering the actual conditions of Kunming. Several criterion have been concluded, such as planning according to local conditions, efficiency first, coordination and so on. PENG Liren and REN Futian(2002) propose that the function of the roadside parking, usually a complementary part of the off road parking but it varies between cities and locations. In this paper, we integrate the advanced plan views and adopt a process of green parking planning with a case study of Caofeidian based on experience discussions.

2. ADVANCED EXPERIENCE IN HOME AND ABROAD

2.1 Canada

In Canada, transport management is recognized as a very helpful means to make effective use of parking space resource, which aims to improve utilization, reduce environment impact and support to the reduce of total traffic demand. There are some tactics as follows.
1 Share parking facilities. This idea is based on different peak parking time periods against different nature of land use.
2 Estimate parking demands more accurately.
3 Reduce parking demand using TDM plan, including parking fee, encouragement of short-term parking and so on.
4 Manage parking lot attached to a building separately.

2.2 France-Paris

Paris transport planning proposed an idea of dividing the city into 3 regions. The main traffic route in the red region is to prohibit parking absolutely. Blue region allows parking charges in limited time, while Green region permits long-term parking. All the 3 regions is monitored by computers in Traffic Management Office. There are several other provisions.
1 Prohibition of discharge in daytime.
2 Prohibit external vehicle into the city when the traffic is saturated.
3 Increase parking fees in the city to limit car parking.(Yang Kuan, 2001)

2.3 Japan

Though Japan has large population and small size of land, it does not limit the use of cars especially. Japan has constructed convenient track systems and bus systems to share most passengers.
1 Prepare parking spaces by oneself if he has just bought a car.
2 Construct public parking lots on roads, parks or schools.
3 High parking fees in the city.
4 Integrated transfer hub in which effectively combines parking, bus stations, stores and so on.

2.4 Singapore

Singapore is an island country in which the land resource is very limited. Unlike Japan, Singapore government seriously restricts the ownership of cars. Based on the analysis of environment capacity, they determine the maximum car capacity.
1 License auction every month to control the social possession of cars.
2 Set a series of tolls in city center. So each car should choose its route and pays for it according to routes, travel time and pollution. This tactic contributes to a smooth traffic situation though the roads in the center of city are not so broad.

2.5 China-Hong Kong

There are 1070 square kilometers land and more than 7 million people in Hong Kong. It is one of the most crowded cities in the world. Hong Kong adopts a lot of ploys to reduce the demand of traffic land.
1 Develop public transport
2 Limit the ownership of private cars by increasing registration tax and fuel tax etl.
3 Restrict parking. For example, some entertainment places do not support parking lots; residential regions are only supported with a small amount of parking; roadside parking is selectively limited.(Wang Yuanqing etl,2003)

2.6 Summary

Based on the study of advanced experiences in home and abroad, we can see that parking planning and management is valued and important for a city. There are various tactics and suggestions to deal with urban parking problems. Environment protection is a very popular topic in recent years and many cities make a parking planning considering of it. We can summarize the experiences as follows.

<table>
<thead>
<tr>
<th>Country or city</th>
<th>Restrict car ownership</th>
<th>Reduce parking</th>
<th>High parking fee</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Public transport development; integrated transport hub etl.</td>
</tr>
<tr>
<td>Paris</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Hong Kong</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

3. GREEN PARKING PLANNING IDEAS-TAKE CAOFEIDIAN AS AN EXAMPLE

Caofeidian which is known as “Bohai pearl”, is located in Tangshan, Hebei province. Caofeidian ecological city is a new city under construction beside the sea. As an ecological city, it requires some new ideas of parking planning compared with the traditional ones to realize comfortable social environment and traffic environment.
3.1 Guiding ideology

The urban construction land in Caofeidian ecological city is 73.8 square kilometers and the population will reach 0.8 million in 2020. As a city under construction, a pretty good planning is significant. As an ecological city, the planning should reflect the concept of ecology. The main guiding ideology of the green parking planning will be elaborated as follows.

1. A guiding type planning. This means that this planning should guide and control the demand of citizens. For example, we set less roadside parking to reduce parking convenience, increase efficiency of roads and restrain desire of private car travelling.

2. Combine with green transport plan index. SWECO company has proposed 141 ecological indices for Caofeidian, in which there are 15 indices about transport. They can be classified as accessibility, efficiency and safety. This is a useful and guiding achievement to propel the following planning.

