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Community Street Space Renewal from Child-Friendly Perspective as Exemplified in Xiaobei District, Guangzhou

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A Dissertation Submitted for the Degree of Master

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Abstract

Streets constitute the linear public space of the city. They are not only the carrier space but also the destination for People's Daily travel. Especially for children, streets are one of the main places for their daily life. But for too long, streets have been designed around vehicles, encroaching on space for walking and cycling. The current street space not only cannot meet the needs of children's safe travel, but also lacks the attributes of public space. Therefore, putting the needs of children first in the design of streets can help build safer, greener, fairer and more livable cities.

This paper firstly sorts out the connotation definition and development context of the theory of child-friendly city. Then, on the basis of sorting out the manuals for constructing child-friendly cities in various countries and the theories of children's behavioral characteristics and psychological development, it preliminarily sorts out the guidelines for the construction of child-friendly city street space. Then, from the perspectives of social activities, policy making and space construction, the paper interprets the latest foreign cases of child-friendly city construction, and points out that from the perspective of child-friendly, street space construction should focus on four aspects: improving children's participation, safety, continuity and comfort of slow driving system. Secondly, the street space and children in Xiaobei District of Guangzhou were selected as the research objects, and the methods of questionnaire survey, children's travel path mapping and path tracking were used to conduct the research. It was pointed out that there were traffic hazards and low comfort in the current street space. Based on the previous guidance of street space construction and the function of streets, the four principles of "safety", "continuity", "comfort" and "children's participation" under child-friendly street space optimization were put forward, and five optimization strategies were formulated accordingly. Finally, according to the above principles and strategies, at the community scale, the slow traffic system is constructed and the daily travel path of children is planned. At the block scale, the targeted optimization design is carried out for four streets with different functions in the base. At the micro scale, the detailed optimization design of street furniture and green facilities is paid attention to.

This paper hopes to provide a new idea for the construction of street space by using child-friendly street space construction guidelines to fully optimize and improve the street space in Xiaobei District of Guangzhou, by meeting the needs of children and then meeting the needs of all the people in the street.

Key words: Child-friendly; Street Space; Optimization

Content

Chapter 1 Introduction

1.1 Research Background

1.1.1 Lack of growth space for children in cities

The challenges faced by urban children today are largely caused by the environment in which they live. According to statistics, 500 children worldwide die every day in road traffic accidents; 127,000 children under the age of five die every year from outdoor air pollution; and the number of obese children has increased tenfold since the 1970s. The lack of streets in cities where pedestrians and cyclists can be kept safe and the frequent driving of children by parents not only fosters a sedentary lifestyle, but also deprives them of the opportunity to travel and play independently. Children who are exposed to noise pollution for long periods of time are unable to concentrate, leading to a decline in their own cognitive functions. These problems of road traffic accidents, air pollution, poor psychological conditions and lack of physical activity are all exacerbated by the construction of urban street spaces that place motor vehicles above people or sustainable modes of transport[1].

The Convention on the Rights of the Child states that a Child is any person under the age of 18. In 2050, it is projected that 70% of the world's population will be under 18.Coupled with trends towards increased urbanization, this will bring the amount of urban children in 2050 to over 4.6 bn[2]. However, in the process of urbanization, urban environments are often designed for adults to meet their commuting, working, consumption and entertainment needs. However, the residential communities are the weakest link of child-friendly cities: complex and dangerous roads deprive children of the opportunity to travel independently; Few activity places near the home limit children's opportunities to play freely; Neglecting child-scale design increases the chance of injury to children... These negative old urban environments will undoubtedly lead to children's inability to cultivate independence and even weaken their sense of self-worth.

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[1] UNICEF: State of the world's children 2021, New York:UNICEF, 2021

[2] United Nations Children's Fund. Child-Friendly Cities Initiative Brochure, 2018

In addition to physical constraints on children's actions, children's perspectives are rarely considered when making decisions related to their interests. Children generally do not participate in voting. If children's opinions are not paid special attention to, children's needs are often ignored by adults, and this marginalization often leads to children's lack of care for their communities and families. Lack of experience of autonomy and independent judgment means that children tend to lose responsibility and self-confidence as they grow up. Therefore, whether from the perspective of physical space or society, the current living environment of children in the old city is generally negative, and they cannot get normal development: they lack both safe and happy space to play and the opportunity to express their opinions freely.

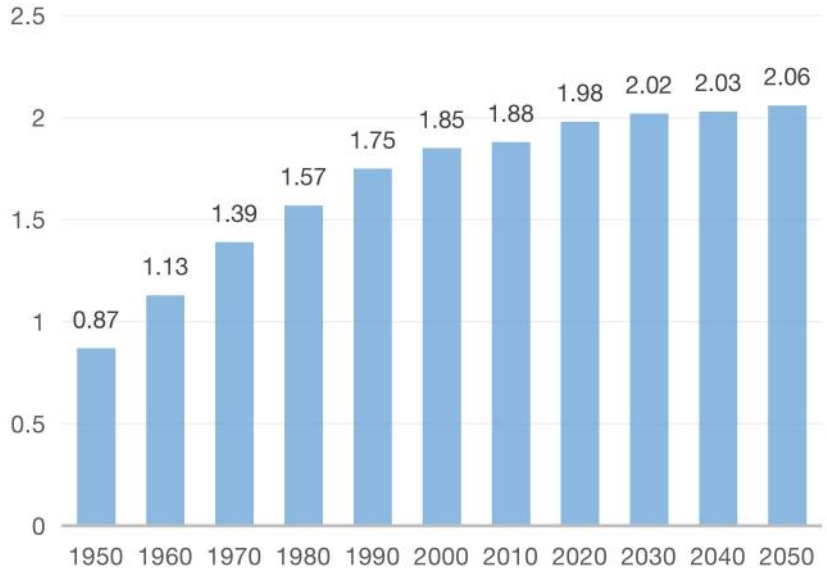


Fig.1-1 Number of children worldwide in billion (Source: Statista Research Department)

1.1.2 Sustainable development and children's rights

The combination of sustainable development theory and children's rights is the basic theory of building child-friendly cities. Sustainable development clearly states that the development of the present generation should not be at the expense of the interests of future generations, and social, economic and environmental development should be integrated through public participation and equal means. *The Convention on the Rights of the Child* states that children have the right to live in a healthy and safe environment and to play freely for leisure. Children's well-being and quality of life are the ultimate indicators of urban

sustainable development construction and management.

Children's Rights and Habitat [3] and *Agenda 21*[4]both emphasize the importance of youth participation in the process of sustainable development and encourage local governments to integrate children's participation into their environmental decision-making systems. Sustainable development, human habitation and the protection of children's rights are closely related. Only a healthy environment and sustainable development policies are the basis for implementing the *Convention on the Rights of the Child.* Therefore, recognizing the important role of children in building sustainable human development requires a child-friendly city. Providing a safe environment where children of all ages can play, learn and develop in society is to create a high-quality living environment for future urban citizens.

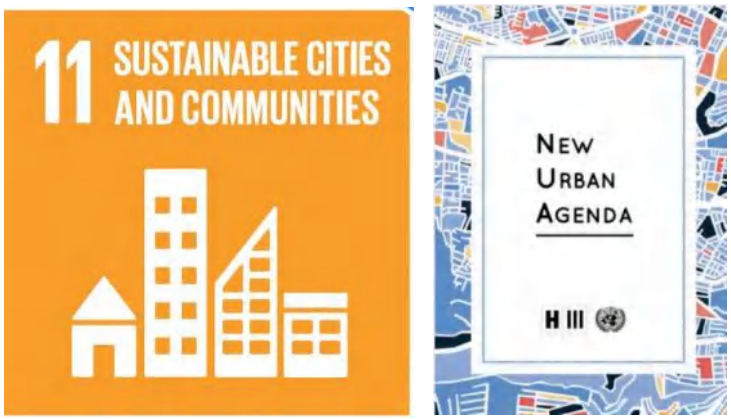


Fig.1-2 The new goals of sustainable development in *Agenda Ⅲ*

1.13. Community renewal is developing on a large scale

Like living organisms, cities exist in a process of development and renewal. Since 1990, urban construction in China has been developing in parallel with urban renewal. The current shift from incremental urban planning to a period of stock planning, driven by structural economic innovation, has made urban renewal one of the main ways of building our cities. In the process of community renewal, there is bound to be an impact on children's lives, so the

[3] UNICEF. Children's rights and habitat: Working towards child-friendly cities,1997

[4] UN. Agenda 21: The Rio Declaration on Environment and Development. New York: United Nations Publications,1992

child-friendliness of the community environment should be one of the indicators reflecting the outcome of the community renewal process.

Xiaobei District is a relatively old urban area in Guangzhou. The neighborhoods in Xiaobei District are densely populated with old residential buildings, as well as urban areas that maintain a traditional street fabric. With the development of the city, the original services and urban spaces in these areas can no longer meet the needs of modern functions. The Xiaobei District has a small amount of poor quality public space, high building density, chaotic and narrow traffic flow, poor infrastructure and a more complex composition of residents. Overall, children in the area face more serious social security and traffic hazards. The study of Xiaobei District is an opportunity to study the renewal of child-friendly street spaces, which can provide children in Xiaobei District with a safe and convenient space to interact and play with their friends, as well as a sense of belonging, being valued and having a sense of value, and enhance their independence.

1.2 Purpose and Significance of the Study

1. Protect children's rights.

Gone are the days when children played freely in community spaces and streets in today's urban life. As the future masters of the city, children have the right to have their voices heard in public affairs, to participate equally in community decision-making and to have a good and healthy development in the spaces they live in. More importantly, building a child-friendly city is not just a matter of urban design; it advocates that children's well-being be central to the institutional structure, professional consensus, social practice and public affairs of the city, with the realization of children's well-being as the ultimate goal.

2. Provide new ideas for the renewal of community street space

Community renewal exists alongside urban development, and community renewal has traditionally been an important part of urban renewal, with research on community transformation and community planning beginning to emerge since the 1980s. Studying the renovation and renewal of public spaces in old urban areas from a child-friendly city

perspective can establish a safe environment for the self-development of children in old urban areas. Safe and coherent walking paths, rich and interesting activity spaces, clean and green living environments... can not only create a series of chain of positive impacts for children, but also provide new strategies for the renewal of street spaces in the community.

3. Improve community cohesion

Community renewal is different from community upgrading. Whereas community upgrading favors the transformation of physical space, community renewal favors the integration of a focus on residents' needs and neighborhoods based on the transformation of space. In terms of value orientation, community renewal has shifted from the mere construction of physical space to a focus on the spiritual needs of people and the sense of belonging and cohesion of urban residents. This paper examines the construction of child-friendly street spaces, which not only allows for the necessary improvement of community street spaces, reconstruction and maintenance activities, but also contributes to building a sense of belonging and cohesion among residents by working together to protect the interests of children.

Fig.1-3 The relationship between the three (Drawn by author)

1.3 Interpretation of Related Concepts

1.3.1 Child-friendly city

"Child-friendly city" is a city, community, or any local government dedicated to the fulfillment of children's rights as set forth in the *Convention on the Rights of the Child*[5]. In these cities and communities, children's voices, needs, priorities and rights are an integral part

[5] UNICEF. Children friendly cities and communities handbook, 2019

of local public policies, processes and decision-making. In a broad sense, a "child-friendly city" is one where children live in a fair and safe environment and have enough space to grow up healthily. At the same time, they are free to express their opinions and actively participate in the construction of the city when making social decisions.

Table. 1-1 Children's rights as implemented in the CFC[6]

Children's right	Content
Non-discrimination	The rights of all children are respected, without discrimination of any kind, irrespective of the child's or the parents' or legal guardian's race, colour, sex, language, religion, political or other opinion, national, ethnic or social origin, property, disability, birth or other status.
Best interests of the child	The CFCI ensures that the best interests of the child are a primary consideration in all actions concerning children. Putting children first is the hallmark of the CFCI[7].
The inherent right to life,survival and development	Children have the right to life, with the government committed to ensuring to the maximum extent possible their right to survival and healthy development.
Respect for the views of the child	Children have the right to voice their opinions and have their opinions considered in decisions that affect them.

[6] UNITED NATIONS. Convention on the Rights of the Child, 1989

[7] CFC: Child-friendly city

CFCI: Child Friendly City Initiatives

1.3.2 Community

The term "community" is a sociological concept, pioneered by the German sociologist Tennessee, which originally referred to a territorial community based on values of identity and emotional ties. Today, urban communities are mostly social units based on a certain territory and value identity. The community differs from the residential area in terms of spatial boundaries and focus: a residential area is "a residential and living settlement enclosed by urban roads or natural boundary lines, corresponding to the size of the residential population, and equipped with a set of public service facilities that can meet the basic material and cultural needs of the residents of the area" and the spatial boundaries are usually enclosed and relatively regular, whereas the boundaries of communities are mainly divided by jurisdictional boundaries and take various forms; in terms of focus, residential communities emphasize the provision of public infrastructure at a spatial level, whereas communities have a more managerial dimension and emphasize the emotional ties between residents.

1.3.3 Street space

Public space in child-friendly communities are those non-profit space that children have the right to use, including outdoor space (parks, green spaces, recreational playgrounds, waterfront beaches, etc.), street space (pathways between children's destinations) and indoor public space that serve children (schools, libraries and other indoor public facilities). Just as important to children as schools, parks and playgrounds are street spaces that can accommodate spontaneous 'informal' activities. In such streets, children can change their mode of travel, rest in comfortable corners, play and learn safely, and explore and learn about their surroundings as they wish. However, streets are the basic units of urban space, through which people experience the city: they are the nodes connecting people with the community and the city, and they are the places where people have social interactions for the first time in their daily life.When street space encourages people to linger, it contributes to a more harmonious atmosphere in the community. Thus, considering the importance of streets, this paper mainly focus on optimization of street space in community.

Streets have always been designed for motor vehicles, but street space should not be simply viewed as a moving space with traffic function, it should be realized as an extension of the interior space of the building, which is a three-dimensional space composed of multiple planes: the ground is the bottom, the facade of the building along the street is the facade, and the sky is the ceiling. At the same time, each plane is made up of many individual elements, which combine to form the space where people move and stay, and make it possible for people to socialize.

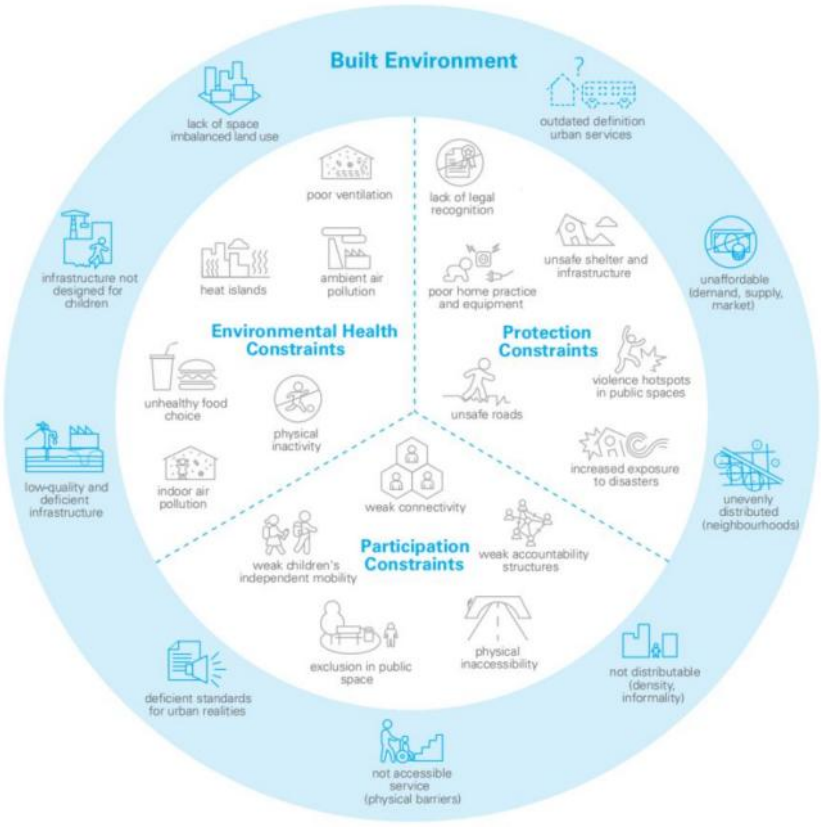


Fig.1-4 Taxonomy of children's vulnerabilities related to the built environment (Source: Shaping urbanization for children)

1.4 Research Methods

(1) Literature reading method: By reading a large number of domestic and foreign literature on child-friendly cities and communities, planning guidelines and other materials, this paper summarizes the conceptual connotation of child-friendly cities, and reviews the development of the theory in detail, secondly, paper summarizes the design points and

value orientation that child-friendly communities should pay attention to at the street level, providing theoretical support for subsequent optimization design.

(2) Questionnaire survey: The street space of Xiaobei District in Guangzhou was selected as the research object. Through questionnaire survey, to learn the evaluation, actual needs and optimization suggestions of children and caregivers in Xiaobei District on the current situation of streets.

(3) Field interview: Conduct face-to-face communication with children and caregivers in the precinct to understand the current situation of children in the precinct

(4) Path tracking: Randomly track children during school hours and weekends, record children's behavior activities, and count the traffic flow and people flow of the main streets in the survey area every 5 minutes during school hours and non-school hours, respectively, to count children's frequent use of streets and stay spaces.

(5) Drawing children's travel path map: Invited children to participate in drawing daily travel routes to school and play, and sort out the streets, spaces and routes to be improved mainly used by children in the area.

1.5 Research Framework

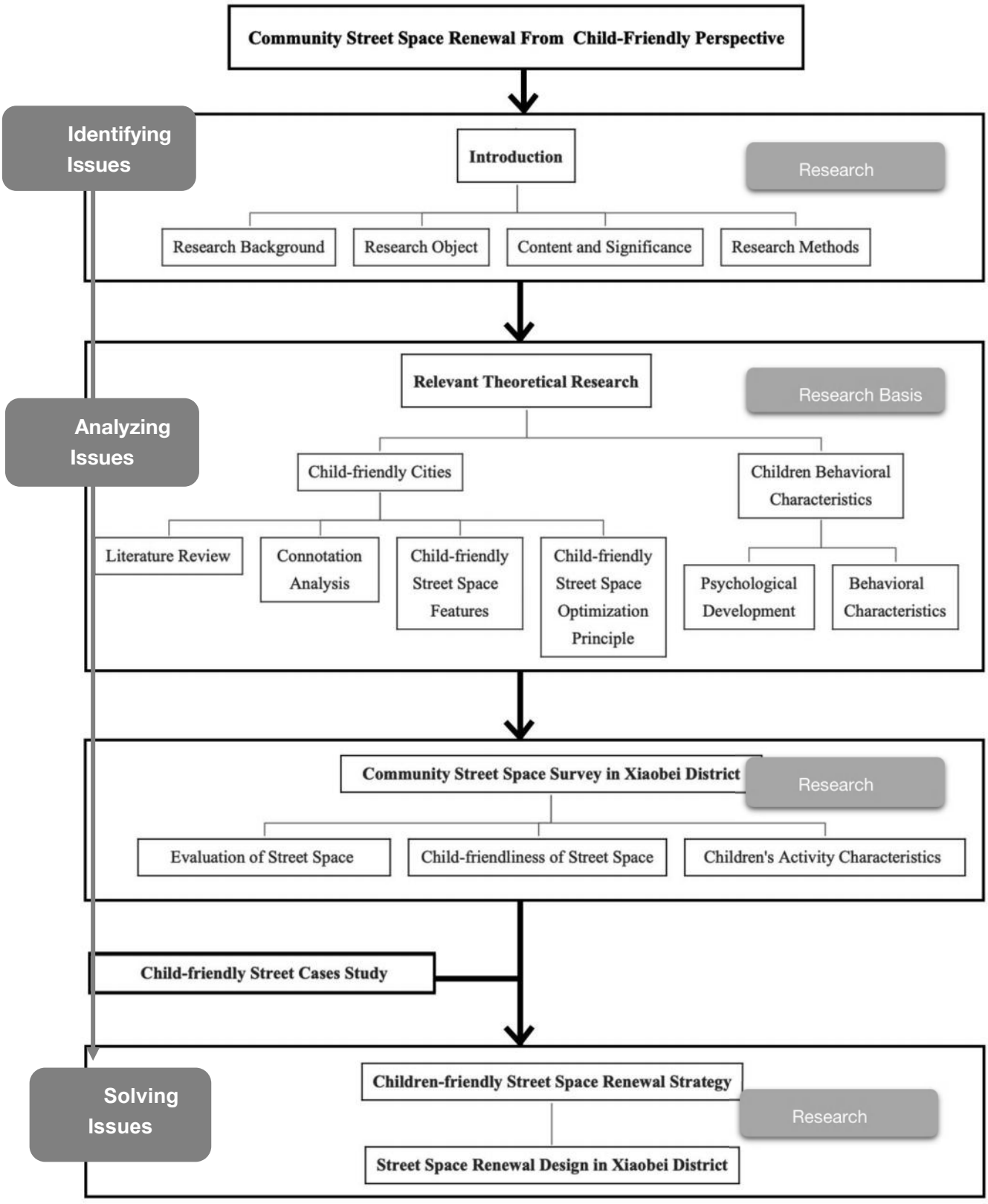
The thesis is divided into four parts and six chapters.

The first part is the introductory chapter of the thesis. It begins by discussing the sources of the chosen topic, presenting the existing problems, clarifying the content and methodology of the study through the analysis of relevant concepts, and explaining the purpose and significance of this study.

The second part, Chapters 2 to 4 of the thesis, is the analytical problem of the paper. Chapter 2 firstly reviews and summarizes the current documents and guidelines on child-friendly city construction, analyses the actual meaning of child-friendliness and uncovers the focus of child-friendly construction in physical space; Chapter 3 examines the current latest construction cases from three aspects: policy, social activities and physical space, in order to obtain ideas on working methods for later renovation; Chapter 4 conducts field research in the Xiaobei district of Guangzhou to obtain information on street.

The third part, chapters 5 and 6, is the solution to the problems of this paper. In Chapter 5, it proposes the principles and strategies for optimizing the street space in a child-friendly way; in Chapter 6, the principles and strategies for optimization are applied to the streets of Xiaobei District.

The fourth part is the conclusion, which reviews the whole paper and summarizes the design theory research results, and explains the shortcomings of the research.


Community Street Space Renewal From Child-Friendly Perspective
Identifying Issues
Introduction
Research
Research Background
Research Object
Content and Significance
Research Methods
Analyzing Issues
Relevant Theoretical Research
Research Basis
Child-friendly Cities
Children Behavioral Characteristics
Literature Review
Connotation Analysis
Child-friendly Street Space Features
Child-friendly Street Space Optimization Principle
Psychological Development
Behavioral Characteristics
Community Street Space Survey in Xiaobei District
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Evaluation of Street Space
Child-friendliness of Street Space
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Child-friendly Street Cases Study
Solving Issues
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Street Space Renewal Design in Xiaobei District

Chapter 2 Literature Review

2.1 “Child-friendly City” Theory Research

2.1.1 History of “Child-friendly City”

Back in the 1960s, when urban planner Kevin Lynch launched the *"Growing up in the City"* project, Lynch realized that the current urban built space environment has a non-negligible impact on the healthy growth of children. In 1992, UNICEF launched the *"Mayors : Defenders of Children Initiative"* in Dakar, proposing that the needs of children should be prioritized politically, and that laws should be amended on the basis of increasing children's public participation, while protecting children who are exposed to war and adversity[8]. In 1996, the United Nations International Children's Emergency Fund and the United Nations Human Settlements Programme officially launched the *"Child Friendly City Initiatives"* at Habitat II, and the key to the initiative was to implement the Convention on the Rights of the Child[9]. The four major children's rights: hearing children's voices and realizing children's needs, priorities and rights, thus guiding the government to develop a series of action plans to make cities more suitable for children to live healthily and grow freely[10].

In 2001, UNICEF further defined the basic elements and characteristics of child-friendly cities (Table 2-1). In fact, different countries have different levels of urban development and the rights of children are also different. Therefore, CFCI does not have a fixed model[11]. The focus of CFCI is to develop a set of action frameworks to help different local governments improve their current working models and flexibly build child-friendly cities that adapt to the current situation of urban development.

[8] UNICEF in Kazakhstan. Child-friendly city: Initiative implementation methodology for the Republic of Kazakhstan. Astana, 2015: 8

[9] UNICEF: United Nations International Children's Emergency Fund

[10] UN. Convention on the Rights of the Child. New York: United Nations Publications, 1989

Table 2-1 Characteristics of child-friendly cities

	Characteristic	Aspect
1	Live in a clean, unpolluted and safe environment with access to green spaces.	Infrastructure, physical space
2	Local governments should ensure that all localities always adhere to the principle of prioritizing the interests of children in policy formulation, resource allocation, and day-to-day management	Policy making
3	Create safe environments for children of all ages where they have free access to leisure, learning, social interaction, psychological development and cultural expression	Infrastructure, physical space
4	Create a sustainable future under equitable social and economic conditions and protect children from natural and social disasters	Sustainable development
5	Children have the right to be involved in policy decisions about their lives and have the opportunity to voice their opinions	Policy making
6	More care should be given to disadvantaged children, such as those whose parents are disabled or families are in difficulty	Social services
7	Eliminate discrimination based on gender, faith, social and economic differences	Social environment

In 2004, UNICEF further outlined CFCI's framework for action in *Building Child Friendly Cities: A Framework for Action*, which includes six areas: Work Structure、 “ 9 Building Blocks ”、Practice Cases、Collaborations and networks, Databases, and Research Centers. “ 9 Building Blocks ” are key component, which concretely guide the direction of local government improvement and fundamentally ensure that children can participate in decision-making processes related to their own interests[12] (Fig.1-4).

[12] UNICEF. BUILDING CHILD FRIENDLY CITIES: A Framework for Action. Florence, 2004: 4-6

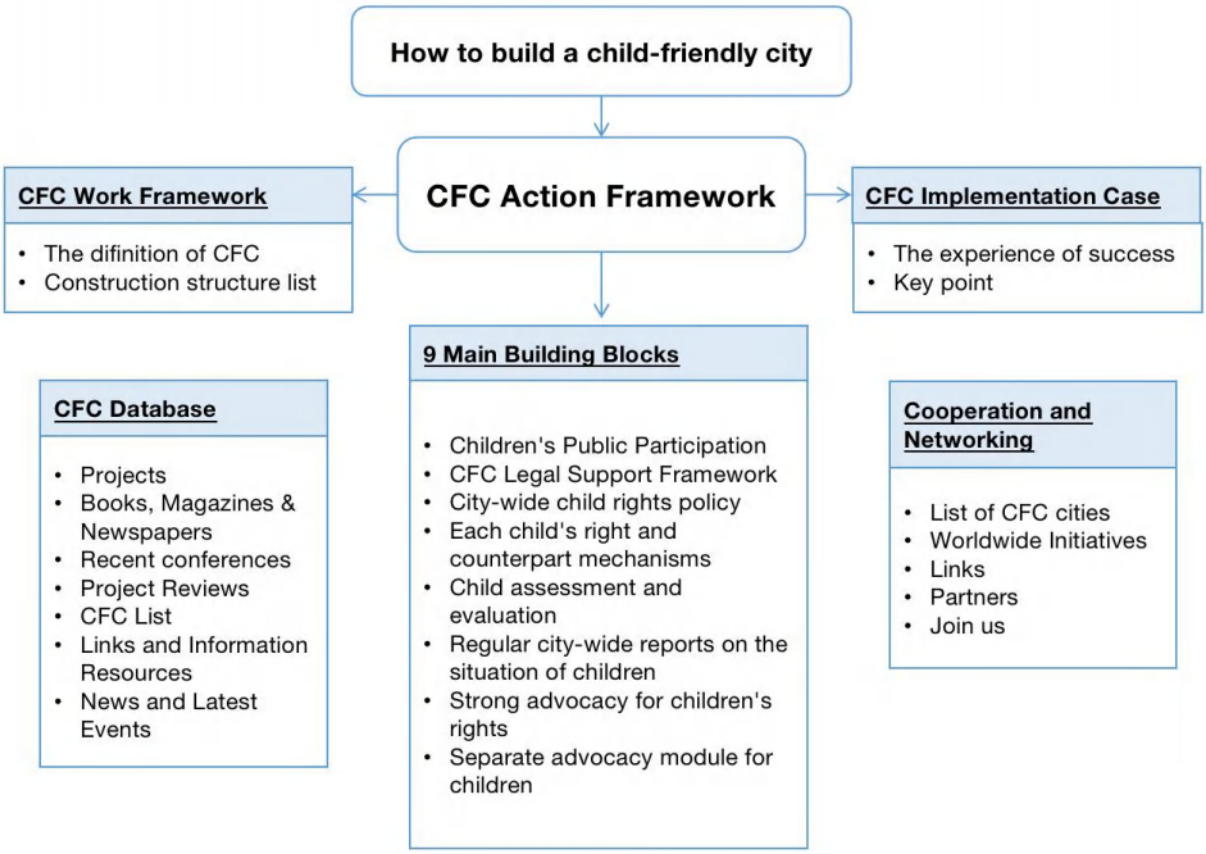


Fig.1-5 How to build a child-friendly city (Drawn by author)

In 2018, UNICEF summarized the experience of global child-friendly city construction cases and issued *Child Friendly Cities and Communities Handbook* to provide a governance framework for building child-friendly cities and communities. The framework consists of two pillars: 1) goals and results to be achieved、2) strategies to achieve these goals and results (Table 2-2、2-3). The strategies streamline the original nine building blocks, set out in 2004.

Table 2-2 Goals for building child-friendly cities

Goals	Aspect
Every child and young person is valued, respected and treated fairly within their communities and by local authorities	Equality and non-discrimination
Every child and young person has their voice, needs and	Clean and safe urban

priorities heard and taken into account in public laws, policies, budgets, programs and decisions that affect them	environment
Every child and young person has access to quality essential social services (this includes healthcare, education, nutrition support, early childhood development and education, justice and family support)	Children participate in decision-making
Every child and young person lives in a safe, secure and clean environment (this includes protection from exploitation, violence and abuse, access to clean water, sanitation and hygiene, safe and child-responsive urban design, mobility and freedom from pollution and waste)	Medical education, nutritional support, early childhood development
Every child and young person has opportunities to enjoy family life, play and leisure (this includes social and cultural activities, and safe places to meet their friends and play)	Social, cultural events and safe places to play

Table 2-3 Strategies for building child-friendly cities

Strategies	**Content**
Collecting Data and Monitoring progress	Assessing the situation of children, setting objectives and monitoring and evaluating progress as well as reporting on it. Independent accountability, including with children
Advocacy and Awareness-Raising	Advocacy and awareness-raising of child rights throughout government and society, including independent advocacy for children
Child-Friendly Laws and Policies	Enacting child-friendly laws and policies. Assessing the impact of these on children

City-Wide Strategic Plan	Developing a city-wide strategic action plan with clear budget allocation and account abilities for implementation
Budget Allocation	Ensuring children get their fair share of resources
Child/Youth Participation	Informing and involving children and youth and respecting their views and experiences; recognizing children and youth as partners and as individual human beings, rights-holders and equal, active citizens
Coordination and Partnerships	Cross-sectoral coordination, leadership and strategic partnerships to maximize the impact of child-friendly policies and programs

In 2019, UNICEF hosted the first International Child Friendly Cities Summit in Cologne, Germany. More than 190 cities around the world signed the summit outcome *The Cologne Child Friendly Cities Mayors' Declaration*, pledging to improve the survival of children in their local communities. At the same time, Child Friendly Cities and Local Governments Inspire Awards were established, to recognize outstanding projects that promote the implementation of children's rights and improve the daily living environment of children in the local area.

Fig.1-6 Children and young representatives in 2019 summit (Source:https://childfriendlycities.org)

2.1.2 "Child-friendliness" and construction dimension

According to *Planning and designing child-friendly living spaces*, issued by UNICEF Switzerland and Liechtenstein, "Child-friendliness means that every child is fully granted all of their rights. Children are seen as competent, active participants at the start and heart of every consideration in child-friendly living spaces. Children's rights are consistently considered – systematically and at all political levels, in all decisions and all measures that affect children, regardless of whether these are administrative, civil or programmatic measures"[13]. Accordingly, the connotation of "Child-friendliness" is to consider the interests of children first and respect their opinions in matters involving children, so as to create an environment conducive to the survival and development of children.

While the CFCI provides a building framework for countries to build child-friendly cities and communities, however, in the actual implementation phase, the focus area of each pilot city are different based on their actual situation. For example, Ho Chi Minh a city in Vietnam, based on the current situation of local children, it mainly focuses on how to narrow the equity gap, provide social services to marginalized children and protect all children from violence;

[13] UNICEF Switzerland and Liechtenstein. Planning and designing child-friendly living spaces, 2021

Cities in Colombia mainly focus on providing basic service for kids, such as healthy nutrition and education; Cities in Germany pay more attention to raise awareness of *the Convention on the Rights of the Child* in local governments and the general public in order to adjust local policies for children and build channels for children's participation in urban development; Cities in Switzerland focuses on providing training for personnel working with children, and providing educational services for children.

Therefore, to summarize the key construction dimensions at the level of child-friendly communities, it is necessary to summarize the goals and areas of building child-friendly communities in different countries and organizations (Table 2-4). In general, the dimension of child-friendly community construction is specifically divided into three directions: "Policy-friendly","Space-friendly", and "Service-friendly". Policy-friendly means that the interests of children are given primary consideration in the formulation of policies; Space-friendly means providing a clean, safe space that meets the needs of children; Service-friendly refers to the provision of material and spiritual services conducive to children's development[14].

