Study on establishment of the on-street parking in Urban Residential Area - Taking Harbin as an Example

Zhang Xiqiao¹, Sun Xu¹ and Zhu Xiaoyan¹²*

¹School of Transportation Science and Engineering, Harbin Institute of Technology, Harbin, China
²School of civil engineering, Inner Mongolia University of Technology, Hohhot, China
*Corresponding author’s e-mail: 20S132077@stu.hit.edu.cn

Abstract. In order to alleviate the problem of "parking is difficult and disorderly" in urban residential areas, the setting of on-road parking in Harbin residential areas is studied and explored. First of all, this paper uses the method of combining manual field survey and inquiry survey to investigate the on road parking settings in residential areas, and summarizes the problems such as the imbalance between supply and demand of parking in the outlet, the unreasonable settings, and the imperfect prompt signs. Based on this, this paper puts forward the corresponding countermeasures on three aspects of parking space settings, parking time settings, and parking space settings, in order to provide ideas and countermeasures for other urban residential parking settings.

1. Introduction

With the rapid development of China's economy and the stimulating demand for travel, more and more cars enter the family. At present, for most of the built residential areas, due to their backward design ideas, the rapid development of private cars has not been fully considered, which leads to the imbalance between supply and demand for parking spaces in residential areas⁴⁻⁵. The problem of on-road parking has become increasingly prominent, which has seriously affected the living environment and quality of life of residents. It is particularly urgent to consider how to regulate on-road parking in residential areas and alleviate the difficulties of on-road parking in residential areas.

At home and abroad, the problem of on-road parking in residential areas has been studied from many angles, but the serious interference caused by the parking defects in residential areas on the on-road and off-road parking lots is seldom considered. As far as Harbin is concerned, there is a big gap between residential areas in different construction years. The sharp increase of family car ownership leads to a serious shortage of on-road parking space in old residential areas, and residents have to choose cheap on-road parking. Although there are parking lots in newly-built residential areas, the quota is often insufficient, or the fees are expensive and only for sale but not for rent. The imbalance of on-road parking supply and demand in residential areas leads to frequent phenomenon of disorderly parking, which seriously interferes with the normal traffic order and brings immense trouble to residents' life.
2. Investigation and analysis of on-street parking in residential areas

2.1. Investigation of on-street parking in residential areas

Under the influence of the national policy, private cars are growing in Harbin. In order to clearly understand the status of on-road parking in residential areas, a 7-day parking survey was carried out in six residential areas with different built years and different housing prices in Harbin, and daytime and night parking was investigated respectively. The investigation of on-road parking in residential areas can fall into three categories: the investigation of parking lots, the investigation of public parking and the investigation of on-road parking. The specific survey content is shown in Table 1.

| Community             | The construction of the year | Own a vehicle (vehicle) | Vehicles per household (vehicles) | Parking facilities (%) | On-street parking (%) |
|-----------------------|-----------------------------|------------------------|----------------------------------|------------------------|-----------------------|
| Liaohe District       | 1993                        | 558                    | 0.41                             | -                      | 61.5                  |
| Liaohe New District   | 1999                        | 980                    | 0.39                             | -                      | 64.2                  |
| Zhongzhi Fangzhou Court | 2001                   | 2160                   | 0.54                             | 31.5                   | 53.1                  |
| Xinheng Modern City  | 2004                        | 362                    | 0.65                             | 31.5                   | 49.8                  |
| Mengke era            | 2003                        | 517                    | 0.85                             | 66.6                   | 31.7                  |
| Time Square           | 2000                        | 600                    | 0.80                             | 78.6                   | 19.2                  |

* Note: Zombie vehicles refer to vehicles that have been continuously parked for more than 7 days

2.2. Analysis on the status quo of on-street parking in residential areas

2.2.1. Unbalanced supply and demand of on-street parking in residential areas

(1) "History" of parking berths has serious debts

There are insufficient parking spaces in some old residential areas in Harbin, and some old residential areas even do not have parking spaces. The parking demand is completely borne by on-street parking spaces, and the parking supply is far from meeting the parking demand.

