# Commuting Space of Primary and Secondary Schools in the Context of Child Friendly Cities: A Case Study of Bajiao Street of Shijingshan District

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**Abstract** With the continuous promotion of the construction of child friendly cities, the school commuting space is an important component of the construction of child friendly roads. Based on the background of child friendly cities, the commuting space of 11 primary and secondary schools in Bajiao Street is analyzed through literature analysis and field research methods. Firstly, the relevant literature on school commuting space is sorted out, and the characteristics of school commuting space are summarized, including transportation, landscape, culture, leisure, and security. Secondly, the characteristics of commuting space of primary and secondary schools in Bajiao Street are analyzed from three aspects: in front of the school gate, path space, and node space. This paper aims to provide reference and guidance for the future construction of children's walking school commuting and promote the construction of a child friendly city.
**Keywords** Child friendly cities, School commuting space, Bajiao Street, Primary and secondary schools
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The United Nations first proposed the concept of child friendly cities in 1996. In 2019, the *Action Framework for Building Child Friendly Cities* officially recognized the ability of children to walk safely on the streets alone as an important indicator to measure the level of child friendliness in cities[1]. In recent years, many cities in China have been gradually carrying out practical work in the construction of child friendly cities and child friendly streets, and school commuting space is an important component of the streets. Therefore, it can provide reference for the construction of child friendly cities in China by studying commuting space of primary and secondary schools.

School commuting space is an important step in promoting the construction of child friendly streets. Currently, domestic scholars have conducted research on the quality evaluation, influencing factors, spatial behavior, safety, and other aspects of school commuting space from different perspectives and scales. Xu Shouheng et al.[2] constructed 18 items of street space quality standards from the perspective of children's needs. Zhang Yu et al.[3] analyzed the internal influencing factors of school commuting path. Bi Bo et al.[4] used GPS behavior tracking method to sort out and summarize the after-school paths and node spaces in the Wanliu and Dashilar areas of Beijing. Xu Zhen et al.[5] found significant differences in home-school distance and potential exposure risks within and between school districts based on POI data. Wu Fengwen et al.[6] constructed evaluation indicators for school commuting path and evaluated its health and safety. Xing Huinan et al.[7] constructed a cross classification multi-layer model to analyze the relationship between the built environment and active school commuting between children's residential communities and schools.

The construction of child friendly cities and communities is an important direction for future urban development. In this paper, primary and secondary schools in Bajiao Street, Shijingshan District, Beijing are taken the research objects. The characteristics of commuting activities and space in primary and secondary schools are analyzed, to promote children's active school commuting, and provide inspiration and reference for the construction of child friendly cities.

## 1 Overview of school commuting space

### 1.1 Definition of school commuting space

School commuting space is a media space between cities and schools, responsible for the functions of information exchange and flow transfer for large-scale students during the period of going to and from school[8]. At present, there is no clear definition of the path and space for school commuting in China. However, relevant scholars mainly focus on the path space for children after school, the surrounding space of schools, and the community-school space to conduct research on safety, environment, landscape, behavior, and space of school commuting. Therefore, the studied school commuting space in this paper refers to the linear space composed of the front space of school gate, the school commuting path space, and the node space in the path.

### 1.2 Characteristics of school commuting space

**1.2.1** Transportation. Transportation is the most basic functional requirement for children's going to and from school, as well as for residents' daily lives. It serves as a functional carrier for children's walking school commuting activities. The school commuting space mainly connects residential areas with schools, while also connecting various node spaces along the path, such as parks and squares. Especially in the front space of school, it carries multiple functions such as pedestrian traffic, driving and stopping of motor and non motor vehicles, waiting for parents to pick up and drop off, and children's gathering and distributing. It is a transportation hub in the school commuting space and has a certain degree of directionality.

**1.2.2** Landscape. The school commuting path not only connects natural landscapes such as urban parks and community green spaces, but also includes artificial landscapes such as urban green belts, park squares, and landscape sketches. At the same time, the school commuting path itself also has a certain landscape function, and plays a beautifying role in the city's roads, such as the interface and road paving along the street.