Table 2-4 Goals and areas of building child-friendly cities in different countries

Country	Goals and Areas	Year
Canada	Goal：1) Increase children's participation; 2) Build a child-friendly legal framework; 3) Protect children's rights in the whole city Focus area: 1) Rights of the child; 2) Access to services; 3) Child participation; 4) Education; 5) Child protection; 6) Support local children's organizations to promote the development of children's	2013

[14] Xu M,Tim G,Mao P,Tian T. International certification mechanism of ""child friendly cities"and related practice and theoretical developments of european and American cities[J]. Urban Planning International, 2021,36: 3-5

	recreation areas, road safety improvements and services Goal：1) Raise the awareness of local government and the public on children's rights and adjust local child-related policies; 2) Children's participation in the development of urban space;	
Germany	Focus area: 1) Integrate children's rights into local government decision-making and giving priority to the best interests of the sectors concerned for children; 2) Build a child-friendly legal framework; ensure the participation of children and adolescents; 3) Enhance children's right to information; 4) conduct follow-up child assessments[15]	2019
Filand	Goal：Identify the most vulnerable groups of children and improve their well-being, structurally improve local governance systems Building block：1) Advocacy for children's rights 2) Equality and non-discrimination 3) Participation: planning, evaluation and development of services 4) Participation: planning and development of public spaces 5) Participation: agenda-setting and decision-making impact 6) Participation: civil society activities 7) Participation: child and adult relations 8) Participation: emphasis on children and childhood 9) Strategic planning, coordination mechanisms and impact assessments 10) Post-use assessment of children[16]	2017
Switzerland	Goal：Ensure children's right to participate, be protected, supported and treated equally in their daily lives Focus area: 1) Child protection policy development; 2) Early childhood development formal and extra-curricular education; 3) Child health promotion initiatives; Urban spatial planning; 4) Planning and	2020

[15] Source: https://childfriendlycities.org/germany/

[16] Source: https://www.unicef.fi/unicef/tyomme-suomessa/lapsiystavallinen-kunta-projektiesittely/

	implementation; 5) Post-production management[17]	
Austria	Focus area: 1) Child-friendly management; 2) Child participation (including interview surveys on child well-being, youth parliaments with child representatives); 3) Child health (including food safety, first aid course training for children and carers); 4) Leisure (including financially subsidised extra-curricular activities, public children's flea markets, sports fields for children); 5) Family and school care (including public open spaces, childcare services); 6) Safety of places (including safe transport environments, playgrounds, etc.); 7) Education (including regular community exchange events, public information on training)[18]	2013
Iceland	Focus area: 1) Promote joint cooperation between different regions and institutions; 2) Encourage children's participation in government and institutional decision-making processes (ensuring that children have clear channels of participation); 3) Collect information on the living conditions of all children regardless of ethnicity and improve the living environment of the most vulnerable children; 4) Train staff involved in services for children (including judging children's health and communicating with them); 5) Social and cultural work (seeking children's opinions on the organization of cultural activities, project grants and facilities for young people's cultural activities, review of the extent of children's participation in cultural activities in the city); 6) Urban planning (increasing the level of children's participation in school planning, outdoor recreation areas, transport planning around schools, cultural and educational buildings)[19]	2020

[17] Source: https://childfriendlycities.org/switzerland/

[18] Source: https://childfriendlycities.org/austria/

[19] Source: https://childfriendlycities.org/iceland/

2.1.3 Street space construction guidelines

As street spaces are not only for traffic, they should also provide places for children to stay and play. Therefore, in order to systematically translate child-friendly street spaces into practice, guidelines for the construction of outdoor activity areas are also included in the study. Based on the above objectives, this paper selects representative design manuals, planning guidelines and child-friendly assessment documents in recent years, then summarizes and collates the construction regulations related to street space and outdoor activity space, including: *the 2019 China Specification For Child- Friendly Community Building* issued by the China Office of Child-Friendly Community Promotion Programme[20], *Shaping Urbanization For Children: A Handbook On Child-Responsive Urban Planning 2018* issued by UNICEF[21], *A Child Friendly Community Self-Assessment Tool For Community Service Providers And Child Advocates,* published by UNICEF[22] , *Growing Up: Planning for Children in New Vertical Communities*, a guideline issued by Toronto, Canada in 2020[23], *"Playground": city* issued by the University of Dortmund, Germany, for testing the child-friendliness of open spaces, streets and residential environments in German cities[24]; *Planning and designing child-friendly living spaces,* a guide for professionals working in urban planning, education and child protection issued by UNICEF Switzerland[25](Table 2-5).

[20] China Child Friendly Community Promotion Program Office. Specification for child-friendly community building. Beijing, 2019

[21] UNICEF. Shaping urbanization for children: A handbook on child-responsive urban planning, 2018

[22] Unicef. A Child Friendly Community Self-Assessment Tool For Community Service Providers And Child Advocates, 2017

[23] ANDREA O, ANNELY Z.. Growing Up: Planning for Children in New Vertical Communities, 2017

[24] M.Oblasser Finek. Playground:city—child friendly design of urban open space[J]. Chinese Landscape Architecture, 2008: 49-55

[25] UNICEF Switzerland and Liechtenstein. Planning and designing child-friendly living spaces, 2021

Fig.1-7 Child-friendly city planning guidebooks (Drawn by author)

Table 2-5 Guidelines for child-friendly outdoor spaces

Dimension		Guideline	Source
Privately Owned Publicly-Accessible Space (POPS)	Amenities Standards	No parkland within a 5-10 minute walk or no park within 250-500 m of a new site, pops must be provided POPS help to form a network of open spaces and provide alternative pedestrian access to the community; POPS provide both an activity area for children and a place for pedestrians to rest; POPS should complement, not replace, the city's overall network of parks and open spaces	Canada

	Diversity	The scale and design of POPS should consider multiple use uses, such as temporary art installations or performances;	
		POPS can be courtyards, front yards and gardens to provide a resting place for families travelling to their destination	
	Semi-open	POPS should have physical barriers, such as fences and low walls, to prevent children from running into the street;	
		They should be established away from the street and within the residential area;	
		POPS should provide seating and gathering space for caregivers to allow for formal or informal supervision	
Public activity space	Area indicator	Minimum standard size per child met	UN
		A 5-minute living circle with at least one outdoor activity area suitable for children under 12 years of age, with appropriate provision of terrain facilities such as sandpits, shallow pools, slides, etc;	China
		At least one outdoor play area suitable for children over 12 years of age within a 15-minute living circle, with facilities such as climbing frames, basketball courts and pitches desirable	
		New parks should be located within 250-500 m of the center of the new build site or within 5-10 minute-walk distance;	Canada

		New buildings should not overshadow existing parks, open spaces and playgrounds;	
		When expanding the open space network: look for opportunities to re-use under-utilised space, such as surface car parks, surplus land plots	
		With sheltered lounge facilities, toilets and drinking fountains	
	Clean	There are public toilets that are safe and easy for children to use	UN
		Accessible via safe routes with minimal distances and intersections	
		Ensure that children can walk to their daily destinations, such as schools, bus stops, residential areas, within a five kilometre radius	UN
		The layout of all types of outdoor play space should be laid out in areas that are safe for children to move around and should be close to children's main travel routes and locations, with appropriate safety measures taken if they are close to urban arteries	China
	Accessibility	Signage system that is readable by children	UN
		Signs designed for children should be as graphic as possible rather than textual, taking care that they are as high as possible;	Swiss
		The specific needs of children with disabilities should be taken into account	
		There are activity facilities available for children	UN

		with disabilities	
		Improved visibility of children to passing people and drivers;	
		Site design that is appropriate to children's scale, for example, step heights;	UN
		Avoid potentially dangerous design elements for example, potholes, trenches	
	Safety	Play equipment and surfacing should be naturalised, soft, flexible and hard-wearing environmentally friendly materials	China
		Choose natural materials as well as native plants as far as possible and plants that are toxic to humans should be avoided;	Swiss
		Reduce the size of motor vehicle parking areas or use restricted parking in areas close to children's activities	
		Children are protected from strangers in their places of activity	UN
		Suitable for day and night use, all seasons and a wide range of weather conditions	UN
	Diversity	Offers a wide range of game types including but not limited to experiential, sensory, seasonal, imaginative and challenging games	
		A range of park types should be included to meet daily, weekly and seasonal needs	Canada
		The park design should combine variable and specific elements to allow for a wide range of	

	activities, rest, climbing and imaginative play, suitable for all ages and abilities, and provide a combination of the following: 1) Specific elements: play equipment suitable for different age groups, such as sandboxes, water features, playgrounds and skateboard facilities; 2) Flexible elements: climbing facilities, grass, mounds, concrete or stone shapes and seating walls	
	The design of outdoor play spaces should take into account planting, signage and lighting	China
	Installing public lighting on footpaths and play areas to expand opportunities for physical activity in the evening	UN
	Encourage the activity venues of primary and secondary schools to be open to the public at regular intervals during non-school hours	China
Annual use	Designed to avoid freeze-thaw conditions, with drainage systems and decentralized overflow channels;	Canada
	Resilient design for extreme weather conditions (storage of rainwater in public spaces, including shading structures and extensive tree planting)	
	Outdoor play areas should be connected by safe and exciting paths to enhance interest, e.g. nature trails	Swiss

	Interest	Use public art installations where possible	UN
		Incorporating whimsy into public art, streetscape, street furniture, parks and open space features to create a sense of fun and playfulness;	Canada
		Design elements that are fun, interactive, educational and child-friendly, using bright colors. For example, fabulous sculptures can stimulate children's imaginations	
	Close to nature	Where appropriate, include natural elements for children to explore	Canada
		Green landscapes and natural spaces should be seen as spaces for children to learn and develop and be easily accessible	Swiss
		Introducing natural terrain to promote physical activity	UN

Table 2-6 Guidelines for child-friendly street spaces

Dimension		**Guideline**	**Source**
Safe Routes	Principles of planning routes	New children's destinations should be combined with existing safe routes wherever possible;	UN
		Integrate children's destinations: schools, community centers, libraries, parks and playgrounds to identify safe routes for	

	children;	
	Cluster destinations to minimize the number of crossings that children need to cross;	
	Observe children's walking preferences for routes;	
	Where cycling routes are provided, they should be linked to child-safe paths and separated from motorways and car parks	
	Transport planning should work with schools to systematically ensure safe routes to school for children of all ages;	
	Where necessary, appropriate measures are taken to clearly mark routes to school, such as the use of special surface materials to distinguish urban motorized roads	Swiss
	Provide continuous paths along the main routes to and from school for children in the community with walking rights of way, linking children's main activity spaces and community public service facilities	China
	Provide traversable paths to reduce walking distances in the urban grid and increase connectivity	UN
Safety	Adopt street models such as share streets to reduce the speed of passing vehicles	Canada
	Cycle paths should connect destinations such as recreation, open spaces and schools,	Swiss

		enabling children to choose appropriate slow-moving transport modes according to their preferences Implement measures to optimize the slow-moving system around community campuses to ensure traffic safety at pick-up and drop-off points and walking spaces for children to and from school, with full-time access; At both ends of the children's school section, signs for children as well as speed limit signs; at children's lateral crossing entrances, slow-down signs and speed bumps should be installed, and the signal control time at intersections should take into account the speed of children's crossing steps; Layout lighting facilities reasonably to ensure the safety of night travel and consider the impact of light height and direction on children	China
Passage space on the street	Accessibility	Provide ramps at public stairways to facilitate the passage of prams and bicycles and improve connectivity; minimize curb radii and lane widths; Wide enough for prams and wheelchairs	Canada
	Comfort	Road surface is flat and without obstructions; Set sidewalks on both sides of the street, and	UN

		widen pavements in busy street sections	
		Parking is available on the cycle route network	Swiss
		Use street furniture and plant trees to provide shade	Canada
		A suitable sidewalk for playing is 3 - 5 m wide, on at least one side, preferably on the sunny side	Netherlands
	Indicators required	There are sufficient widths and adequate proportions for sidewalk, cycle lanes and public transport lanes to minimize lanes and space for vehicular traffic	UN
		Use safe ground solutions;	
	Intersection	Avoid overpasses and barriers that are not conducive to children, the elderly and the disabled	
Motorway	Lane separation	If using a non-share street format, a vegetated barrier should be used to separate it from the motorway	Canada
	Intersection	Design pedestrian-oriented crosswalks and widen the pavements in conjunction with landscaping to reduce the width of crossings	Swiss
Buildings along the street	Creating vitality	Consider building setbacks to create plazas;	
		The ground floor building should uses clear glazing to provide “street level eyes”	Canada

Safety	Enhance the transparency and activity of the building's ground floor to activate the street environment and improve safety and walk-ability	UN

To sum up, in recent years, in community spaces, child-friendly mainly focus on: proximity, diversity and safety of outdoor spaces; in the conduction of transportation spaces, more attention is paid to the safety, continuity and comfort of street spaces. Besides, considering that indoor public spaces are generally built educational and care institutions and other buildings, more attention is paid to architectural designs that meet the scale of children, so they are not considered much in the subsequent research system.For the different types of public space, the key words were further refined, as elements of the subsequent site research (Table 2-7，2-8).

Table 2-7 Elements of outdoor public space survey in child-friendly community

Type	**Level**	**Sub-level**	**Note**
POPS	Openness	Spatial openness	Openness of the entrance space
		Managing Openness	Access for children, residents nearby
			With safe slow walking paths to activity areas
Public activity space	Proximity	Complementary Standards	1. The appropriate distance for school-age children to reach a green space within walking distance is 300-400 m
			2. The distance suitable for children over 12 years of age to travel by bicycle is within 1 km

			3. Areas for infants and toddlers should be located close to housing
		Diversity of play facilities	The venue has both fixed and flexible play facilities to meet the needs of children of all ages
	Diversity	Diverse site space types	Set lounge areas, activity areas, natural spaces
		Diverse functions	For people of all ages
	Safety	Safe site design	Install signs for children, public lighting, and avoid potentially dangerous design elements such as potholes and trenches
		Designed to a child's scale	Child-readable signage system, facilities to meet the physiological scale of children, e.g. step height

Table 2-8 Elements of street space research in child-friendly communities

Level	**Sub-level**	**Note**
Continuity	Path space continuity	Smooth road surface with no obstructions
		Few junctions to cross
		Continuous walking and cycling routes
	Catering for children's accessibility	Street width meets baby carriages and wheelchairs
		Pictorial signs that are readable to children
		Ramps and handrails are provided at height differences
Safety		The width of footpaths and cycle paths complies

	Safe design of street sections	with the regulations
		Use of special paving for road surfaces
		Install vegetation buffer strips
		Install pedestrian crossings, speed limit signs, speed bumps, etc.
	Safe intersection	Widen pavement at intersections to reduce the width of the road
	Social surveillance	Increase the number and variety of shops along the street
		Increase the transparency of street-level shop elevations
	Restrictions on motor vehicles	Limit the speed of motor vehicles in key areas
		Provide pick-up and drop-off points and dedicated time lanes for children around schools
Comfort	Quality of rest space	A variety of lounge space types
		Provide colourful art installations to enhance interest
		Provide vegetation barrier, three-dimensional greenery, etc.
	Street amenities	Enrich the street furniture
		Provide parking for bicycles, children's roller skates, etc.
		Provide wi-fi, street light and shading facilities

In general, in recent years, the construction of child-friendly community street spaces has focused more on: 1) safety, both in terms of safe physical space design practices and in terms of measures to ensure the safety of children. Safe physical space design practices include adequate widths, safe intersections, and so on; child safety measures include measures to

control traffic on streets around schools and minimum standards for transparency along street facades to ensure adequate "street eyes", and so on; 2) continuity, which focuses on establishing; 3) Comfort, both in terms of the quality of the resting space and the availability of facilities, such as a wide range of resting spaces or additional, artistic murals or interactive street furniture to enhance children's enjoyment of the street.

2.2 Psychological and Activity Characteristics of Children

When improving the child-friendliness of community spaces, it is important to be aware that children have different scales of movement to adults - for example, children take twice as long to cross the road as adults - but also to recognize that children have their own unique psychological aspects of the environment, for example, they are often curious about their surroundings and are more attracted to appropriately cluttered spaces than to clean and tidy parks. The design of child-oriented street spaces therefore needs to take into account the process of children's perception of the environment and the characteristics and types of outdoor activities.

2.2.1 Psychological development of children

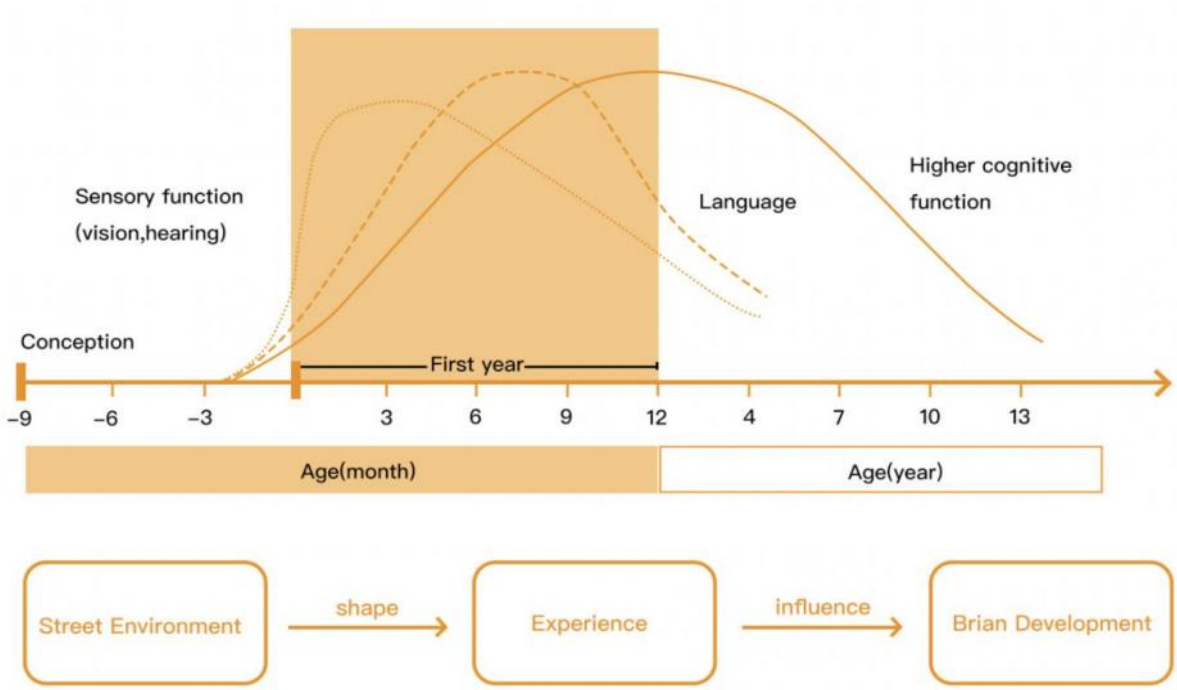


Fig.1-8 Process that environment affects children's brain development（Source：Designing streets for children）

Children's brains develop as they interact with their environment and the information they receive, and the environment in which they grow from birth influences areas of the brain

that are strengthened, and these enhancements and modifications form the basic structure of the brain, laying the foundation for later development of higher level functions such as hearing and language[26]. Therefore, in addition to affecting the quality of the environment in which children live, the environment also has a significant impact on the development and growth of young children and the overall health of their caregivers.

Fig.1-9 The different needs of children at different ages (Source: https://globaldesigningcities.org)

Piaget proposed that the child's psychological development is a state of continuous adaptation of the organism to its environment: a movement from a state of lower equilibrium to a state of higher equilibrium. He argues that the child's response to the external environment is not a passive reception of information, but rather the subject actively analyses and interprets the environment in relation to its existing mental framework, then updates it and develops its own understanding[27]. At the same time, children's psychological development and behavioral characteristics have obvious stages, and children at the same stage have similar thinking characteristics, combined with Piaget's theory of children's psychological development stages, divided into the following four stages[28] (Table 2-9):

[26] Global Designing Cities Initiative. Designing Streets for Kids. New York: National Association of City Transportation Officials, 2020: 6-9

[27] Shen Y, Wang H. A Study on the theme space of Children's Park based on the theory of Child Psychology -- A case study of Fuzhou Children's Park[N]. Journal of Nanjing Forestry University (Humanities and Social science edition), 2012, 4

[28] Yang H, Shi X, Zheng L. A review of Piaget's theory of child cognitive development[J]. Forward Position, 2007, 6: 55-57

Table 2-9 Stage of psychological development of children

Stage	Psychological characteristics	Behavioral characteristics
Sensorimotor stage: 0-2 years	① Deepen awareness of environment through sensation and movement ② Change from instinctive reflex action to purposeful activity ③ Perceives objects as existing objectively and eternally	① Need an adult to accompany them in simple activities; unable to explore the world independently ② Perceives the outside world by grasping, crawling, holding, etc. ③ Unable to use imagination to its fullest potential
Pre-operational stage: 3-6 years	① Thinking from self, self-centered ② Able to use symbols and imagination to recognize the environment ③ Able to express concepts in language ④ Initial socialization	① Have the ability to move independently and have initial thinking skills ② Have a curiosity to explore their surroundings and enjoy going outdoors for activities ③ Enjoy observing and imitating the behaviour of people around them
Concrete operational stage: 7-11 years	① A decrease in self-centerdness, with children's interests shifting to things outside due to expanded interaction and schooling ② Increased socialization ③ Initial development of an objective, connected system of understanding	① Increase in need for outdoor activities and range of activities ② Increase in sense of competition and shift from creative play to rule-based play ③ Gradual increase in independent thinking skills

	④ Being able to use past experience to solve problems	
Formal operational stage: 12-15 years	① A shift again from the external environment to a concern for one's inner world and the development of one's personality ② Have the ability to use abstract thinking and increase the level of socialization	① Enjoy competitive sports and activities of an adventurous and challenging nature ② Turn to the development of the intellect and mind

2.2.2 Activity characteristics of children

Understanding the characteristics of children's activities is a prerequisite for designing child-friendly spaces. Although there are age and gender differences among children in the same community, research has found that most children tend to have the following similar characteristics when they are outdoors：

1) Randomness: Children's activities are full of uncertainty and randomness because their attention is easily distracted by what is around them and because children's minds are more fluid. Because of their curiosity, they prefer paths that can be explored and therefore prefer winding, narrow paths to straight, large paths. In addition, if there is no space for some of the children's activities, they will explore sites with potential activity on their own, for example by suddenly climbing over railings or stacking street furniture while walking.

2) Self-centerdness: Children tend to be self-centered in their activities, focusing on a particular environment and ignoring potential hazards in their surroundings. Children's activity areas should be designed with appropriate protective measures, such as the use of soft flooring materials, to minimize hazards.

3) Close to nature: Children need birds, fish and insects, trees and grass to grow. Nature is a natural learning ground for children and outdoor activities have been proven to improve children's physical coordination, balance, tactile sensitivity and perception. Playing in a natural environment engages the full range of the body's senses, sight, sound, smell, taste and touch. A nature-loving, spiritual child is naturally alert to the materialistic environment of the city and they know how to enjoy simple happiness.

4) Seasonality and timing: The timing and frequency of children's activities are strongly influenced by the seasons. The frequency of children's outdoor activities is higher in the comfortable spring and autumn months, and decreases in the winter and hot summer months. The time spent outdoors is also influenced by the school day, with preschoolers being the most active during the day and children after the age of three preferring to spend time outdoors after school and before dinner. In addition to this, the number of

children who are outdoors increases during weekends and during the summer and winter holidays[29].

Fig.1-10 Consider the different ways in which children use the streets (Source: Designing streets for kids)

[29] Wei Z. Study on the clustered community street environment inducting children's street activities: A case study of Hongli community in Shenzhen[D]. Shenzhen: Harbin Institute of Technology, 2018

2.2.3 Physiological scales of children

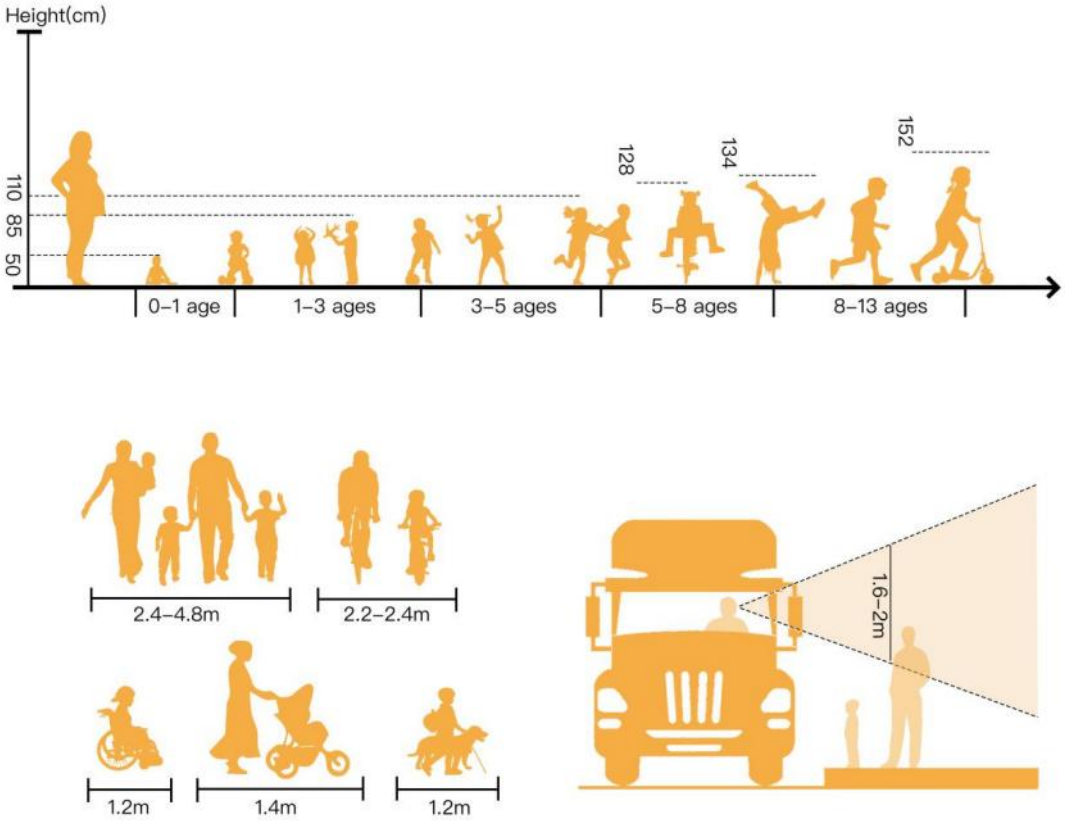


Fig.1-11 Physiological scale of children（Source: Designing Streets for Kids）

To design streets for children, consideration must be given to children and all those who interact with them, including pregnant women and older people caring for children. Based on this, the physical development of children and the scale of their activities often have the following patterns：

Firstly, pregnant women tend to walk slowly, so it is advisable to provide them with resting facilities every 50-100 metre. Infants under 6 months of age rely on strollers to get around, and caregivers often carry many supplies for young children at this age. For them, changes in road height, gaps in street tiles and narrow passing spaces can significantly reduce their mobility, thus, street accessibility is essential. Then, from 6 months to one year old, babies begin to rely on crawling to explore the world. Later, as they grow, children gain more independence and freedom, starting with walking or cycling to school with their caregivers.

Some 1 - 3 year olds have the ability to cycle and walk, and they can ride a child's bicycle alongside their caregiver[30].

Fig.1-12 Considering the travel patterns of the most vulnerable children (Source: Designing streets for kids)

In addition, young children's brain structures develop rapidly in the first three years of life, the period when children grow and learn fastest, so introducing stimulating and interesting elements such as patterns and colors to the street can improve children's cognitive levels. Many children aged 3-5 years have the ability to travel independently, running at speeds close to that of an adult jogger, while they begin to play on the pavement and can safely cross certain types of streets with a caregiver. Children aged 5-8 years can cross streets or ride bicycles alone or with a partner in slow-moving neighborhoods. Children aged 8-13 years have the ability to travel completely independently. They can use urban cycle paths, cross wider roads and further extend their walking or cycling range[31].

[30] Meng X. Evaluation and optimization design of neighborhood physical environment for the purpose of child-friendliness[D]. Shenzhen: Harbin Institute of Technology, 2020

[31] Global Designing Cities Initiative. Designing Streets For Kids. New York: National Association of City Transportation Officials, 2020: 10-11

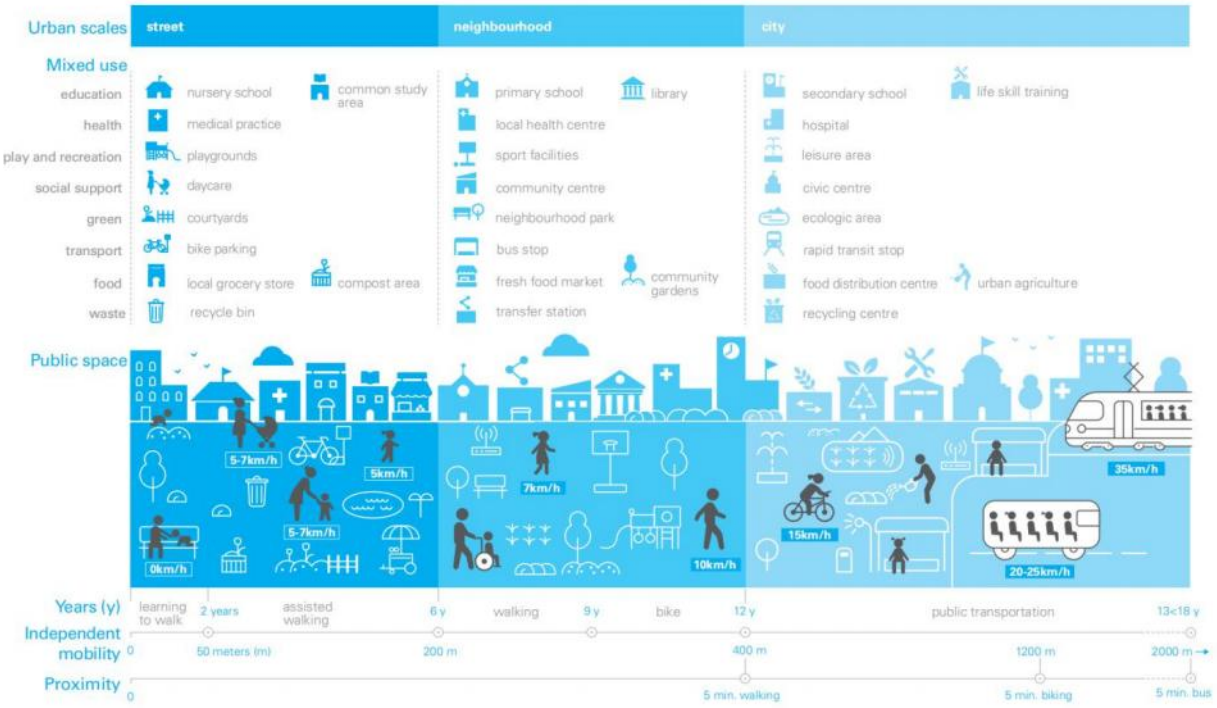


Fig.1-13 Space and scale of urban childhoods (Source: Shaping urbanization for children)

2.3 Summary

This chapter elaborates on theories and concepts related to child-friendly, introduces the development process of child-friendly city theory, the characteristics and connotations of child-friendly cities. Besides,also explores the activity characteristics , psychological characteristics of children and the relationship between children's own development patterns with their environment which can better understand the relationship between children's own development with their environment.

This chapter lays the theoretical foundation for the subsequent study of the relationship between street space and children's activities, which uses the streets in Xiaobei District as the research object.

Chapter 3 Relevant Cases Analysis

3.1 Social Activity Level：Play Street

Fig.3-1 The play street provides space for children to play（Source: https://playingout.net/）

Introduction of Play Street

Play Street, also known as Playing out, is a low-cost social organizing initiative to promote children's physical activity and mental health[32]. Founded in 2011 by Alice Ferguson, Amy Rose and other co-founders, it is a non-profit social change organization that aims to restore children's freedom to play in the streets and spaces they live in to promote their health, well-being and sense of belonging. The campaign creates a safe space for children to play by getting their neighbors in the community to close their streets to vehicular traffic for a few hours. On the other hand, as organizing the event required the community to come together, it fostered a sense of connection, belonging between neighbors of different ages and backgrounds.

Play Street thinks that : streets constitute the vast majority of public space in the city. To see them only as places to drive and park cars is to massively undervalue them. Streets can and should be places where people can sit, talk, read, play and walk, thus using streets by a new way can change this situation. In the UK, over 1,330 street communities are involved, benefiting around 40,170 children and 20,085 adults. Bristol is the main implementation city for Playing Out in the UK and provides practical case help and support to residents in other

[32] Playing Out. How to organize playing out sessions on your street—a step by step manual, 2022

cities. Play Street hopes to progressively change the public attitude of society as a whole towards children playing outdoors by organizing regular (usually once a month) street play events, and even developing policy, planning and design perspectives for streets and cities.

The process of organizing Play Street

Anyone wishing to run Play Street in their community can access the distribution guidelines on the website, specify the date and location of the event by applying to the community and obtaining permission, distribute posters to inform the community, clarify the rules for cycling in and out during the event, and provide simple training for volunteers before receiving an outfit kit, including road closure signage, street play sets and more.

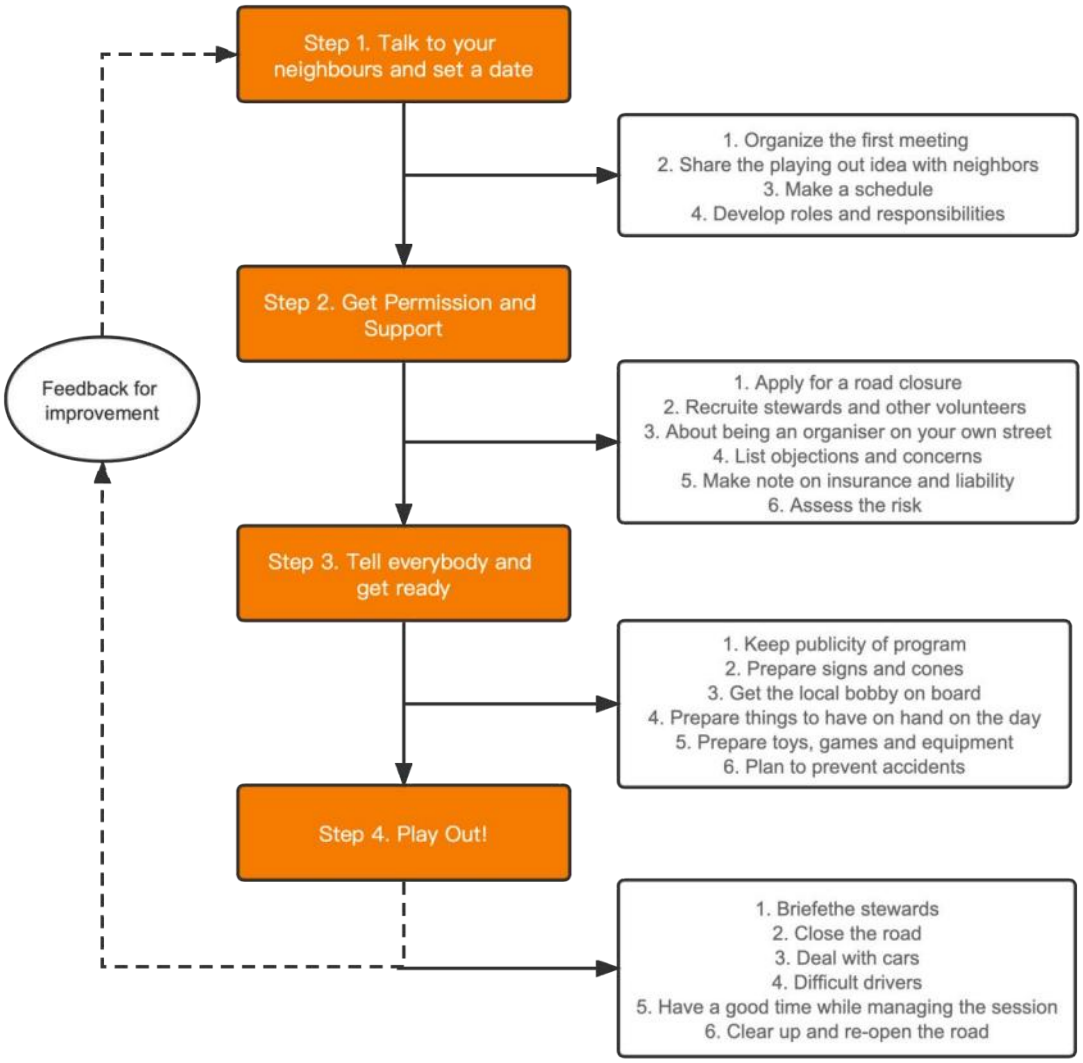


Fig.3-2 The Preparation process of Play Street (Drawn by author)

The report of Play Street

Since the outbreak of the COVID-19 pandemic, the Home quarantine policy has had a significant impact on children, with 48% of UK adults reporting that their children have absolutely no access to the outdoors during the lockdown, according to Natural England research, and the impact is even greater for children from low-income families[33].Providing children with a safe and active place to play every day close to home helps to address these inequalities and is precisely what Play Street set out to do.

1. Children's health

Play streets offer a low pressure environment in which children can be active, developing skills like learning to ride a bike, and increasing their enjoyment and confidence levels. Both of these help towards children pursuing more active lifestyles later in life. The majority of people reported children developing physical literacy skills through play streets sessions, including riding a bike (61%), ball games (55%) and scooting/rollerblading/skateboarding (57%). Over half (57%) of people reported that play streets directly increased their child's level of physical activity.

