

# The Management of Non-motorized Vehicle Parking in Metro Stations from the Perspective of Public Demands: A case study of Pingguoyuan Station in Shijingshan District

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**Abstract** The issues of slow traffic connection around Pingguoyuan Metro Station were studied, such as the disorderly parking of non-motorized vehicles in the entrances and exits and the difficulty in maintaining order over the long term. Through policy review, on-site observation, and analysis of public feedback, the underlying reasons such as extensive parking space configuration, the lack of coordination mechanisms, and the spatial tension caused by the overlapping of peak traffic flows were revealed. Besides, comprehensive response paths were proposed from aspects of facility optimization, the reconfiguration of the responsibility system, and the improvement of the public participation mechanism, including the construction of intelligent parking spaces, the establishment of a joint management model between the local area and the operating unit, and the transformation of the handling of public demands from passive response to proactive governance. The research results can provide a reference for the coordination of traffic organization and grassroots governance around urban railway stations.

**Keywords** Connection of subway stations, Parking of non-motorized vehicles, Public demands, Collaborative governance, Pingguoyuan Station

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The *Outline for the Construction of the Powerful Transportation Nation* states that a green and convenient urban transportation system should be established, and railway stations need to enhance the connection between public transportation and pedestrian systems to meet the needs of cyclists. The *Regulations on Non-motorized Vehicles in Beijing City* further stipulates that subway stations should set up centralized parking areas and electronic fences, implement management responsibilities, and regulate parking order.

In the context of the mechanism of “responding to complaints immediately- responding to public calls”, Shijingshan District implements the policy of “one station, and one strategy”, and joint rectification has been carried out at Pingguoyuan Station. Currently, it faces the problem of facility shortages and the potential rebound of governance results. Participatory governance emphasizes the collaborative participation of the government, the public, and enterprises in public affairs. Through 12345 complaint feedback and coordination between streets and subway operators, it achieves a transition from single management to co-governance, improving governance accuracy and public recognition. In this paper, in view of parking problems of non-motorized vehicles at Pingguoyuan Station, the causes of parking problems were analyzed, and corresponding countermeasures and optimization suggestions were proposed.

## 1 Current situation of nonmotorized vehicle parking at Pingguoyuan Metro Station

Pingguoyuan Metro Station is located in the west of Shijingshan District, Beijing. Metro Lines 1 and 6, and Xijiao Line (S1 Line) intersect here. It is one of the earliest metro hubs in western Beijing and an important gateway connecting Shijingshan District with the central urban area. The surrounding area is mainly composed of old industrial and mining communities, land for urban renewal and bus hubs. The surrounding residential population is dense and the combination of workplace and living space is obvious. With the advancement of regional renewal and the addition of transportation functions, the commuting groups have become increasingly diverse, including factory workers, metro commuters, delivery riders, students, and elderly travelers, etc. The proportion of non-motorized vehicle travel is significantly high. In recent years, ground space has been continuously compressed due to metro renovations, road construction, and commercial support projects. Pedestrian, cycling, and vehicle traffic spaces are intertwined. During peak hours, the pedestrian and vehicular traffic in the station area interfere with each other, and the pressure on the slow-moving system has become increasingly prominent.

At present, the non-motorized vehicle facilities around the station are still at an initial stage. Only a few ground-marked parking areas are

set up near entrances A and C, and the facilities are simple and limited in number. Most of the parking areas lack rain shelters, charging stations, lighting and video surveillance. The night-time usage environment is poor, and the safety is insufficient. Some parking areas are cramped due to proximity to bus stops or entrances, and the access is inconvenient. The actual utilization rate is low. Most commuters tend to park their electric bikes and bicycles under the subway steps, on the sides of blind paths or in the gaps between fences, forming a habit of “proximity parking”. It not only affects the smoothness of pedestrian passages but also brings certain fire and safety hazards. Although electronic fences have been set up for shared bikes, their locations deviate from the main pedestrian passage. Moreover, the signs are not obvious, and citizens have a vague understanding of the parking area. The scheduling frequency of enterprises is insufficient, so that vehicles are piled up like mountains in some areas, while on the other side, parking spaces remain vacant, showing a state of “partial saturation and overall imbalance”<sup>[1]</sup>.