**1.2.3** Culture. The front space of the school gate and node space in the school commuting space are important display windows and platforms for the campus to showcase the image and culture of the school to the city. Additionally, the

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district where the campus belongs will also form its own unique block culture, which is usually transformed into a unique element symbol for display in the school commuting path. Therefore, the school commuting space carries the display of school and neighborhood culture.

**1.2.4** Leisure. In addition to being used as a pathway for children to and from school, the school commuting space is also a space for residents to use in their daily lives and commuting. Therefore, various leisure and entertainment facilities will be connected in the school commuting space, which will trigger various games and communication activities between children and parents during the school commuting process. The walking space along the school commuting path should add more functions and fun, and its content and form should be more rich and interesting, to meet the new needs of healthy growth of children in the current era.

**1.2.5** Security. Primary and secondary school students lack the ability and awareness of safety defense, and are highly susceptible to security threats. There is a high degree of crowd gathering during the period of going to and from school, which poses certain safety hazards. As a buffer zone between the campus and the city, the school commuting space plays an important role in protecting children. Along the school commuting road, various fences and deceleration facilities should also be installed to reduce the traffic threat of passing vehicles, allowing children to grow up healthier and safer.

## 2 Characteristics of children's school commuting activities

### 2.1 Spatial–temporal characteristics

The time for children to go to and from school is relatively fixed, and the time to go to school is generally concentrated between 07:30 and 08:00, while the end of school is generally divided into time periods for each grade, mainly concentrated between 15:00 and 16:00. Therefore, the travel time for children to study has a strong regularity and relatively fixed time and location, and the time of activity occurrence is relatively concentrated.

### 2.2 Behavioral characteristics

Children not only walk but also engage in activities such as stopping and playing during the process of school commuting. Due to venue limitations, children's activities on the streets are mostly accompanying activities of traffic activities, with temporal and regular characteristics. Meanwhile, due to children's desire to gain attention in social activities, they choose to express themselves and communicate with each other, resulting in children's social distance being generally much smaller than that of adults.

### 2.3 Cognitive characteristics

During walking, children's horizontal field of view is only about 60°, while their vertical field of view is smaller, so the things in front of them are more attractive to their attention, and they lack a response to the distant view. In addition to meeting the safety needs of children school commuting, streets also need to ensure the convenience and safety of school commuting from children's cognitive perspective, set up activity venues that meet the needs of children and surrounding residents, and create a good neighborhood atmosphere.

### 2.4 Psychological characteristics

The psychological scale of children refers to their recognition of the surrounding environment and facilities. Hidden, irregular, and special spaces are loved by children, who possess a strong curiosity and adventurous spirit. The intimacy scale for children is usually within 1 m, while for adults it is within 3 m. At further distances, both children and adults have a psychological acceptance range of 20−25 m. Therefore, in the design of commuting space of primary and secondary schools, consideration should be given to the scale differences between children and adults in terms of domain perception and sensory systems, in order to meet children's activity needs.

## 3 Overview of primary and secondary schools in Bajiao Street

### 3.1 Overview

Bajiao Street is under the jurisdiction of Shijingshan District, Beijing. It is located in the middle of Shijingshan District, with a land area of 6.3 $km^2$, a registered residence population of about 75,100, and a total of 23 communities. According to the list of primary and secondary schools published by the Shijingshan District People's Government, there are a total of 11 primary and secondary schools, and statistics are made on their founding years and land area (Table 1). Among them, 5 primary schools are Gucheng Second Primary School in Shijingshan District of Beijing, Gucheng Second Primary School Branch in Shijingshan District of Beijing, Beijing Shijingshan Foreign Language Experimental Primary School, Shijingshan District Experimental Primary School in Beijing, and Primary School Department of North China University of Technology Affiliated School. North Campus of Beijing Academy of Educational Sciences Affiliated Shijingshan Experimental School, South Campus of Beijing Academy of Educational Sciences Affiliated Shijingshan Experimental School, and North China University of Technology Affiliated School are nine-year consistent schools, and Experimental Middle School, East Campus of Gucheng Middle School, and Gucheng Middle School are middle schools.

