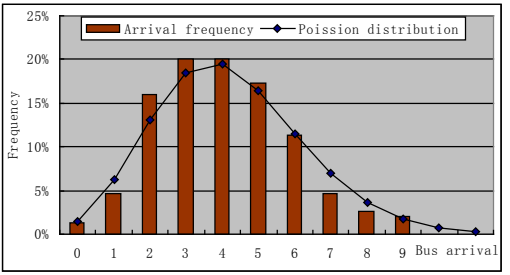

Figure 7. Comparison between the arrival frequency and Poisson distribution

With the overtaking rate α=0.348, and the average parking time E(T)=34.3s, then μ_1=1.75 according to equation(2). Assuming that the maximum value of demand-supply ratio is δ=1.2, then PCR=0.652 according to equation(5). So the parking needs can be satisfied at this stop, but the reliability is relatively low as buses may arrive in a batch.

As above mentioned, parking reliability of this bus stop can be raised either by increasing parking spaces and reducing parking demands.

The increase of parking spaces form 5 to 6 will just cause a slight rise of PCR from 0.652 to 0.702. The rise of PCR to 0.8 requires more than 7 parking spaces, which will increase the total length of platform to more than 100m. Long platform is not encouraged as it causes trouble for passengers to find and get on the bus, and is usually restricted in civil development.

Parking demand can be reduced by extending average arrival headway, cutting down the number of bus routes and average parking time. Take the data in figure 1 as an example, bus routes with tight schedules such as 426, 465, 601 and 863 should be readjusted in arrival intervals. If the headway is extended to about 4.5min, PCR will be improved to 0.784, which is a significantly better result compared to increasing parking spaces. What's more, redundant and repeated bus routes should be analyzed and rearranged. For example, PCR can be improved to 0.804 by cutting down repeated bus routes such as 125, 132 and 608. If both the two methods are taken to this stop, PCR will rise to 0.898, and batch arrival will be greatly reduced.

CONCLUSIONS

This paper depicts the arrival and departure of buses at a bus stop as a birth and death process, In view of co-ordination of supply and demand, we defines the bus stop parking capacity reliability in order to measure the probability that bus stop accumulative capacity meet parking demand, put forward the parking capacity reliability model for multi-routes bus stop with multi-parking spaces. Based on sensitivity analysis of the parameters, analyses how the available parking space, average parking time as well as amount of bus lines impact on bus stop parking

capacity reliability. The result can be served as essential reference for bus stop design and optimization as well as the regulating of bus operation.

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The Planning Strategy of Combination Mode of Slow Traffic Ways in Central City of Chongqing

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ABSTRACT

By analyzing some slow traffic ways in some domestic and international cities, this paper proposes a combination mode of slow traffic ways which is suitable for Chongqing, a typical mountain city. The combination mode is composed of personal rapid transit system, Crossing-river cableway, pedestrian access and overhead pedestrian trails, which are corresponding to the pedestrian corridor, pedestrian street and pedestrian unit, with the consideration of interface between them. This model can solve the problem which bicycles are inappropriate for Chongqing people fundamentally, and make a high efficiency, low power consumption slow traffic patterns.

INTRODUCTION

With over 32 million residents Chongqing is one of the fastest growing urban areas in the world. The core city is situated in mountainous terrain between the Jialing River and Yangtze River which create many challenges for pedestrians, when climbing some of the hundreds of steps and stairs in the city. According to a study by Gehl Architects, it found large numbers of pedestrians walking in the city, but very poor quality in the urban environment. Unlike many western cities in China, nowadays, Chongqing has many elderly citizens, children and large numbers of vendors to support a very vibrant urban street cuisine in traditional areas of the city.

Based on study of public space and public life, Gehl Architects has developed strategies for creating a pedestrian network and recommendations for public space quality. These included the creation of a continuous riverfront park, an extensive pedestrian network throughout the core city designed with particular emphasis on the topography rise and connections to public transportation. Adopting which slow traffic way or a combination mode composed of variety slow traffic ways at certain places is the key problem of Chongqing that this article solve.