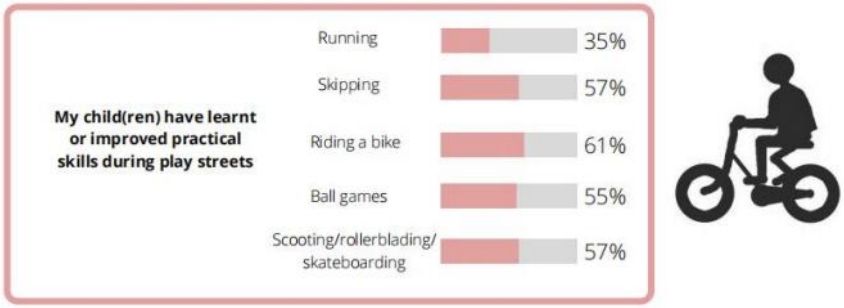


Fig.3-3 The survey results in physical activity (Source: Play Street Resident Survey Report 2021)

2. Mental wellbeing and impact of lockdown

Children have suffered enormously during the pandemic through spending so much time indoors, inactive and isolated. Some children barely left home at all during lockdown and many have been seriously impacted by reduced physical activity and social interaction. The report showed that Play streets allow children the safe space to begin to rebuild their social

[33] Playing out. Resident Survey Report of 2021, 2021

confidence, physical activity and sense of belonging in their communities.

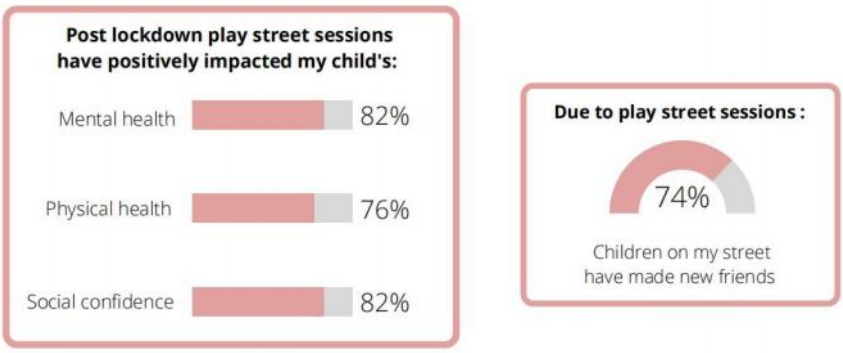


Fig.3-4 The survey results in mental health (Source: Play Street Resident Survey Report 2021)

3. Play streets and street use

The longer term effects of play streets, reflected through behavioural and attitude change. These changes demonstrate that play streets are a spring board for greater, long term change. The above data also demonstrates the impact temporary road closures for play can have on wider societal issues, ranging from children's rights to active travel and the perceptions of 'who owns the road'. Through engaging with play streets residents have gone

on to feel more empowered to lobby for more long term changes.

Fig.3-5 Being involved in play streets has made new attitude towards street use (Source: Play Street Resident Survey Report 2021)

3.2 Policy Framework Level：Urban 95

Fig.3-6 Urban 95 Handbook and Brochure（Source: https://bernardvanleer.org/solutions/urban95/）

Urban 95 is a project launched in 2016 by the Dutch NGO: Bernard van Leer Foundation, which aims to improve the living environment for children and caregivers. The campaign seeks to consider the poor design of current planning from the perspective of a three-year-old child with an average height of 95 cm[34]. Since 2016, Urban 95 has been committed to building local alliances, identifying urban problems and actively developing new and efficient solutions. Urban 95 is expected to expand its partners to at least 63 cities worldwide in 2023[35].

Urban 95 is aimed at helping caregivers interact more frequently with young children, relieving caregivers of the stress of caring for children, facilitating easy access to services for families with children, and making the most of existing programs that focus on children's well-being and integrating them strategically. With this in mind, Urban 95 has four levels of

[34] The Bernard Van Leer Foundation. An Urban95 Starter Kit: Ideas For Action, 2019

[35] Source: https://bernardvanleer.org/solutions/urban95/

strategy development, both in terms of improving caregivers' parenting practices and in terms of macro-level policy and planning:

1. Pilot project evaluation system: A sound pilot project should allow for the direct involvement of all stakeholders and sectors, while allowing for the rapid implementation of optimized solutions and easy monitoring of progress and evaluation of benefits.
2. Technical assistance: Building child-friendly cities requires cross-sectoral cooperation and therefore requires training and competency testing for different roles, including municipal staff, planners, child education specialists, etc. For example, Urban 95 emphasizes helping parents obtain parenting counselling and providing parenting services to increase positive interaction between caregivers and children and to relieve caregivers of the stress of caring for children, rather than just building convenient services for caregivers and children.
3. Develop implementable design guidelines and other tool-kits: summarize practical frameworks and strategies on a web-based platform, e.g. Urban 95 lists planning principles for child-friendly spaces, including: mixed communities with services that meet children's basic needs within 15 minutes' walking distance, vibrant green public spaces, safe transport routes, low-pollution healthy environments, etc., to provide pilot projects with Technical guidance on the feasibility of pilot projects.
4. Building Global Partnerships: aims to highlight the importance of global cooperation and investment in this area.

Among these, the development of implementable planning guidelines corresponds to the construction of the physical-spatial dimension of child-friendly cities. In the context of urban planning, through long-term research on the behavioral habits of urban children and their caregivers, Urban 95 has identified five key ways in which young children experience the city:

1. Children prefer to pay attention to details, such as steps on the pavement or tile patterns that they can be drawn to play and explore.
2. Young children rely on caregivers to get around the city. The design therefore needs to

consider how to make it easy and quick for families with prams and toddlers to reach their destinations.

3. For young families, travelling to and from childcare centers, maternity services, childcare, green spaces and supermarkets can be tiring and expensive.

4. Toddlers are shorter, so they are also more likely to breathe in the exhaust fumes from the cars that come and go.

5. For children, waiting (for buses, in queues) is tedious and boring. Therefore introducing features at these stations that allow them to explore and play will make waiting easier and also create opportunities for learning and social interaction.

Fig.3-7 Projects of Urban 95 that improve the living environment for children（Source: https://bernardvanleer.org/solutions/urban95/）

Based on these child perspectives, Urban 95 examines how urban planning and design can help young children grow up in cities, with specific policies divided into two categories：

1）Family-Friendly Urban Planning and Design：

1. Mixed-use community within a 15-minute walk that meets the functional needs of young families

2. Green public spaces close to home that allow young children to explore safely while providing amenities for caregivers

3. Safe transportation system that allows families to travel freely and safely as they wish

4. Healthy environment with good air quality and low noise pollution

5. Vibrant community atmosphere

2）Healthy Environments for Children：

1. Pay attention to and improve the air quality in children's main activity areas: as children breathe more frequently than adults, they are more vulnerable to air pollution and regular exposure to polluted air can have a negative impact on children's brain development, so it is important to ensure that the air quality in and around areas used more frequently by children is up to standard.

2. Improve accessibility to natural areas: Children's regular exposure to nature for play, exercise and rest helps them to better develop motor skills (e.g. playing with sand and water), while natural areas encourage them to explore their surroundings in a progressive manner. On the other hand, for the caregivers, the natural environment also helps to alleviate their own feelings of anxiety[36].

Overall, Urban 95 provides more appropriate, safe and fun spaces for children and their caregivers in the community by making planners aware of how urban design affects children's development.

[36] The Bernard van Leer Foundation. URBAN 95 Brochure, 2021

3.3 Space Construction Level：Block by Block

Fig.3-8 Children use Minecraft to design community events(Source: Limahttps://assemblepapers.com)

With the acquisition of Mojang by Microsoft in 2015, the Block by Block Foundation was launched to expand its reach, and Block by Block is one of the few non-profit organizations actively supporting the implementation of the UN's Sustainable Development Programme. Because Minecraft is easy to use and can be quickly picked up by people of all ages, backgrounds and education levels, the integration of the computer game Minecraft into public space planning during the transformation of spaces provides for the full participation of children as well as non-professionals.

The Block by Block methodology was incrementally refined, learning from the experience in multiple cities and countries. Block by Block consists of 3 phases and 16 activities and works closely with UN-Habitat.The phases involved in Block by Block Methodology are: 1) Preparation phase: involves developing a programme cycle, organizing workshops, site selection, developing a funding strategy and providing basic technical support to community members; 2) Design phase: works with community members using Minecraft to design public spaces and presenting the design proposals to local authorities as well as professionals through workshops; (3) Implementation phase: translating the Minecraft designs into professional proposals to ensure the feasibility and implementability of the project.Thus, Block by Block methodology gives voice to those who are not usually heard, but who are most impacted by the planning decisions.

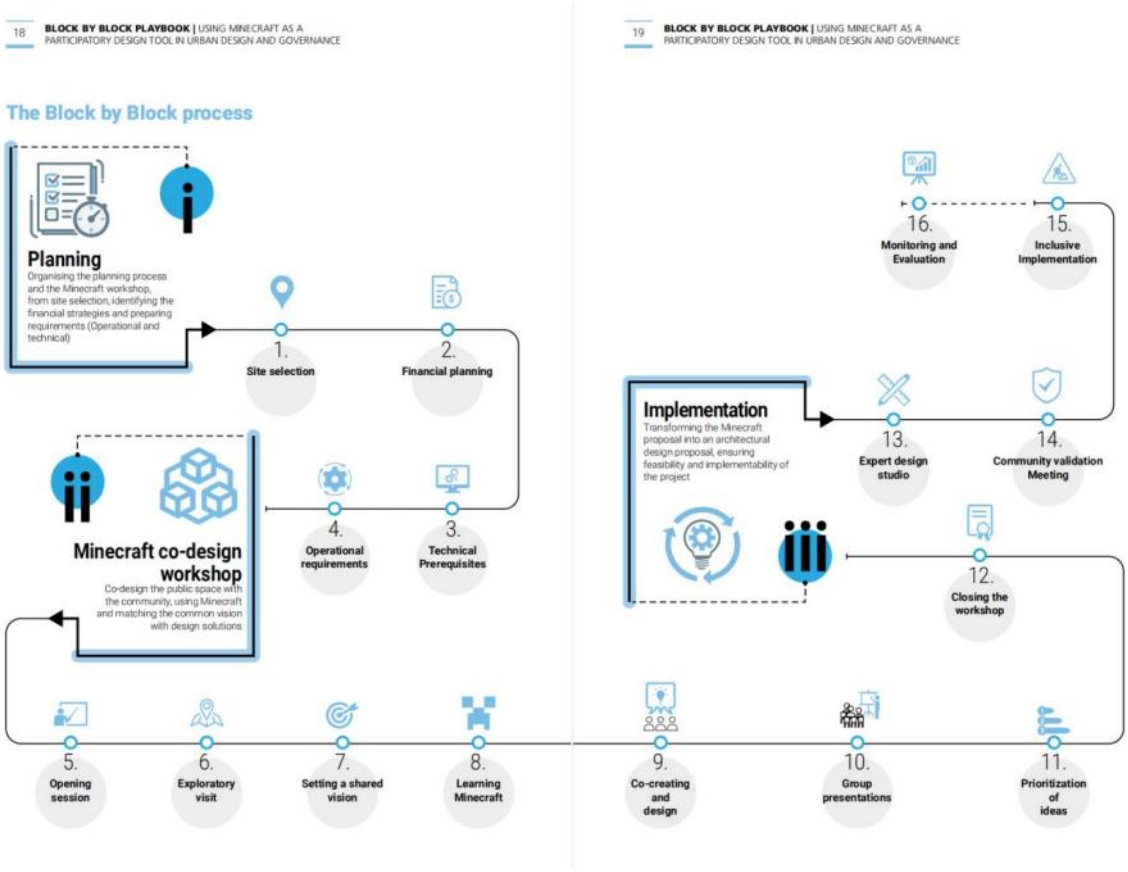


Fig.3-9 Block by Block Methodology (Source:The Block by Block playbook)

Take the Public Spaces for Children Project, a technical assistance provided by UN-Habitat to Mozambique in 2017, as an example of how Block by Block is enhancing children's participation at the level of physical space design[37]. Mozambique's existing building density is low, public facilities are scattered and unevenly distributed, and people have to travel long distances to access services. National development will also suffer if children do not have access to good public spaces and safe travel.

The project aims to create safe, inclusive and accessible public spaces for children in urban Mozambique by incorporating children's perspectives in the urban planning process, improving children's urban governance and improving public spaces. The project involves local children aged 11-13, school teachers, planners, university students in related fields, community and city staff.

[37] Un-Habitat. The Block By Block Playbook:Using Minecraft As a Participatory Design Tool In Urban Design And Governance [M]. Nairobi: Publication Of Un-Habitat, 2021

The workflow of the project can be generally divided into two phases: (1) the data collection phase, and (2) the evaluation phase.

(1) Data collection phase:

After the municipality had selected a public space that it was interested in restoring, the workshop began to recruit volunteer university students to collect the opinions and comments of children in local schools about the streets in their neighbourhood, where the methods used to collect opinions included.

1. using the mobile phone app KoBoToolbox and a GPS tracker to help children map their daily travel routes, while the app also identifies and records the quality of urban spaces, e.g. KoBoToolbox identifies streets that are not safe enough, etc.

2. The workshop guided the children to use elements such as cards and blocks to describe the spaces and routes they use on a daily basis in a playful way. The workshop then categorized the above spaces and asked the children for their views on the different spaces they use: e.g. "How do you use this space? Is it fun/safe? Why do you use/not use this space? How would you like to improve the space for everyday use?"

3. Using the game software, Minecraft (a computer game in which many 1 m^3 cubes form a world in which players can build scenes as they wish) to model actual places, the workshop then invites children to model in Minecraft the material elements needed to intend to improve the quality of the space.

(2) Secondary assessment phase:

Fig.3-10 Children present their design proposal with workshop (Source:The Block by Block

playbook)

1. Analyzing Minecraft models produced by children and working with children to prioritize the required elements.

2. Implementing the children's play modelling into a professional technical drawing representation.

3. Presentation of the resulting scenarios to the children and municipal staff and reassessment of the prioritization of the elements needed for the selected public spaces.

4. Finally, after the construction of the project, the workshop invites the children to decorate the site with local artisans to enhance the interest of the site.

The Public Spaces for Children Project, launched by Block by Block and UN-Habitat in Mozambique in 2017, provides children with the right to participate in urban governance. Children are empowered to participate in urban issues and raise awareness to drive change in their communities by learning about spaces, services and infrastructure.

Fig.3-11 public space micro-intervention at Parque Manhattan in (Source: Limahttps://assemblepapers.com)

3.4 Summary

This chapter systematically introduces three case studies: 'Playing out', Urban 95 and Block by Block, which focus on social activities, policy planning and physical space construction, respectively, to learn about current action plans, planning frameworks and spatial optimization efforts for child-friendly cities. The case studies summarize the key areas of focus and lay the foundation for the subsequent development of principles and strategies to optimize the street space in the Xiaobei District.

Chapter 4 Street Space Survey in Xiaobei District

Selecting streets in Xiaobei District, Guangzhou for the study. Through questionnaires, field interviews, route tracking and mapping of children's travels, the research explores the daily behavioral activities of children in the Xiaobei District, as well as the evaluation and needs of residents and children for the current street space in the community.

4.1 Research Overview

4.1.1 Scope of the research

Guangzhou Xiaobei Road Primary School is located at the foot of Yuexiu Mountain, which has a long history of 100 years. The base is close to the old central axis of Guangzhou, and the west side is close to important public buildings such as Sun Yat-sen Memorial Hall, Guangzhou Municipal People's Government, Yuexiu Park, etc. The location of the base area is very important, and optimizing the street space in the base has a significant impact on the overall style of Guangzhou.

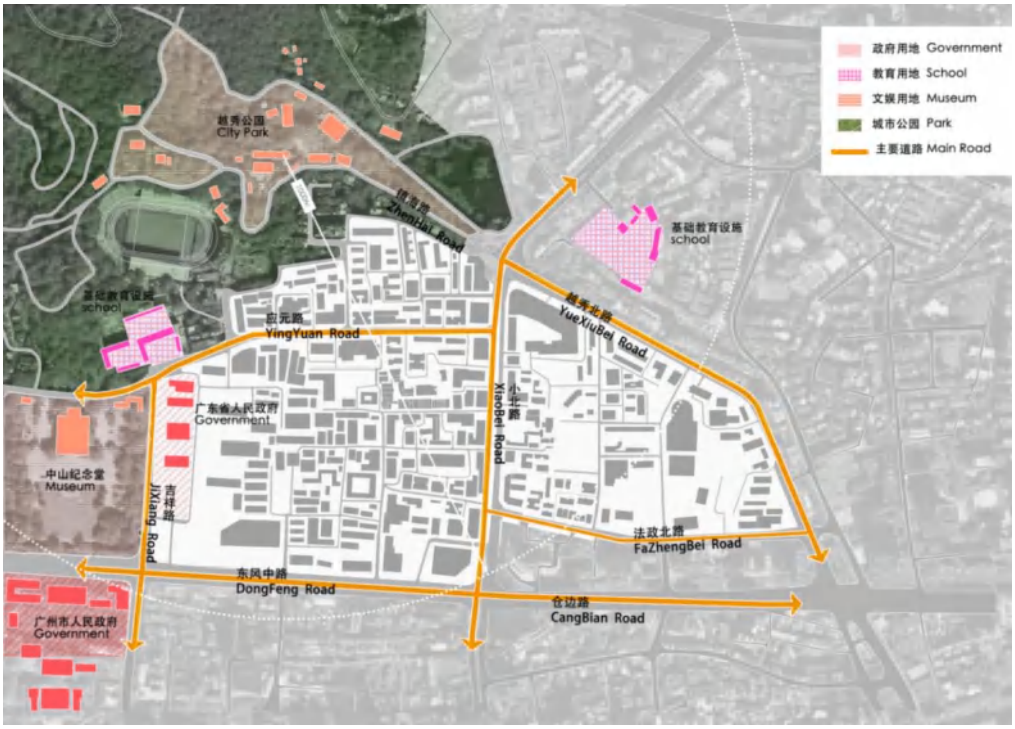


Fig.4-1 Surrounding condition of site（Drawn by author）

The study was based on the maximum independent travel of children over 7 years of age:

Centered on Xiaobei Road Elementary School, street spaces of 7 communities within a radius of 500 m are the research objects. The research included two primary schools, three kindergartens, two cultural squares, two community parks and several pocket parks (Fig.4-2). The buildings in the community except for the Sanyuanli community residential buildings are relatively recent in the year, other residential buildings are mainly low-rise old residential buildings. In terms of road conditions, Xiaobei Road in the base is an urban secondary trunk road, Yingyuan Road and Fazheng Road are urban branch roads, other streets in the rest of the range are mainly living streets. The buildings on both sides of the street are mainly residential and retail businesses, accompanied by some children's training institutions.

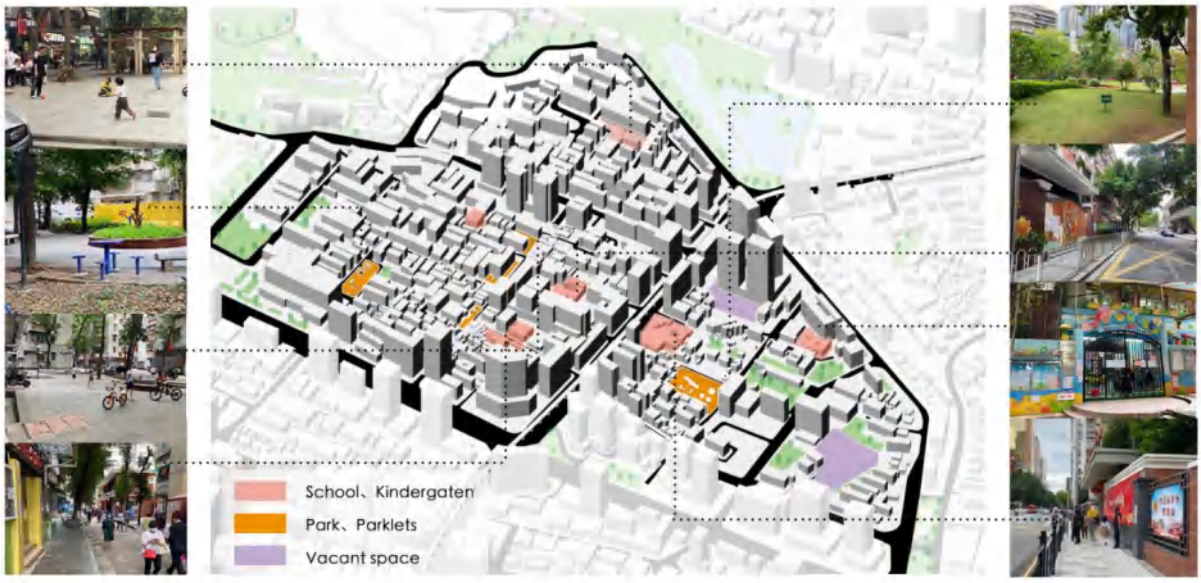


Fig.4-2 Distribution of children's daily destinations in Xiaobei District（Drawn by author）

For the internal roads of the base, Xiaobei Road is a two-way three-lane road, urban branch roads such as Yingyuan Road, Fazheng Road and Yuexiu North Road are two-way single lanes, while Tianxiang Street and Guangfu Road are also motorized because they are close to the school (Fig.4-3). The rest of the internal roads in the community are mostly pedestrian streets, where walking and cycling coexist and motor vehicles are prohibited. Due to the lower road grade and the age of construction, the roads within the communities tend to be narrower and have poorer facilities (Fig.4-4).

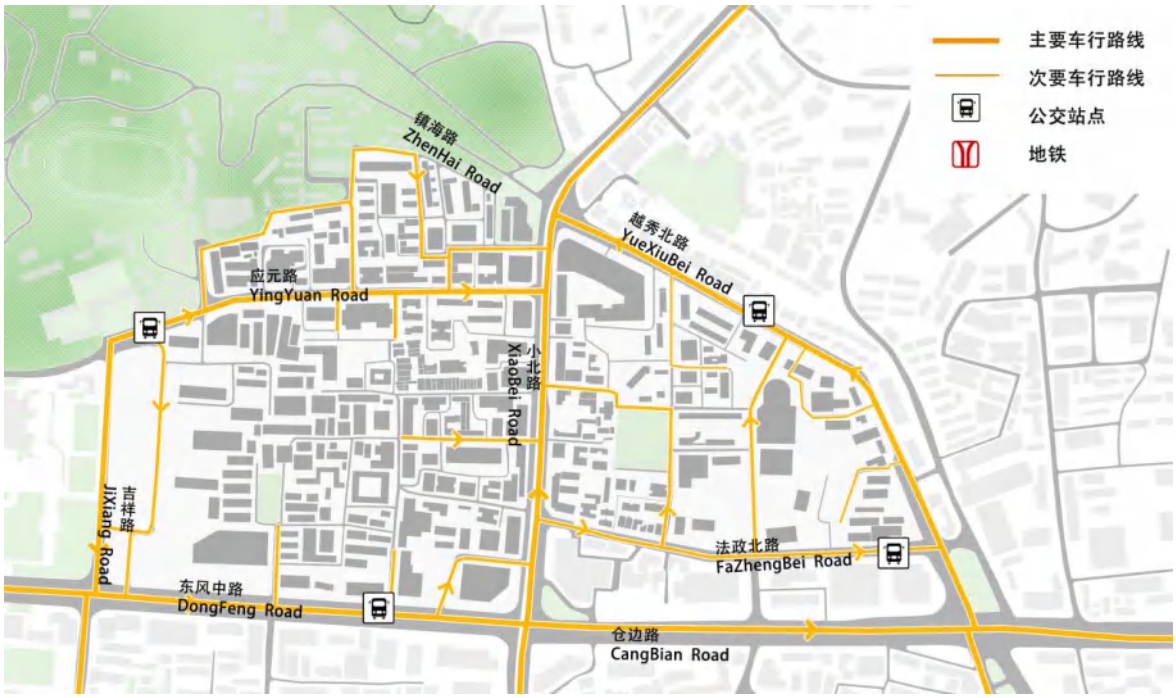


Fig.4-3 The current vehicle mobility system of site（Drawn by author）

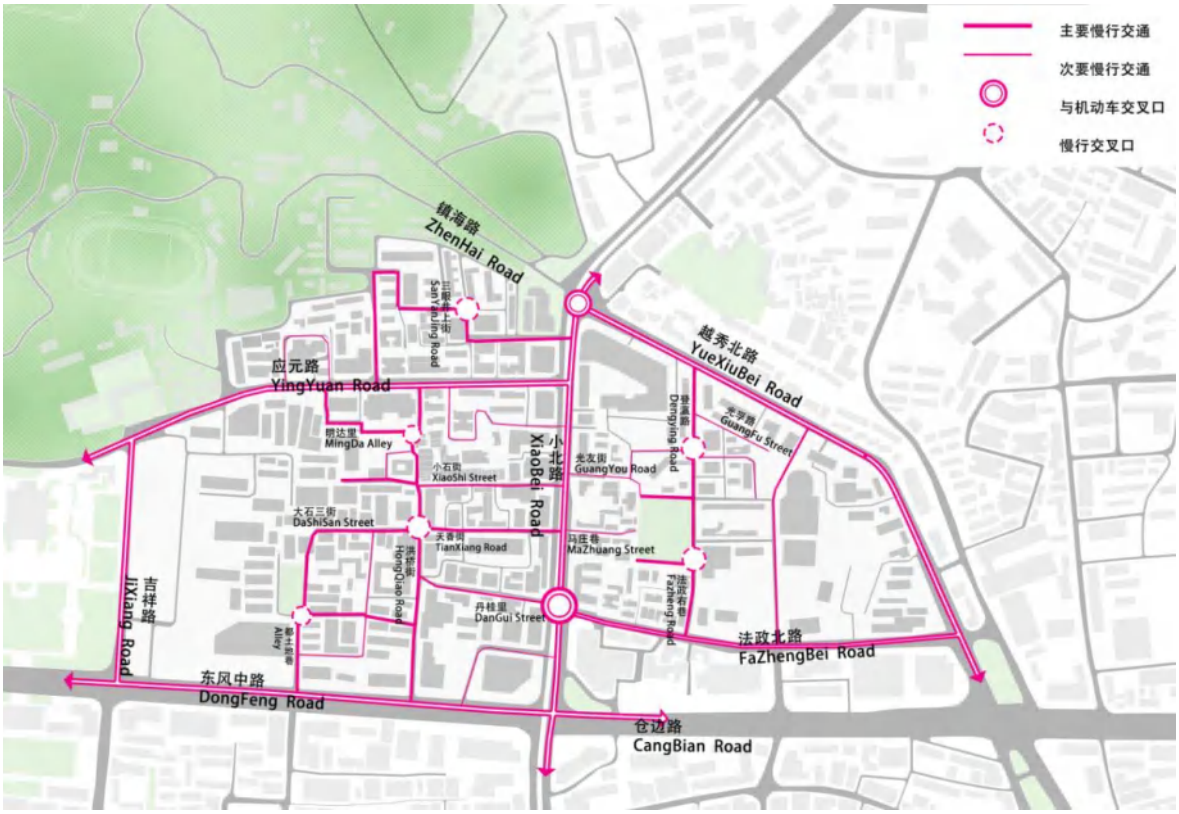


Fig.4-4 The current slow traffic system of site（Drawn by author）

4.1.2 Research subjects

It was found that the age group of children in Xiaobei Road area is mainly concentrated in 0-14 years old. Most of the children aged 0-5 years travel with their parents, and the scope of their activities is restricted; while children aged 6-14 years are much more active and spend more time outdoors, so this paper takes children aged 6-14 years as the main research object. Questionnaires were distributed to parents and children, and interview questionnaires were compiled to obtain the basic characteristics of children in the area, their activity characteristics, and their evaluation of the current street use. A total of 100 questionnaires were distributed to parents and 86 were returned, with a valid return rate of 86%; 50 questionnaires were distributed to children and 47 were returned, with a valid return rate of 94%.

Fig.4-5 Distribute research questionnaires (Photoed by author)

4.2 Behavioral Analysis of Children in Xiaobei District

4.2.1 Activity space of high frequency use in Xiaobei District

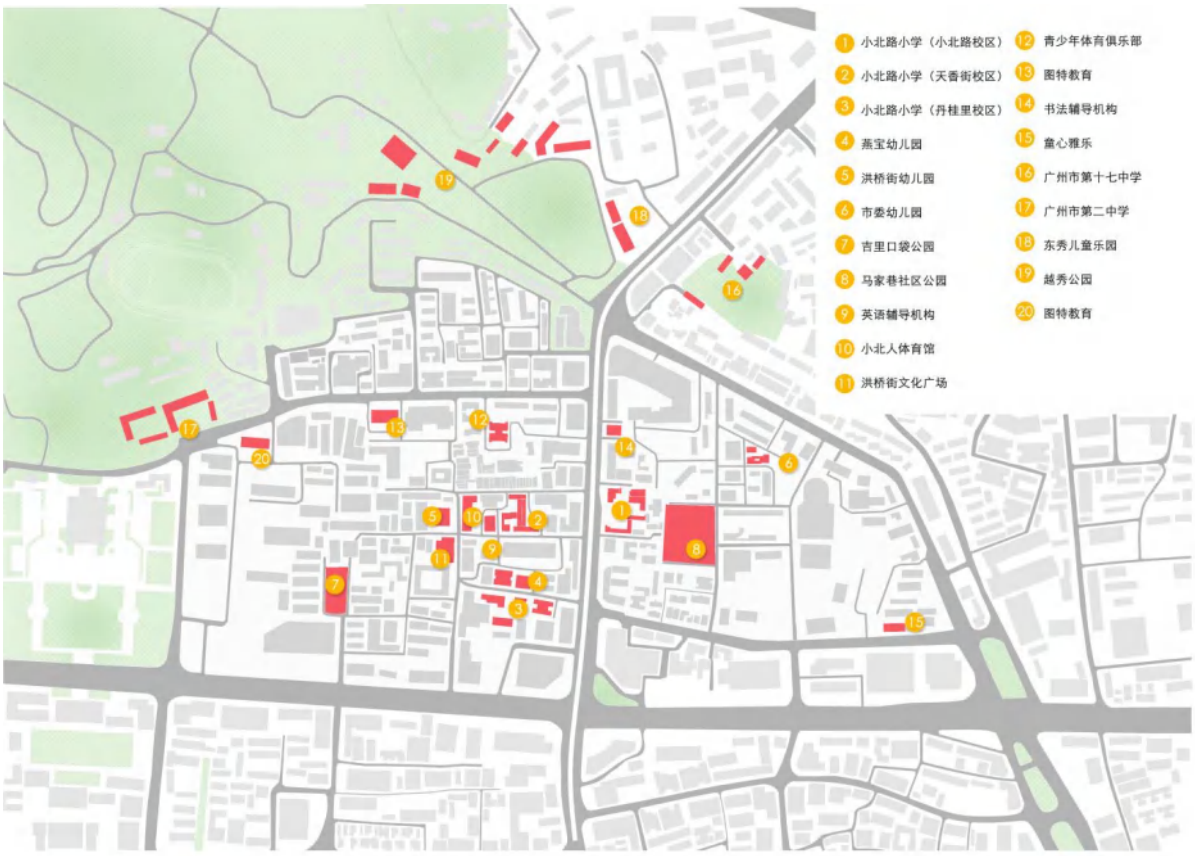


Fig.4-6 Distribution of child-related facilitiese（Drawn by author）

It is found that the distribution of children-related buildings and outdoor spaces in the base is "generally scattered, but locally concentrated" (Fig.4-6). In terms of the subsequent design, further research is needed to count the sites that children use most frequently.

Separating the high frequency destinations for children in Xiaobei District on school days and rest days, the results showed that: on school days, the destinations that children travel to most frequently include kindergartens, schools, department stores, Majiaxiang Community Park, Yuexiu Park and Yoshino Pocket Park; on rest days, the destinations that children arrive at most frequently are after-school hobby classes, Majiaxiang Community Park, Yuexiu District Park Community Clinic and commercial stores.

Through sorting, children's travel destinations can be broadly divided into educational institutions, outdoor playgrounds, medical and health care, and commercial consumption

categories (Table 4-1).

Table 4-1 Current condition of children's high -use space

Type	Name	Content	Problem	Photo
Educational Institutions	School	Gather for chat, wait, cycle or walk to school	The height of the signage does not match the scale of children, there is not enough waiting space, gathering space at the school entrance is too narrow, and there is not enough fun elements	 
	Kindergarten	Play games, run, play, wait	Lack accessible ramps, lack of signage for children, insufficient waiting space	

Outdoor playground	After-school interest classes	Gather for chat, wait, cycle or walk to school	Only available at certain times, under-used and fragmented	
	Majiaxiang community park	Gather for chatting, play activities, play games, stay and relax	Inadequate facilities for children of all ages and poor accessibility	 
	Jiye Pocket Park	Gather to chat, play activities, do homework, stay and relax	Single play facility, isolated and secluded, poor supervision of the surrounding crowd, small site area	

	Hongqiao Street Cultural Square	Purchase snacks,gather and chat, cycle, rollerblade,climb furniture along the street, wait	Lack of interesting elements and street furniture	
	Yuexiu park	Gather for a chat, group games,cycle rides,roller skates	Distance from the community and lack of facilities for children	
	Open space in front of the house	Use of play equipment, run and play, do homework	Lack of street furniture to stop and rest, lack of facilities for children to play	
Health Care	Community Health Clinics	Vaccinations and medical appointments with an adult	Lack of waiting space, use wood or warm colors to reduce children's anxiety	

Commercial	Food stalls, restaurants	Eat, stay and rest alone or in a group	Can be partially set back to enlarge the front bunk position, cramped space, poor comfort	
	Department stores, small shops	Shop alone or in a group, stop and talk, wait in line	The variety of commercial businesses along the street is relatively homogeneous and the transparency of the façade is poor	

It can be seen from the summary that the main sites currently in use are "generally dispersed and locally clustered", which means that children only go to more distant locations on rest days, so when planning travel routes, it is possible to consider respecting children's intended routes for dense areas and observe their preferred routes, while for more distant areas the design of routes should be based on accessibility and safety considerations. For example, for educational institutions, traffic control and other safety measures should be considered when optimizing the surrounding streets, but for outdoor play areas, the streets should focus on the comfort of children travelling, for example by setting up seats every 50-100 m for children to stay or wait.

4.2.2 Types and characteristics of children's activities in Xiaobei

According to the map, the distribution of children's activity spaces in the base was recorded, and the shades of colour in the map represent the number of children (Fig.4-6). According to the graph, it is found that children's activity sites are mainly concentrated in the pedestrian paths, community parks, in front of convenience stores, street corners, school entrances and entrances in the community, while children prefer to gather at street intersections, so children's activities may be under the threat of traffic. Therefore, it can be concluded that the different degree of openness of activity sites and vehicle conditions also affect the type and spatial distribution of children's informal activities in some extent.