### 3.2 Characteristics and classification of primary and secondary schools

Typological analysis of primary and secondary schools in Bajiao Street of Shijingshan District can provide a more comprehensive understanding of the spatial characteristics of the campus in the area, enabling a more in-depth study of the school commuting space of primary and secondary schools in Bajiao Street. According to the quantity relationship between primary and secondary schools and adjacent urban roads, the 11 primary and secondary schools in Bajiao Street are divided into three types: single-sided road, double-sided road, and multi-sided road (Fig.1).

**3.2.1** Single-sided road. Single-sided road refers to a school with one side directly facing the city or community road. There are three schools

**Table 1 Overview of primary and secondary schools in Bajiao Street**

| No. | School name | Establishment year | Area//$m^2$ |
|---|---|---|---|
| 1 | Gucheng Second Primary School in Shijingshan District of Beijing | 1965 | 14,005 |
| 2 | Gucheng Second Primary School Branch in Shijingshan District of Beijing | 2013 | 5,851 |
| 3 | Beijing Shijingshan Foreign Language Experimental Primary School | 2002 | 8,632 |
| 4 | Shijingshan District Experimental Primary School in Beijing | 1988 | 15,877 |
| 5 | Primary School Department of North China University of Technology Affiliated School | 1997 | 9,137 |
| 6 | North Campus of Beijing Academy of Educational Sciences Affiliated Shijing-shan Experimental School | 1961 | 10,225 |
| 7 | South Campus of Beijing Academy of Educational Sciences Affiliated Shijing-shan Experimental School | 1961 | 17,631 |
| 8 | North China University of Technology Affiliated School | 1997 | 18,439 |
| 9 | Experimental Middle School | 1990 | 12,000 |
| 10 | East Campus of Gucheng Middle School | 1959 | 11,504 |
| 11 | Gucheng Middle School | 1959 | 54,216 |

of this type, namely Gucheng Second Primary School, South Campus of Beijing Academy of Educational Sciences Affiliated Shijingshan Experimental School, and Gucheng Middle School, accounting for 27% of the total number of primary and secondary schools. The entrance and exit of schools that usually use single-sided road have a relatively small range, with only one school gate. The position and direction of the opening are single, and the quality of the space in front of the school gate is related to the level and width of the adjacent road. It is easy to cause congestion during the period of going to and from school, and the problem of mixed pedestrian flow is more serious.

**3.2.2** Double-sided road. Double-sided road refers to primary and secondary schools with two sides directly facing urban or community roads, and the roads on both sides of the school intersect or are distributed on both sides of the school. There are a total of 5 primary and secondary schools using this type, including 3 primary schools, namely Gucheng Second Primary School Branch, Experimental Primary School, and Primary School Department of North China University of Technology Affiliated School. There is one nine-year consistent school and one middle school, which are North China University of Technology Affiliated School and Experimental Middle School, accounting for 46% of the total number of schools. It is the most commonly used type in primary and secondary schools. Primary and secondary schools that use double-sided road have a wider selection of school gates, with two gates available for pedestrian and vehicular separation.

**3.2.3** Multi-sided road. Multi-sided road refers to the situation where primary and secondary schools have three or more sides adjacent to the road, and the opening of their front entrances and exits is very flexible, creating a more convenient school commuting space and entrance layout. This type of schools include Foreign Language Experimental Primary School, North Campus of Beijing Academy of Educational Sciences Affiliated Shijingshan Experimental School, and East Campus of Gucheng Middle School, accounting for 27% of the schools. However, due to the presence of multiple urban roads, the continuity of children school commuting is low, and there are many road intersections, which increases safety hazards during the school commuting process.