3. Attitude towards private cars. Auto industry is important for economy of a country, so it is almost impossible to limit the ownership of cars in China like what is done in Singapore. More and more cars affect city environment and traffic condition seriously. But we can take some measures to restrain car travel. In a word, we pay more attention to how to guide car travel than how to reduce car purchase.

4. Classification. This word has two meanings. 1) we should classify types of parking spaces as supporting parking, public road-outside parking and roadside parking in this planning. 2) we should assort Caofeidian ecological city as several typical areas: entrance and exit of a city, transport hub, residential areas, public facilities of different levels and large public places. We will study each type carefully to provide suitable schemes.

5. Combine with other parts of this green transport planning. Parking planning is a part of transport planning and they should be well integrated. For example, we should coordinate parking system with road system, public transport system and slow-travel system.

6. Implementation. That is to say the planning should be detailed, realistic and easily implemented.

3.2 Planning process

3.2.1 Process
3.2.2 Parking demand estimation
According to the research of demand estimate methods, we finally choose two ways to estimate total parking demand estimation in Caofeidian ecology city.

1 Parking generation rates model
Parking generation rate is the required parking spaces of the unit land use. The model is based on the relationship between the nature of land use and productivity of parking demand. The basic idea is that we take land plots of different types of land use as parking attraction places, while the total parking demand is the sum of each individual plot. This method mainly takes land use into consideration and is especially fit for new city planning (Zhang Xiuyuan et l, 2006). The formula of this model is:

   \[ P_d = \sum_{j=1}^{n} (R_{dj})(L_{dj}) \quad j=1,2,...,n \]

   \( P_d \) - parking demand of peak hour in year d;
   \( R_{dj} \) - parking generation rate of the j th type of land use in year d;
   \( L_{dj} \) - the amount of the j th land use in year d;

2 Travel and attraction model
The production of parking demand is closely related to the situation of social economy, while the social economy is connected with the amount of attracted cars. The principle of this model is to make a relationship between the parking demand of peak hour and the car travel and attraction situation in a region (Zhang Xiuyuan et l, 2006). This model pay more attention to the behavior of vehicle, which is quite different from the former model.

We choose two parking demand estimate models which focus on different directions. They together describe the two mainly parking demand factors: land use and vehicle behavior. At the same time, they can verify each other.

3.2.3 Parking control zoning
We zone Caofeidian city into 4 parts according to different levels of parking facilities support. It is shown in table 2 and figure 3.

<table>
<thead>
<tr>
<th>Zoning</th>
<th>Distribution</th>
<th>Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>No car area</td>
<td>Most of roadsides</td>
<td>Avoid affecting road traffic situation</td>
</tr>
<tr>
<td>Car restriction area</td>
<td>Some roadsides and residential areas; public facilities area of the city level</td>
<td>Provide limited parking places to restrain car travel, especially in the center of the city</td>
</tr>
<tr>
<td>Transition area</td>
<td>Public facilities area below the city level; upscale residential areas.</td>
<td>Satisfy the demand of citizens but not encourage car travel</td>
</tr>
<tr>
<td>Fit for parking area</td>
<td>Entrance and exit of a city;</td>
<td>Encourage p&amp;r mode and the</td>
</tr>
</tbody>
</table>
According to table 3, we classify the city into 5 typical areas, then take different measures to solve the parking problem.

<table>
<thead>
<tr>
<th>Typical areas</th>
<th>Character</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrance and exit of a city</td>
<td>P&amp;R mode most for foreign cars</td>
<td>Provide quite enough parking spaces, encourage P&amp;R mode</td>
</tr>
<tr>
<td>Transport hub</td>
<td>P&amp;R mode most for local cars</td>
<td></td>
</tr>
<tr>
<td>Residential area</td>
<td>Support enough parking for community residents, but limit visiting cars.</td>
<td>Limit car parking places in varying degrees</td>
</tr>
<tr>
<td>Public facilities area</td>
<td>Different level of public facilities is treated differently. Higher level, more seriously parking repression</td>
<td></td>
</tr>
<tr>
<td>Large public area</td>
<td>Encourage public transport and reduce car traveling</td>
<td></td>
</tr>
</tbody>
</table>