(2) The sales rate of parking spaces in residential areas is not high

Due to the high price of parking spaces in residential areas, and the lax management of on-street parking fees, the illusion of unbalanced supply and demand of parking spaces and full on-street parking is caused.

(3) Unreasonable rate of on-street parking spaces

"Specifications for on-street parking spaces on urban roads (GA/T 850-2009)" stated that the on-road parking berth rate in mega cities should be less than or equal to 8%. Due to historical reasons, the on-road parking berth rate in Harbin residential areas is generally high. The old residential area is particularly serious.

2.2.2. Unreasonable setting of on road parking

(1) Uneven distribution of parking lots

Compared with centralized parking lots and equipped parking lots that are far away from the entrances and exits of residential areas and charge fees, residents are more willing to choose convenient on-street parking spaces for temporary parking.

(2) The parking phenomenon of occupying other road land is serious

Due to the shortage of on-street parking spaces in residential areas and relatively insufficient management. Occupation of sidewalks, parking on no-stop marking lines, and parking within intersections occur frequently.

(3) The parking method is not standardized
Insufficient publicity and education on parking knowledge, and relatively more novice drivers, will lead to the phenomenon that the vehicle parking does not enter the parking space and affects the road traffic, and the parking space utilization rate is affected by the occupation of two parking spaces.

2.2.3. On road parking signs are not perfect

(1) The parking signs are not uniform
Due to the lack of unified understanding of the parking lot, off-road parking and on-road temporary parking, there are deficiencies in planning, construction and setting traffic signs, which can not guide and regulate drivers to park correctly.

(2) Lack of on road parking facilities
The setting of on-road parking signs and markings is unreasonable or too simple, which can not effectively provide the relevant information of on-road parking, and lack the means to guide the parking people to find the place to allow on-road parking.

3. Countermeasures for on-street parking in residential areas

3.1. Countermeasures for setting up on-street parking spaces in residential areas

3.1.1. "Multistorey parking building" in the residential area
In view of the lack of parking spaces in residential areas, which causes a large number of vehicles to be parked on the road, multi-storey parking buildings can be set up. Cars in residential areas can directly reach all floors of the parking building. At the same time, the parking building The top floor can be cultivated with roof green plants.

3.1.2. Road space optimization in residential areas

(1) Use the street as a parking lot
Aiming at the uneven distribution of parking lots in residential areas and the high rate of on-street parking spaces. It is recommended to use residential streets as parking lots. The specific settings are shown in Table 2. In the use of street parking lots, preferential treatment is given to nearby residents. Residents only need to pay a small monthly fee to use street parking spaces first.

| Street width conditions (W/m) | Berth setting |
|-----------------------------|--------------|
| 7<W<12                      | Delineated parking spaces on the side of the residential area |
| W≤7                         | After the parking space is delineated on the side of the residential area, it will be changed to one-way traffic |

(2) Implement green parking
In view of the imbalance between the supply and demand of parking spaces in residential areas and the high rate of on-street parking spaces, green parking is recommended. It removes the walls of private residences and installs parking spaces (yards) while expanding the living area of residential areas. Roads, planting green plants, beautifying the appearance of houses, etc.

3.2. Countermeasures for the setting of parking time on the street in residential areas

3.2.1. Set up on-street parking spaces at night
In view of the imbalance between the supply and demand of parking spaces in residential areas and the high rate of on-street parking spaces, it is recommended to set up night parking spaces on wider roads, as shown in Figure 1. The following conditions should be met:

(1) Ensure that the remaining road width after setting up parking spaces is above 5 meters, and the minimum is not less than 3.5 meters.
(2) The establishment of parking spaces does not affect the safe and normal passage of vehicles, and entrances and exits should be smooth and orderly.

(3) Parking spaces should be more than 50 meters away from road intersections, underpasses, sidewalks, overpasses, and subway entrances and exits.