Fig.4-7 Types of outdoor activities of children in Xiaobei（Drawn by author）

Piaget J argues that play provides an opportunity for children to consolidate existing cognitive structures and to develop and modify them appropriately to conform to the facts. Piaget J divides play into three categories according to children's stage of cognitive development: practice play, symbolic play and rule-based play[38]. Based on Piaget J's play theory, the activity behaviors of children in Xiaobei were divided into the following five specific categories (Table 4-2) [39]:

Table 4-2 Types of outdoor activities of children in Xiaobei

Type	**Note**	**Specific Behavior**	**Photo**
Sensory-based activities	These are activities in which children use their senses to experience the physical and social environment.	Touch the rocks and soil, smell the plants, or watch the interaction of people in their environment	

[38] Yang N. Piaget's theory of play[J]. Studies in Preschool Education. 1994,1:12-14

[39] Guo Y. Research on urban park design based on children's behavior pattern[D]. Shenyang: Shenyang Jianzhu University. 2020

Interactional activities	Refers to group activities such as talking and playing with people in the physical environment, and is an important way to help children build their sociality	Talk and play with partners	
Movement-based activities	This refers to a variety of physical activities in which children use various types of play equipment accompanied by physical movements such as running, jumping and climbing	Play badminton, ride bicycles, roller skate, jump and run	
Creative activities	These activities reflect the autonomy of the child and are often characterized by children combining different materials according to their imagination or by observing and imitating the behaviour of adults and using their imagination to simulate everyday life.	Build blocks, pile sand	

Rest-based activities	Primarily refers to static behaviors in which children stay for short periods of rest.	Observe, sit, eat	

During the research, it was found that children's behavioral needs are different: those in the street are mainly motor, sensory and social activities, while resting and creative activities require a specific activity space and are more likely to take place in more open outdoor areas. The subsequent optimization of the street space should therefore try to meet the needs of these activities. For example, for sporting activities, the street design can provide climbing railings or ramp elements to meet the needs of children for physical exercise.

4.3 Analysis of Street Space in Xiaobei District

4.3.1 Types and characteristics of street spaces

The same road will have different features when passing through different areas, and its cross-sectional design should meet the corresponding functional requirements. The activities of children on the street are closely linked to the functions of the surrounding buildings on the street. Therefore, when classifying a street, factors such as road vehicular traffic, activities along the street and streetscape should be fully considered.

Based on the classification standards of street types in the *Shanghai Street Design Guidelines*, divided the level and types of street in Xiaobei District (Fig.4-7). For the street level, the roads in the Xiaobei District are mainly divided into sub arty, branch roads and community roads.

The functions of the streets are divided into five categories: commercial streets, comprehensive streets, landscape and recreational streets, living service streets and

thoroughfares（Fig.4-8）(Table.4-3)[40]。

Fig.4-8 Road classification in Xiaobei District（Drawn by author）

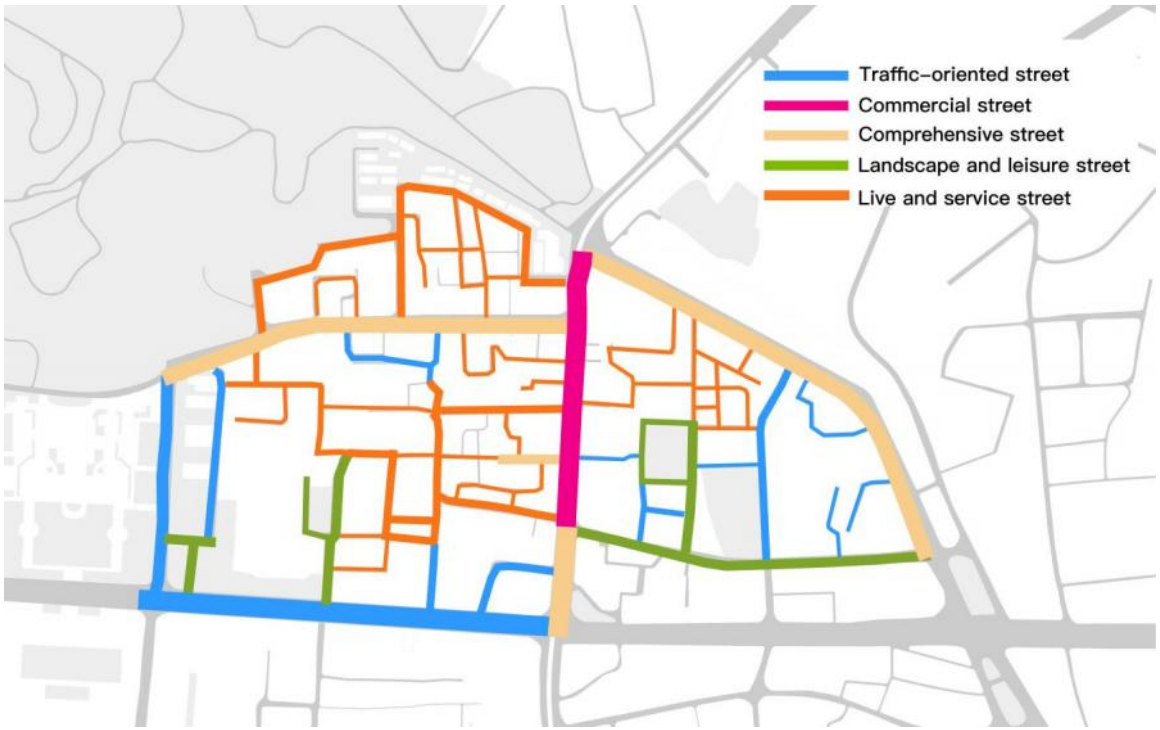


Fig.4-9 Street types in Xiaobei District（Drawn by author）

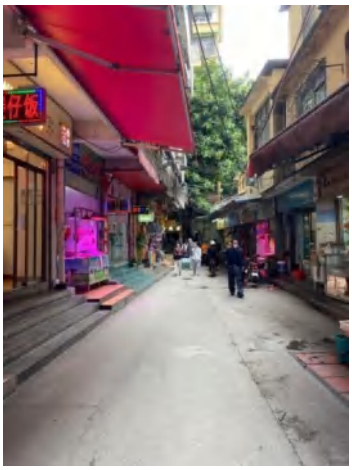
[40] Shanghai Urban planning and design research institute. Shanghai Street Design Guidelines[M]. Shanghai:TONGJI UNIVERSITY PRESS,2016 :32-37

The community streets in the Xiaobei District form a dense network of slow-moving systems. These streets tend to be small in scale, and the pedestrian flow is mostly local residents, with more children's play taking place. The majority of the streets are living service streets that undertake the daily communication and activities of the residents and have a pleasant atmosphere; the traffic-led streets in the community are mostly alleys with closed interfaces on both sides, which tend to be crowded and narrow and less permeable, with less pedestrian and vehicular traffic; the landscaped streets in the community tend to locate close to parks, and these streets generally have good natural landscapes, with recreational facilities and fitness equipment arranged on the side of streets.

The external urban roads of the community groups in the Xiaobei District have both traffic and some commercial service functions, and they are comprehensive streets. The buildings on both sides of these streets are large in scale; the buildings on the streets are mixed in function; the pedestrian flow structure is more complex; and the high volume of pedestrian and vehicular traffic during school hours brings noise and air pollution. Due to the age of construction, the pavement space on both sides of the motorway is narrow and even partially missing.

Table 4-3 Street types in Xiaobei District

Type	Note	Photo
Commercial street	The buildings on both sides of the street are dominated by retail, restaurants and other commercial functions. Those are streets with certain service functions and distinctive businesses	

Traffic-oriented street	Streets are more traffic oriented with mainly non-open interfaces twice	
Landscape and leisure street	Streets with a strong historic, landscape or waterfront character and a concentration of large-scale recreational facilities on both sides of the street	
Live and leisure street	The street is dominated by businesses that serve the daily lives of local residents, such as small and medium-sized retail, restaurants and public services.	
Comprehensive street	Streets with two or more types of functions, interfaces	

4.3.2 High-frequency use of street space analysis

To further clarify the scope of the study, the traffic and pedestrian flows on the main streets in the area were counted every 5 minutes during school hours and non-school hours respectively to obtain a table of traffic and pedestrian flow statistics（Fig.4-9）：

Fig.4-10 Number of people and motor vehicles

The streets within the base are divided into three tiers based on the number of children on the streets and the volume of motor traffic（Fig.4-10）：

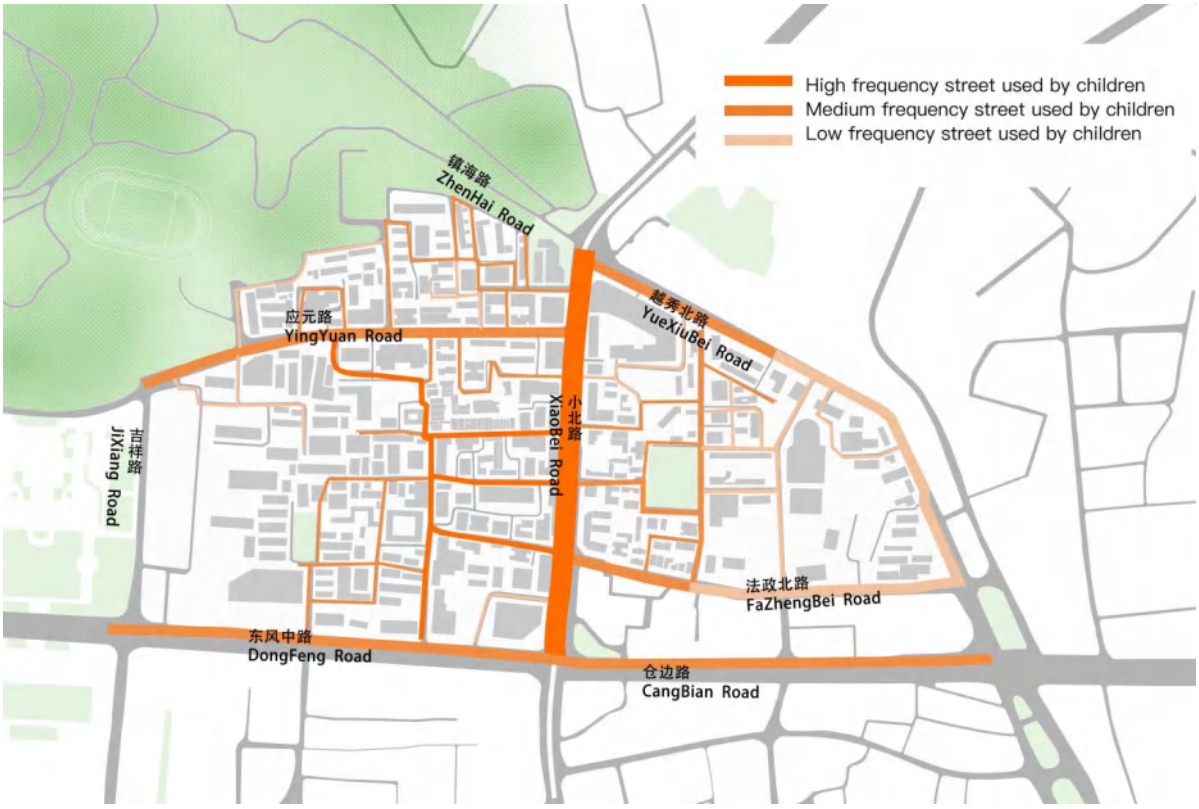
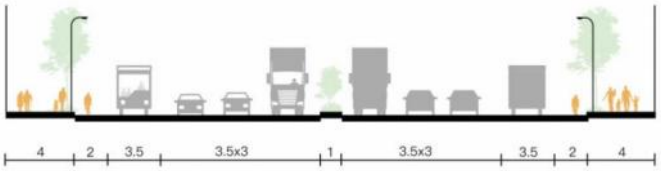
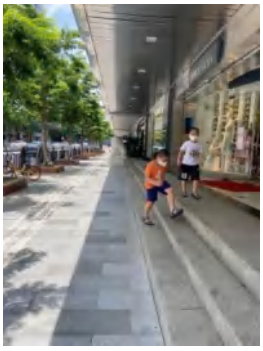
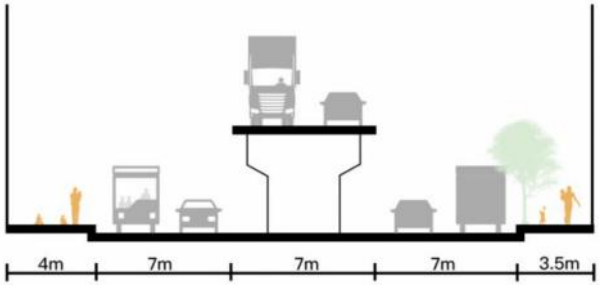
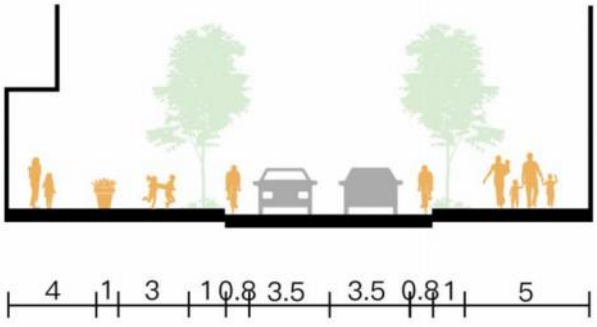
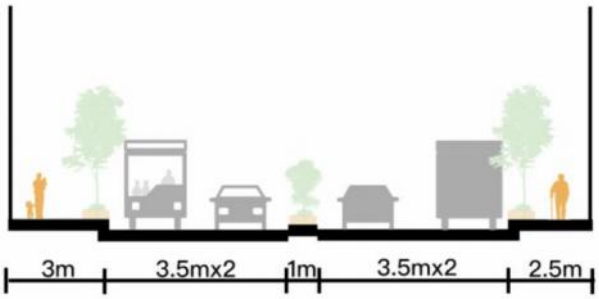
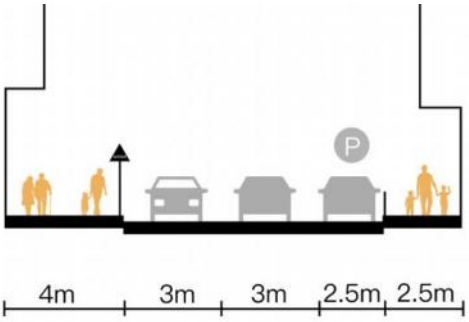
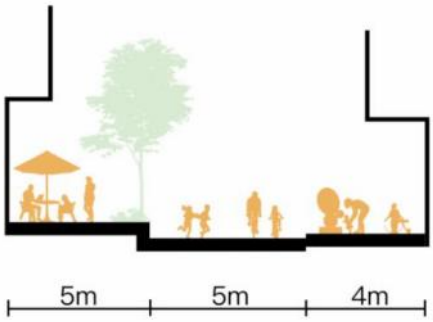


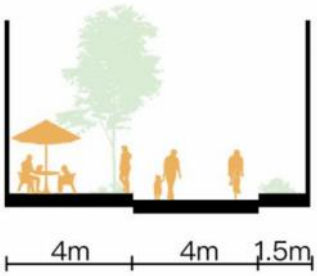
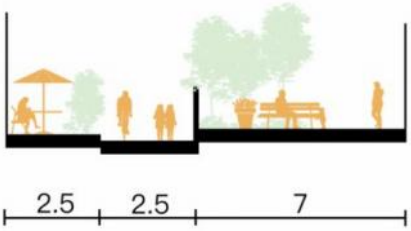
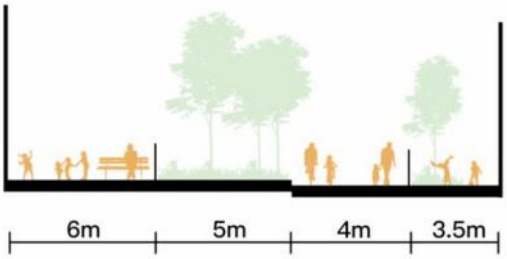
Fig.4-11 Street use frequency rated by children（Drawn by author）

It can be found that streets with high frequency of use can be broadly divided into two categories: the first category is streets located near children's daily use destinations, such as Xiaobei Road and Tianxiang Street; the second category is streets for internal community living, such as Hongqiao Street and Xiaoshi Street. These streets are better able to ensure the safe movement of children due to the restriction of motor vehicles, but they often suffer from problems such as street constriction and dilapidated facilities. Draw up profiles of the current state of high frequency use street and record children's activity behaviour（Table 4-4）:

Table 4-4 Sections of street in Xiaobei District（Drawn by author）

Name	Section	Photo
Dongfeng Road		
Xiaobei Street	 High activity during school drop-off and pick-up times, mostly passing, accompanied by short stops	
Yingyuan Road	 Children travelling to and from school, stopping and playing	

Fazheng Road		
	Shopping and jostling in shops	
Tianxiang street		
	Children passing to and from school, chatting and playing, parents waiting	
Hongqiao Street		
	Main street for children's parental activities, shopping, stopping, playing, resting	

Dangui street		
Main street for kindergarten children, drop-off and pick-up, shopping, parents waiting		
Mingda Ally		
Most children travel to and from school		
Alley		
Children's main passage		

4.4 Analysis of Questionnaire Results

The questions are divided into three main categories: basic characteristics of children's outdoor activities, evaluation of current community streets and future directions for street optimization. The options for the questions are based on the previous summary of spatial construction, mainly related to "path space continuity", "accessibility", "road safety", "social supervision", "control measures" and "rest space quality". "The questions are based on the previous summary of spatial construction aspects, mainly on 'continuity of path space', 'accessibility', 'road safety', 'social supervision', 'control measures' and 'quality of rest space', to investigate the specific needs of parents and children in terms of safety, comfort and continuity of the street.

Taking into account the children's limited cognitive and expressive abilities and their preference for pictorial representations, the first step was to use children's illustrations to draw a street map of Xiaobei District, after which the children were invited to use markers to mark "Routes of Daily Activity", "Streets they like to use " and "streets they don't like to use". This was used to collect children's opinions and to increase their participation.

The questionnaires were mainly targeted at parents and were supplemented by interviews with children's views. In response to the above research plan, 69 valid parent questionnaires were returned as well as 45 maps drawn by the children.

4.4.1 Children in Xiaobei prefer to travel on foot

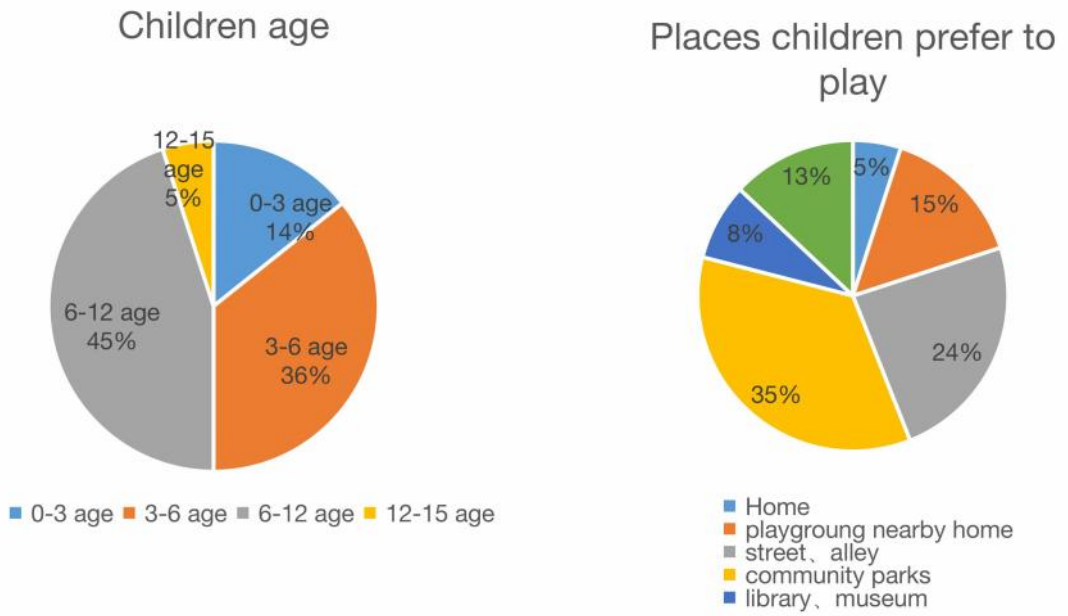


Fig.4-12 Children age and places prefer to stay（Drawn by author）

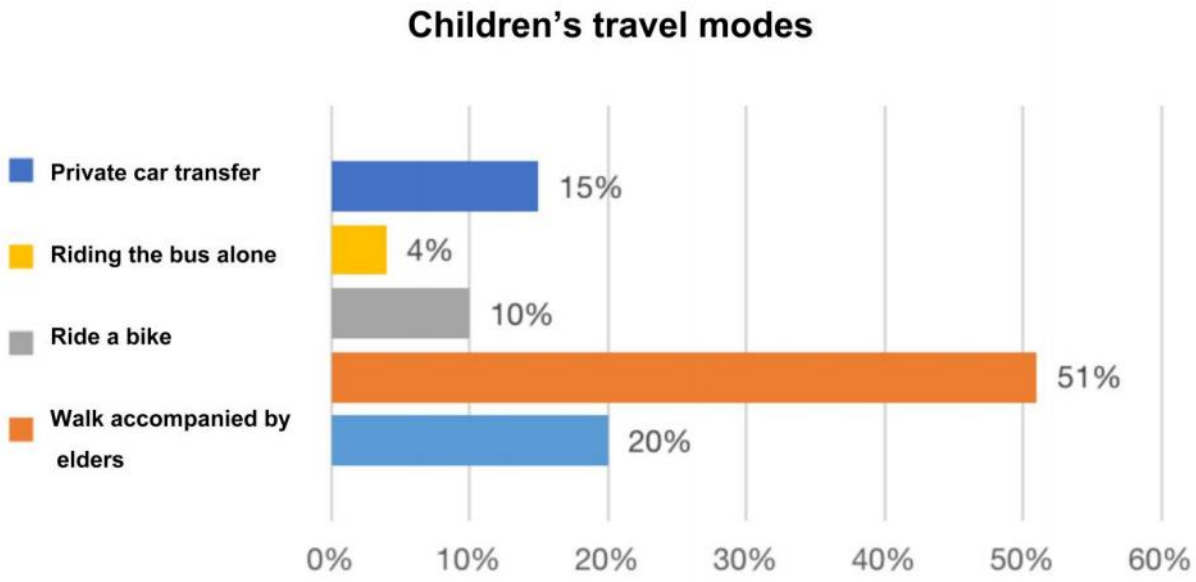


Fig.4-13 Children's travel modes（Drawn by author）

According to the survey, in terms of children's willingness to travel, 70% of children want to travel independently or with their peers, but only 20% of children actually travel

alone, 51% travel with their elders and 15% travel in a private car; in terms of preferred activity venues, 35% of children prefer community parks and 24% prefer to play in the streets.It can be seen that children in Xiaobei District have a strong desire to travel independently or with their peers, but in reality most children travel with their parents; in addition, the lack of space for children to play in the streets cannot be ignored.

4.4.2 Comfort of the street space needs to be improved

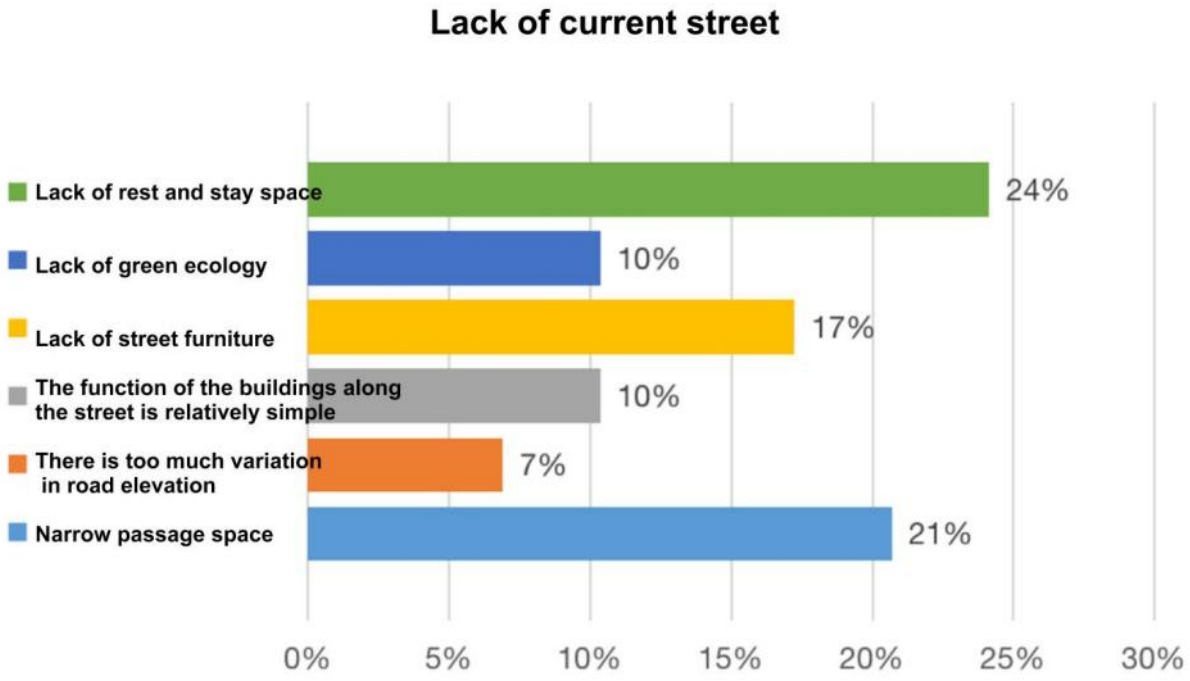


Fig.3-12 Lack of current street space（Drawn by author）

In terms of evaluating the current streets, the streets in the area are generally characterized by narrow circulation spaces, inadequate street safety measures and a lack of areas to stay. Comments on the current street environment: "Lack of space to rest and stay" (24%), " Space for passage is narrow" (21%), "Lack of fun", e.g. installations that can interact with (17%), and "single style and functional homogeneity along the street" (10%) and "lack of greenery" (10%).This shows that parents and children are generally concerned about the

width of the street space, the possibility of staying and playing, and comfort.

It can be seen that in terms of comfort, there is a general lack of walking paths occupied by share bicycles, a lack of street furniture, a lack of ecological greenery, artistic street installations and a single type of open space. Improving the comfort of the street space will help to prolong the time children spend on the street and reduce the pressure on caregivers to look after children.

4.4.3 Street safety is a priority for optimization

Interviewees generally felt that the main factors limiting children's independent travel were: traffic risks, social security risks, and destinations being far from home. According to the main reasons for restricting children from travelling alone include, "traffic hazards" (39%), "social security hazards" (28%) and "destinations far from home" (21%), which shows that street optimization mainly requires reducing the threat of urban motor vehicles and strangers, as well as rational planning of the location and number of public facilities that meet children's daily needs, taking full account of children's ability to walk, with the proximity of destinations more influencing children's willingness to travel.

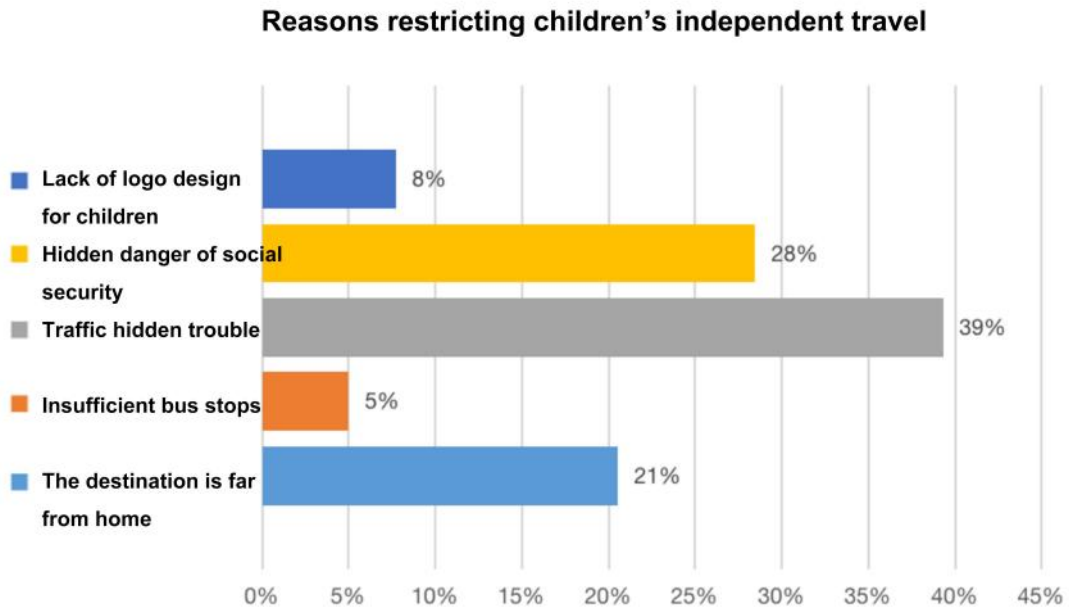


Fig.4-14 Reasons restricting children's independent travel（Drawn by author）

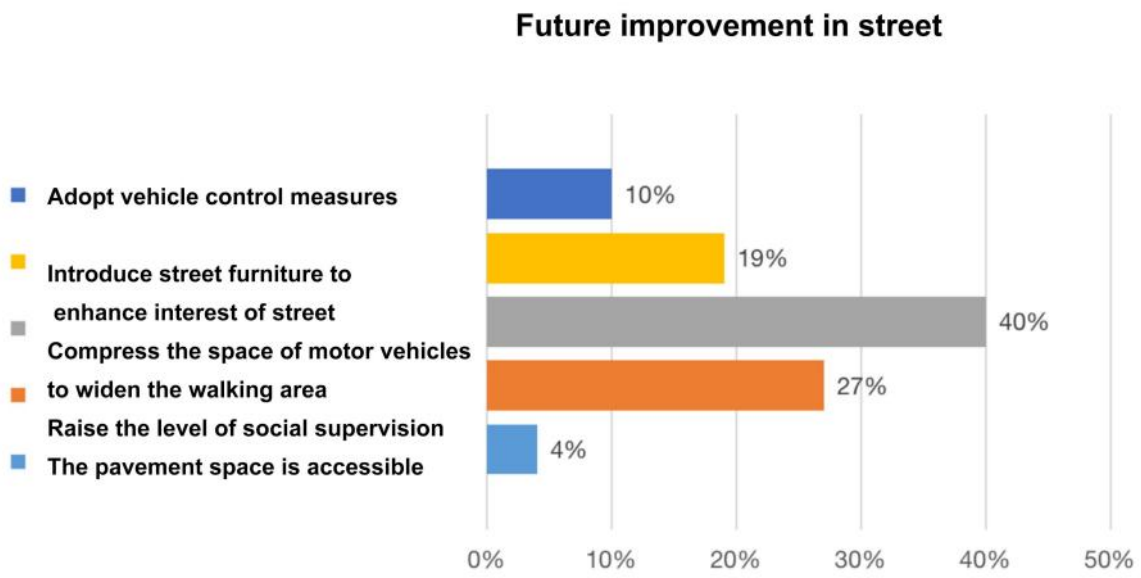


Fig.4-15 Future improvement in street（Drawn by author）

In terms of future street improvements, parents felt that "reducing the space for motor vehicles and widening the space for walking" was most important in terms of improving the safety of streets. In addition, 19% of parents and children would like to see the introduction of educational street furniture to promote children's brain development through interaction with their surroundings, and 10% believe that traffic control measures in key areas such as schools would increase children's chances of travelling independently. The other 10% felt that traffic control measures in key areas such as schools would improve children's chances of travelling independently.

It can be concluded that in terms of safety, the current community street environment is generally not conducive to independent travel for children due to narrow walking spaces, motor vehicle hazards, social security hazards and a lack of accessible design. Improving the safety of street travel is a priority for street improvement.

4.4.4 Children's travel routing preferences

Children's travel habits are often slightly different from those of adults due to differences in activity psychology. For example, they prefer narrow, winding paths that they can explore to straight, empty streets. Therefore, children's opinions need to be taken into account in order to plan travel routes appropriately. In addition, inviting children to participate in the mapping of the neighbourhood is a way of increasing children's participation in the planning of the neighbourhood, reflecting their willingness to contribute to the transformation of the current community and being child-friendly in nature[41]. In summary, children's participation in the mapping process, by assisting children in mapping their daily routes to and from school and to their activities, allows for an understanding of children's travel preferences and stopping points, while respecting their choices.

The planning of children's paths must be based on a safe street environment and a rational connection between children's everyday places [42]. Therefore, the map abstractly marks children's daily use destinations in the form of children's illustrations, including places such as homes, schools, kindergartens and community parks, and selectively extracts the streets near these areas, mainly expressing the streets near the key areas.

[41] Liang s, Huang B, Su J. Safety street design strategies for child-friendly environment: an empirical study of residential community in Beijing old city[J]. Urban Planning International, 2020, 3: 29-33

[42] Zeng P, Can L. Safe block and children's travel route planning under the concept of child-friendly city:a case study of Holland[J]. City planning review, 2018, 11: 103-108

Fig.4-16 Children's Map of distribution of child-related infrastructures in Xiaobei（Drawn by author）

Children's travel routes were counted on school days and rest days, respectively, and found that on school days children's travel routes were concentrated between school, home and the community park; on rest days, they were between home and the nearby tutoring facility and the park in the Yuexiu district, expanding the range of children's travel routes and making them more dispersed.