### 3.3 Scope of school commuting space in Bajiao Street

According to the definition of the service scope for primary and secondary schools in the *Design Specification for Primary and Secondary Schools* (GB 50099−2011), the service radius for primary schools should not exceed 500 m, and the service radius for secondary schools should not exceed 1,000 m. Therefore, according to the service radius in the specification, the commuting space range of primary and secondary schools is studied at the requirements of 500 and 1,000 m, respectively (Fig.2).

## 4 Analysis on commuting space characteristics of primary and secondary schools in Bajiao Street

### 4.1 Front space of the school gate

The front space of the school gate is the starting and ending point of children school commuting, as well as the transitional space connecting the campus interior space and the external urban roads. In addition to children's use, school staff and parents who pick up and drop off are also the main users of the space. The density of children activity group is high, and the space is diverse in form and flexible in function, which has a significant impact on the space of school commuting path. According to the relationship between the school gate and urban roads, it can be divided into three types: introduction, street facing, and end to end (Fig.3).

**4.1.1** Street facing style. Street facing style of primary and secondary schools are tangent to urban roads, and the school gate faces the street directly and is tangent to the urban road, with a small reserved area. The space at the school entrance is flat and cramped, with insufficient distribution and buffering capacity. Parents and children usually cannot stay here. During the school commuting period, parents waiting and parking areas often occupy pedestrian space, and the shuttle flow and urban public transportation interact with each other. For example, North Campus of Beijing Academy of Educational Sciences Affiliated Shijingshan Experimental School, Gucheng Second Primary School, North China University of Technology Affiliated School, East Campus of Gucheng Middle School, and Experimental Middle School commonly use the method.

**4.1.2** Introduction type. By connecting community roads to urban roads, primary and secondary schools are introduced into the community. The school gate is generally kept at a distance from the street, providing a certain buffer and distribution effect on urban roads, thereby reducing the interference of urban traffic on children entering and leaving school during the school commuting period. Primary schools often use this method, such as Experimental Primary School, Foreign Language Experimental Primary School, Primary School Department of North China University of Technology Affiliated School, and Gucheng Second Primary School Branch.

**4.1.3** Terminal type. At the front of the school gate, pedestrian roads are used to connect with urban roads, separating urban motor traffic from school commuting transportation. Generally, a waiting area for parents of each class is set up here, which has a relatively small impact on urban traffic and is relatively safe for children's walking traffic, such as South Campus of Beijing Academy of Educational Sciences Affiliated Shijingshan Experimental School and Gucheng Middle School.

### 4.2 Path space

Path space is an excessive buffering stage between the campus environment of primary and secondary schools and the urban environment, which evacuates people to various communities and connects various public activity spaces in the city. On the way out of school, primary and secondary school students not only engage in general activities such as solitude, company, and companionship, but also engage in activities such as recreation, socializing, and shopping. The primary and secondary school paths in Bajiao Street can be divided into two types of roads: urban roads and community roads, among which urban roads can be further divided into traffic roads and life roads.

The degree of motorization on roads with traffic characteristics is relatively high, and vehicles travel at a fast speed, which can easily cause psychological pressure on children. In addition, there is a lack of traffic safety islands and necessary safety crossing facilities, such as North Campus of Beijing Academy of Educational Sciences Affiliated Shijingshan Experimental School and North China University of Technology Affiliated School (Fig.4). Life oriented roads focus on service functions, with diverse functions on both sides of the road. The continuity of the surrounding pedestrian space is poor, and the effective width of pedestrian walkway is relatively small, such as Gucheng Second Primary School and South Campus of Beijing Academy of Educational Sciences Affiliated Shijingshan Experimental School.

