Analysis of the Feasibility of Hov Lane of Shichang Avenue in Weihai City

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Abstract. Based on the experience of international traffic demand management policies, the Hov (high occupancy vehicle) has been introduced to the research on urban traffic planning and design. Through the collection and analysis of international experience in the design and operation of Hov lane, the requirement for Hov setting has been analyzed in China and the evaluation indexes of Hov lane have been proposed. By building the Hov design platform, this paper provides the methodology for the design and evaluation of Hov lane program. Through the research of this paper, we provide some scientific basis for the decision-makers and give some theoretical guidance for the Hov project in future.

1. Introduction
In 1990, the United States introduced the concept of HOV (High Occupancy Vehicle), which refers to high-occupancy vehicles with a large number of passengers[1]. Giving such vehicles a certain amount of road-priority driving rights is a strategy for solving traffic congestion on traffic corridors abroad[2]. So far, there have been nearly 40 years of development history, and a relatively mature Hov lane design, planning, operation and management system has been formed[3]. The related research shows that all states and local governments in the United States support the development of Hov lanes, and at the same time, the development of Hov priority policies plays a good role in relieving urban traffic congestion and protecting the social environment [4].

Looking at the current situation and development trend of the Hov lane at home and abroad[5], the setting of the Hov lane alleviates the traffic congestion status to some extent, improves the road traffic efficiency, optimizes the allocation of road resources, facilitates people’s travel, and enhances the signal control capabilities of the intersections. Above all, Hov lane has better promotion potential.

2. The feasibility of setting up Hov lanes in Weihai
There are no strict and uniform set-up and implementation standards for existing foreign-made Hov lanes, but their setting goals are the same, that is to ease traffic congestion and reduce traffic pollution. In order to achieve this goal, the specific setting methods and operation methods can be varied, which provides the possibility of setting up Hov lane in Weihai City. In the aspect of urban land use, Weihai City is similar to many European cities and it has the characteristics of mixed use of various types of...
land. In terms of road system setting, expressways and trunk roads are also the core road grades often used in Weihai City's traffic corridors; At the level, intelligent traffic monitoring equipment has developed rapidly. All these provide favorable physical conditions and technical support for the setting of the Hov lane. To sum up, the setting of the Hov lane in Weihai City has the following feasibility: the urban land form with no obvious boundary between the residential area and the commercial area easily leads to traffic jams on the main road, and the high-density traffic flow provides traffic conditions for the setting of the Hov lane. Urban traffic corridors formed by trunk roads and expressways provide road conditions for the setting of the Hov lanes.

3. Hov lane type

According to the different sections and operating policies, the common HOV lanes mainly have the following 5 categories:

- Hov lanes in the same direction. This is the most commonly used form. The HOV lanes are marked with traffic markings and signs. The direction of traffic is the same as that of the adjacent ordinary lanes. HOV lanes are provided on both sides of the road. In accordance with the isolation between the adjacent ordinary lanes, it can be divided into two types: buffered and unbuffered. Among them, the buffer type has a certain width separation between the HOV lane and the ordinary lane. This type of lane was originally applied to the El Monte Bus Lane. The California Department of Transportation set the width to 1.22m, which was later widely adopted as a design standard.

- Separation of HOV lanes. The HOV lane is separated from the adjacent traffic flow with guardrails to control the entrance and exit of the lane. In the traffic corridors with obvious traffic directions, the driving direction of HOV lanes generally does not change.

- Reverse HOV lanes are set on road sections with obvious tidal traffic. HOV lanes borrow one side of the extra traffic capacity and are separated by cone-shaped road signs or automatically movable guardrails, which are used by peak traffic, and their traffic flow direction and ordinary lanes. The direction of traffic is opposite.

- Bypass lanes. Bottleneck areas such as intersections, ramp entrances and toll gates are only used by the Hov vehicles.

- Bus-only Hov lanes. Only public transport vehicles are allowed, and the stations and corresponding auxiliary facilities are limited.

In recent years, with the deepening of the research on the Hov lane, the type of the Hov lane in the United States has gradually evolved. In the course of researching the development of the Hov lanes in the United States during nearly 30 years in 2002, chuck fhua concluded that the existing Hov lanes have gradually evolved into the same-direction traffic lanes and the reverse-direction driving Hov lanes. The original dedicated lanes are gradually These two types of transitions. The United States fhwa concluded in the summary report of the Hov lane in December 2008 that most of the co-directional traffic flows in the Hov lane, which accounted for 54% of the number of reported Hov lanes.

4. Shichang avenue Hov lane setup plan

Given the current situation of the World Changchang Road section, it is difficult to reconstruct or expand the road. Considering the economic and technical operability of the same-direction Hov lane, this paper proposes to use the same vehicle Hov lane.

4.1. Standard of driving vehicles and use time

Drawing on domestic and international city experience, vehicles that allow the use of multi-occupant lanes must meet the following conditions at the same time:

- The model is a small, miniature passenger car with a passenger load of 9 or less. The vehicle must have 2 or more members, and the first officer must not take children under 12 years of age.