TRAFFIC PLANNING IN CHONGQING

In 2006, a research for 《Pedestrian System Planning》 was conducted by Chongqing Institute of Transportation Planning. Combining the main characteristics of "mountain city" and "river city', this study has formed an unique pedestrian space where people can have a wonderful journey, enjoy the beautiful scenery and do some leisure and fitness exercise. The pedestrian space is found on the important pedestrian areas, ecological parks and tourist attractions within the city.

In this study, the pedestrian space was divided into 3 levels, they are pedestrian corridor, pedestrian street and pedestrian unit.

Pedestrian corridor: it refers to a long and strong continuity distance in a certain area. As the main transportation travel channel, the surrounding area residents usually walk through it to do some leisure and fitness exercise. To ensure the safety and comfortable, pedestrian corridor should be strong structural and functional, and the time of walking through the whole gallery is not less than an hour.

Pedestrian street: it is a certain area where there are a large number of commercial facilities, attracting many concentrated flows of people. Normally, pedestrian street is an area of about 3 to 8 square kilometers, which refers to the business district in the center of downtown and has a strong pedestrian demand. Overall, pedestrian street is a concentrated, intensive and diversified system.

Pedestrian unit: it is a certain area with a strong peak-hour traffic where a variety of traffic modes are gathered. At these places, there are many transportation hubs, such as bus stations, rail stations, and airports. Generally speaking, a pedestrian unit area is 1 square kilometers and also treated as the center of transport facilities.

According to the pedestrian traffic systematic survey, planners have proposed a planning composed of 18 pedestrian corridors, 8 pedestrian streets, and 18 pedestrian units (see Figure 1).

FOUR KINDS OF SLOW TRAFFIC

Personal rapid transit (PRT)

Personal rapid transit (PRT), also called podcar, is a public transportation mode featuring small automated vehicles operating on a network of specially built guide ways (see Figure 2). PRT is a type of Automated Guideway Transit (AGT), a class of system which also includes larger vehicles all the way to small subway systems. In PRT designs, vehicles are sized for individual or small group travel, typically carrying no more than 3 to 6 passengers per vehicle. Guide ways are arranged in a network topology, with all stations located on sidings, and with frequent merge/diverge points. This approach allows for nonstop, point-to-point travel, bypassing all intermediate stations. The point-to-point service has been compared to a taxi or a horizontal lift.

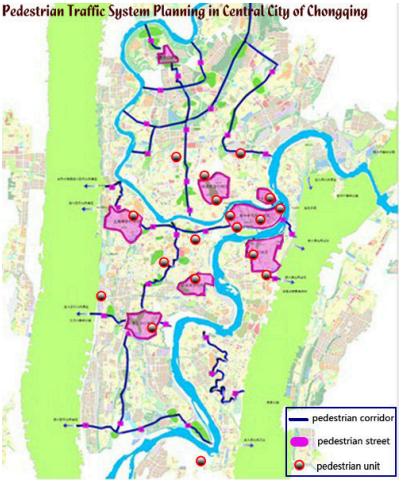

Figure 1. Pedestrian system planning in central city of Chongqing illustration

Figure 2. Personal rapid transit illustration

Table 1. Key Indicators of PRT

Line capacity(vehicle/h)	5000-7200
Site service capabilities(per vehicle)	1500
Speed(km/h)	32-97
Energy consumption(J/km)	90(when speed is 40km/h)
Maximum gradient(/%)	15(i=H/L)
Minimum turning radius(/m)	11
Adaption of climate	Normal operation in the conditions of rain, snow, ice and less than 120 km / h wind speed
Waiting time	Non-peak hours, no waiting time; peak hours, 80% of passengers waiting less than 30s, 99% of passengers waiting less than 2min

Because of the traffic management of single cycle, large numbers of pedestrians have many challenges when they are walking through business districts in Chongqing. But the PRT track can pass through these pedestrian traffic bottlenecks, so that pedestrians can travel through these places smoothly by PRT.