![Figure 1 Night stop sign of sidewalk](image)

3.2.2. Create shared parking spaces

There are not enough parking spaces at night in residential areas, and most of them are free during the day. In contrast, parking spaces such as schools, shopping malls, and office spaces are not enough during the day and a lot of them are free at night. Therefore, residential areas and nearby office spaces can be negotiated to share parking spaces, office vehicles can park in residential areas during the day, and residents can park in office parking lots at night, improving the efficiency of parking resources utilization.

3.2.3. Opening of road space and public facilities

(1) Make full use of the underground space of arterial roads

In some areas where parking spaces are very tight, parking lots can be built under adjacent arterial roads. Make the parking lot close to the entrances and exits of residential areas and roads, which is convenient for residents to travel, but special attention should be paid to the design of traffic safety facilities at each entrance and exit.

(2) Arterial road parking

The method of parking in the center of the road is limited to daytime use, and generally the total road width is not less than 15 meters. The road material needs to be processed differently, and it can function as an isolation belt.

(3) Parking under viaduct

The space resources under the viaduct are very abundant, and it is a natural parking lot. It is recommended to transform it into a parking lot under the viaduct for unified management, which can increase parking spaces for residents and effectively alleviate the current parking congestion in the residential area.

3.3. Countermeasures for on-street parking spaces

On-street parking spaces can be arranged in four ways, namely, on the sidewalk, on the non-motorized vehicle lane, on the motorized and non-motorized vehicle lane, and on the motor vehicle lane\(^{10-14}\). Conventional parking methods on the road are generally divided into three types: parallel, oblique and vertical. The arrangement of on-street parking spaces should be parallel.

In view of the serious situation of parking on the road in residential areas occupying other roads and the irregular parking methods, in addition to setting up parking spaces in accordance with the norms and standards\(^{13}\), parking spaces should also be designated according to specific road conditions, and parking methods on the road should be regulated, as follows.

(1) Specific parking garage division

Borrowing foreign advanced cases, for the convenience of special people, special parking spaces such as barrierfree parking spaces and special parking spaces for unloading have been set up in unconventional parking spaces on both sides of the road for temporary parking only, as shown in Figure 2 and Figure 3.
(2) Division of compact parking spaces
In the case of allowing on-street parking, in order to minimize the use of road traffic resources, delineate compact parking spaces. As shown in Figure 4, the parking spaces are only drawn with a line, one is parked next to each other, and the parking distance does not exceed 50cm. This division method can maximize its parking potential while ensuring the traffic function of the road. At the same time, the way of marking can regulate the way of parking.

(3) Partition of parking spaces with specific colors
Specific colors are mainly divided into three colors: blue paid parking spaces, white free limited-time parking spaces, and yellow private or special parking spaces. There is a toll machine or parking ticket office near the blue parking space. When parking, the owner will get a small ticket with the parking time limit. The owner needs to drive the vehicle out of the parking space within the specified time of the small ticket. Otherwise, it needs to be overtime. Pay more than three times the fine in time, and the actual penalty amount should be negotiated and decided by the relevant department and reported to the price department for record, as shown in Figure 5. The notice sign next to the white parking space indicates the parking time limit. The car mainly puts the parking card to the parking time by the window for others to view. The yellow special parking spaces only allow special vehicles, such as fire trucks, police cars, snow sweepers and other vehicles to park free of charge, as shown in Figure 6.

(4) Improve on road parking signs
In view of the problem of disunity and imperfection of the warning signs of on-road parking facilities in residential areas, the warning signs of temporary parking in the outlet are formulated by unifying the parking signs with relevant departments. Guide signs for on-road parking facilities in residential areas are set to guide drivers with parking demand to choose reasonable on-road parking space.

4. Conclusion
As an important focus of parking system planning and design, on-road parking in residential areas plays an important role in solving people's livelihood problems. Based on the analysis and research of on-road parking in Harbin residential area, this paper puts forward specific improvement measures, including
the improvement of parking space and time and the optimization of parking space. Measures to solve
the parking problem in Harbin residential area are shown in Table 3.