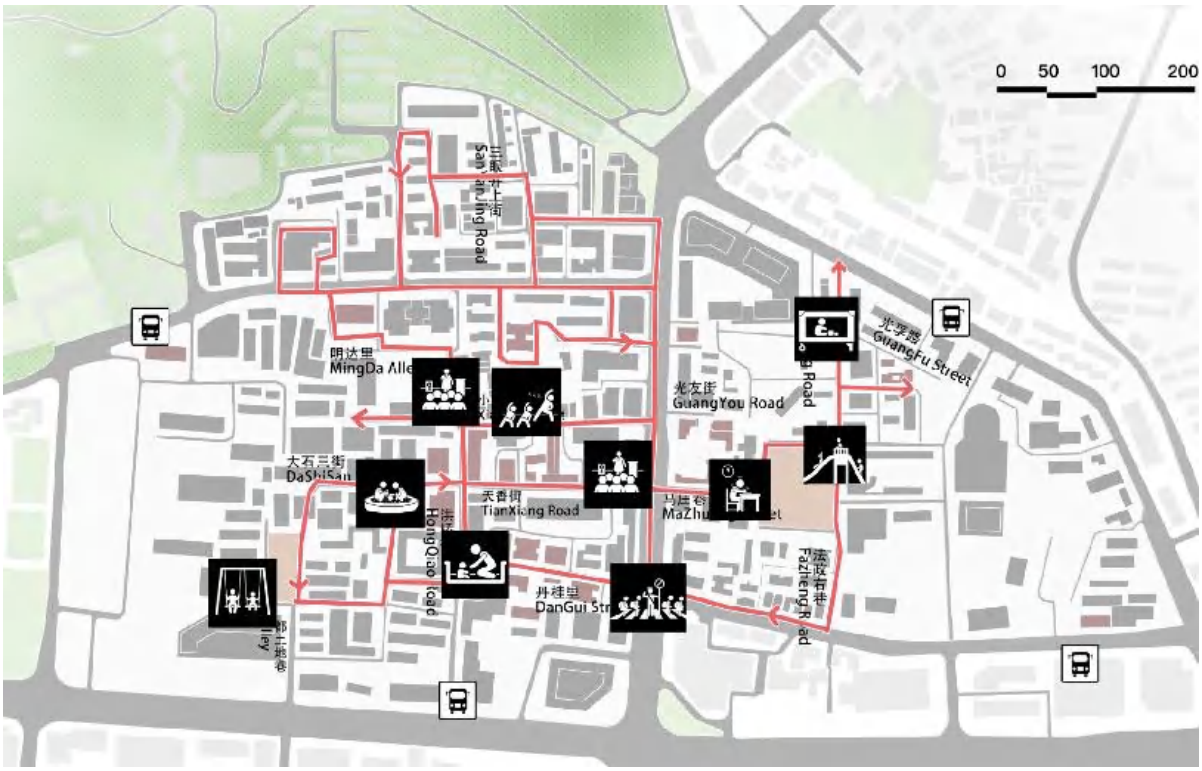


Fig.4-17 Children's daily travel path on school day（Drawn by author）

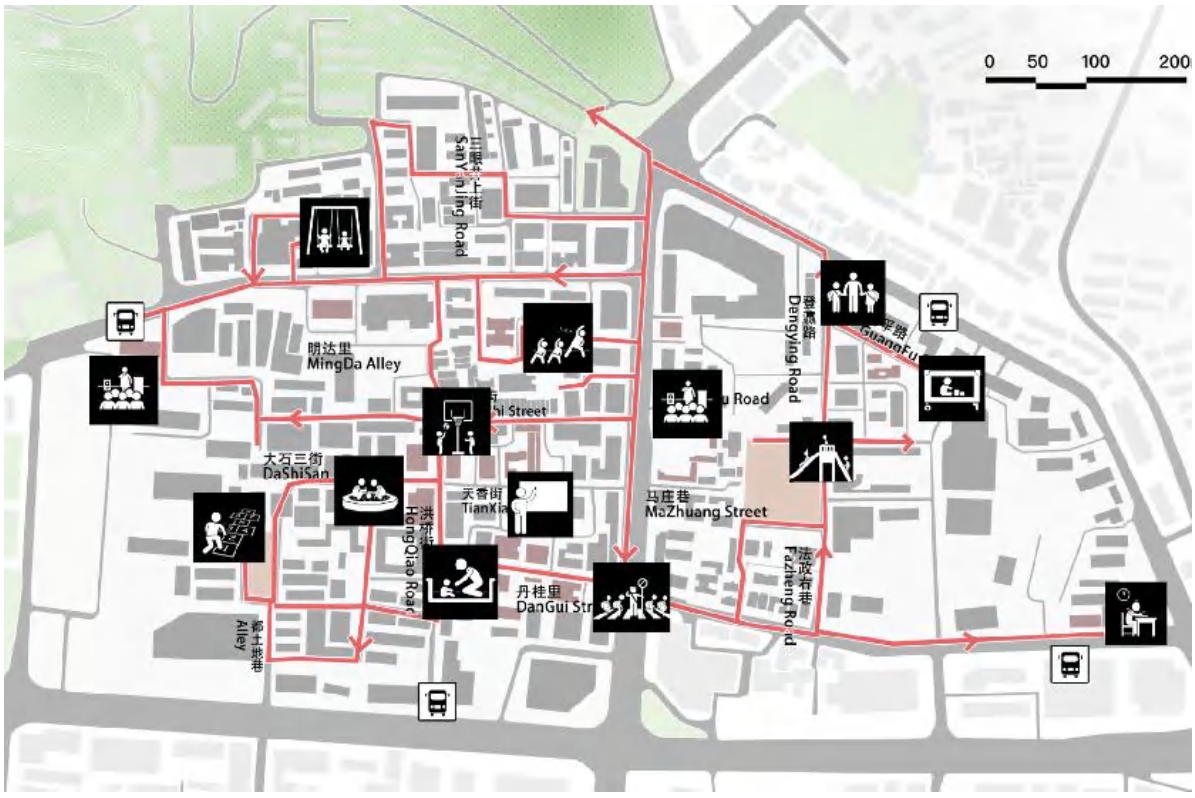


Fig.4-18 Children's daily travel path on weekend（Drawn by author）

The collection and collation of habitual travel routes drawn by children helps to identify children's real travel routes. Based on the above map, it was found that children often use the streets near their schools: Xiaobei Road, Yingyuan Road, Tianxiang Street, Dan Gui Road and the streets within the community, Hongqiao Street and Mingda alley, followed by the streets leading to the activity venues within the community: Fazheng Lane and Dangui Lane.

Fig.4-19 Overall children's route for most trips

Among these streets, the generally better rated were, Hongqiao Street and Dagui Lane. The reasons for choosing these streets included the lack of motor traffic, the large number of shops along the street, the open space in front of the shops for activities, and the variety of greenery and vegetation. The poorly rated street was Little North Road for reasons such as too

narrow a space to stay and the high speed and number of motor vehicles on the outside of the street. For other streets in the community, the lack of attractive stopping facilities or their remote location meant that they were only used by children living nearby for their daily trips, so they could be excluded from the subsequent design as a travel route.

Overall, it is clear from the children's personally drawn habitual routes that children prefer streets that are safer or have space for play along the street, providing a direction for subsequent street optimization.

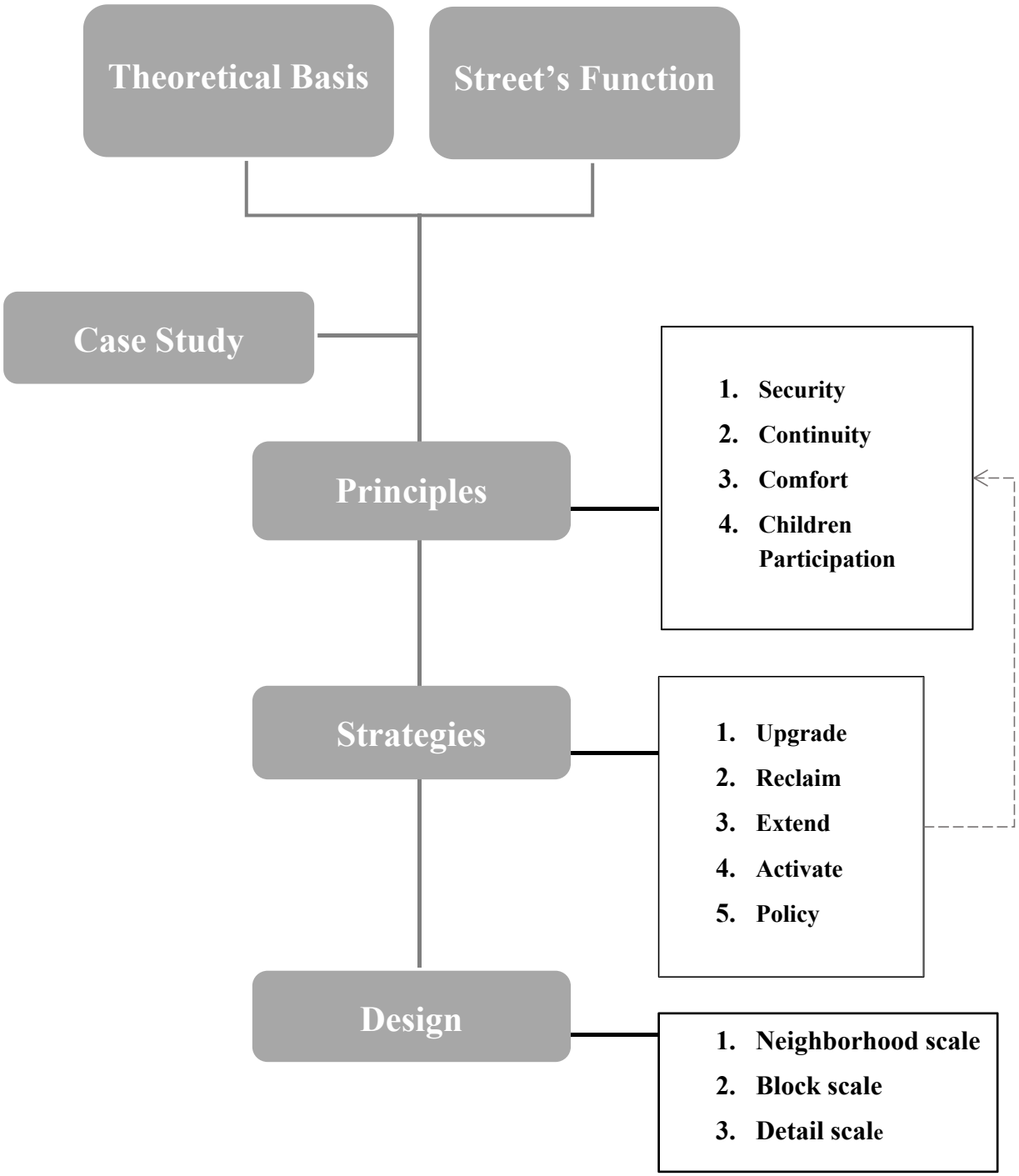
4.5 Summary

This chapter takes the street space and children on the street in the Xiaobei District as the research object. Firstly, it investigates the distribution of children-related activity facilities, the transportation system within the base and the types of children's activities as a whole. Then, according to the function and level of the street, it investigates the current situation of streets used by children with high frequency in a longitudinal and in-depth manner.

In addition, through the compilation of questionnaires, the current evaluation of the streets by children and caregivers, their usage needs were obtained. The findings suggest that community street spaces such as Majestic Lane lack safe site design and do not fulfil the function of a 'front yard' for children to play in, and that appropriate strategies need to be developed to provide opportunities for children to travel alone and explore the street space.

Lastly, by sorting out children's drawings, children's daily travel routes were obtained, laying a realistic foundation for the subsequent planning of children's travel routes and the renewal of street spaces.

Chapter 5 Child-Friendly Street Space Renewal Strategy in Xiaobei District



5.1 Renewal Principles of Street Space in Xiaobei District

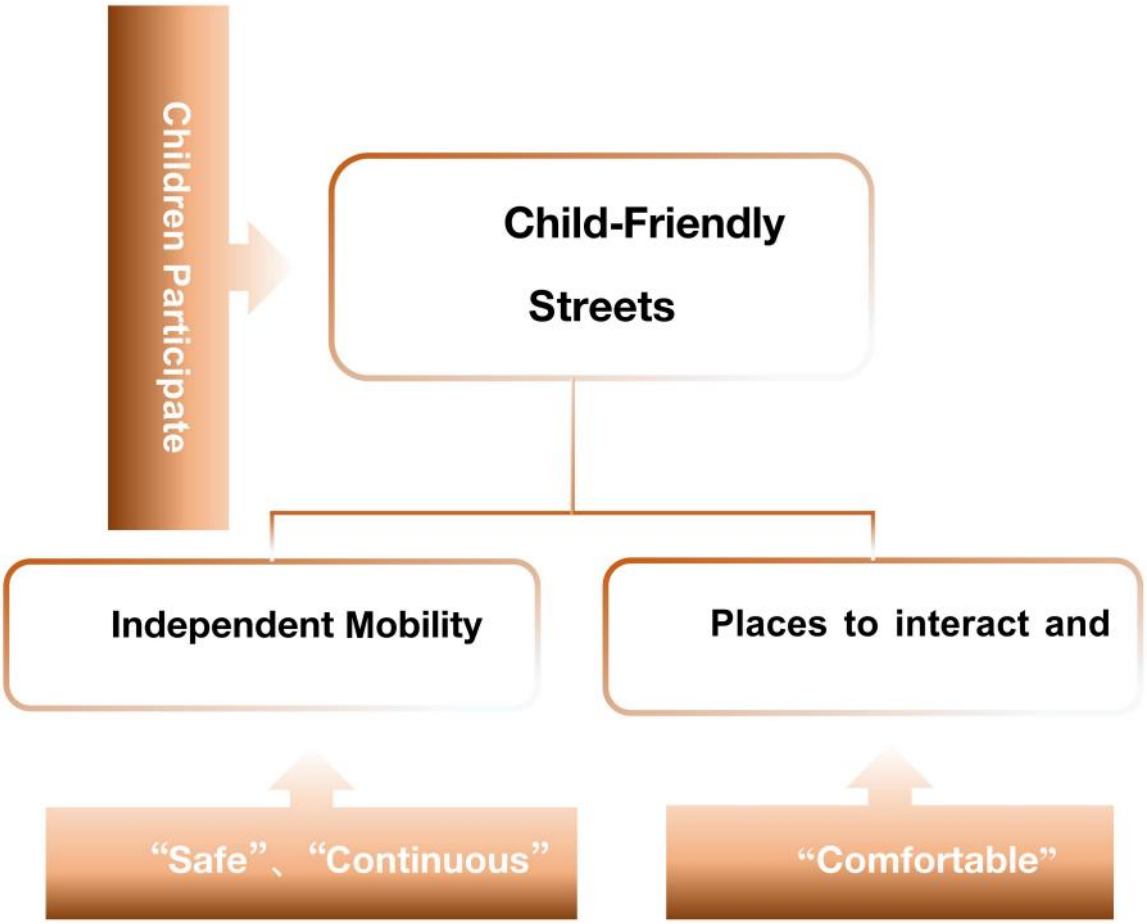


Fig.5-1 Child-friendly street features（Drawn by author）

Streets provide spaces for people to walk and for people to stop and rest, interact and play. In addition to housing, day care, schools, parks and playgrounds, streets are also important spaces for children, which support healthy brain development by providing a safe, healthy and stimulating environment on the street[43]. Therefore, child-friendly streets need to meet the two basic functions of children's use: to travel safely and independently, and to stay interactively. Meeting "safe independent travel" corresponds to the principles of spatial safety and continuity, which means that a safe, complete and continuous travel route covering

[43] Zhang D. Study on the children's activity space of Changsha old block under urban renewal process[D]. Changsha: Hunan university, 2017

children's daily travel destinations needs to be established[44]; In addition to this, meeting the 'interactive stay' requires that children are provided with a wide range of places to rest and interact with friends and family, responding to the principle of comfort in street design.Finally, the fundamental requirement of child-friendliness is to respect the views of children, to protect their rights and to listen to their voices.Therefore, it is necessary to actively pay attention to children's voices in street regeneration and to fully explore the paths of children's participation.

Fig.5-2 Street improvement projects " Put People First" in Addis Ababa

[44] Xi X. Research on safe travel path and the planning strategy of old residential areas based on the concept of Children-friendly city: a case study of Tianjin[D]. Tianjin: Tianjin university, 2020

5.1.1 Security

Foreign examples of child-friendly streets show that street design must eliminate or minimize potential hazards in order to safeguard the physical and mental health of children and their caregivers. Compared to adults, children are physically and psychologically underdeveloped and more vulnerable to the environment in which they live, so they need a safe environment first and foremost to provide the basis for subsequent learning and growth[45].

Safe and healthy streets include four aspects: firstly,“road safety”, such as the design of conflict-free routes for pedestrians and vehicles, separation and protection of slow-moving areas, and adequate lighting; secondly,“safe intersection design”, either by partially widening the pavement at junctions, reducing the width of crosswalks or partially raising the pavement at the intersection, all of which can improve the recognition of children's travel paths and thus drivers' attention; thirdly, “making full use of social surveillance”, for example active but not overcrowded streets are often safer than isolated and cold streets, this can be greatly enhanced by increasing the variety of building features around the street or by increasing the permeability of the building facade; Finally,“implementing vehicle control measures” to control the speed of vehicles and the number of parking spaces on streets around key areas,which are common and effective safety measures.

[45] Carolyn W. policies and practices that promote children’s independent mobility[J]. Urban Planning International, 2008, 23: 56-60

Fig.5-3 Before and after streets renovation in Fortaleza, Brazil(Source:https://globaldesigningcities.com)

5.1.2 Continuity

What children need is not playgrounds and squares, but a complete and inclusive city. Isolated and scattered homes, schools and activity spaces, even if beautifully designed, can cause some concern for carers and discourage children from visiting them because they are not very accessible. Activity spaces that are connected by a complete network of safe, comfortable walking spaces tend to be more attractive and receive frequent visits from children[46].

The creation of a complete and continuous pedestrian network requires the rationalization of pathways. For example, depending on the location of existing children's facilities and the use of the streets, children's activity areas can be located on continuous walking and cycling routes as far as possible, connecting indoor and outdoor children's daily activity areas through the linear space of the street, thus turning these paths and residential blocks into part of the city - the great playground. On the other hand, continuity also requires

[46] Siphiele M. Children-friendly city: from playground to street[J]. Beijing Planning Review, 2018, 3: 125-128

consideration of the continuity of children's walking in physical space, which includes whether the pavement is child-scaled and accessible to children and their caregivers.

Fig.5-4 The new raised crosswalk enhances accessibility

(Source:https://globaldesigningcities.com)

5.1.3 Comfort

Children are often slower and more fatigued than adults, so the streets do not only serve the purpose of passage, but also provide places for them to rest and regroup. For these stay-able public spaces, comfort is an important criterion for evaluating the quality of the space. Comfortable street spaces generate more social interaction and prolong the time children spend on the street.

In addition, the first five years of a child's life are a critical period for brain development. Providing children with interesting art installations or enlightening interactive installations on the street can increase the positive interaction between children and their external environment, stimulate their brains to receive more information and improve their responsiveness. Therefore, seting street furniture is also key to improving comfort, for example a bus stop with educational elements can not only ease children's anxiety about waiting but also encourage them to learn and play in the street.

The comfort of the street rest space can be enhanced through the modification of the original road surface. For example, the street surface can be expanded at appropriate locations,

or the buildings along the street can be partially set back to create a series of small strip and block spaces along the street, with an emphasis on introducing ecological elements. In addition, the incorporation of fun and playful facilities also satisfies the natural inclination of children to play. Play increases opportunities for physical exercise, develops sporting skills and encourages social interaction, which is essential for children's development.

Fig.5-5 The painting bring more fun in street, Fortaleza, Brazil

(Source:https://globaldesigningcities.com)

5.1.4 Children participation

Respecting the wishes of children is the main idea behind building child-friendly cities. Children have the right to be involved in the decisions that are made in the cities in which they live. And as many foreign cases have shown, when people are involved in a project, they are more likely to support it and even maintain it afterwards. Encouraging children and caregivers to participate in the design of street optimization can therefore help to raise awareness of 'child-friendly' streets and make people more conscious of using them and promoting and even maintaining them.

Fig.5-6 Children involved in street design (Source: https://globaldesigningcities.com)

5.2 Optimization Strategies of Street Space in Xiaobei District

Fig.5-7 Five street renewal strategies（Drawn by author）

A safe and interesting street network is the primary basis for a child-friendly city. Children use a wide variety of streets in their daily lives, and the focus of street optimization is directed in different directions due to the different types of streets. The main streets where children move around in Xiaobei District can be broadly classified as: “streets around key

destinations", "community living streets", "commercial and mixed-use streets", and "thoroughfares". Depending on the scale of these streets, the volume of traffic around them, and the density of buildings and other uses, should adopt different combinations of optimization strategies to ensure that each street meets the needs of children who can safely experience unstructured learning and play and find some moments of joy.

Through the analysis of the base study, the strategy for optimizing street space in Xiaobei District includes five aspects (Fig.5-7):

I. Upgrade the safety level of streets and complete missing safety facilities

II. Reallocate the street space available to children

III. Extend road space to create a positive street frontage interface

IV. Activate streets for children to play and learn

V. Develop measures to protect children's travel

5.2.1 Upgrade：Meet Basic Safe Needs

The caregiver's assessment of how safe the street is largely determines how often the street is used by children. If caregivers do not consider the street environment to be safe enough, they are less likely to allow children to spend too much time there. The primary strategy for optimizing streets is therefore to upgrade the safety level of existing streets, which must meet the minimum standards for street safety, and to improve missing protection features such as vegetation barriers to separate pedestrians and vehicles, and night-time lighting.

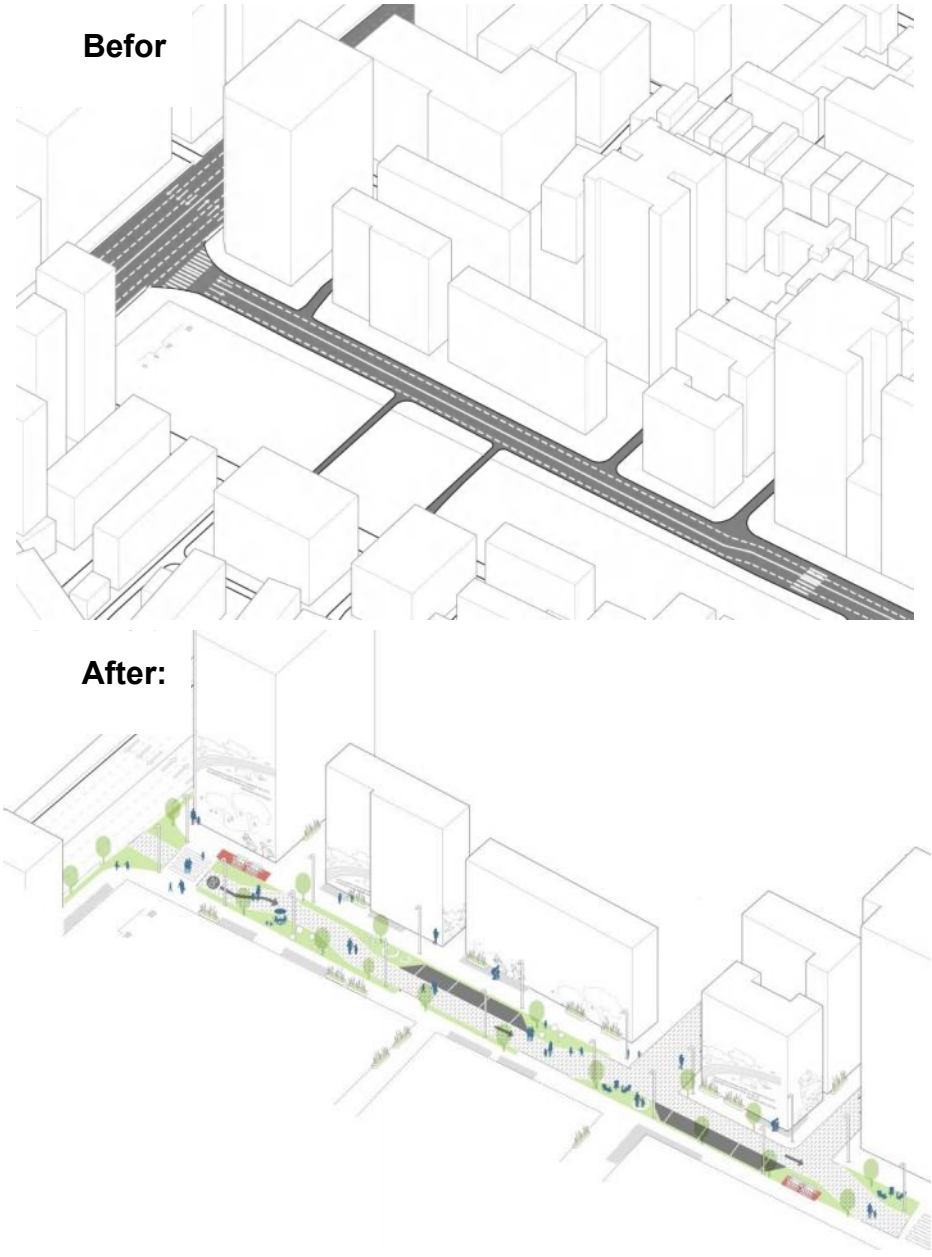


Fig.5-8 Example of optimizing streets based on five strategies（Drawn by author）

1. Safer intersection design

For streets with a high pedestrian flow, the pedestrian priority should be ensured by taking into account the speed of children's steps, extending the duration of the green signal crossing appropriately, or installing raised pedestrian crossings and partially raised intersections. In addition, the use of measures such as: ground markings, pavement with continuous pavement and reasonable control of kerb radii can also prompt motor vehicles to avoid pedestrians and ensure safe passage for children.

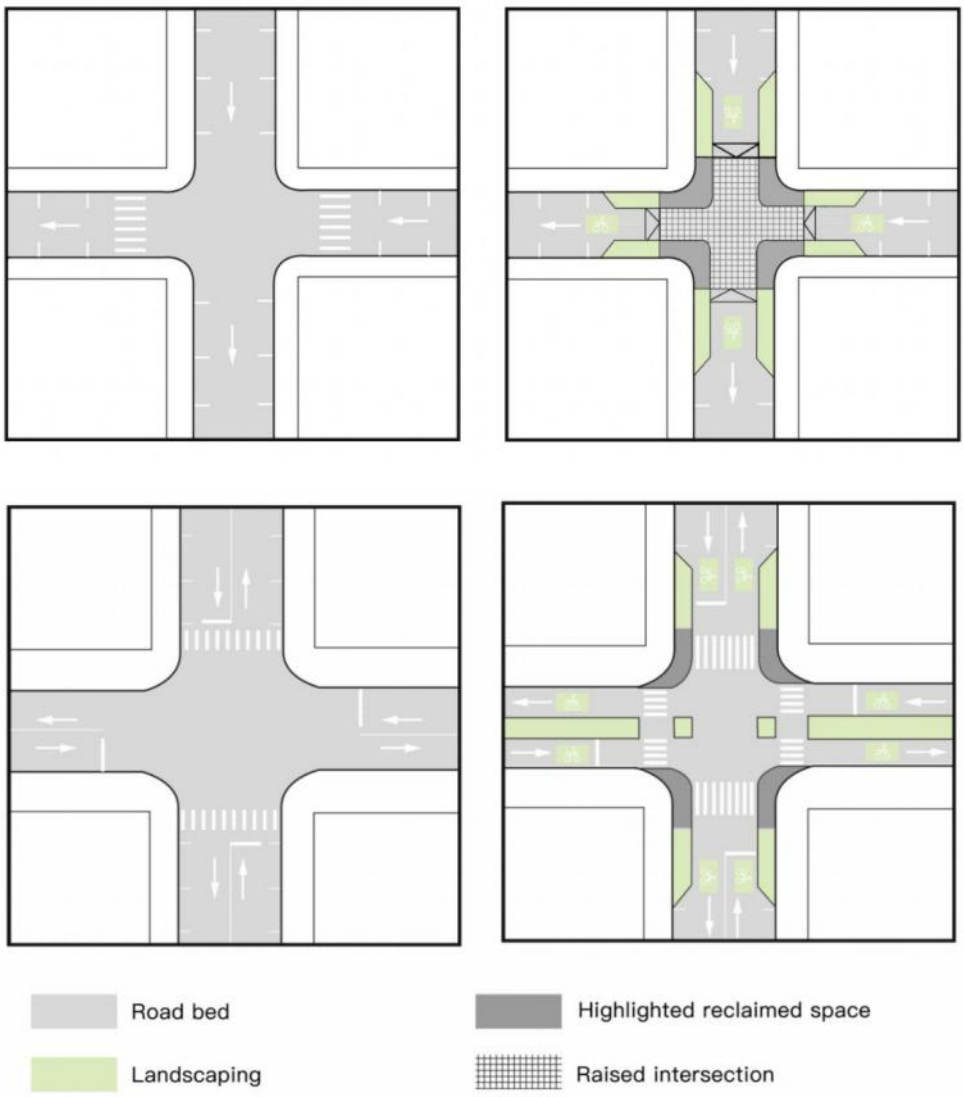


Fig.5-9 Tighten corner radii to compact intersection（Drawn by author）

2. Ensure continuity, safety and accessibility of footpaths

The scale of motor vehicles is reasonably controlled according to the road class and the surrounding business; pavements are made up where they are missing; pavements that do not meet the passing width are widened to ensure that the width of the passing space is at least 1.8m; pavements on both sides of main and secondary roads are widened to reduce the uneasiness of children and pedestrians to fast-moving motor vehicles; lastly, attention is paid to keeping the road surface consistent and level and reducing unnecessary height of the road surface.

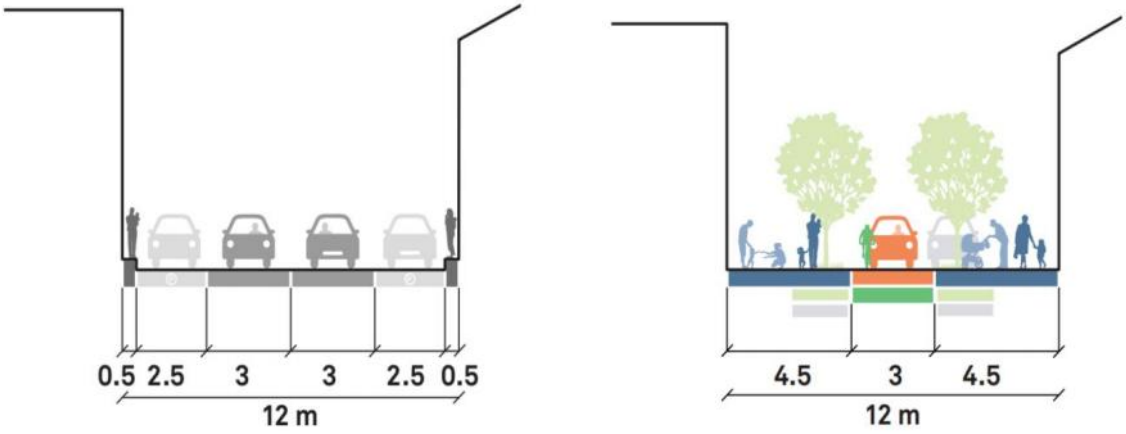


Fig.5-10 Widen the existing sidewalk to ensure continuity（Drawn by author）

3. Improve facilities for the protection of slow-moving spaces

A safe cycling network provides children and young people with the conditions for independent travel, while there are fewer traffic conflicts between bicycles and pedestrians. Improving the safety of bicycle travel can significantly improve the use of street space. The first step is to ensure that the width of non-motorized lanes meets the needs of use. The width and form of the non-motorized lane should be determined according to the road surface conditions: 3.5m and above for lanes protected by dividing strips and 2.5m for lanes divided by painted lines; secondly, additional hard barriers are needed to provide protection on streets where motor vehicles operate at speeds above 30 km/h to increase cyclist comfort and safety. Hard barriers include green belts, railings and road stakes.

For streets within communities with low motorized traffic, a share street design can be used. The elimination of kerbs and the use of monolithic paving at ground level allows for the sharing of street space between pedestrians, non-motorized and motorized vehicles, while narrowing mixed traffic spaces and street entrances and exits, distinguishing mixed areas from pedestrian areas to protect cyclists.

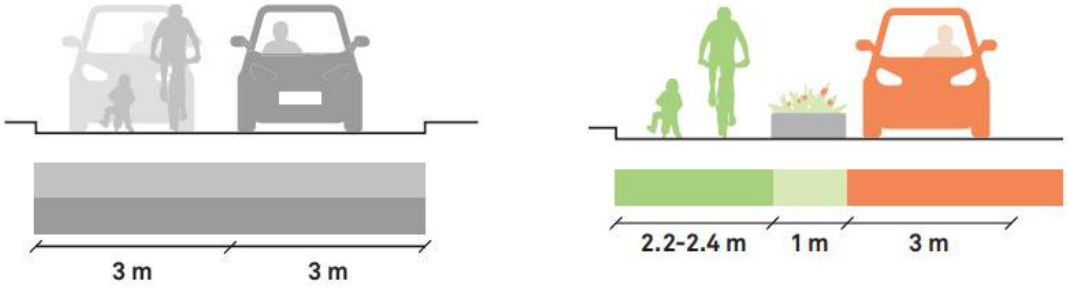


Fig.5-11 Using protected cycle tracks to protect children from motor vehicle（Drawn by author）

5.2.2 Reclaim：Allocate Space for Children

Space is a valuable resource in cities. The way street space is distributed determines the efficiency of travel and the way people actually use the streets on a daily basis. The redistribution of street space includes three aspects: limiting the use of private cars; reorganizing street space where children can play and learn; and promoting efficient and sustainable modes of transport and redistributing road space.

1. Reallocate road space for sustainable and efficient mobility

Reasonable control of the size of motorways and reduction in the number and width of lanes increases the space for slow traffic. Narrow lanes can slow down traffic, and in addition to this, coherent and neat trees, street lights and building interfaces can make drivers' views narrower and therefore more cautious. Therefore, lane widths on urban roads should not exceed 3.25 m for mixed traffic of large and small cars, and can be reduced to 3 m for small cars only, but should not exceed 3.3 m on roads where buses and large trucks are allowed to pass.

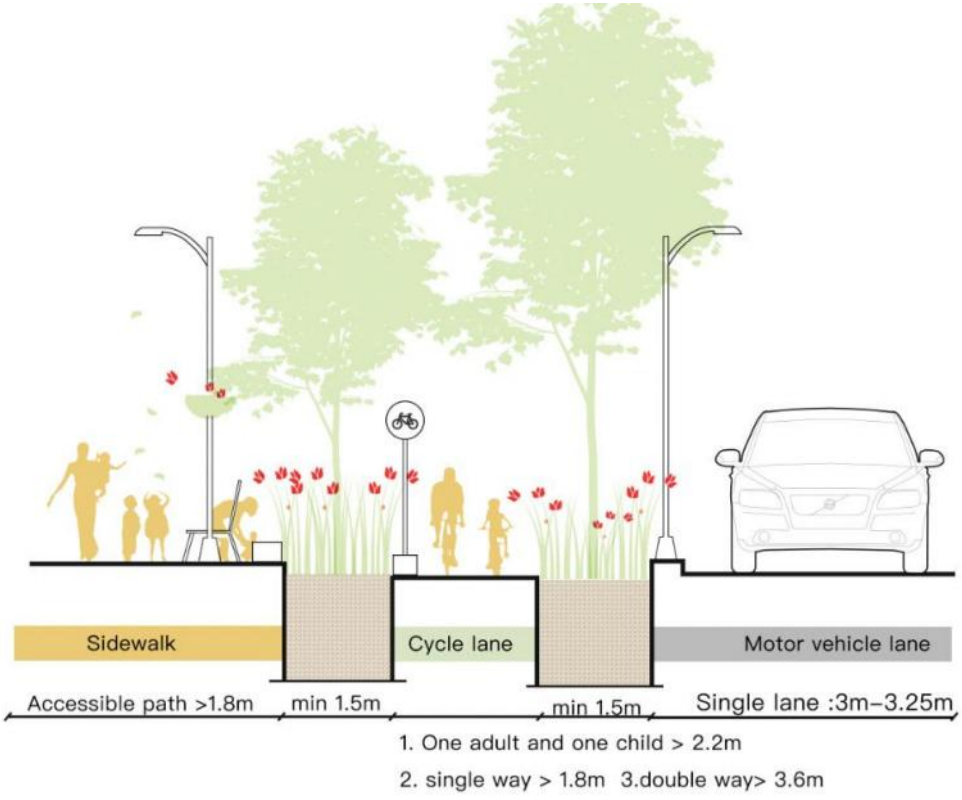


Fig.5-12 Limit lane width of private vehicle（Drawn by author）

2. Expand the public space of the pavement

Where there is a shortage of space for children in the community, pocket spaces on the street can be used as a complementary form of space for children's activities. Through measures such as reducing the width of motorways and the radius of intersections to increase the width of footpaths, opening up the boundaries of buildings with public attributes on the street frontage, reusing unused space and partially setting back first floor buildings, the saved space is reorganized and designed to include structured and unstructured play elements as spaces for children to stay and play.