- The pilot will allow passengers to enter “2+” vehicles in advance. Next, based on traffic conditions, it will assess whether the “2+” lane needs to be adjusted to “3+”.

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Morning peak hours are 7:00 to 9:00 on weekdays and 17:00 to 19:00 in night peaks. Motor vehicles other than multi-occupant vehicles are prohibited from driving through multi-occupant vehicle lanes. There are no restrictions on other hours and all vehicles are allowed to use.

4.2. Logo Design
Take the "multi-occupant lane" as the Chinese name of the Hov lane (in conformity with the national standard), a dedicated lane marking is set at intervals above or at the side of the lane for multi-occupant vehicles, and the dividing line between the lane of the dedicated lane and the adjacent lane is a white dotted line. The corresponding characters and the white multi-occupant lane pattern logo are set on the ground, and the number of passengers loaded flag is set to “2+”. The demarcation line of the Hov roadway is 4 meters white solid line, 4 meters interval (usually the road line demarcation line is 2 meters solid line, 4 meters interval), the ground prompt word is white.

In order for the public to anticipate the multi-occupant vehicle lanes in advance, a single bicycle will leave the multi-occupant vehicle lane in advance. In the area 200 meters, 100 meters and 50 meters away from the “multi-occupant vehicle lane”, it is necessary to set reminder signs in several steps. In order to let the public know more clearly the starting position of the lanes for multi-occupant vehicles, striking signs should also be set at the starting point and the end point.

5. Hov lane design evaluation indicators
The purpose of setting up the Hov lane is to improve the road section transportation capacity, make full use of road resources, increase the reliability of road transportation, and reduce traffic congestion. However, due to the incomplete consideration of the influencing factors in the evaluation of Hov schemes and the single evaluation indicators of the program, the resulting implementation of the designed design of the Hov lanes resulted in poor results. There were many cases in which the Hov lanes were running smoothly and the ordinary lanes were heavily congested.

Therefore, based on the three parameters of traffic flow, this paper constructs evaluation indicators for Hov design based on foreign Hov lane design principles, which mainly include: the number of cross-section transportation, per-vehicle driving time, and per-person trip delay.

5.1. Software Simulation Evaluation
Since the Hov lane setting has not yet been implemented on Shichang Avenue, the simulation of the Shichang Avenue can only be performed through software simulation. Based on the investigation of the current conditions of the road geometry, traffic flow, traffic composition and vehicle characteristics, the VISSIM simulation software was used to test and evaluate the effect of the implementation of the Hov lane of the Shichang Avenue.

5.2. Before and after the implementation of Hov lane
Comparison of the number of people transported on the road section From the data obtained from the simulation, it can be seen that after the implementation of the Hov lane, the number of people transported by ordinary cars did not change much, while the number of people transported by Hov vehicles increased significantly. This is because the number of Hov lanes opened is much higher. People will choose green and fast travel. The specific changes are shown in figure 1.
Comparison of the number of people transported by section

![Comparison of the number of people transported by section](image1)

Figure 1. Comparison of the number of people transported by section.

Comparison of driving time The data obtained from the simulation was used to make a histogram. From figure 2, we can clearly see that after setting the Hov lane, the road condition has improved. Ordinary cars’ travel time remains the same or slightly increases, while the travel time of Hov vehicles is much reduced because Hov vehicles line up in dedicated entrance lanes at intersections to reduce queuing time, and Hov vehicles can travel on special lanes. Reduce the disturbance caused by vehicles changing lanes.

![Comparison of the travel time](image2)

Figure 2. Comparison of the travel time.

Comparison of delays in the trip From the data obtained from the simulation, it can be seen that after the implementation of the Hov lane, the trip delay of the ordinary car remains basically unchanged, while the delay of the Hov vehicle is much lower. This shows that road traffic congestion has been alleviated during peak hours. When a dedicated Hov lane is added, traffic congestion on the Shichang Avenue can be alleviated without sudden changes in traffic conditions. As shown in figure 3.
This paper focuses on the Hov lane, and studies the setting conditions, design schemes and evaluation indicators. Mainly complete the following aspects:

From the perspective of improving road utilization efficiency, increasing the number of road transporters, and relieving road traffic congestion, an evaluation indicator for the design of Hov lane design was proposed.

Analyze and study the operation of traffic simulation software at home and abroad, and select the vissim microscopic simulation software as the simulation software based on actual needs. The use of actual survey data to complete the drawing of the static road network provides a basis for the evaluation of the lane design program.

Taking the Shichang Avenue in Weihai as the research object, based on the investigation of field sections, entrance and exit traffic flow, and residents' willingness to travel, the setting conditions were analyzed, and the design of the lane was completed in terms of driving road sections, running time, and allowable vehicle types. Use vissim and software to simulate the design and complete the evaluation of the plan.

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