Primary and secondary schools that rely on community roads for school commuting evacuation have a lower degree of openness in the school commuting space environment. They use public activity spaces in the community to set up waiting areas for parents. However, there

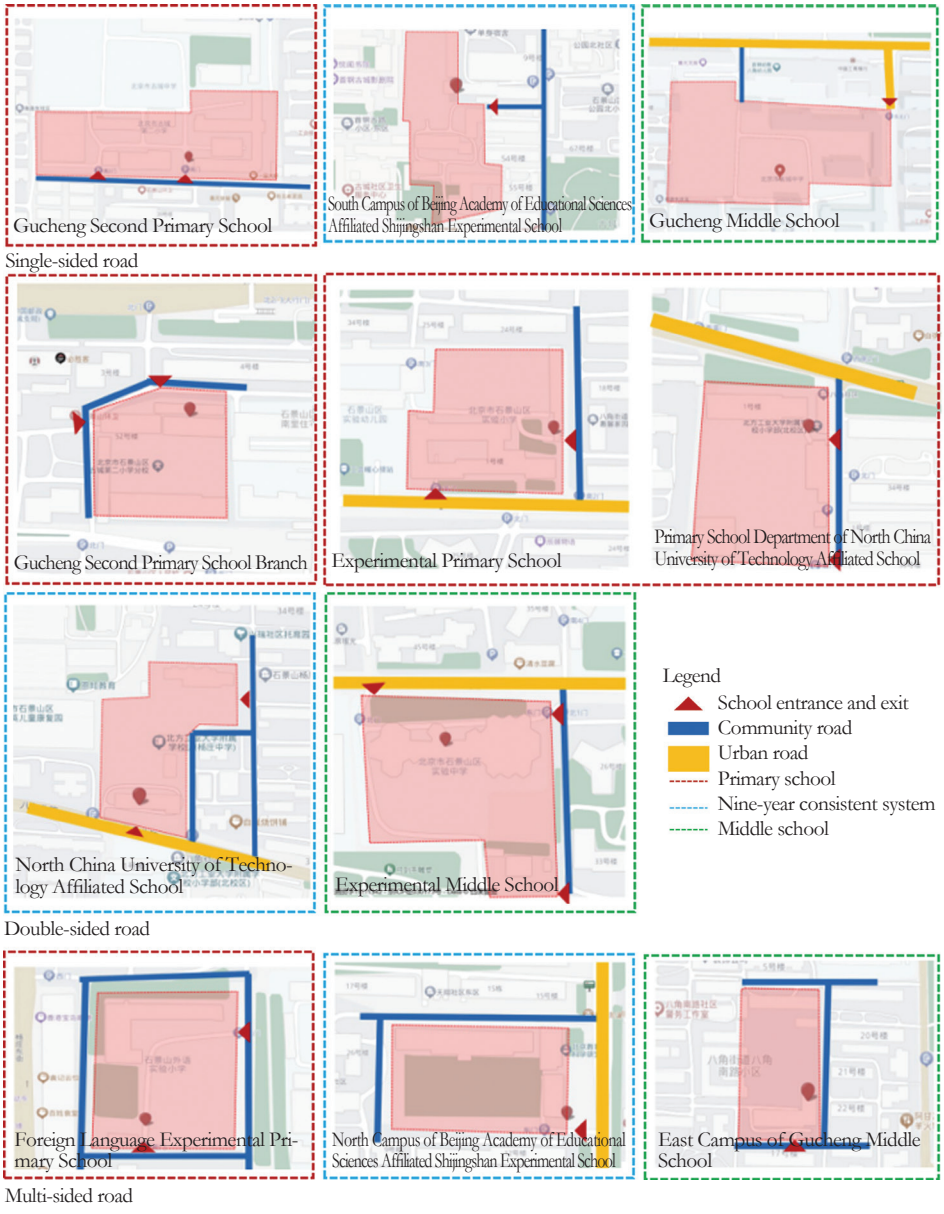


**Fig.1 Classification of primary and secondary schools in Bajiao Street**

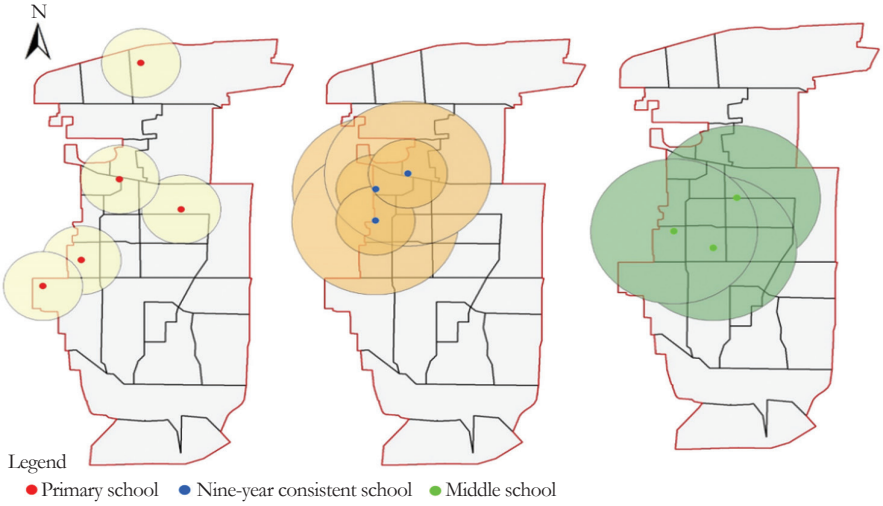


**Fig.2 Scope of school commuting space in Bajiao Street**

is generally less parking space in older residential areas, and the original pedestrian road system is not well planned. The road is used as a parking space, with narrow pedestrian passages and mixed traffic. Primary schools usually adopt this method, such as Foreign Language Experimental Primary School (Fig.4), Gucheng Second Primary School Branch, Experimental Primary School, and Primary School Department of North China University of Technology Affiliated School.

### 4.3 Node space

Node space refers to the space that briefly stops on the school commuting path, and is mainly divided into six types: intersection space, park green space, bus stop space, street stop space, small square space, and shop front space (Fig.5). According to Fig.5, it can be seen that the intersection has the most spatial nodes, with a spacious space. However, both pedestrian and vehicular traffic are high, posing significant safety hazards and inhibiting the occurrence of children's school commuting activities. The space next to bus stops is one of the most important places for children to stop and wait during their school commuting journey. Due to the wider service scope of secondary schools and the farther community students live in, the average walking distance is longer than that of primary schools. Therefore, middle school students tend to visit public transportation facilities such as bus stops more often. Recreational activities mainly gather in front of bus stops, with a relatively single type of activity. Primary school activities are distributed in various node spaces.

