Research on the traffic organization optimization countermeasures in highway service area under the abnormal condition

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Abstract. In order to effectively improve the utilization rate and service turnover rate of highway service area, and make the traffic flow more smoothly, this paper studies the transportation organizations under special circumstances, such as extreme weather, natural disasters, holiday peak trips and other special situations. Traffic organization optimization countermeasures are proposed from three aspects: controlling the total amount of traffic, optimizing the internal organization and improving the departure rate. The result can provide reference for the construction and optimization of service area in the future.

1. Introduction
In recent years, China's national economy continues to develop rapidly, the level of national consumption is escalating, car number has climbed sharply. With the vigorous development of tourism and the changes of service requirements, many problems have appeared on the highway service area, such as insufficient parking, lack of public toilet, inappropriate bathroom proportions. The queuing phenomenon of women's toilets is particularly serious, which affects traffic organization. The internal traffic organization management is not standardized, the passenger and cargo zoning is not clear, the traffic mark is vague and chaotic, which leads to serious parking disorder.

Some scholars have some research on Transportation organization of service area. Dai Guozhong [1] puts forward the problems of traffic organization management in service area in china. Wang Guoliang [2] considered that the important measure of the internal traffic organization of highway service area is the overall layout of the site, and reasonable site layout can reduce unnecessary traffic flow and effectively improve the efficiency of site operation. Zhou Tong [3] discussed the design significance of traffic organization in service area, and analyzed the shortcomings of the current domestic services facilities. Wang Jianwei[4] analyzed the law of people and traffic flow in service area, and putted forward the optimization countermeasures. Yang Xianlian[5] put forward that the separation of cars and trucks should be rationally induced by modern science and technology. Yang Yunxing [6] analysed the five stages of find-road behaviour in the open service area motorists in the service area, clear traffic organization flow line and important node identification system is extremely important. Because the lack of research on the traffic organization of highway services , this paper
puts forward the countermeasures for the transportation organization of the highway service area under the abnormal condition.

2. The current situation analysis of highway service area

2.1. Unclear function, messy layout
There are many unreasonable layout problems in domestic service area. Some of them will build gas stations at the entrance. In the case of a large amount of traffic, the waiting time is long, and the queue of vehicles is likely to be in the deceleration lane. Some service area use inverted parking for the parking spaces of large vehicles, which affects traffic efficiency and safety. Some service area have narrower approach roads, and different vehicles behind can only wait in line, resulting in low utilization rate of gas stations.

2.2. Arbitrary stop, difficult parking
Due to the small land expropriated in the early stage of construction, some service area do not have reserved space for expansion, resulting in many problems, such as venue crowded, difficult parking, and illegal parking, as shown in Figure 1. It is the Pioneer Service Area on G15 Shenhai Expressway. Some service area have not been different design according to mountain conditions, as shown in Figure 2. the distance between the truck parking space and the parking space of the Daguan Service Area of the Baomao Expressway is close and the elevation difference is large, resulting in unnecessary safety hazards.

2.3. Sign confusion, blurred marking
Some service area lack the necessary orientation signs design. On the one hand, the traffic line markings of many domestic service area are ambiguous, and the layout is chaotic. For example, the Daguan Service Area of Baomao Expressway, the Zunyi Service Area of Lanhai Expressway and the Jiuchang Service Area all have blurred and unclear markings. On the other hand, the traffic sign indication is not clear, most of the service area in China are not marked with sidewalks and crosswalks.

2.4. Toilet crowded, waiting time is long
The toilet line is long in service area, especially in female toilets. This phenomenon is particularly obvious in the abnormal situation. On the one hand, because the limitation of land requisition, the capacity of toilet setting is insufficient. For example, the female toilet in the Renhuai service area has only four position, which are in short supply under peak conditions. On the other hand, the ratio of the position in the toilet design does not match the actual demand, the female toilets are less occupied, and the service area are queued for toilets during the holidays.