According to the statistics from the 12345 hotline in Beijing and the community governance platform in Shijingshan District, the complaint mainly revolves around “difficult parking”, “chaotic parking”, and “poor safety”. During peak hours, there is a shortage of parking spaces at the subway entrances, and residents often have to walk tens of meters to find an empty spot. Frequent

illegal parking occupies blind paths, fire escape route, accessible ramps and other public spaces, seriously affecting the safety of passage for the elderly, children and those with limited mobility. Insufficient nighttime lighting and the lack of video surveillance have led to theft or damage of some electric vehicles, reducing residents' sense of security. Although the street office, urban management, and subway operators have carried out joint clean-up actions many times, they mainly focused on relocation-warning-rectification, failing to establish a long-term mechanism from the aspects of facility supply and management system. Some temporarily added simple parking areas are soon occupied or abandoned due to lack of subsequent maintenance. Overall, the parking of non-motor vehicles around Pinguoyuan Metro Station has typical characteristics of "high demand, limited space, and short-term management", and has become an important difficulty affecting citizens' travel experience and urban refined governance.

## 2 Causes of problems

### 2.1 Insufficient facilities and limited space resources

Pinguoyuan Station is an old hub, and its infrastructure was built earlier than the stage of rapid regional development. The parking plan of non-motorized vehicles can not match the current high-density commuting demands. There are only a few temporary marked parking spots around the station area, and they are located along the outer edge of the subway entrances and beside bus terminals. They lack systematic layout and have simple facilities. There are mostly no shelters, lighting, surveillance, and charging equipment, so bikers are more likely to park in closer informal areas such as blind paths and stairways (Fig.1 and Fig.2). Especially on sunny days or during morning and evening commutes, non-motorized vehicles and pedestrians are intertwined, and disorderly chaos and poor accessibility issues are particularly prominent<sup>[2]</sup>.

The ground space has been continuously squeezed by subway renovations and area updates. Some existing parking spots were closed or reduced during construction, further tightening the already limited slow-moving space. During peak commuting hours, the flow of pedestrians, cyclists, and construction vehicles intertwine, intensifying spatial conflicts. The supply of facilities is significantly insufficient, forcing users to park in "empty spaces" and causing disorderly accumulation<sup>[3]</sup>. This problem is essentially an asymmetry between fixed space supply and high-intensity commuting demands, belonging to a

structural spatial contradiction.

### 2.2 Diverse usage demands and the mismatch of parking behavior

The radiation area of Pinguoyuan Station is extensive, and the cycling group, which is composed of factory workers, subway commuters, students, the elderly, and delivery riders, has distinct diversified characteristics. The requirements of different groups for parking distance, convenience, safety and parking methods vary significantly (Fig.3).

In the absence of sufficient parking facilities, delivery riders and commuters prefer to park at the nearest location, so that sensitive areas such as blind paths, fire escape routes, and accessible ramps are occupied. The safety of the elderly and children during traveling thus decreases. Although shared bikes have electronic fences, their parking locations deviate from the main traffic lanes, and due to insufficient enterprise scheduling efforts, the coexistence of "stacked bikes" and "empty bikes" persists. Insufficient nighttime lighting and lack of surveillance also prompt some residents to prefer parking closer to the flow of people, further reinforcing the behavior of disorderly parking.

### 2.3 Multi-party management boundaries are blurred and there is a lack of a closed-loop governance mechanism

Around Pinguoyuan Station, there are multiple management entities: the subway company is responsible for the station area, and the street is responsible for public opinion coordination but lacks the authority for facility construction; the urban management department is responsible for law enforcement, and the enterprises of shared bicycles are responsible for vehicle scheduling. Although multiple departments are involved, there is a lack of a unified responsibility chain, resulting in the situation of "multi-departmental management without unified coordination".

The governance approach has long relied on "centralized rectification" and "sudden clean-up" to solve immediate problems with short-term measures, but lacks a regular supervision mechanism and facility renewal mechanism. For example, joint law enforcement actions can "clear the subway entrances" in the short term, but due to the lack of simultaneous improvement of parking supply and behavior guidance, the order quickly rebounds, presenting a typical cycle of "order on the surface-chaos on the next day".