## 5 Conclusions

A school commuting space of child friendly is not only a physical space for safe travel, but also an activity space for children's public life, free interaction, and social inclusion. Starting from the background of building a child friendly city, this paper conducted field research on 11 primary and secondary schools in Bajiao Street of Shijingshan District, and analyzed the school commuting space from four aspects. Firstly, the characteristics of children's school commuting activities are analyzed from four aspects: spatio-temporal characteristics, behavioral characteristics, cognitive characteristics, and psychological characteristics. Secondly, the school commuting space has five major characteristics: transportation, landscape, culture, leisure, and security. Thirdly, the types of schools in primary and secondary schools in Bajiao Street are summarized, which are mainly divided into three types: single-sided road, double-sided road, and

| Type | Graphic | Characteristic | Realistic photo |
|---|---|---|---|
| Street facing style | School / Entrance / Urban road | Immediacy of the influx or outflow of people and vehicles and the display of the school's image | North Campus of BAES Affiliated Shijingshan Experimental School |
| Introduction type | Urban road / School / Entrance | Using a road to separate urban motor traffic from students. Not only does it avoid urban peak motor traffic, but it also strives for buffer space for school pedestrian and vehicular traffic | Experimental Primary School |
| Terminal type | School / Entrance / Urban road | Using pedestrian roads to connect the school gate with urban roads, separating urban motor traffic from school commuting traffic, reducing the impact of urban traffic, and making pedestrian traffic relatively safe | South Campus of BAES Affiliated Shijingshan Experimental School |