Crossing-river cableway

Because of the mountainous terrain in core city, people had to rely on the ships to cross the river. In 1970's, the traffic way between the core cities mainly relied on 36 ferries. What's worse, this traffic way was depend on weather to a large extend.

At the beginning of the 1982, Chongqing has built a cableway across the Jialing river, which was the first passenger cableway in China (see Figure 3). From then on, the average passengers were more than 12,000 person-day until 1990's, and the most was up to 25400 person-day. In 1987, the second ropeway, named "Yangtze River passenger ropeway" was completed and put into operation (see Figure 4). The cableway starts at Changan temple in Yuzhong District, goes across the Yangtze River and stops at the Shangxin street in Nanan district. The total length is 1166 meters. Carrying 10500 passengers daily, the cableway is called "the first air corridor in the magnificent Yangtze river". At that time, the ropeway became an indispensable traffic way, greatly decreasing the traffic pressure between each district.

With the passage of time, many roads in Jiangbei District and the Huanghuayuan Bridge have been built and put into operation. Traffic pressure has been greatly alleviated, the Jialing river ropeway was not popular as before. In fact, it would be removed by the government.

Figure 3. Jialing river ropeway

Figure 4. Yangtze river ropeway

Pedestrian access

In some older streets, especially streets in Yuzhong district, pedestrian traffic is very inconvenient, such as the narrow and crowded pedestrian road, full of obstacles, vehicular road, exhaust pollution of motor vehicle, lacking of crossing facilities, road signs and sunlight and rain shading facilities. What is worse, the elderly and the disabled feel very inconvenient when they use.

Pedestrian road is the basic element of pedestrian network. In general, the pedestrian road should have sufficient width to meet the requirements for pedestrian. Pedestrian routes must be provided with a recognizable landmark, and should not place any obstacles. To enhance the connectivity of pedestrian passage and solve the problems of difference, automotive facilities should be provided for pedestrians, such as escalators, lifts and automatic sidewalks (see Figure 5).

Figure 5. Comfortable pedestrian access illustration

Overhead pedestrian trails

Despite of setting the road crossing facilities, Overhead pedestrian trails (see Figure 6) could also be built in crowed places for pedestrians crossing a busy street conveniently, such as Jiefangbei, Sanxia Spuare. Long distance elevated walkway can also be used as a solid pedestrian network, connecting important interval hub. Elevated walkway has a number of advantages, including: vehicle separation, directly providing, continuous and all-weather pedestrian network, safety and convenience, and the efficiency of connecting the main commercial buildings, sports facilities, residential area and traffic hub, which reduce part of travel demands.

The elevated walkway system has been built in high density commercial district (Yangjiaping commercial center) and achieved good effects. Connecting a plurality of housing developments, the elevated walkway system should also be developed at some interchanges of commercial buildings and public transportations in other business districts.

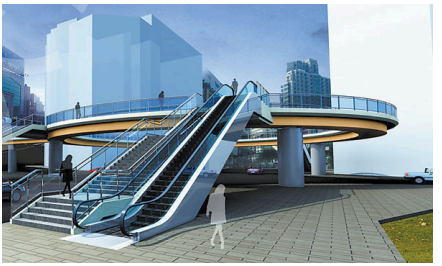

Figure 6. Overhead pedestrian trails in construction in Chongqing

The transfer and connecting between slow traffic ways and public transportation

Pedestrian corridors, pedestrian streets, pedestrian units were seen as three sub-systems of pedestrian system. Their distribution pattern generally is that the walking corridors cross through the walking streets and connect with walking units, and walking units are randomly distributed in the walking streets. The pedestrian traffic system throughout the urban city of Chongqing is such a distribution pattern, as is shown in Figure1. In the previous section, we introduce 4 slow traffic ways and illustrate their service area. So only do we combine the slow traffic ways and take the conversion into consideration can solve the traffic problems in a pedestrian area.