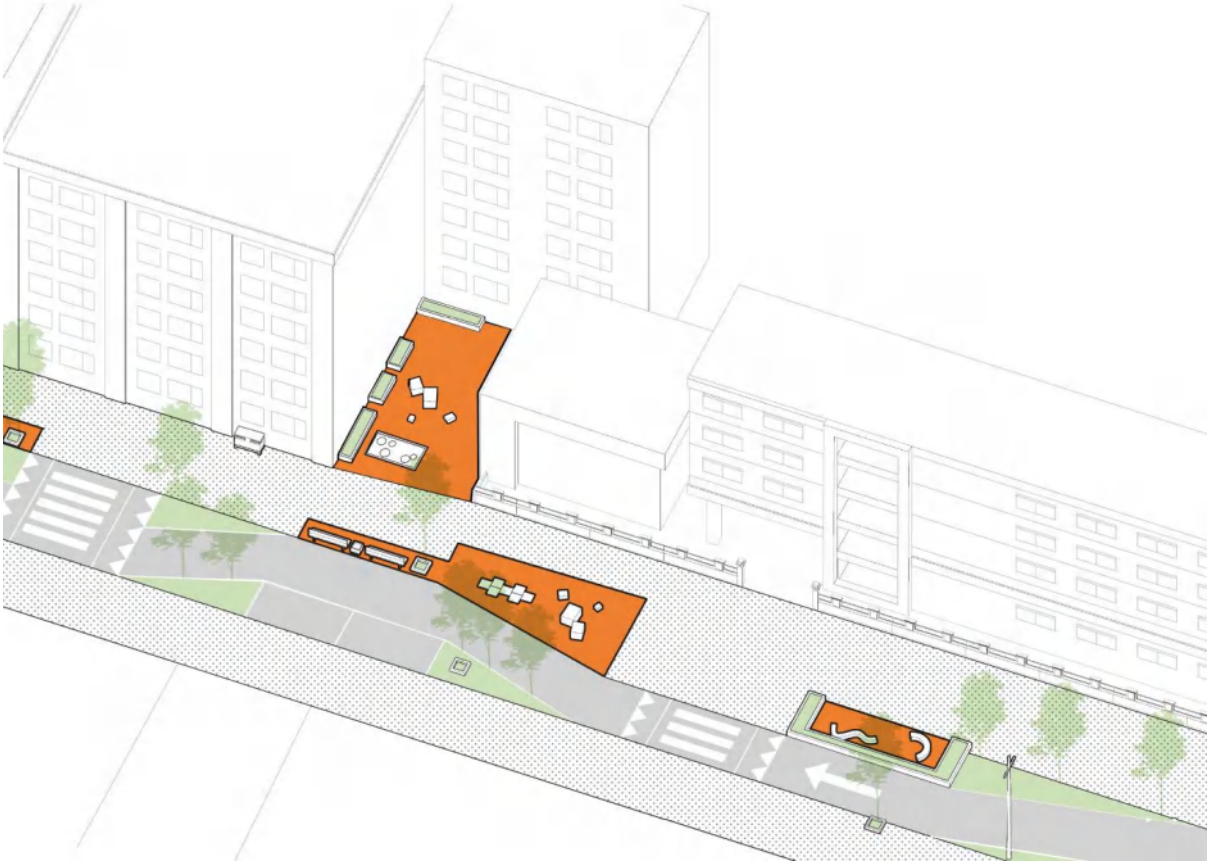


Fig.5-13 Reclaim space for kids to use for play（Drawn by author）

3. Adopt the share street model to revitalize the neighbourhood

Street vitality can be enhanced by emphasizing the public space attributes of neighbourhood streets with low traffic volumes. Pedestrian-led pedestrian streets can be created by limiting motorized traffic through the adoption of changing the location of amenity strips and parking strips and offsetting horizontal alignments. At the same time speed management measures are adopted, with motor vehicle speed limits of no more than 10-15 km/h, to enable the coexistence of people and vehicles.

Fig.5-14 A form of one-way share street（Drawn by author）

5.2.3 Extend：Build Active frontage

Extending the street experience to adjacent areas makes the street more active and interactive, increases the attention of passing people to the street and makes the most of unused areas[47]. When street space is limited, multi-functional strips can be formed using roadside amenity strips, such as planting street trees with non-motorized parking or incorporating businesses to form open spaces. The strategy consists of three main aspects: firstly, to fully integrate the use of children's activity facilities near the street; secondly, to create an active facade along the street; and thirdly, to enhance the degree of functional complexity of the area along the street.

1. Fully integrate facilities for children's activities in the vicinity of the street

Considering make fully use of the space adjacent to the street, both in terms of micro-spaces created by building setbacks at street level, privately owned internal public passageways, and some public facilities such as school playgrounds, museums, libraries, etc. Also encourage owners to remove fences and walls from local areas of buildings with public attributes on the ground floor and open up the internal areas to children's activities throughout the day to create more attractive streets[48].

[47] Han X,Chen k. Research on Child-friendly Cities: A Case study of Portland Pearl District[J]. Urban Planning International, 2016, 9: 26-33

[48] Zhao N. Child-friendly neighborhoods design and enlightenment[D]. Beijing: Beijing Forestry University, 2010

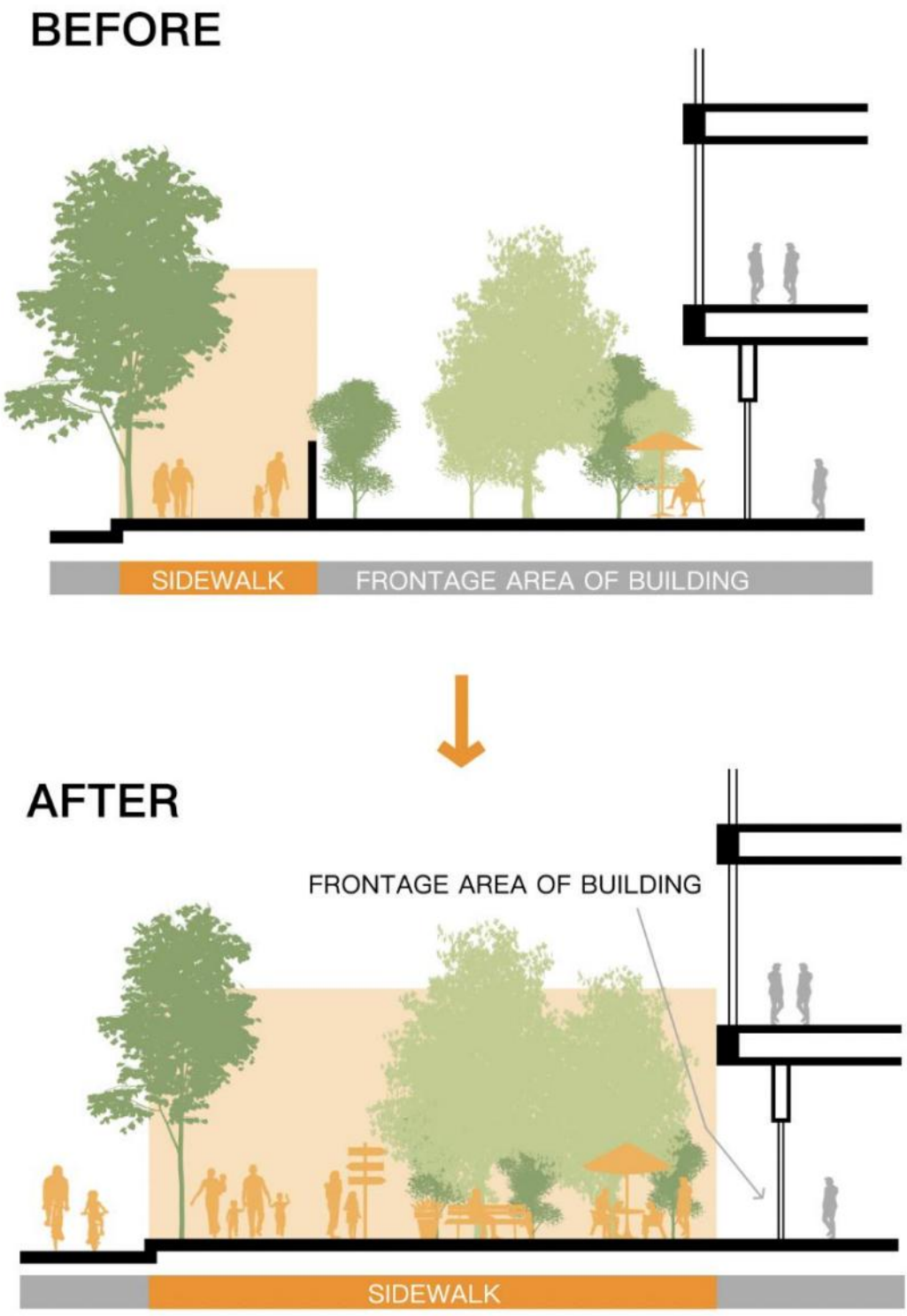


Fig.5-15 Incorporate adjacent spaces to widen the sidewalk space and add eyes on the street

（Drawn by author）

2. Create active street facades

Encourage the setting up of mixed sets of small and medium-sized restaurants and retail businesses on the ground floor; regulate the height, style and number of entrances of buildings along the street; improve the transparency of the ground floor building facade; for commercial streets, the minimum transparency of the first floor street wall interface should reach more than 60% of the total area, and encourage the setting up of display windows; for lifestyle service streets, the minimum transparency of the first floor street wall should reach more than 30% of the total interface.

Fig.5-16 Encourage transparency in facades（Drawn by author）

3. Enhance the functional complex of buildings along the street

By providing a variety of functions, it is possible to ensure that children and carers have access to everyday services within easy walking distance. Encourage complex land use in neighborhoods, increase the diversity of ground floor businesses and mix and match commercial retail, restaurants, culture and community services to increase the intensity of street activities; without affecting the smooth flow of the circulation area, the front areas of buildings can be used to provide leisure facilities or commercial facilities, such as green decorations and public seating for children; allow commercial activities along the streets or public art activities along the streets to activities to enrich urban culture.

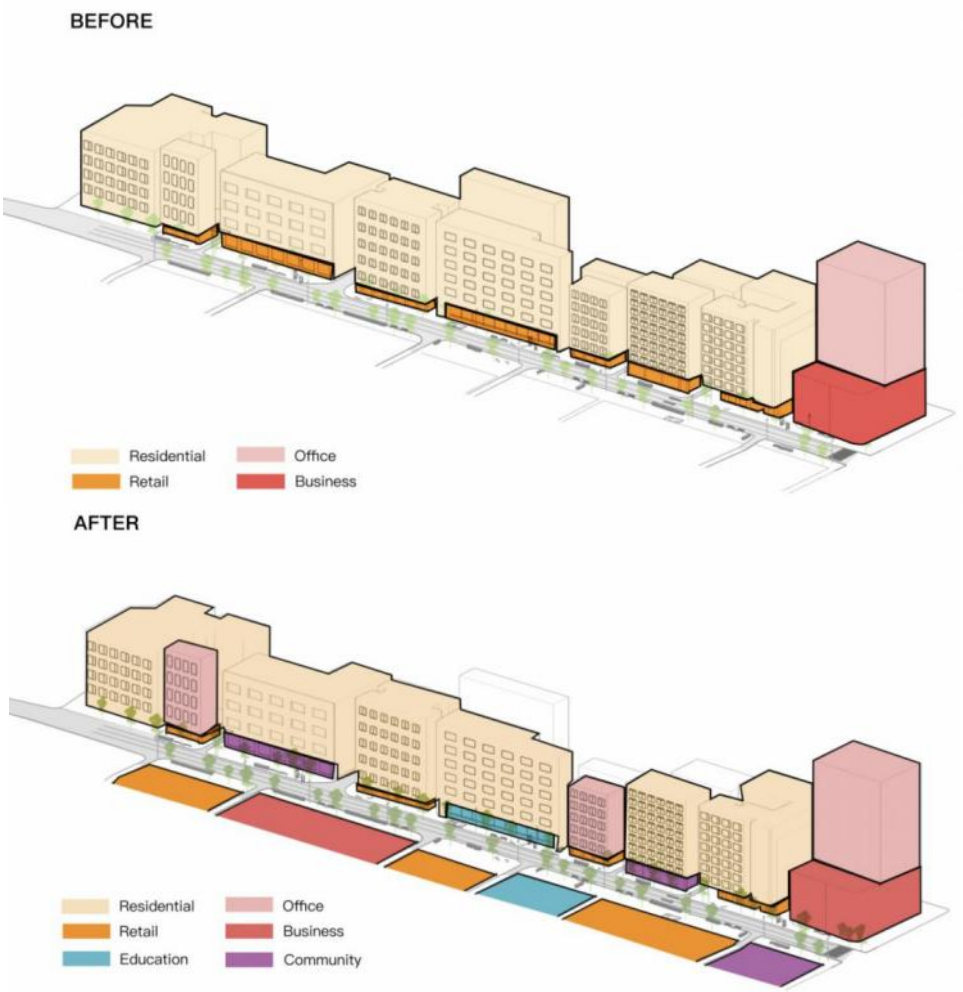


Fig.5-17 Enhance the mix of street functions to activate the street space（Drawn by author）

5.2.4 Activate：Promote Street Vitality

Urban streets should function not only as safe and efficient spaces for movement, but also as interesting public spaces that can cater for children and caregivers to eat, rest, change, socialize, stay and play. The comfort of the space can be enhanced in four ways: i. designing a range of different kinds of spaces to meet the needs of children's behavioral activities in the street space, such as private stopping spaces for children walking or caregivers caring for or nursing young children; ii. adding fun and enlightening educational elements to the street to stimulate children's brain development and also to provide opportunities for interaction with people in the street; iii The integration of natural landscaping into the street to beautify the street while reducing the impact and pollution caused by surrounding motor vehicles; iv. Encourage the organization of street play in conjunction with the street space to enhance the public space attributes of the street.

1. Offer a range of different sizes of rest places

These stopping places range from small-scale shaded seating to larger-scale pocket gardens and small street squares. Taking into account the flow of people through the streets, the interface of the businesses, and the rationalization of seating, street squares and green spaces in the main destinations for children to travel to and in areas where they often stop, such as small shops and bus stops, create nodes of rest and encourage children to interact and stop, thus enriching their spatial experience [49]. These stopping spaces should be able to support both formal and informal activities and facilitate interaction between children and carers. Resting nodes should be at least 2 m wide and 5 m long.

[49] He y. A preliminary study on the strategy of urban old block renewal from the perspective of “child-friendly”:take Zhangjiayuan district,Chongqing as an example[A].Urban Planning Society of China. China Urban Planning and Design Development Report[C]. Beijing: China Architecture & Building Press, 2019: 2-5

Fig.5-18 A series of recreation areas of different sizes for children to stay（Drawn by author）

2. Add fun and enlightening facilities

Play is one of the main ways in which children learn and grow during their early years of education. Play and learning should be integrated into the street as much as possible, with elements that elicit interaction between children, caregivers, e.g. poems, idioms, simple mathematical equations, in appropriate locations to increase the interactivity of the street environment, so that children can deepen what they learn in the formal environment during their daily outings[50]. For example: providing entertainment or diversions for children at bus stops, as children are often bored while waiting, by providing games and artistic elements,

[50] Zhong Y. Research on child-friendly public space of the residential area:take the Xinghui residence community for example[D]. Guangzhou: South china university of technology, 2017

both develops developmental skills and greatly improves the experience for caregivers and children when using transport[51]. Therefore, fully seeking out unused spaces on the street, blank walls, floors, street furniture, and improving children's experience of the space by changing textures, materials, paving, colors and other elements, the flip needs to focus on regular maintenance.

Fig.5-19 Add playful and educational elements on street（Drawn by author）

3. Integrate the natural landscaping

Natural landscaping in urban streets not only creates good visual effects and shade, but is also a place for children to play and learn, extending the time children and caregivers spend

[51] Yang F, Ceng T, Zhong Z. The current situation of old communities' children outdoor activity space and the improvement strategy [J]. Design community, 2017: 114-119

on the street[52]. Planting street trees near seating and play facilities not only increases opportunities for children to interact with nature, but also provides shade for resting spaces. As children are lower to the ground and can enjoy flowers, grasses and other low landscaping up close, take their height and eye level into account when choosing plants: priority should be given to plants that are non-toxic and attract butterflies and birds, while signs can be added to indicate that children can touch these plants.

Fig.5-20 Use green wall、tree pits and planesr to add landscaping（Drawn by author）

4. Regularly organizing street play activities

Play is one of the main ways in which children learn and develop early on, and integrating play and learning into the streets can enhance what children learn in a formal

[52] Xiong D. Street environmental correlates of child-friendly city:a lens of healthy study[D]. Nanjing: Southeast University, 2020

setting. Communities can organize children's play activities on the street by making parts of the street car-free on weekends and holidays, or by planning events such as street art performances and temporary art exhibitions. All of these activities can bring together residents of all ages in a way that provides a share space, which increases community cohesion and contributes to community safety and maintenance[53]

Fig.5-21 Temporarily close vehicle lanes and organize children to play in the streets（Drawn by author)

[53] Zeng P,Xi X,Cai L. A comparative study of children's safe travel routes in Tianjin's old residential areas based on the concept of child-friendly city[J]. Urban Planning International, 2020, 3: 38-42

5.2.5 Policy: Protect Children' Travel

In addition to the adoption of pedestrian priority street design, there is a need to develop measures to protect children's travel assistance and to further harmonize the impact of motorized traffic on children's travel. Different sections along the road should be subject to different vehicle control measures depending on the surrounding conditions, for example speed limit settings should be increased for areas of high child activity and school sections. The development of measures to protect children's travel can reduce conflicts between children and motor vehicles by means of speed limits for vehicles in key locations, the use of time-sharing in streets and the regulation of parking space design[54].

1. Adopt vehicle control measures to protect children's safety

Driving at high speeds often narrows the driver's field of vision and affects their reaction time. The chances of a person being seriously injured or killed in a collision at speeds of 30-40 km/h are greatly reduced. Therefore, the maximum speed limit should be 10-20 km/h on narrower streets, share streets and pedestrian-led pedestrian streets, which can greatly reduce the danger to children from motor vehicles; for roads near schools, community clinics and parks, the maximum speed limit should be 30 km/h.

[54]Zhao T. Research on children’s outdoor activity space in Guangzhou community[D]. Guangzhou: South China University of Technology, 2017

Fig.5-22 Limit private vehicles' speed and prompt sustainable mobility choice（Drawn by author）

2. Management of street use by time slot

Motor vehicles can be banned from branch roads with a high volume of walking traffic during children's school drop-off and pick-up times. Alternatively, on weekends and holidays, car-free control of some streets to encourage cycling and promote the concept of slow travel. For conflicts between people and freight traffic on living streets in the community, unloading facilities should be regulated, timing should be guided to avoid taking up the pavement during high activity levels, and early morning and late night can be used to organise freight traffic[55].

3. Parking strip setup management

For streets near children's main destinations, temporary parking can be set up and the number of vehicles parked can be reduced by means of charging; for commercial streets

[55] Xu D, Zeng J, Ha L. Research on child-friendly Urban street space Planning and design strategy [A]. China Urban Planning. Sharing and Quality -- Proceedings of 2018 China Urban Planning Annual Conference[C]. Beijing: China Building and Building Press, 2018: 424-433

outside the community, parking strips should be set up carefully under the condition of ensuring a smooth passage space to avoid affecting the continuity of children's walking space. And as far as possible combined with the parking belt set line offset, parking belt length is not easy to exceed 30 m, more than 30 m, it is appropriate to use the raised pavement to separate. And it is not suitable to arrange parking belts on both sides.

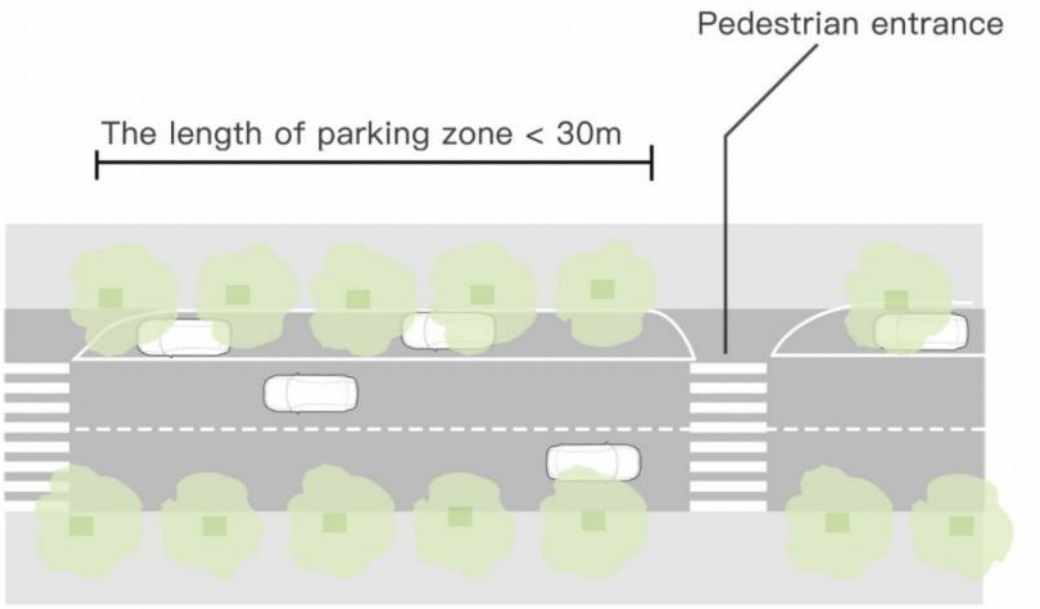


Fig.5-23 Parking zone width limit is not more than 30 m（Drawn by author）

5.3 Summary

This chapter develops principles and strategies for street space optimization from the perspective of the needs of children that need to be met by a child-friendly street space, and specifies the direction of optimization for subsequent street space design.

A child-friendly street should ensure that :**1) children can travel independently and 2) there is space for rest and play.** On this basis four principles of street optimization were developed: “safety”, “continuity”, “comfort” and “child participation”. Subsequently, five strategies were developed based on the four optimization principles：

I. Upgrade the safety level of streets and complete missing safety facilities

II. Reallocate the street space available to children

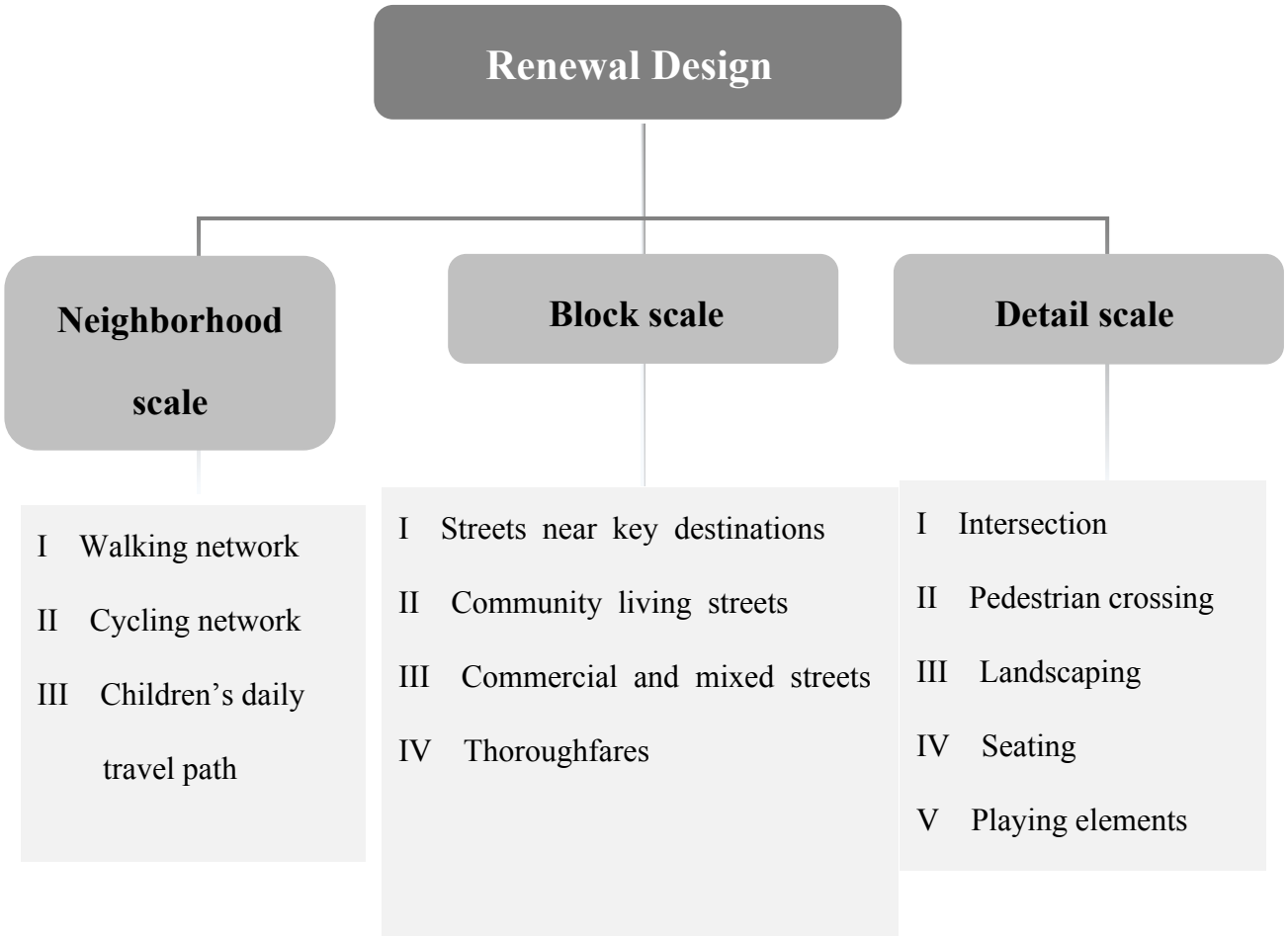
III. Extend road space to create a positive street frontage interface

IV. Activate streets for children to play and learn

V. Develop measures to protect children's travel

It should be noted that for different types of streets within a community, the focus of optimization is different and therefore the selection of strategies should be focused on each.

Chapter 6 Child-Friendly Street Space Renewal Design in Xiaobei District



6.1 Neighborhood Scale: Street Network Design

6.1.1 Walking network

A complete and integrated pedestrian network is essential for building child-friendly streets. As children rely heavily on walking to get around, a complete pedestrian network allows them to safely and easily reach destinations that they use frequently in their daily lives. At the same time, for children who lack quality playgrounds near their homes, streets are an important recreational and social place for them.

The current urban pedestrian space is mostly configured according to the width of the central carriageway: often the pedestrian space on both sides of high-grade urban roads is of appropriate width and well-equipped, but for roads with a higher pedestrian demand within the community, the pedestrian space is instead constricted and the environment is poorly built. Therefore, when optimizing the pedestrian network, it is important to first consider the function and grade of the street to meet the pedestrian needs of children. For example, for streets outside the community, where there is less motorized traffic, a share street format is more realistic, while streets for internal community living can take the form of pedestrian streets and incorporate street furniture to enhance comfort. In conclusion, an integrated pedestrian network system needs to rationalize the walking pattern of streets according to the type of street, to ensure safety and continuity of children's walking trips, and at the same time, to improve comfort by fully searching for suitable locations on the street and incorporating street furniture with resting and interactive spaces.

In optimization, the sidewalk should cover both sides of all the city's main and secondary roads and branch roads, meeting the basic safety requirements, while incorporating setbacks and parklets in unused areas, and always ensuring that the width of the clear path in the sidewalk is greater than 1.8 m. Laneways are usually located between buildings in a small area and are usually accompanied by clutter, which leads to poor visibility; on the other hand, laneways are generally narrow, mostly 2-3m, and are only suitable for single and double traffic. On the other hand, laneways are generally narrow, mostly 2-3 m, and only cater for single and double traffic, with occasional non-motorised traffic. Therefore, when optimizing

the laneway, attention should be paid to improving the permeability of both sides of the street and enhancing the visibility of the laneway to passers-by.

Yingyuan Road is a two-way single-lane urban feeder road, the width of the original road's non-motorised lane is too narrow to accommodate only one non-motorised vehicle, which is far from meeting the actual demand and is in urgent need of optimization and renovation. At the same time through the base research found that: Yingyuan Road motor traffic flow is relatively small; because the north side of the road is the Sanyuanli community, so Yingyuan Road is one of the community most of the children's daily route to and from school; at the same time because of the number of shops on both sides, gathered a large number of people flow. It is therefore very suitable to be transformed into a share street. Dengying Road, Fazhengn Lane and Tianxiang Street are community roads, and because of their proximity to the community school and park, they can easily gather a large number of people at certain times of the day; at the same time, because they are responsible for the transportation of motor vehicles and have narrow roads, they should also be optimally transformed into share streets to enhance the safety of children using these streets(Fig. 6-2).

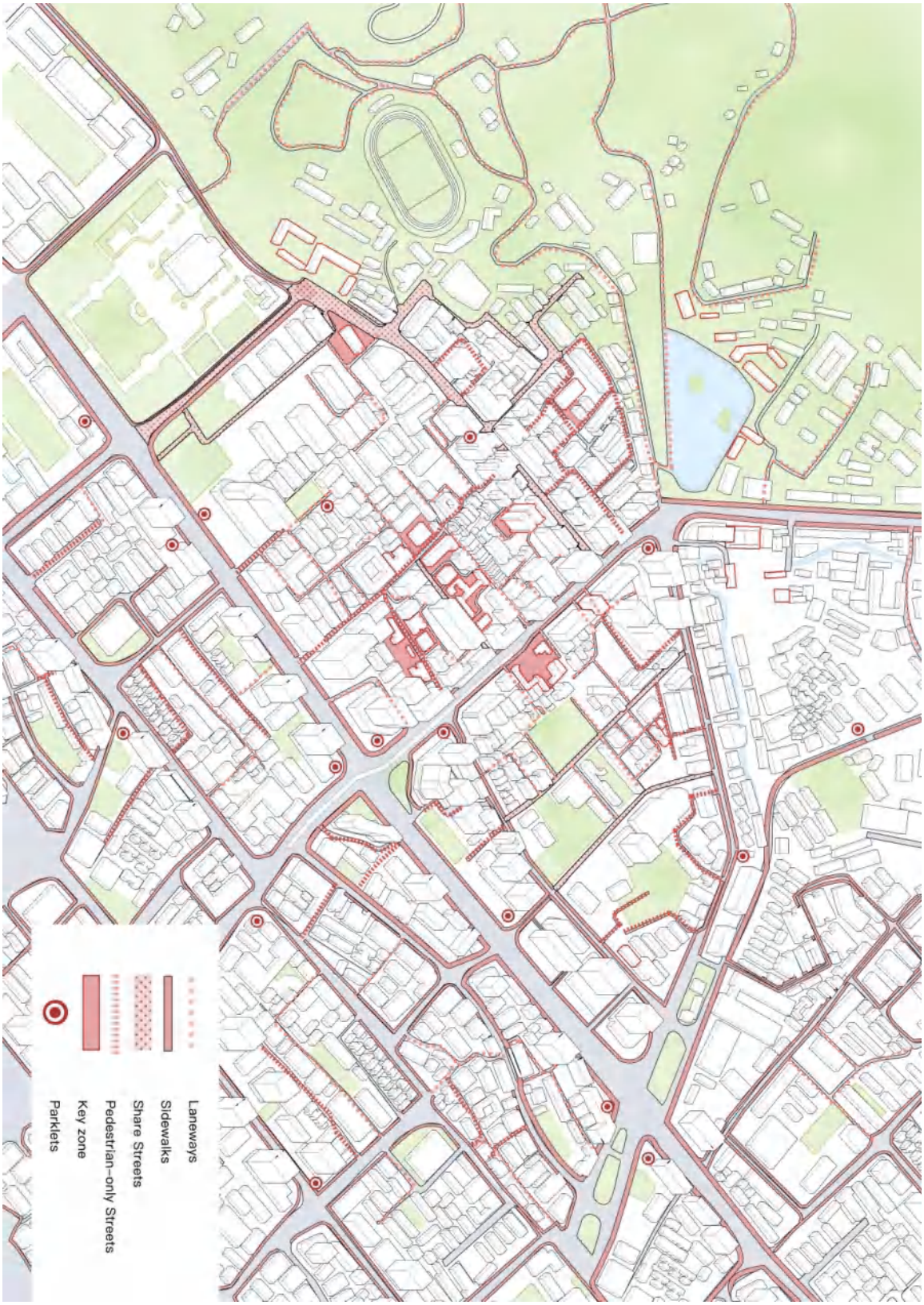


Fig.6-2 The walking network in neighborhood scale（Drawn by author）

6.1.2 Cycling network

Children aged 6 can use bicycles safely in the company of adults; above the age of 13, the frequency of bicycle use increases considerably and a complete cycling network covering the inner and outer streets of the community is indispensable. In addition to the number of lanes, widths and cross-sections, the choice of lane dividers, the location of bicycle stations and parking areas, and signage should also be carefully considered to meet the needs of children of all ages.

For streets outside the community, there should be hard separated cycle lanes to protect children and carers from motorised traffic, and the type of hard separation and number of lanes can be chosen according to the width of the road. As cycling is a much lower potential threat to pedestrians than motor vehicles, streets in communities where motor vehicles are prohibited can be mixed, i.e. cycle street, where a change in paving material can differentiate the road space and hard segregation is no longer required.

Bike share stations should be located near all key travel destinations such as Xiaobei Primary School, community parks and lifestyle supermarkets. At the same time, different types of bicycles, such as larger cargo bicycles with pockets, should be installed to provide a cycling option for caregivers with young children.

The internal road system of old residential areas is generally a mixed pattern of pedestrian and vehicular traffic, but with fewer motor vehicles. For the internal roads of residential areas, the whole should be upgraded and transformed into shared streets with a focus on slow traffic, and children's activity facilities and activity venues should be arranged on the streets to increase the space for children on the streets. As Yingyuan Road and Fazheng Lane within the neighbourhood and Tianxiang Street near the school undertake a small number of motorised transport functions, a shared street format is appropriate for the transformation, allowing pedestrians, bicycles and a small number of motorised vehicles to pass at low speeds.

Roads with a large width in the walk zone and a high demand for pedestrian traffic are suitable to be transformed into roads with a focus on slow traffic, allowing children to use the

full width of the road for free movement. Community roads such as Hongqiao Street, Xiaoshi Street and Dangui Street have a certain street width, and at the same time, the functions of living and commerce are distributed on both sides, so it is appropriate to adopt the form of cycle street, allowing walking and cycling to be combined(Fig. 6-3).