In terms of public opinion governance, the model of "responding to the people's call" can quickly capture specific demands, but most measures remain at the emergency handling

stage, such as moving vehicles, posting notices, and re-laying lines, and fail to transform into root-level governance. For instance, demands related to the layout adjustment of parking areas, coordination of land use, or facility construction require cross-departmental approval or financial investment, so that the problem has not actually been resolved, and there is a lack of true tracking, evaluation, and continuous maintenance.

In the current governance, the participation of residents, property management, and community organizations is insufficient, and grassroots forces have not been included in the common governance system, so that there is a clear case of one-way governance only by the government.

## 3 Countermeasures and optimization suggestions

### 3.1 Improving parking facilities and spatial organization

In response to the imbalance between the supply and demand of parking space of non-motorized vehicles at Pinguoyuan Metro Station, facilities and spatial organization should be optimized primarily (Fig.4). For a green area adjacent to the entrance F of the subway, the attractiveness of standardized parking can be enhanced by dividing and adjusting, reasonably arranging centralized parking spaces, setting up a rainproof and theft-proof parking shed, and combining with charging and monitoring facilities for electric vehicles<sup>[4]</sup>. At the same time, it is needed to optimize the flow of pedestrians and vehicles, appropriately separate pedestrian paths from non-motorized vehicle paths, use ground signs and directional signs to clearly indicate the parking area and direction of travel, reduce the overflow of vehicles into non-parking areas such as blind paths and fire escape routes, and transform the parking order into a "visible, controllable, and maintainable" state<sup>[5]</sup>.

### 3.2 Group-based guidance and flexible management

The diverse nature of cycling groups and the significant differences in their needs are important reasons for the recurring issue of disorderly parking. Therefore, it is necessary to shift from a model of "single-space supply" to a differentiated and flexible management approach. In the core area close to the subway entrances, "short-term parking areas" can be set up to meet the high mobility needs of delivery riders and fast commuters. In the slightly distant locations, larger "long-term parking areas" can be constructed to reduce interference among different demand groups.