**Fig.3 Relationship between the space in front of the school gate and the road**


**Fig.4 Path space**


**Fig.5 Node space type**

multi-sided road. Among them, double-sided road is the most commonly used method in primary and secondary schools. Fourthly, the school commuting space of Bajiao Street is analyzed from the aspects of the school gate front space, path space, and node space. A large number of clusters is formed in the space in front of the school gate in a short period of time. Therefore, it is necessary to reduce the intersection between various flow lines, plan temporary parking spaces reasonably, reduce crowd gathering, and use different colors and materials of paving to distinguish the waiting area for parents, which is conducive to parents and children quickly identifying the area and increasing a certain degree of fun. The path space needs to optimize traffic flow lines, implement speed limit management on motor vehicle lanes within the scope of children's school commuting, create exclusive up and down school paths for children's safe passage, and ensure the continuity of children's walking space. At the same time, secondary school commuting roads should be set up to guide recreation and social activities. The node space needs to explore a small-scale space with multiple functions to meet the strong exploratory activity needs of children, and public activity spaces suitable for children's behavioral characteristics. Through the study on the school commuting space of primary and secondary schools, the aim is to

(To be continued in P30)

**Table 2 Take Baidu map street view of Dacheng Road for environmental assessment**

| Sampling point | Vertical greening | Blue sky ratio | Building style | Road width | Daylighting |
|---|---|---|---|---|---|
| SKSS1-F | 0 | 1 | 0 | 1 | 1 |
| DCSE2-F | 0 | 1 | 0 | 1 | 1 |
| DCSE3-F | 0 | 1 | 0 | 0 | 0 |
| DCSE4-F | 0 | 1 | 0 | 1 | 1 |
| DCSE5-F | 0 | 1 | 0 | 0 | 0 |
| DCSE6-F | 1 | 1 | 0 | 0 | 1 |
| DCSE7-F | 1 | 1 | 0 | 0 | 1 |
| DCSE8-F | 1 | 1 | 1 | 0 | 1 |
| DCSE9-F | 1 | 1 | 1 | 0 | 1 |
| DCSE10-F | 0 | 0 | 0 | 0 | 1 |
| DCSE11-F | 0 | 1 | 0 | 1 | 1 |
| SKSS2-F | 0 | 1 | 1 | 1 | 1 |
| Average | 0.33 | 0.92 | 0.25 | 0.42 | 0.83 |

the canal, and found that (1) there are relatively few linear canal viewing spaces along the canal; (2) there are mainly gaps in the landscape series and transition of the Grand Canal cultural scenic spots; and the marginal and little-known ancient architectural culture needs to be activated and improved; (4) the surrounding architectural features need to be improved. To a certain extent, the surrounding construction land encircles and squeezes the space of the ancient architectural sites on the edge, blocking the light; (5) the way of slow walking observation route still needs further improvement. Research has found that there are multiple sections of under-crossing tunnels for motor vehicles in the surrounding area. It is speculated that the purpose of setting up under-crossing tunnels is to avoid traffic congestion near the commercial area. However, this has to some extent affected the continuity of the viewing route for the river scenery, and the viewing space for slow traffic along the river series needs further improvement. (1) In addition to focusing on the cultural display in the Grand Canal cultural scenic spot, the culture will be further extended to the outside, on the basis of the overall connection of large-scale canal culture, to further improve the neglected and relatively unknown site culture retention. (2) Improve the three-dimensional greening in the middle of the tour route, and promote the spatial planning and construction of the slow space.

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(Continued from P26)

provide reference and guidance for the future construction of children's walking school commuting, and ensure that children have a healthy and safe experience of walking school commuting, promoting the construction of child friendly cities.

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