Table 3  Summary of countermeasures for on road parking

| Serial number | Problem                                | Countermeasures for on-street parking |
|---------------|----------------------------------------|--------------------------------------|
| 1             | Supply and demand imbalance            | ➢ Set up multi-storey parking buildings (3.1.1)  
                |                                        | ➢ Implement green parking (3.1.2)  
                |                                        | ➢ Set up parking spaces at night (3.1.2)  
                |                                        | ➢ Establish shared parking spaces (3.2.2)  
                |                                        | ➢ Open public facilities (3.2.3)  
|               | High on-street parking rate            | ➢ Set up night parking space (3.2.1)  
                |                                        | ➢ Improve on road parking signs (3.3)  
                |                                        | ➢ Establish shared parking space (3.2.2)  
                |                                        | ➢ Open public facilities (3.2.3)  
| 2             | Unreasonable parking space settings    | ➢ Establish shared parking space (3.2.2)  
                |                                        | ➢ Open public facilities (3.2.3)  
|               | Uneven distribution of parking lots    | ➢ Specific parking space division (3.3)  
                |                                        | ➢ Compact parking division (3.3)  
                |                                        | ➢ Improve on road parking signs (3.3)  
|               | Occupy other land for parking          | ➢ Specific parking space division (3.3)  
                |                                        | ➢ Compact parking division (3.3)  
|               | The parking method is not standardized | ➢ Improve on road parking signs (3.3)  
                |                                        | ➢ Compact parking division (3.3)  
| 3             | On road parking signs are not perfect  | ➢ Improve on road parking signs (3.3)  
                |                                        | ➢ Compact parking division (3.3)  
|               | Lack of on road parking facilities     | ➢ Improve on road parking signs (3.3)  
                |                                        | ➢ Compact parking division (3.3)  

References

[1]  Guo Liming. Study on planning and design of on road parking in urban residential area [D].  
        Xi'an: Master's thesis of traffic engineering of Chang'an University, 2010.  
[2]  Hao Ruimin. Research on parking in urban residential areas after cars entering families [D].  
        Nanjing University of technology.  
[3]  Zhang Yu. Research on parking problems in urban residential areas [D]. Xi'an University of  
        architecture and technology, 2006.  
[4]  Donald Shoup, Geng Xue, Zhu Yuehua. Vehicle cruises generated by searching for on road  
        parking spaces [J]. Urban traffic, 2012, 10(1):84-88.  
[5]  Roodbergen K J, Vis I F A. A survey of literature on automated storage and retrieval  
        systems[J]. European Journal of Operational Research, 2009, 194(2):343-362.  
[6]  YAVUZ A. BOZER, MYEONSIG CHO. Throughput performance of automated storage/retrieval  
        systems under stochastic demand[J]. IIE Transactions, 2005, 37(4):367-378.  
[7]  Vis I F A. Survey of research in the design and control of automated guided vehicle  
        systems[J]. European Journal of Operational Research, 2006, 170(3):677-709.  
[8]  Feng Huanhuan, Zhu Congkun. Analysis of roadside parking rate in Guanqian area of Suzhou  
        [J]. Journal of Suzhou University of science and Technology (Engineering Technology  
        Edition), 2009, 22 (2): 29-32  
[9]  Zong Fang, Zhang Huiyong, Jia Hongfei. Evaluation of parking fee policy based on Bayesian  
        network [J]. Journal of South China University of Technology (NATURAL SCIENCE  
        EDITION), 2010, 38 (7): 78-83
[10] Wang Yuanqing. Parking facilities planning [M]. People's Communications Press, 2003
[11] He Chongming. Research and application of urban parking planning [M]. China Construction Industry Press, 2006
[12] Chen Jun, Zhou Zhiyong, Mei Zhenyu, et al. Urban parking facilities planning method and information guidance technology [M]. Southeast University Press, 2007
[13] Pan Changfa, Cao Guohua. Study on the establishment of parking standards in urban roads [J]. Journal of transportation engineering and information, 2009, 7 (2): 45-50
[14] Li Zhongdong. Traffic management details in New York [J]. Urban traffic, 2007, (06): 86-87