3.2.4 Supporting parking index study
Supporting parking index is quite different in varying cities. For a new city planning, we should study the indices of different cities first, then get a integrated, appropriate result. The
feature of city should be considered, at the same time, the aim of this planning should be clear in mind. (Chen Jun et al., 2007)

Table 4 supporting paring index in Caofeidian ecological city

<table>
<thead>
<tr>
<th>Land use</th>
<th>index</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Villa</td>
<td>1.2</td>
<td>/family</td>
</tr>
<tr>
<td>Upscale residential area</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>General residential area</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Office building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upscale office</td>
<td>0.65</td>
<td>/100 square kilometers</td>
</tr>
<tr>
<td>Administration</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>General office</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Business center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large business center</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>General center</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Retail outlets</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Market</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Entertainment center</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Sports center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary school</td>
<td>2</td>
<td>/100 seats</td>
</tr>
<tr>
<td>High school</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

3.2.5 Public parking setting
After the above study, it is relatively easy to get the amount of public parking. First, we get the total parking demand using models described in 3.2.2; then we can obtain the supporting parking amounts according to the parking indices; finally results of subtraction is what we need in the initial stage. It will be revised later.

3.2.6 Results revised
The initial planning results should be revised based on several principles.
1 Satisfy the need of more than 25 thousands social public parking.
2 Because the roads in new city are planned as narrow and dense, we encourage parking outside roads.
3 Experiences show that the number of social public parking is about 10%-20% of the supporting parking.
4 Well connection with bus system and slow-travel system.
5 Prohibit the entrance of cars in slow-travel region.
6 Consider green transport indices.
7 Consider environment capacity of each region.

3.2.7 Parking management
Parking management is an effective means to realize and guarantee the goal of planning. We just list some management methods to illustrate it.
1 Parking charge
It is widely used both in home and abroad. As an important way of parking management, it can not only regulate parking desires, but also increase government revenue. The principle of this is to adopt economic lever to adjust people’s demand. The charge rate in this planning is set as follows: public facilities of city level> public facilities below city level> large public
area > residential area > transport hub; entrance and exit of city (free).

2 Parking guidance system
This system provides convenient parking service though the real-time information dissemination of varying forms, such as the VMS board. It is helpful to guide the parking demand, improve road transport service and ease the traffic congestion by reducing meaningless parade.

It could be a part of ITS. The basic information we need is that how to get the parking and how many seats is available right now. The information should be published in different stages according to the varying distance away from a parking lot.

3 Management in car forbidden area
It is a common phenomenon that people stop their cars random and outside the parking places. Seriously management is necessary for it. Some technology methods also could be adopted.

<table>
<thead>
<tr>
<th>Table 5 some ways to forbid illegal car parking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage scope</td>
</tr>
<tr>
<td>Main roads with large traffic</td>
</tr>
<tr>
<td>Slip roads</td>
</tr>
</tbody>
</table>

3.3 Contrast with traditional parking planning

We summarize the similarity and difference of traditional parking planning and green parking planning shown in table 6.

<table>
<thead>
<tr>
<th>Table 6. similarity and difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
</tr>
<tr>
<td>Aim</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Index choosing</td>
</tr>
<tr>
<td>Suitable usage scope</td>
</tr>
<tr>
<td>Focus</td>
</tr>
</tbody>
</table>

4. CONCLUSION

Transport planning and management should reflect the concept of sustainable development and environment protection nowadays. In this paper, we mainly introduce a concept of green parking planning. Based on the carefully study of experiences, we take Caofeidian ecological city as an example and discuss the process of green parking planning. The innovation and
contribution of this paper is:
1 We propose the guiding ideology of green parking planning. It could be helpful to propel the development of planning.
2 A real case is made use of to illustrate the process of planning.
3 We contrast green parking planning with traditional parking planning and define the suitable usage scope of these two.
4 We do not only advance a concept which has close contact with the trend of development in the world, but also describe the implementation process in detail.
Of course, there are some deficiencies in this paper, such as the planning results can’t be verified in short term and so on. We’ll follow this case and make further study of it.

ACKNOWLEDGEMENT
Thanks for the support of the program of Caofedian ecological city comprehensive traffic planning and P.H.D Programs Foundation of Ministry of Education of China (Grant No. 20070003065).

REFERENCES