Fig.1 Occupation of blind paths by non-motorized vehicles



Fig.2 Disorderly parking of non-motorized vehicles

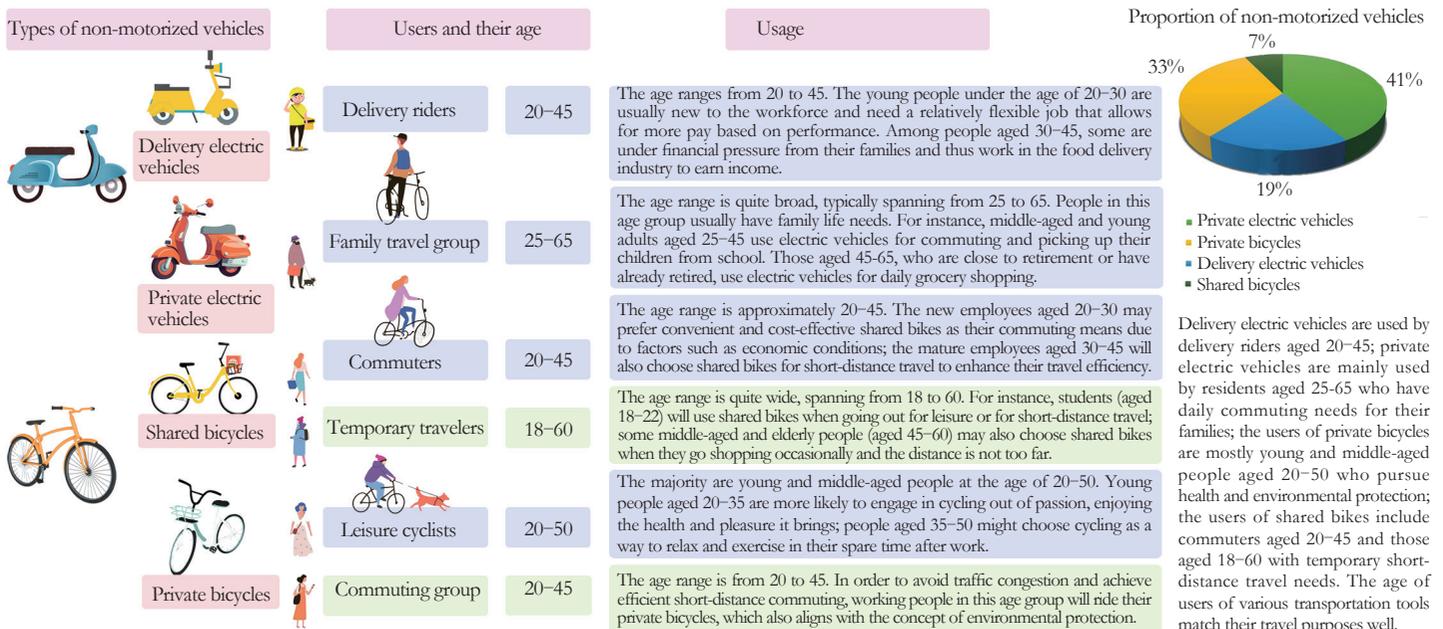


Fig.3 Types of non-motorized vehicles and their applicable users



Fig.4 Planning effect of the external open space of Pingguoyuan Metro Station and optimized economic indicators

In terms of shared bikes, the layout of electronic fences should be optimized, and they are placed on accessible pedestrian paths. Recognition degree should be enhanced through ground markings. At the same time, a dynamic scheduling mechanism should be established to conduct predictive scheduling based on passenger flow, time periods, and parking saturation, reducing “local congestion” and “overall imbalance”<sup>[6]</sup>. For nighttime parking, lighting and surveillance can be added to enhance security and reduce residents’ motivation to “park nearby at the subway entrances”.

Through differentiated supply and flexible management, the contradictions between different demands can be alleviated, and users’ behavior can be re-matched with spatial conditions.

### 3.3 Establishing collaborative governance and pre-response mechanism

The current biggest weakness in governance

lies in the unclear responsibility chain and unstable cooperation mechanism. Therefore, it is necessary to take streets as the leading unit to establish a regular coordination mechanism among the subway operator, the urban management department, enterprises of shared bicycles, and the property management unit. The management responsibilities of each party within the station, outside the station, and within the red line boundary should be clearly defined to achieve quantifiable responsibilities and traceable work.

Enterprises of shared bicycles should be included in the local assessment system. The execution rate of electronic fences, vehicle dispatch efficiency, and parking order maintenance should be as evaluation indicators to form a closed system, in which enterprises have motivation and local authorities can supervise<sup>[7]</sup>.

Based on the mechanism of “responding to the people’s call”, it is also necessary to promote governance to shift from responding to complaints immediately to taking action before problems arise. A warning mechanism should be established based on 12345 complaint data, parking saturation monitoring, and passenger flow data. During peak hours, temporary parking areas should be set up in advance, and managers should be dispatched, or key areas should be directed to enhance the initiative of governance.

Meanwhile, residents, volunteers, and community property management should be encouraged to participate in daily order maintenance and the co-construction of small-scale facilities, forming a collaborative governance pattern involving the government, enterprises, and communities, and advancing problem governance from short-term remediation to long-term co-governance.

#### 4 Conclusions and outlook

The prominent issue of non-motorized vehicle parking at Pingguoyuan Metro Station is not caused by a single factor, but is the result of insufficient facilities, tight space, lack of management, and the growing public demand. It is found that the parking areas around the station are limited in quantity and scattered in layout, making it difficult to match the peak-hour demand; each department is responsible for a separate part, which has led to fragmented governance, and rectification actions are more inclined to be temporary responses, lacking sustainability; public demands truly reflect problems such as unsafe space, inconvenient vehicle retrieval, and inadequate management. Based on this, the research proposes to promote the parking order at the station from “chaotic management” to “normal governance” by improving parking facilities, implementing vehicle and pedestrian separation, establishing a collaborative governance mechanism, and moving “responding immediately to complaints” forward to “early warning governance”.

This research still has limitations: firstly, the data are mainly from on-site observations and complaint information, and there is a lack of precise statistics on passenger flow, parking usage rate, etc.; the analysis of supply and demand and time changes is relatively shallow, and the technical feasibility and implementation cost have not been fully considered. Secondly, it focuses on a single subway hub, and the station is not compared with other stations. Moreover, a generalizable governance model that can be promoted has not been formed yet. In the future, AI recognition and big data technologies can be introduced to build a non-motorized vehicle management system, expand the research

scope, and form an adaptation plan for “aging urban area + transfer stations”.

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