Fig.6-3 The cycling network in neighborhood scale（Drawn by author）

6.1.3 Children's daily travel path

The Children's Daily Travel Path is a way of linking children's everyday places, such as homes, schools and green spaces, together in a logical manner to ensure that children can travel safely and independently along these streets, allowing for more spontaneous play and chance encounters within the neighbourhood, thus benefiting children's intellectual and physical development. Due to the differences between children's and adults' travel habits, the most important step in the design of the Children's Daily Travel Path is the involvement of children, which should be combined with their daily travel maps and the frequency of street use (Fig. 6-4):

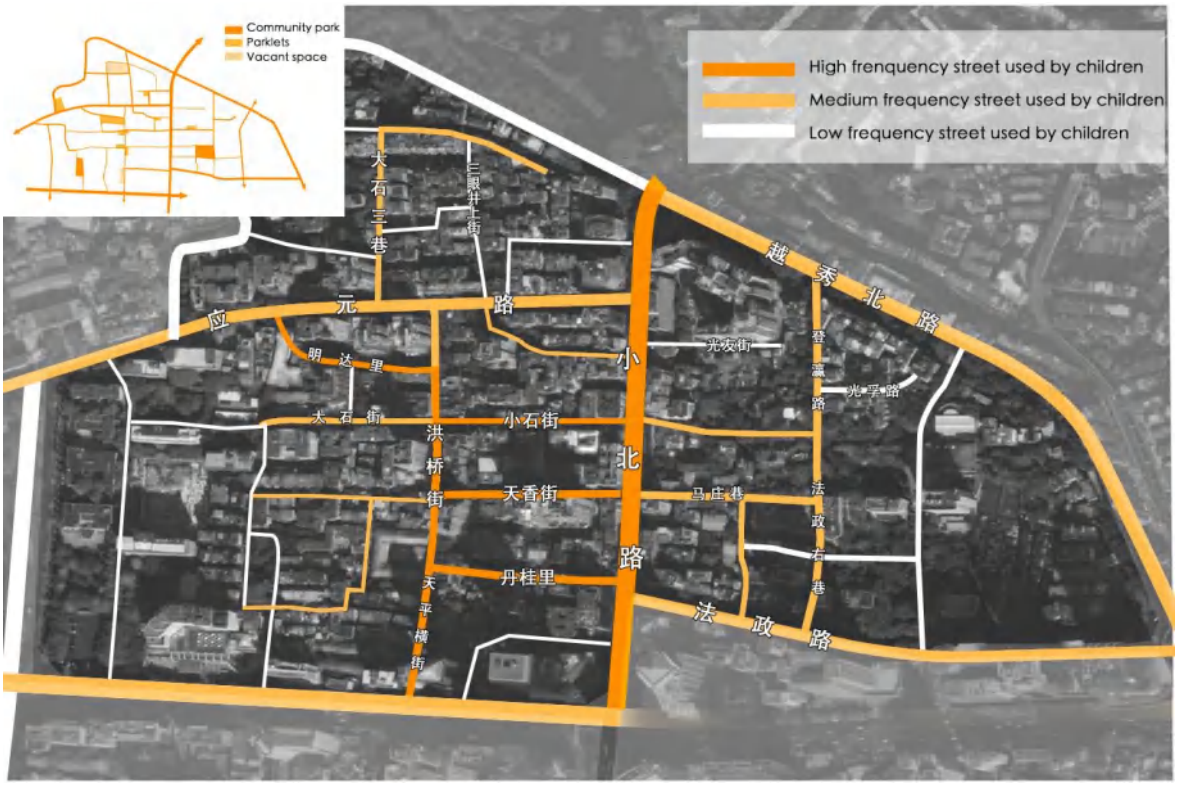


Fig.6-4 Street use frequency rated by children（Drawn by author）

The safe travel path areas should follow the principle of pedestrian priority and implement measures such as limiting the flow of vehicles during specific time periods. Based on the distribution of children's activity areas within the site, it can be found that: around both sides of Xiaobei Road, there are roughly four key design areas included, so rational planning of children's travel paths requires linking these key design areas as much as possible. (Fig.6-5) Combined with the high frequency of street use mapped by children, the travel path planning process for children is shown in the following diagram (Fig. 6-6)：

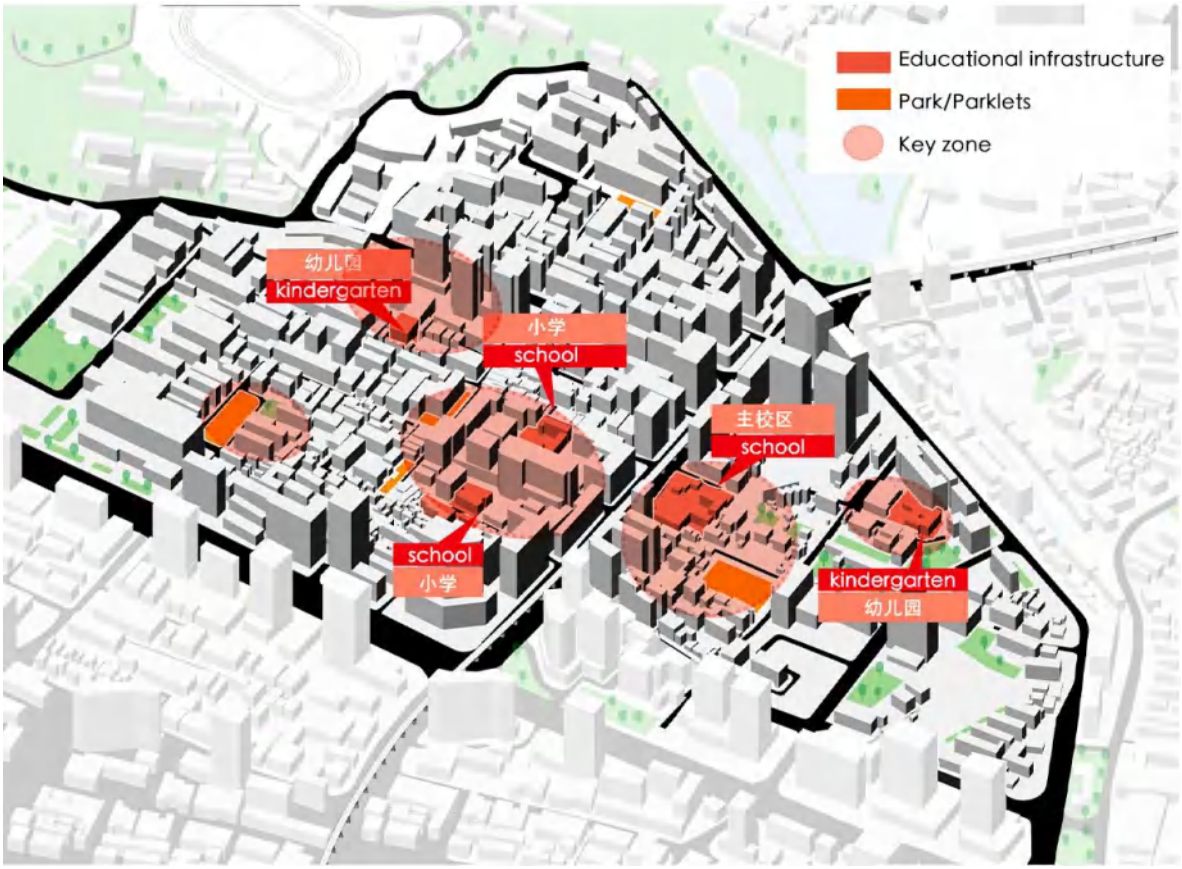


Fig.6-5 Children's high frequency destination and key design zone（Drawn by author）

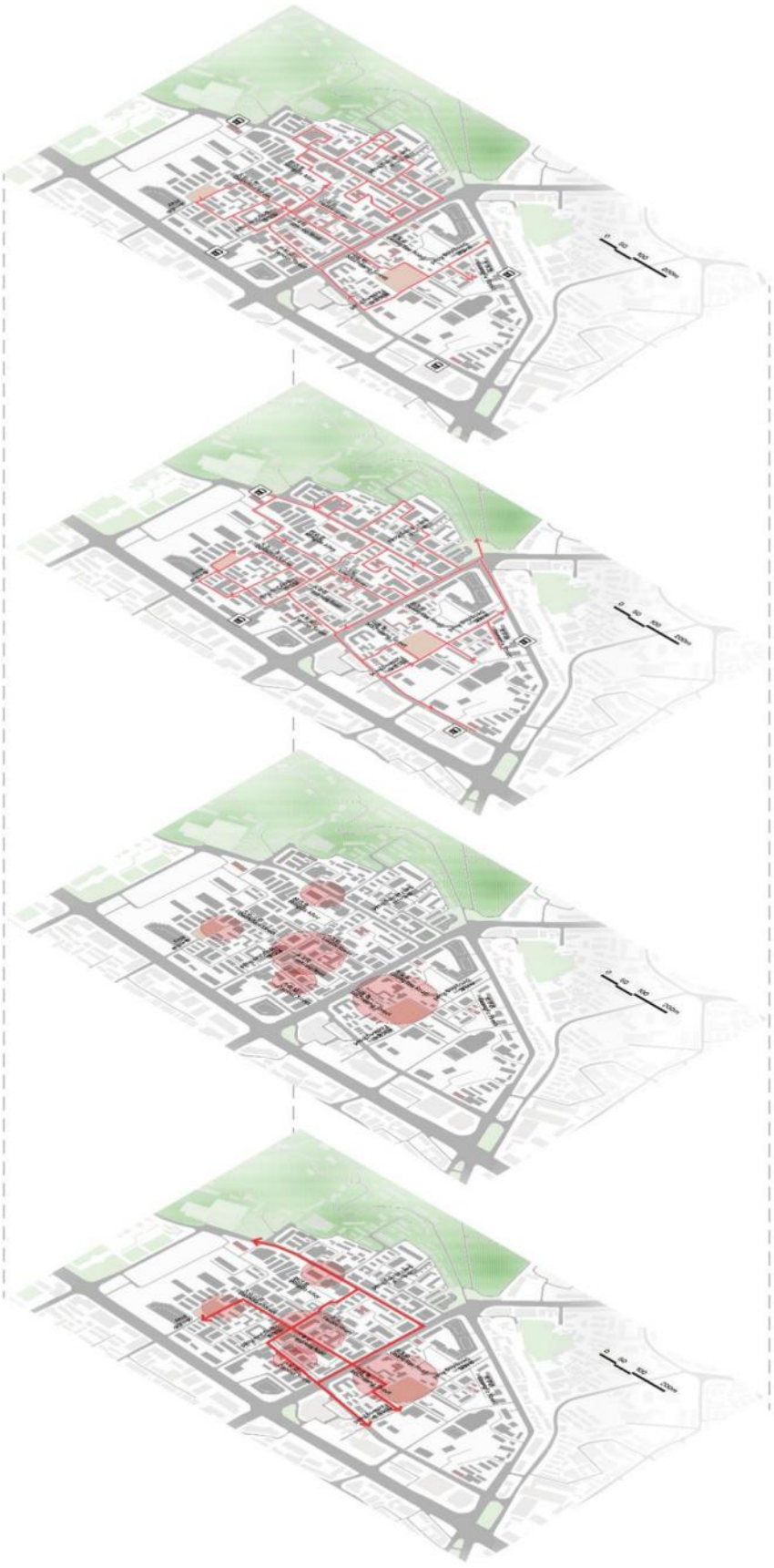


Fig.6-6 Process of building children's travel path（Drawn by author）

The final implementation of specific design boundaries for children's daily travel paths, collated to obtain the optimized range of streets in the Xiaobei District (Fig. 6-7)：

Fig.6-7 Specific scope of street should be updated（Drawn by author）

As shown on the map, the optimized streets include four streets in total: 1. Xiaobei Road: a secondary urban road with three lanes in both directions, mainly undertaking the function of vehicle transportation, due to the encroachment of pedestrian space, there is an urgent need to improve the safety of the street; 2. Yingyuan Road: a two-way single-lane urban feeder road with a rich variety of commercial shops on both sides, at the same time, due to the wide pavement, so the design space can be manipulated; 3. Hongqiao Street: a main street with no motor vehicle traffic, with ageing street facilities, so the main concern is to improve the comfort of the street; 4. Tianxiang Street: an urban branch road directly in front of the school, with a single lane in both directions, the current situation urgently needs to expand the space for collection and distribution in front of the school, while further restricting the passage of motor vehicles through the design.

6.2 Block Scale: Street Renovation Scheme

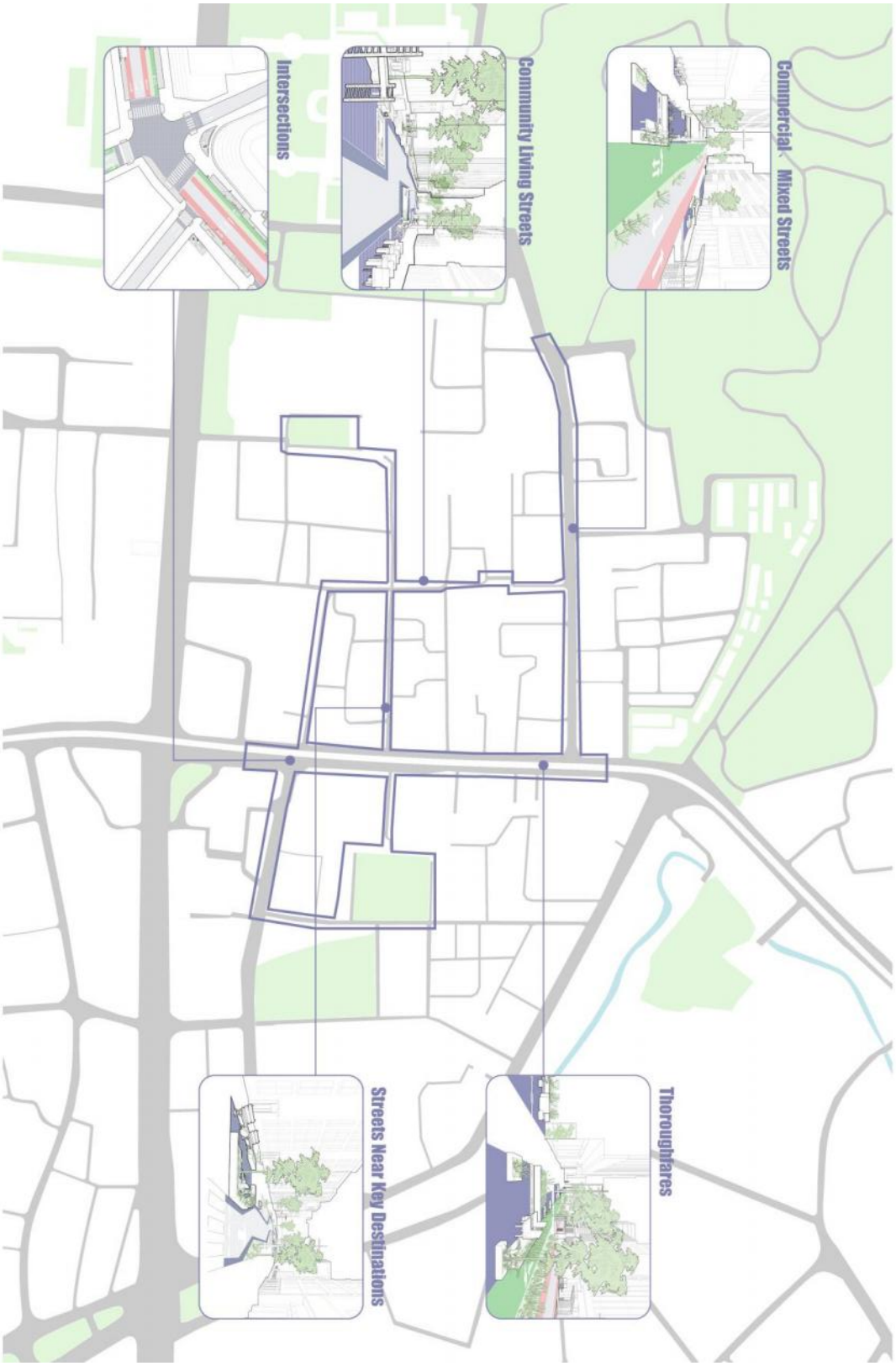


Fig.6-8 The overall layout of street optimization in Xiaobei District（Drawn by author）

6.2.1 Streets near key destinations

Streets near services such as schools, nurseries, playgrounds and libraries should be a priority area for street improvement. These streets are often spatially constrained and carry large volumes of people and vehicles during the school run, but lack appropriate traffic control measures and are often congested and chaotic. In addition, as the function of these services is clearly dominant, the streets near these buildings should be seen as an extension of their function and should also be safe, fun and educational.

Challenges and current situation

Tianxiang Street, which directly faces Xiaobei District Primary School, is a two-way one-way street. After on-site research, it was found that the following problems currently exist in Tianxiang Street (Fig.6-8):

I. The presence of office buildings on one side of the street and the arrangement of parking spaces on the other side of the street, which leads to school buses, private cars and lorries competing for parking areas on the roadside and causing conflicts with other motorists.

II. The age of the street, the limited space on the pavement, the inability of the narrow pavement to accommodate pupils' conversations and chases, and the occasional haphazardly placed obstacles on the road (street lights, poles, rubbish bins), so that children and caretakers are often forced to walk on the carriageway

III. There is not enough space for gathering and dispersal in front of the school and parents often encroach on the motorway during drop-off and pick-up times to wait for their children to be released from school, further contributing to the chaos and disorder on the roads

IV. There are no pedestrian crossings on the streets aligned with the school entrances and the long crossing distances result in children crossing the road in traffic

V. The lack of bicycle parking areas near the streets greatly reduces the interest of children as well as caregivers in choosing to travel by bike

VI. The fences and walls around schools are not sufficiently interesting, active and

transparent

VII. The number of speed limit devices, such as signs is not sufficient to ensure the safety of Tianxiang Street

Fig.6-9 Original situation of Tianxiang street（Drawn by author）

Optimization strategies:

Streets near major destinations should be optimized firstly to avoid pedestrian-vehicle conflict and to encourage cycling and walking through them, while finding sufficient unused space for children to rest and wait and socialise and play. This can be achieved, for example, by partially extending the children's activity area into the vehicle traffic area. Secondly, streets near major destinations can mitigate pedestrian-vehicle conflicts by limiting vehicular access to major destination streets. Access to these streets should also be encouraged in a slow-moving manner, by creating designated pick-up and drop-off zones at specific times, thereby controlling the flow of traffic, yet allowing access for emergency vehicles. Finally, intersections near major destinations should also be prioritized for upgrading.

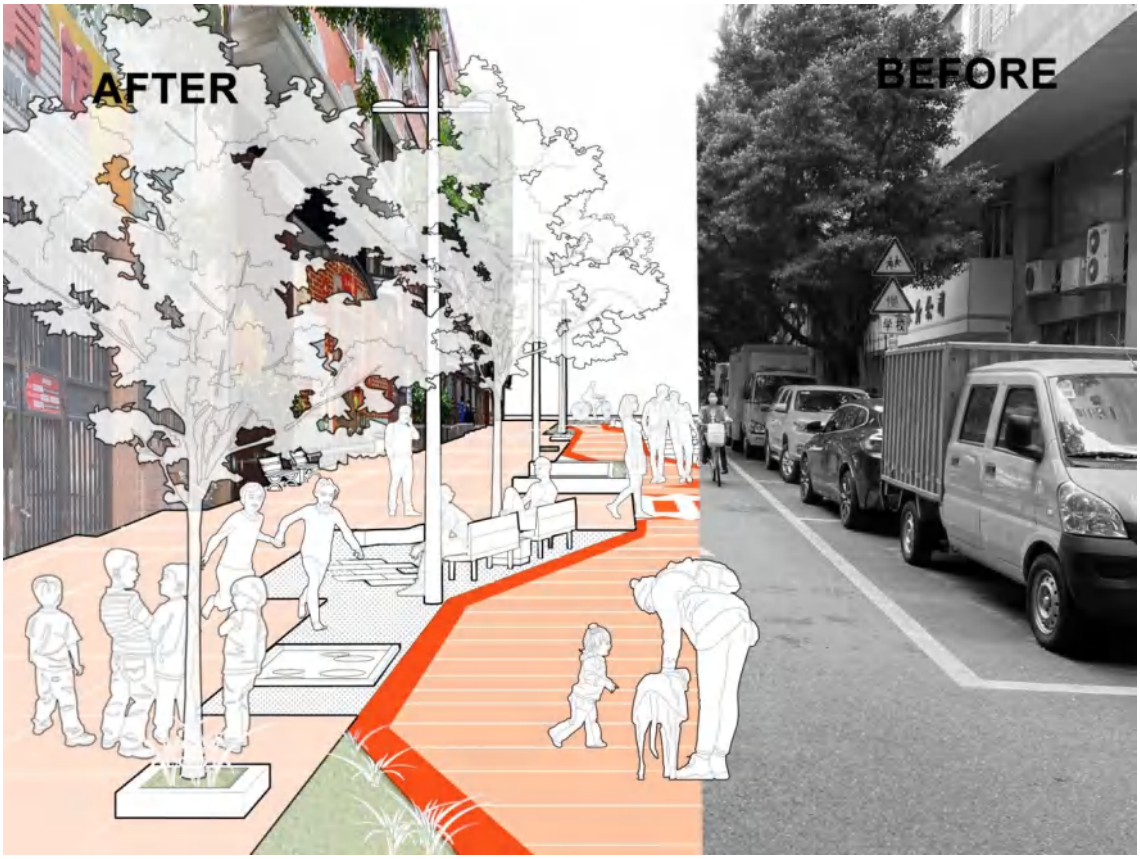


Fig.6-10 Before-and-after images of Tianxiang Street（Drawn by author)

Strategy I: Adopt the model of share street

Remove the curb and replace the paving material in the street, create a shared street with a 10 km/h speed limit for motor vehicles by providing a narrow motorway with paving stones and furniture, using the horizontal offset of parking spaces and tree pond locations.

Fig.6-11 Turning the existing two-way single lane into a share street

Strategy II : Optimize space for pedestrian travel

The movement through the space is oriented towards pedestrians. Add vertical deflections, such as raised crossings and speed bumps, to reduce the speed of incoming motor vehicles at the intersections of Tianxiang Street with other streets(Fig.6-11).

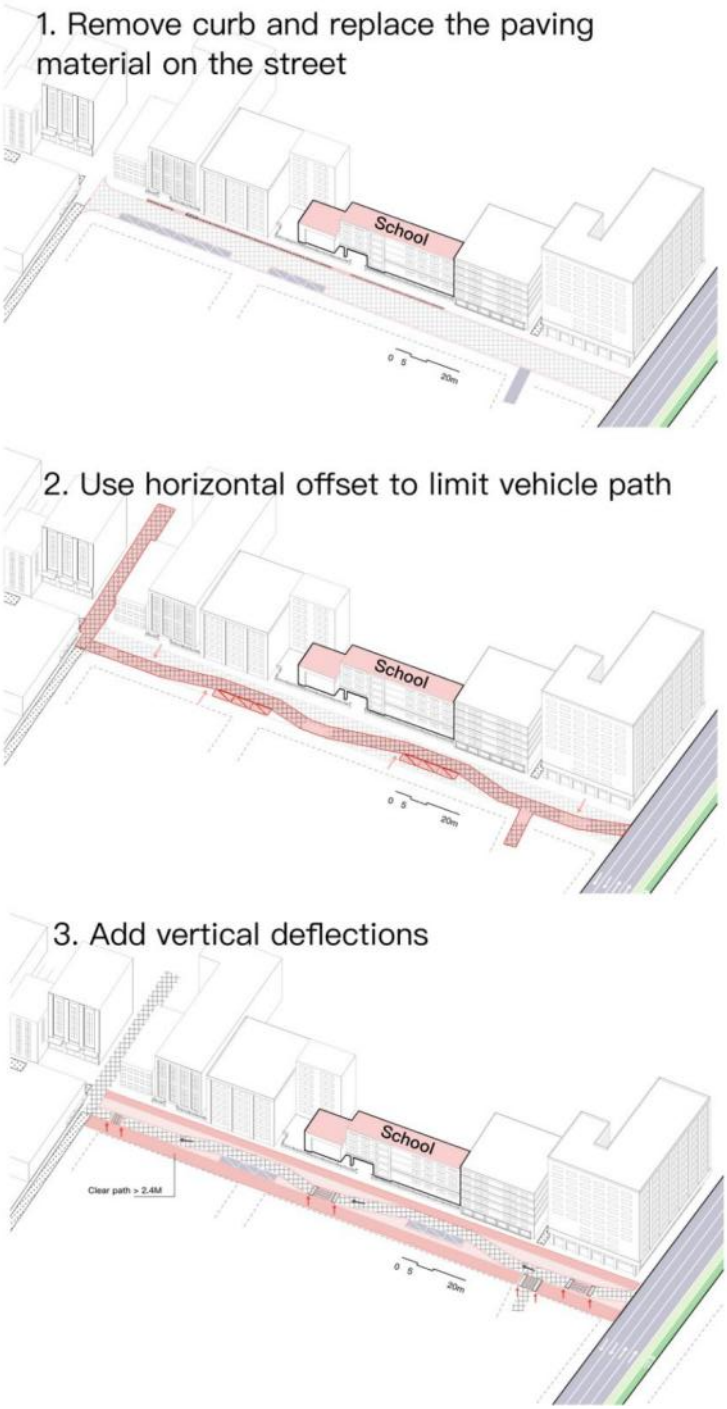


Fig.6-12 The process of optimizing the passage space（Drawn by author）

Strategy III: Provide a buffer zone for school

With the high volume of foot traffic in school areas during drop-off and pick-up times, the reclaimed motorway not only provides space to widen walking and cycling space, but also adds a school entrance staging area in a suitable location, which can cater for children waiting for carers and playing with peers after school.

Strategy IV: Optimize spaces for street activities

I. The fencing established by the school was removed and part of the schoolyard was extended into the public realm of the street as well as into nearby turnouts, allowing children in the community to use these play areas and other open spaces after school and on weekends.

II. Installing play structures and street furniture, such as spray-painting meaningful poems and mathematical equations on the ground, provides opportunities for children to learn(Fig.6-12, 6-13).

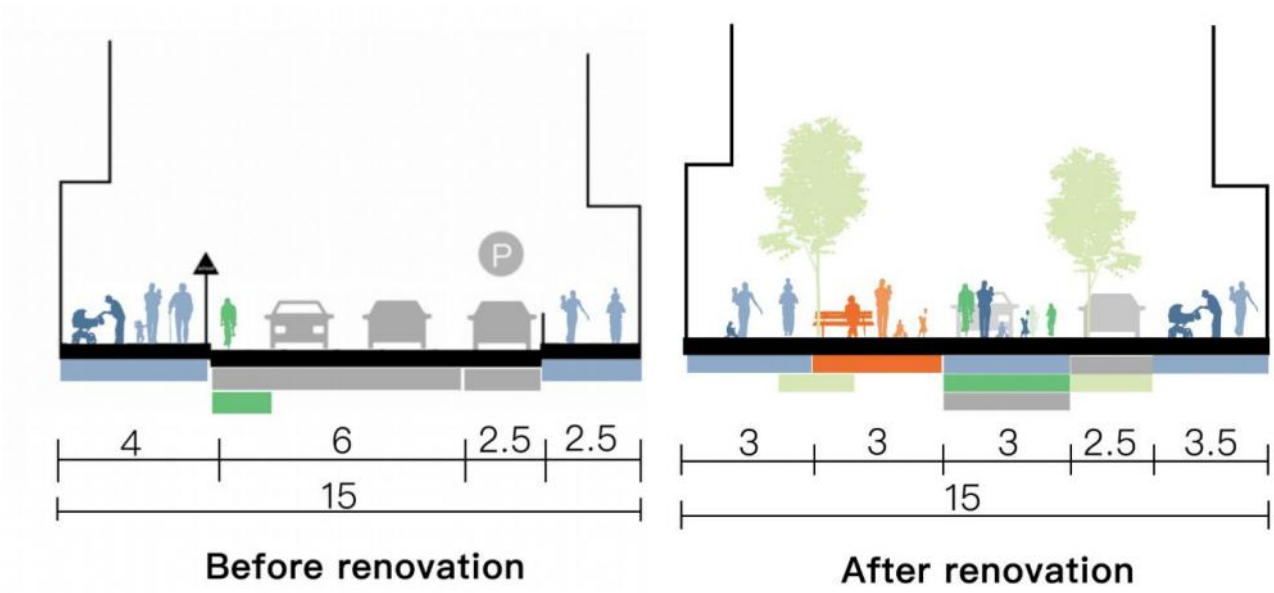


Fig.6-13 Section of Tianxiang Street before and after renovation (Drawn by author)

Fig.6-14 The process of optimizing street activity space Ⅰ（Drawn by author)

Fig.6-15 The process of optimizing street activity space Ⅱ（Drawn by author）

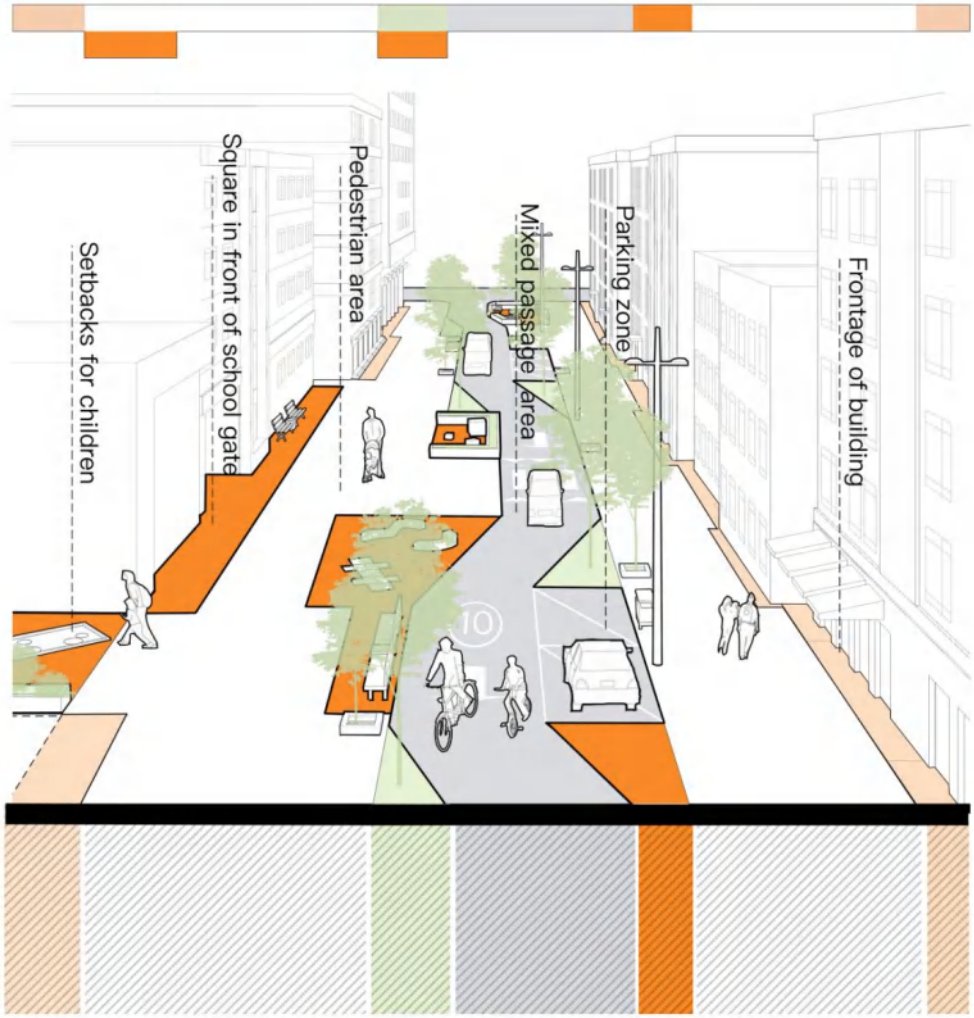


Fig.6-16 Tianxiang street functional zone profile（Drawn by author）

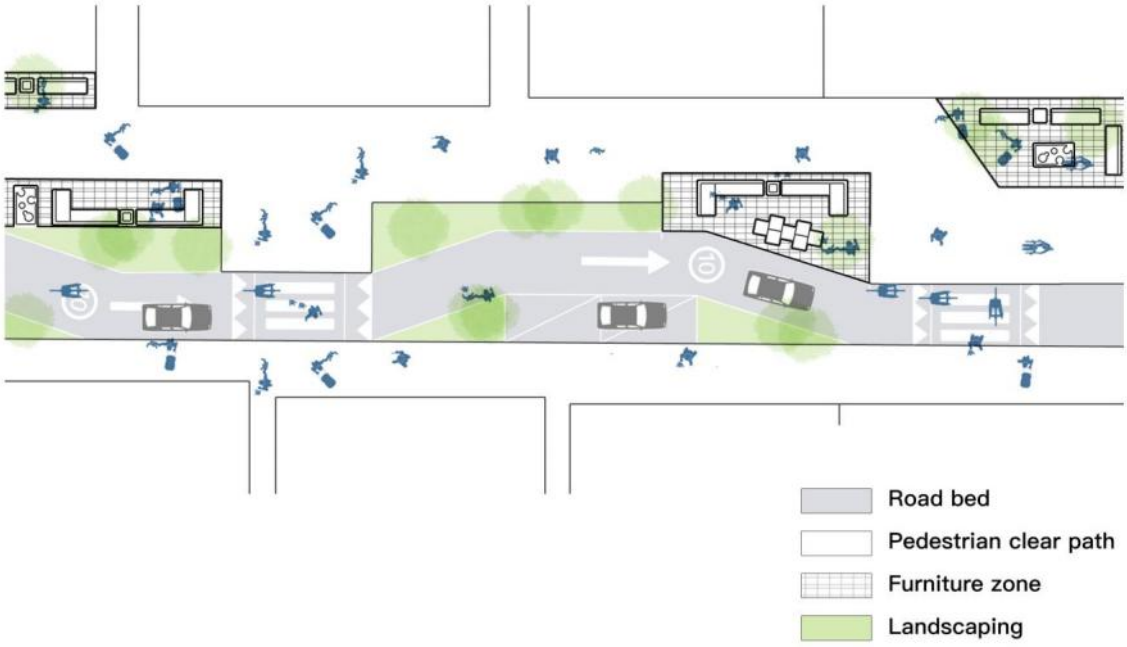


Fig.6-17 Tianxiang street optimization plan（Drawn by author）

Fig.6-18 Perspective view of the school entrance on Tianxiang Street（Drawn by author）

6.2.2 Community living streets

The internal streets of the community are the front yard of people's lives, an extension of their family life, and people play and socialize in these living streets. They are spaces of transition to the city and are the first contact with the public realm in people's daily lives. If these streets attract and retain people, community cohesion can be strengthened. Living streets become even more important when there is a lack of space for children within the community, acting as a type of open space where children can play.

Challenges and current situation

Hongqiao Street is a community living street. Many retail and restaurant buildings are located on both sides of the street, making it one of the most popular streets in the community. The main problems currently existing on the street are as follows (Fig. 6-17):

I. Due to its close proximity to Tianxiang Street, part of the street is available for municipal parking and therefore part of the area is a mixed pedestrian and vehicular area.

II. The street frontage selling out-of-place furniture, miscellaneous items and parked bicycles severely encroach on the pavement, making space for movement more limited.

III. On-street parking areas leading to conflicts between pedestrian and vehicular flows on the street; localized abrupt contraction of the interface at the intersection of pedestrian and vehicular traffic on the street.

IV. Lack of adequate street crossing facilities, lighting, etc.

Fig.6-19 Original situation of Hongqiao street（Drawn by author）

Optimization strategies:

The transformation is mainly carried out in four aspects: firstly, the existing motor vehicle parking spaces are removed and the pedestrian-led street is replaced by a mixed pedestrian street; secondly, the local road surface is widened to maintain the continuity and smoothness of the pedestrian space; as the buildings on both sides of the community living street are mainly small restaurants and businesses, it is necessary to plan the location of outdoor dining areas and facility strips in a reasonable manner; finally, the community living street also assumes the function of a children's activity area, and it is necessary to transform a suitable location on the street into a children's activity area.

Fig.6-20 Before-and-after images of Hongqiao street（Drawn by author)

Strategy I. Adopt pedestrian -priority street model:

Removing the existing parking spaces and transforming part of the mixed pedestrian and vehicular area into a pedestrian-priority street. By changing the width of the entrance, the material of the pavement and the vertical elements such as the bollards, the pedestrian priority zone is visually identified by the passers-by.

Strategy II. Widen the clear path in street for pedestrians:

The street is widened by setting back part of the first floor and enlarging the space in front of the building to create additional space for circulation (Fig. 6-18).