3. Traffic characteristics analysis under abnormal conditions
The extraordinary traffic characteristics of road service area are mainly reflected in climate changes, holidays and schedules.
3.1. Climate characteristics
Changes in traffic volume on road sections are significantly affected by climate environmental. The change of four seasons has a great effect on road conditions the human activities. Under different climates and seasons, the traffic organization of service area is quite different.

3.2. Holiday characteristics
People generally choose to take advantage of national holidays to travel, to enhance the fun of life. People travel during holidays and weekend has brought problems for the service area traffic organization [7].

3.3. Arrangement of event activities
Large-scale festivals activities will bring tourists gather and evacuation in a short period of time. The staying time of tourists in the service area is short, and the instantaneous visitor numbers is large. The accommodation and evacuation of service facilities in a short period of time put forward higher requirements.

4. Traffic organization countermeasures under abnormal conditions
The abnormal traffic characteristics of the service area lead to the imbalance of the time distribution. The problem of abnormal traffic organization can be solved from the aspects of controlling the total amount of driving in, optimizing the internal organization and improving the exit rate.

4.1. Control the total amount of driving in
Controlling the total amount of driving in can start from the tide system of parking in service area. For example, during a certain period of time, only some vehicle is allowed to enter service area, and the adjacent service area allowed other vehicles in. Under abnormal conditions, the tidal system of service area can alleviate the capacity of service area and simplify traffic organization. The service area in the early planning stage were rather messy, there was no exact distinction and definition between the large and small service area, and the parking areas in the service area were not planned according to the functionality, so that the service area on the same highway were not difference in the scale and function. Therefore, in the planning stage of service area, in addition to meeting the basic common service requirements, the basic facilities and supporting facilities should be arranged according to the different vehicles, so as to ensure that all kinds of facilities in the service area can make the best use [8]. Facility layout can improve the classification management of service area and solve the waste problem caused by unreasonable resource allocation in the service area, and can adjust the driver's habits in the service area to reduce fatigue driving.

4.2. Optimizing internal organization

4.2.1. Marking line optimization
When laying out marking lines in service area, the first principle to follow is to accurately transmit information to the driver and induce the driving route of the vehicle. The structure type and layout of the marking should be based on the linearity of the driving road. The setting of traffic signs should take into account the range of visual range and visual clarity of the vehicle in the process of driving at night. Multifunctional complex service facilities should emphasize their aesthetics.

Variable traffic signs placed in the service area can improve site utilization and usage turnover. For example, during the holiday, the variable traffic sign placed in parking lot could make some of the more vacant truck parking lots as temporary bus parking, or can flexibly changed the traffic flow. The clear and beautiful marking has a good guiding effect. The parking space of the foreign service area is obvious, the marking is clear. Some of them also set the pedestrian line marking between the parking spaces of the bus, and carry out the color paving, as shown in the figure. 3. The domestic G50 Huyu
Express cold water service area (Figure 4) and G15 Shenhai Express Park Park service area have a good role in setting the marking line.

Figure 3 pedestrian line. Figure 4 Huyu Expressway Lengshui Service Area.

4.2.2. color paving of Parking space
Color pavement of parking spaces can better divide different parking areas and realize the separation of passengers and goods. Color pavement can guide the driver to enter the designated area more quickly. At the same time, it also enhances the overall landscape effect of the service area. It helps people with disabilities to find a specific parking space more conveniently. The color pavement of the gas station helps the driver to enter a specific refueling area more accurately.

4.2.3. Add parking spaces
There are many ways to add parking spaces when the place is limited, such as encrypted stations, adopting a central layout, using cross parking spaces, plaza parking layouts, building a three-dimensional cross parking garage, and establishing a differential parking system. If necessary, the area of the parking lot can be enlarged by removing the green separation belt of the parking lot. For the reconstruction and expansion of service area, the number of parking spaces for different types of vehicles can be predicted based on the survey results of different vehicles can be set within a reasonable floating range of the predicted results. For example, the Jingha Expressway Heli Service Area, the Huyu Expressway Qichun Service Area and the Jiezidun Service Area have a relatively large number of truck parking spaces.