To illustrate the combination of slow traffic ways and conversion patterns, we simulate a commercial center (see Figure 7), which is treated as a virtual walking transportation system. In this system, the roads crossing the region are treated as pedestrian corridors, the central business district is treated as the pedestrian street, groups of buildings are treated as pedestrian units.

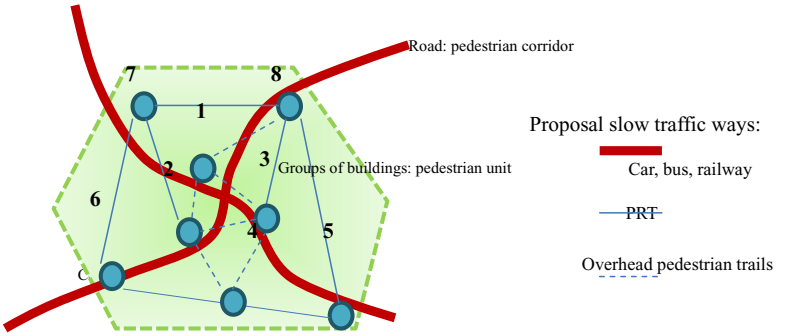

Figure 7. A virtual walking transportation system illustration

As is shown in the above picture, the road treated as pedestrian corridor is usually supplied for motor vehicles and public transport (represented by the heavy

solid line), such as private cars, buses and rail transit. The pedestrian corridors links up the communication lines between the buildings aside by the roads. We can see two lines of 6-2-8 and 7-1-3-5 in the picture. You can also set personal rapid transit system along the gallery, but there will be a contradiction between the rail line. In view of the completion of rail transportation system planning in the core city of Chongqing, the personal rapid transit system should be specially planning and design.

Due to the long distance, residents can't easily pass through the walking units where there is lack of slip roads to connect, such as between 6 and 7, and between 8 and 5 in Figure7. PRT (represented by the thin solid line) can be used as a certain mode of transport to make up for the shortcomings of the various traffic ways and exert their strengths. For example, we can establish the PRT system network around a major subway station, so the multi-level transportation system is formed by short-range using PRT, long-distance using subway. What's more, using PRT system can reduce road traffic during the peak period and give full play to the capillaries system effect because of the public transport and taxies' over-reliance on road traffic, and also reduce the buses and taxies operation density in branches, take full advantage of resources into bus rapid transit and mainline transport, improve the operating speed of the vehicle and enhance transport efficiency.

The distance between the walking units in the core area is usually short, but due to the blocking of roads, pedestrian access is not very convenient, such as between 1 and 3, and between 2 and 4 in Figure7. You can build elevated walkways (represented by the dotted line) to connect the buildings. Thus, not only effectively dredge the flow of people, but also make the crowd directly walk into floor without crossing busy city streets. Overhead walkway can connect with the two layers of space between commercial buildings. It not only strengthens the commercial building links, but also forms a new street corridor in the ground outside the space. Corridor width should be 5-10 meters. Aside the corridor, people can properly set some plants or a small amount of recreation spaces.

The convergence between pedestrian channel and traffic facilities should be considered as a whole. Such as, walking system should be well integrated with bus stops, rail stations, the entrances of pedestrian bridges and underground channels should connect with bus stations and railway stations.

CONCLUSION

Slow traffic is directly related to people's livelihood, which is the focus of government's concerning. To solve the pedestrian traffic problem, it requires a lot of efforts from every department. For example, the construction of facilities demands enough fund protection, it should make some verification scientifically before making any decisions. Depending on the existing slow traffic planning, it should implement each measure as soon as possible, and make a high efficiency, low power consumption slow traffic patterns.

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