In the case that the current service area have insufficient capacity and the actual situation does not allow for effective expansion, it should be considered from the perspective of the entire road network. The parking space can be increased by adding service area. For most service area, when the driver enter the service area from the acceleration/deceleration lane, there is generally enough width between the through lane and the main line to reduce the visual impact of the main line vehicle. For the limited service area, it is recommended to extend the driveway or parking lot to the main line side, to make full use of the site area to increase the parking space, such as the Shenhai Expressway Sutong Bridge Service Area and the Nan'an Service Area, as shown in Figure 5.

The inclined parking system is constructed by using the terrain height difference, as shown in Figure 6. The terrain difference parking system is a compound slope parking berth constructed of reinforced concrete. The vehicle can be moved up or down from the slope, and the site utilization rate is increased by 50%-100% by utilizing the ground drop. In the actual planning, it is more economical and reasonable to construct the terrain difference height oblique parking system than the common mechanical three-dimensional parking garage, and reduce the cost while increasing the greening rate.
4.2.4. Increase the exit rate

In the abnormal situation, the most demanding service area are the parking lot and the toilet, and the phenomenon of queuing or crowding mainly occurs in the parking lot and the toilet. Increased exit rates can be achieved by optimizing the toilet layout.

1) Public toilets are placed separately from the service building.
For service area with sufficient land occupation, public toilets and comprehensive service buildings can be constructed separately during initial construction or renovation, such as the Yinkun Expressway Zengkou Service Area. The composite construction of integrated service buildings can be considered to reduce the unsMOOTHness of vertical traffic organization.

2) Set up a second public toilet.
For service area with large scale or large traffic flow, it is recommended to set up a second public toilet, which not only reduces the number of cross-overs of traffic organizations, but also improves the efficiency of service area and toilets. Under abnormal conditions, the second public toilet can greatly reduce the pressure on public toilet turnover. The second toilet is set up in the Shenhai Expressway Longdong Service Area, Baishui Parking Area and the Shanwei Houmen Service Area in Guangdong.

3) Set up a temporary toilet or a gender-free toilet.
Under the limited conditions of the site, there is not enough space for the construction of the second toilet, and the temporary toilet can be added in advance during the period when the abnormal traffic is approaching. The addition of gender-free toilets can not only make up for the shortage of the number of major public toilets, but also effectively alleviate the unreasonable situation of the ratio of the positions, and to a large extent reduce the queuing of women's toilets.

4) Install the toilet seat idle reminder.
On the one hand, the toilet seat idle reminder can provide more accurate tips for the passengers who queue up in the toilet, which is beneficial to the staff and passengers to improve the efficiency of decision-making according to their own time schedule, and improve the turnover rate of the toilet; on the other hand, it can alleviate the anxiety of the queue waiters and improve the comfort of the passengers in the service area.

5. Conclusion

According to the research in this paper, under the abnormal conditions, the traffic organization of highway service area should start from three aspects: controlling the total amount of driving, optimizing the internal organization and improving the driving rate.

• Under abnormal traffic conditions, the method of controlling the total amount of driving is mainly the tidal parking system. Only certain specific vehicles are allowed to enter during a certain period of time, simplifying traffic organization and improving service turnover.

• Optimize the internal organization including the traffic sign and line optimization, the color paving and the additional parking spaces; etc.; the traffic sign and line can be optimized by setting the entrance traffic sign, the variable traffic sign, and the pedestrian passage between the parking spaces. In order to enhance the identification and enhance the effect of landscape construction, color paving can be carried out for different car parking spaces. Additional parking Spaces can be added by
encrypting stations, plaza-style parking layout, constructing three-dimensional intersecting parking garages, establishing and constructing the inclined parking system of elevation difference, and appropriately expanding the scale of land to the main line.

- The construction of public toilets separately from the main service rooms, the addition of second public toilets, temporary toilets and non-gender public toilets, and the installation of toilet idle reminder devices can effectively reduce the traffic flow cross in the site, improve the departure rate, and thus improve the smoothness of traffic organization.

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