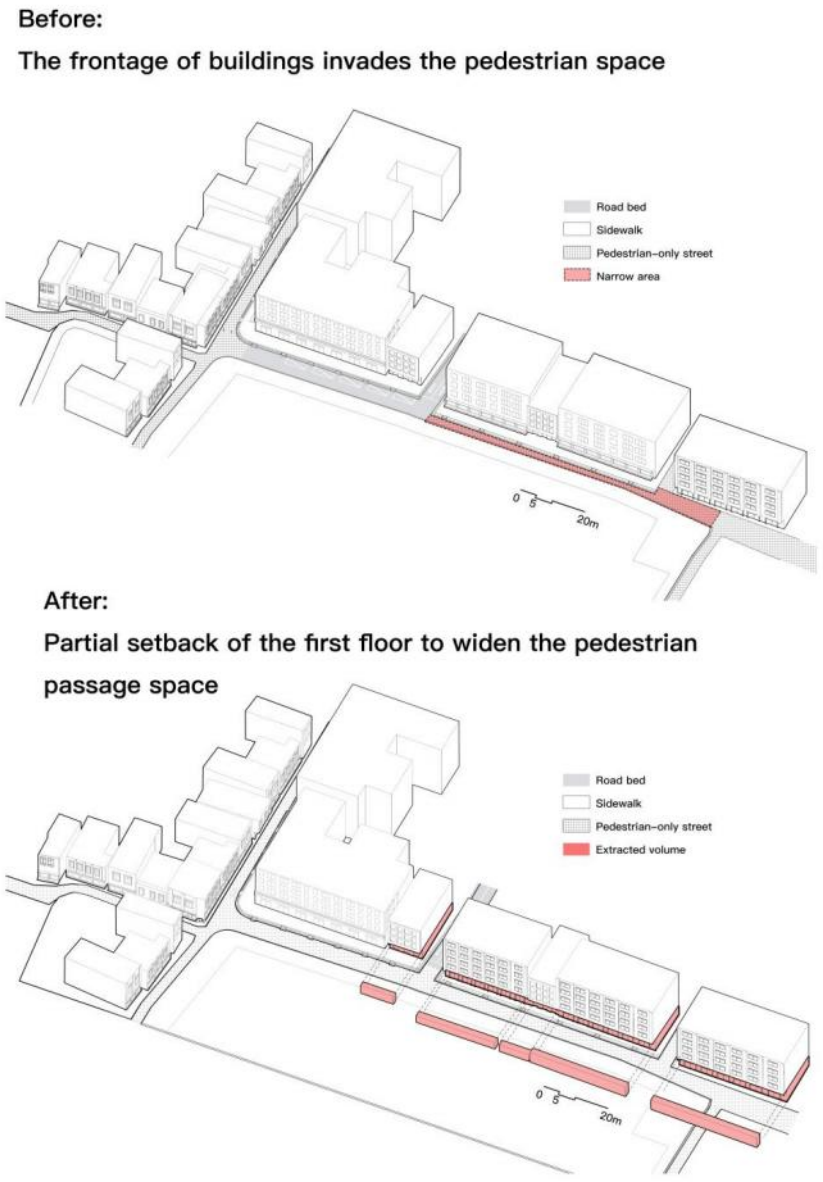


Fig.6-21 The process of widening the clear path in street for pedestrians

Strategy III. Rationalize the planning of amenity zones to maintain the continuity of the pavement passage space:

The continuity of the pedestrian space is often interrupted by randomly parked bicycles and catering furniture, so it is necessary to provide a furniture display area and a non-motorized parking area in order to maintain the uninterrupted flow of the circulation area. The front area of the first floor, which is dominated by display windows and vending windows, can be 0.5-1 m; the front area for outdoor display and outdoor catering can be 1.5-2 m wide.

Strategy IV. Inserting children's activity spaces along the streets:

Living streets where play can take place can compensate for the lack of public spaces for activities in the community. When inserting play spaces, the seating position needs to be carefully considered to make it easier for carers to look after children (Fig.6-20 6-21).

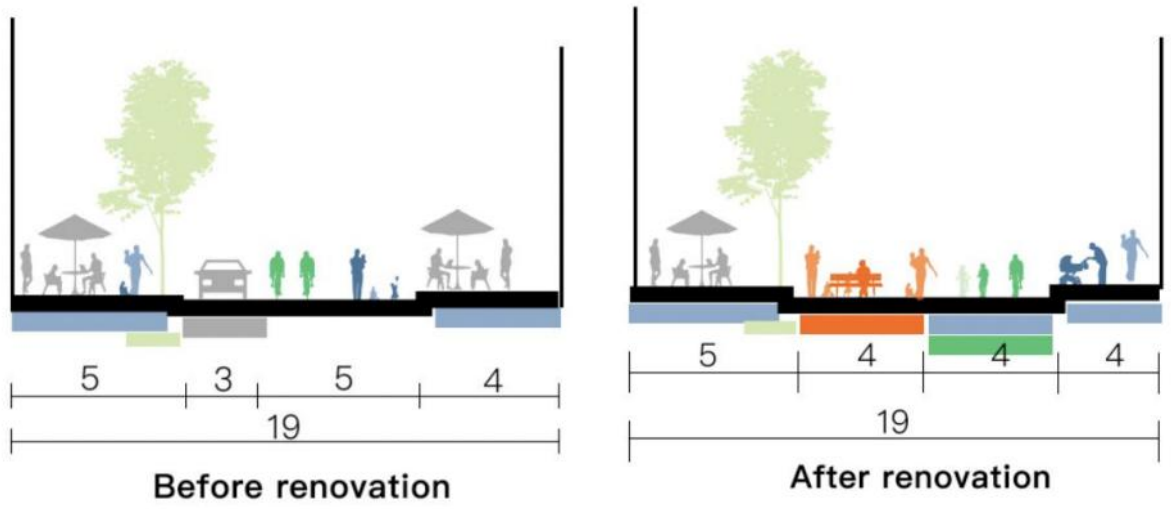


Fig.6-22 Section of Hongqiao Street before and after renovation (Drawn by author)

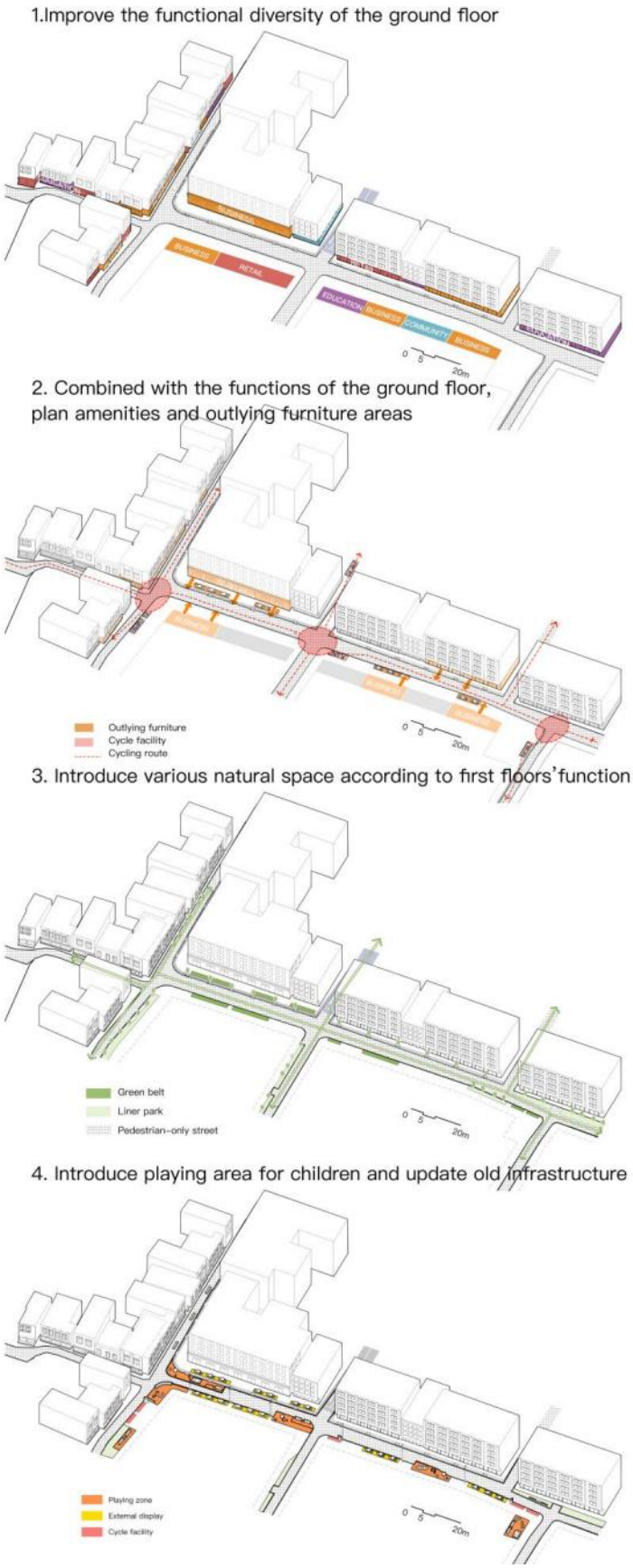


Fig.6-23 The process of inserting children's play spaces（Drawn by author）

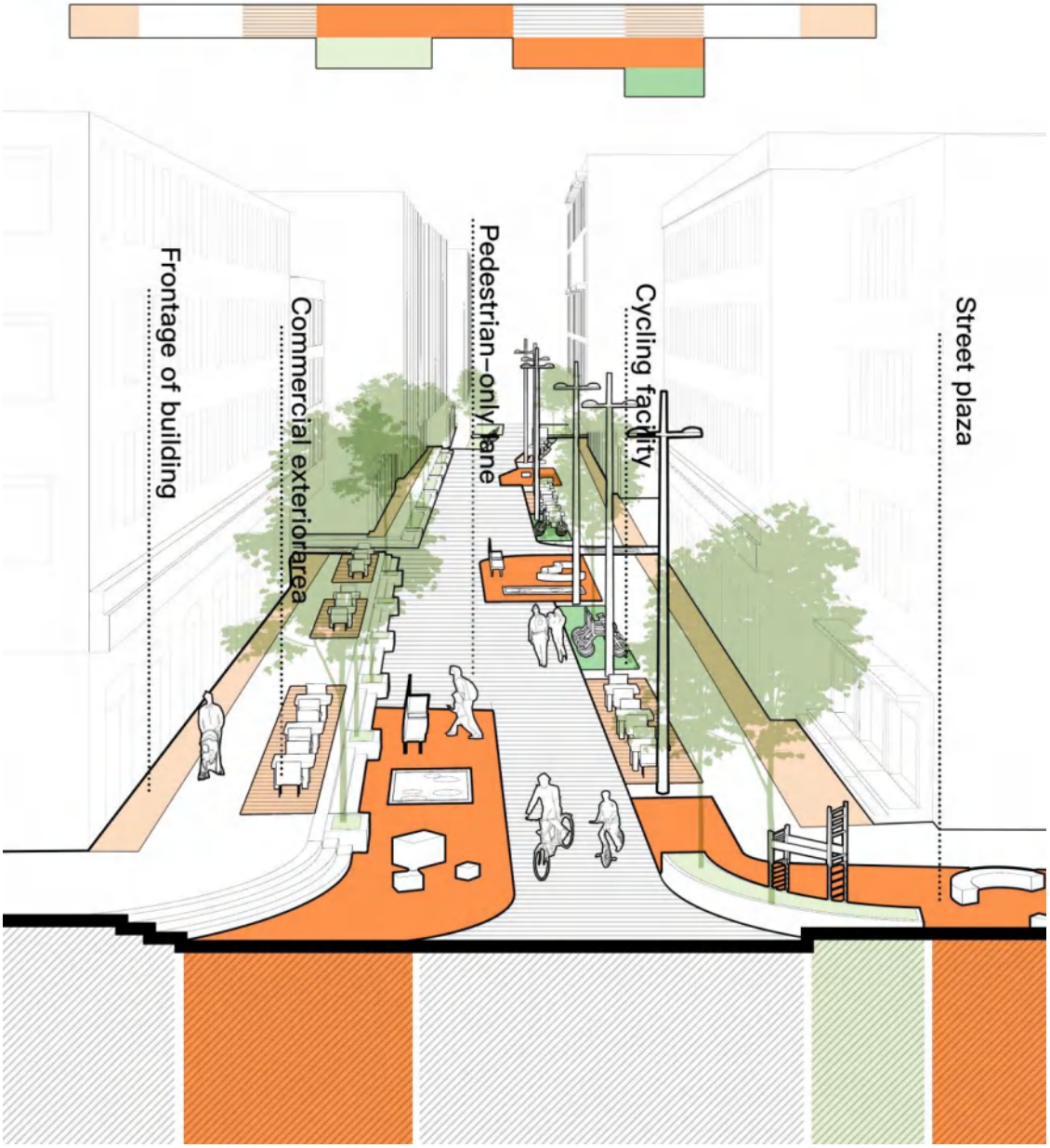


Fig.6-24 Hongqiao street functional zone profile（Drawn by author）

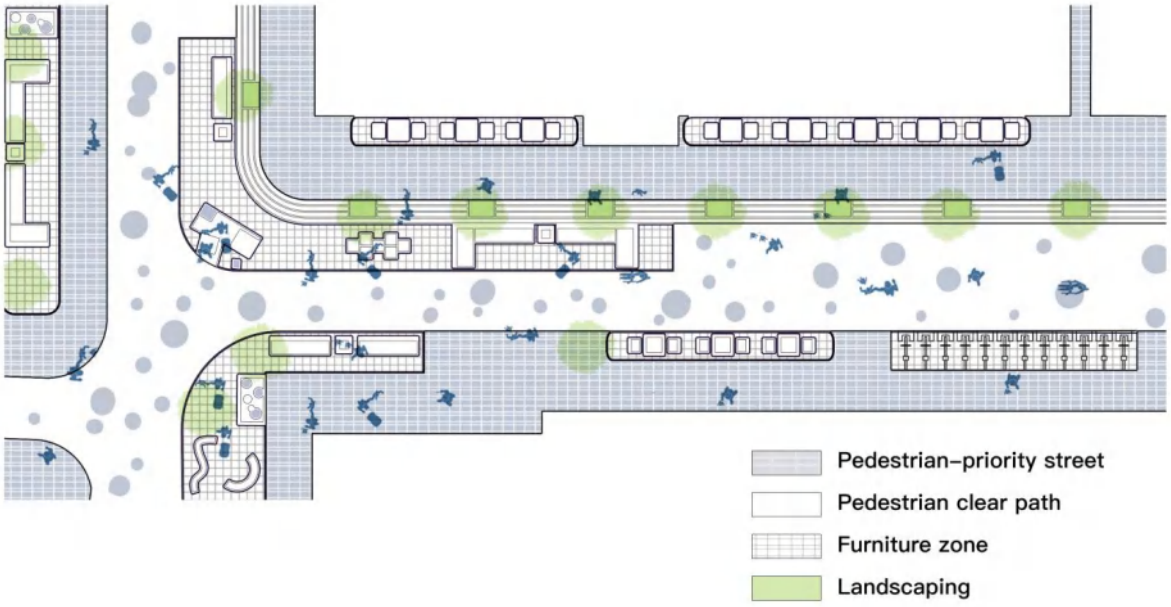


Fig.6-25 Hongqiao street optimization plan（Drawn by author）

Fig.6-26 Perspective view of Hongqiao Street: a pedestrian priority streets with play areas for children（Drawn by author）

6.2.3 Commercial and mixed streets

Commercial streets take on functions that are generally more complex than other streets, for example, providing services for people during the week and catering for activities such as shopping and eating at weekends. Parking and rest areas on these streets are often restricted by commercial activities. As a result, the pavements of commercial streets usually need to be wide enough to accommodate a large amount of pedestrian activity and commercial activity. On the other hand, as commercial streets act as a link within the community, people travel to the street by more diverse modes of transport, such as walking, cycling, public transport and driving private cars, so the design of the street needs to consider a variety of transport modes.

Challenges and current situation

Yingyuan Road is a one-way street in both directions outside the community, with retail and restaurants as well as government services spread on both sides of the street, and therefore has medium to high pedestrian and vehicular traffic throughout the day (Fig. 6-24).

I. Due to the width of the motorway, the non-motorway space is severely compressed to less than 1 m and there is no segregation, which greatly reduces the willingness of people to travel by bike.

II. The street crossing facilities are too far apart and people choose to cross the road from time to time for convenience, posing a greater safety hazard for children.

III. Due to the retail businesses on the ground floor, on-street parking for loading and unloading occurs from time to time, and cars stopping to unload can encroach on pedestrian space.

IV. Because of the noisy and crowded street environment, few children stay to play or rest.

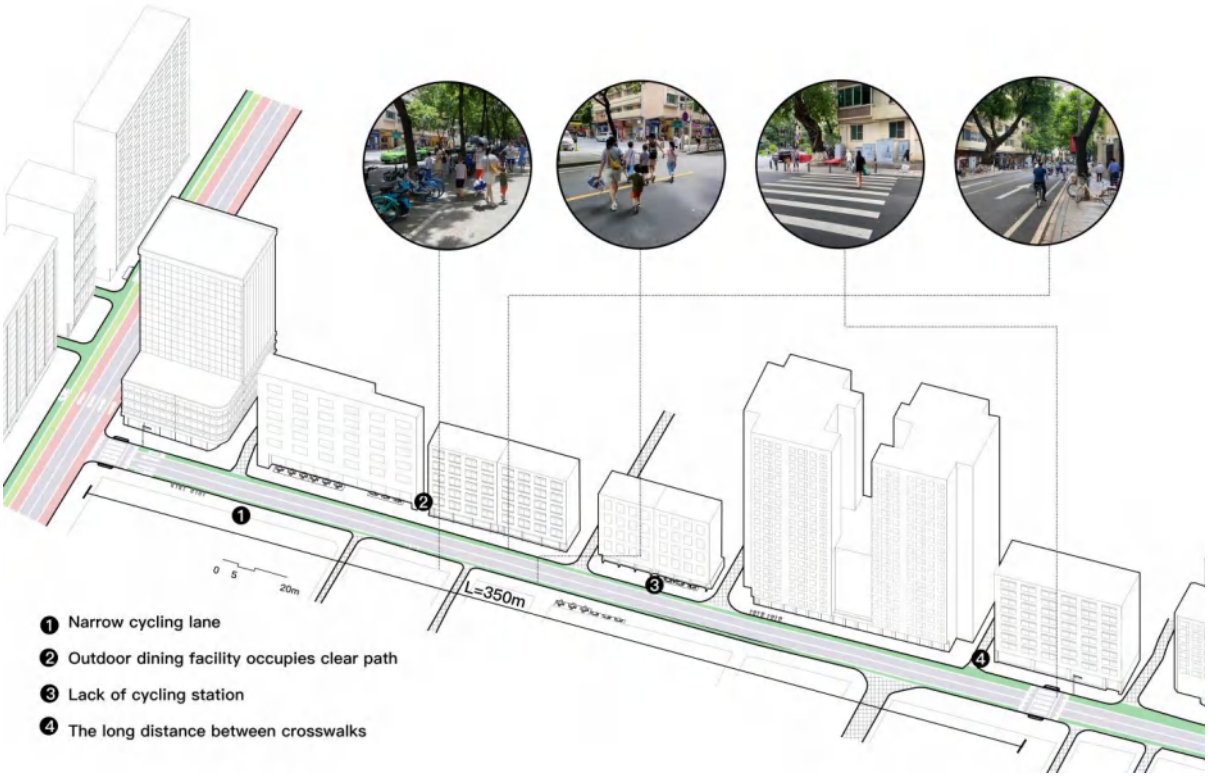


Fig.6-27 Original situation of Yingyuan street（Drawn by author)

Optimization strategies:

Commercial streets are often travel destinations for different groups of people and need to be designed to take into account the needs of a wide range of people. When optimizing commercial streets, strategies are often adopted such as: compressing space for private car traffic; expanding bus lanes and cycling lanes; and adding high quality public space in suitable locations (Fig. 6-25).

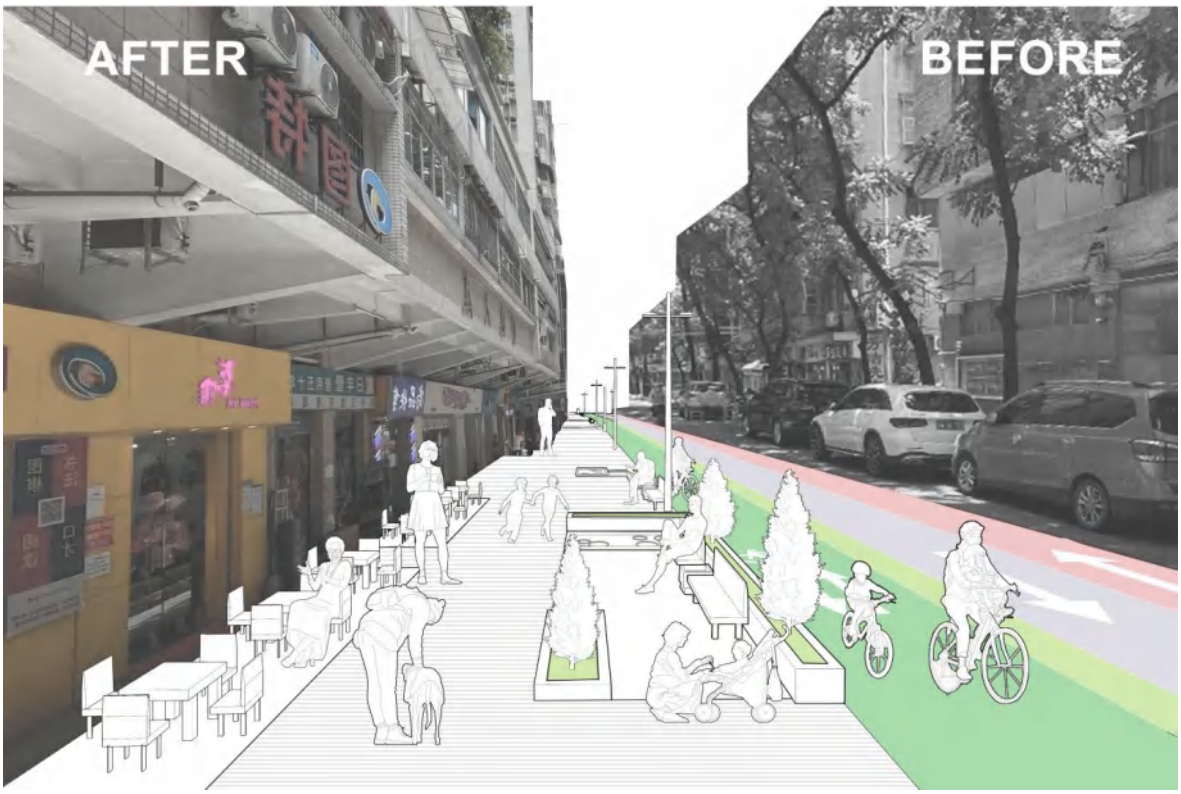


Fig.6-28 Before-and-after images of Yingyuan road（Drawn by author)

Strategy I. Meet multiple modes of transport and force motor vehicles to move at a slower speed by reducing motorways and adding junctions:

I. Reasonable control of the size of motorways and increased space for slow traffic :

Replace motorized lanes with public transport lanes and cycle lanes wherever possible. Bus lanes can allow taxis and some vehicles to pass, thus using less road space to transport more people on trips, and using the recovered road space to widen the footpath. The width of the mixed lane for large and small vehicles can be reduced to 3.25 m and the width of the lane for small cars can be reduced to 3 m.

II. Improve street permeability :

Increase the number of junctions in the neighbourhood, particularly at bus stops or large retail outlets. Provide street crossings in accordance with pedestrian demand and reasonably control the spacing of street crossings, which should generally be limited to 100 m and not exceed 150 m maximum.

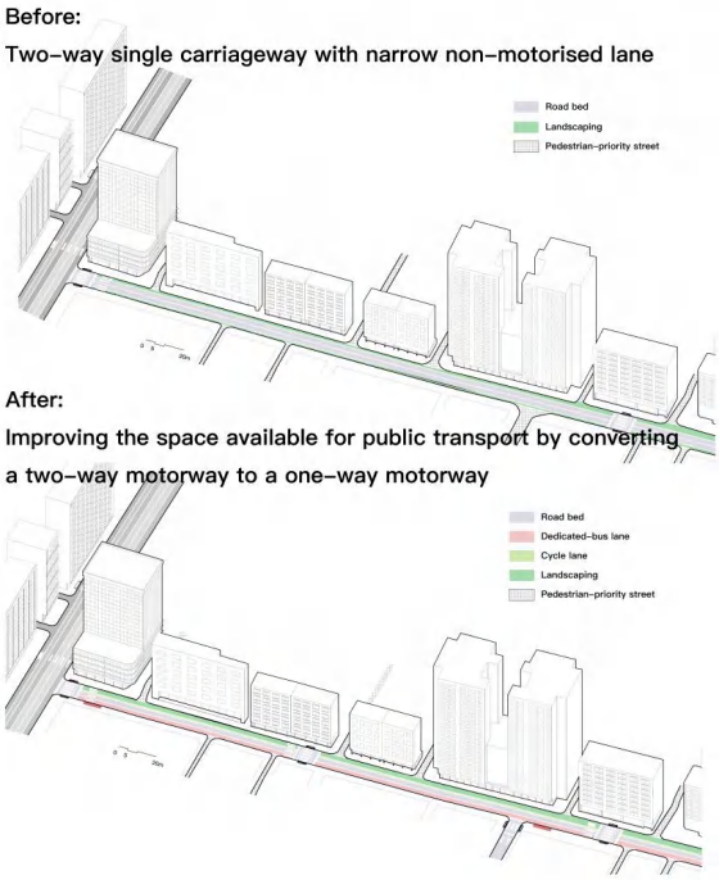


Fig.6-29 Improve space for public transport modes（Drawn by author)

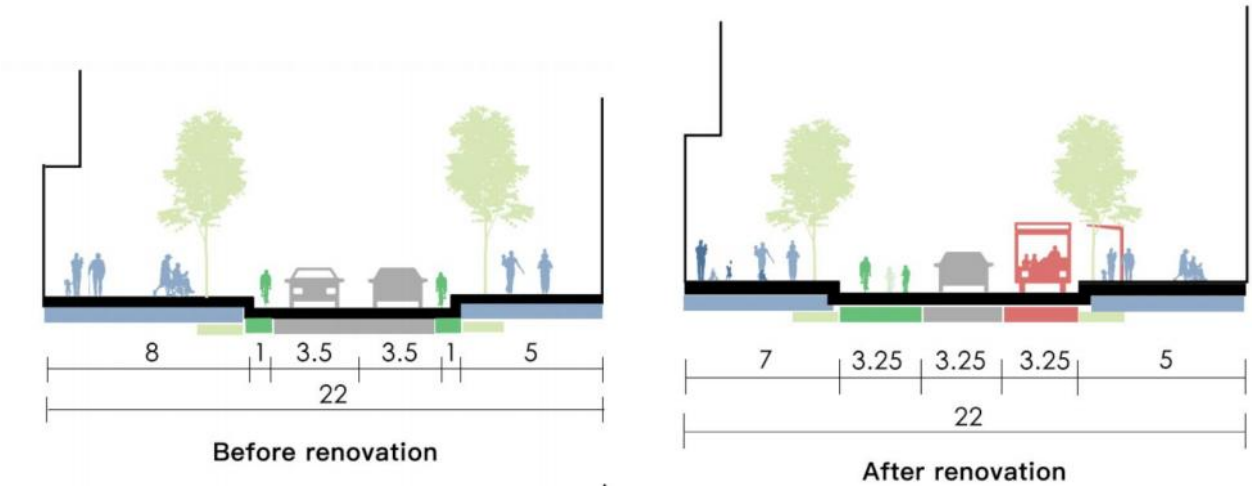


Fig.6-30 Section of Yingyuan Road before and after renovation (Drawn by author)

Strategy II. Logically zone street spaces to ensure pedestrian accessibility

I. The frontage of the building should be provided when the ground floor building provides an active function, but should avoid interference between the passage area and the frontage of the function along the street: the frontage of the first floor building where display windows and vending windows are the main feature can reach 0.5-1m; the width of the frontage where outdoor goods display and outdoor dining of facilities are carried out can reach 1.5-2 m.

II. Providing areas for children to rest and play with sheltered facilities, for example, play and interactive elements at transit stops, while ensuring that pedestrian space is unobstructed (Fig. 6-28).

Strategy III. Adopt vehicle control measures to reduce the impact of motor vehicles

Managing the demand for parking on both sides of the street by reducing the number of parking spaces on the street or adopting a parking charging strategy. Besides, installing signals at intersections and extend the duration of the signals appropriately to take into account the speed of children walking (Fig.6-29).

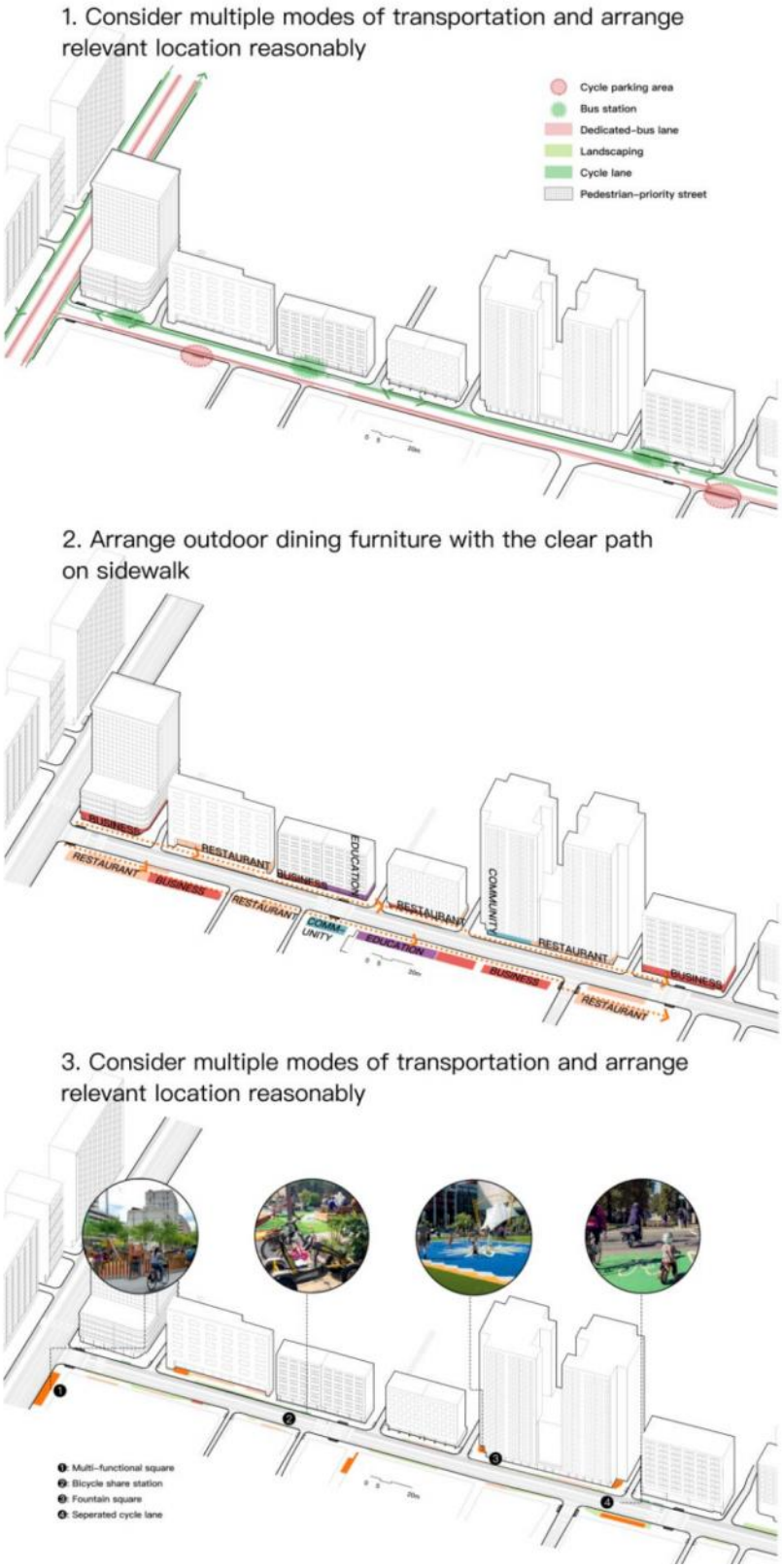


Fig.6-31 The process of optimizing the functional zoning of streets（Drawn by author)

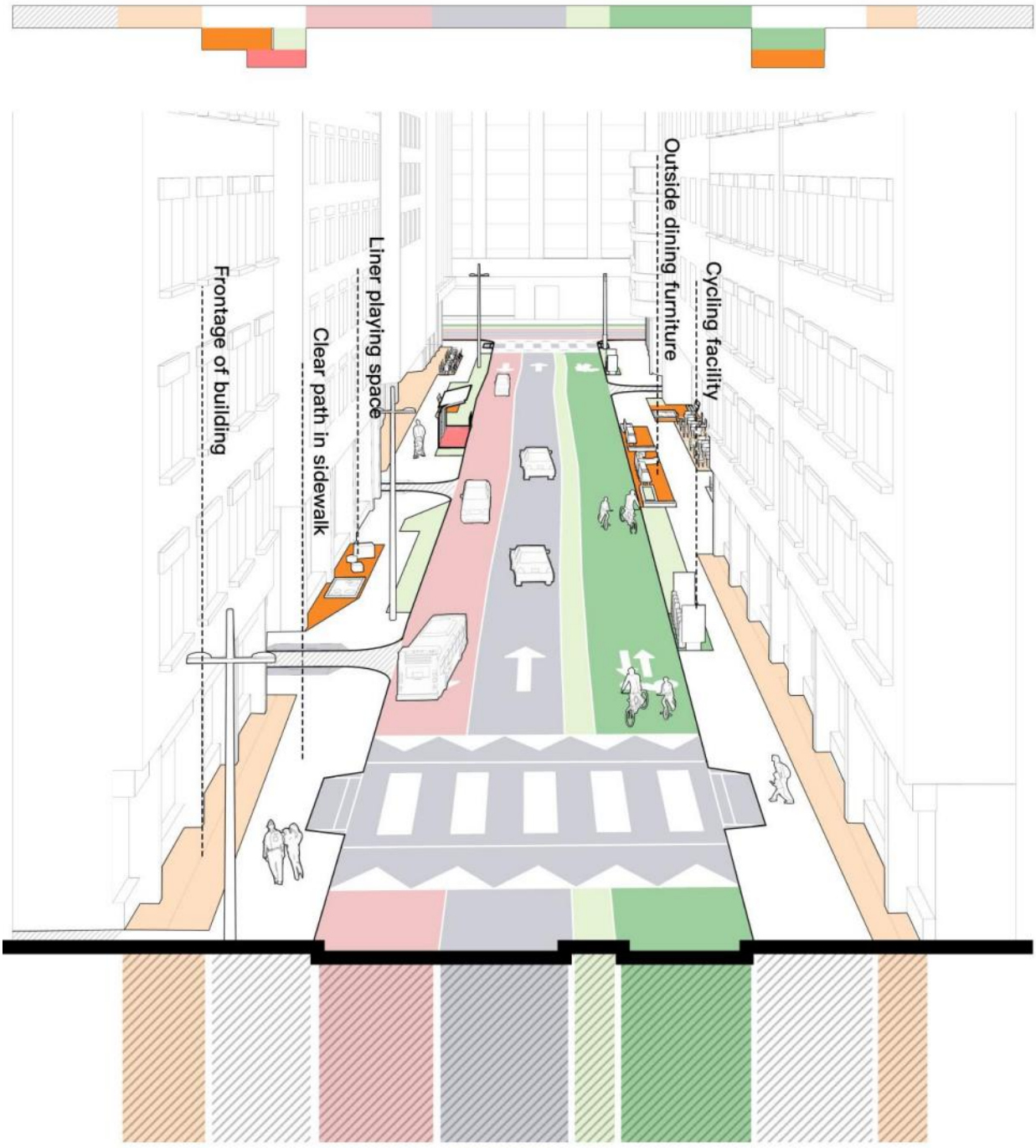


Fig.6-32 Yingyuan street functional zone profile（Drawn by author）

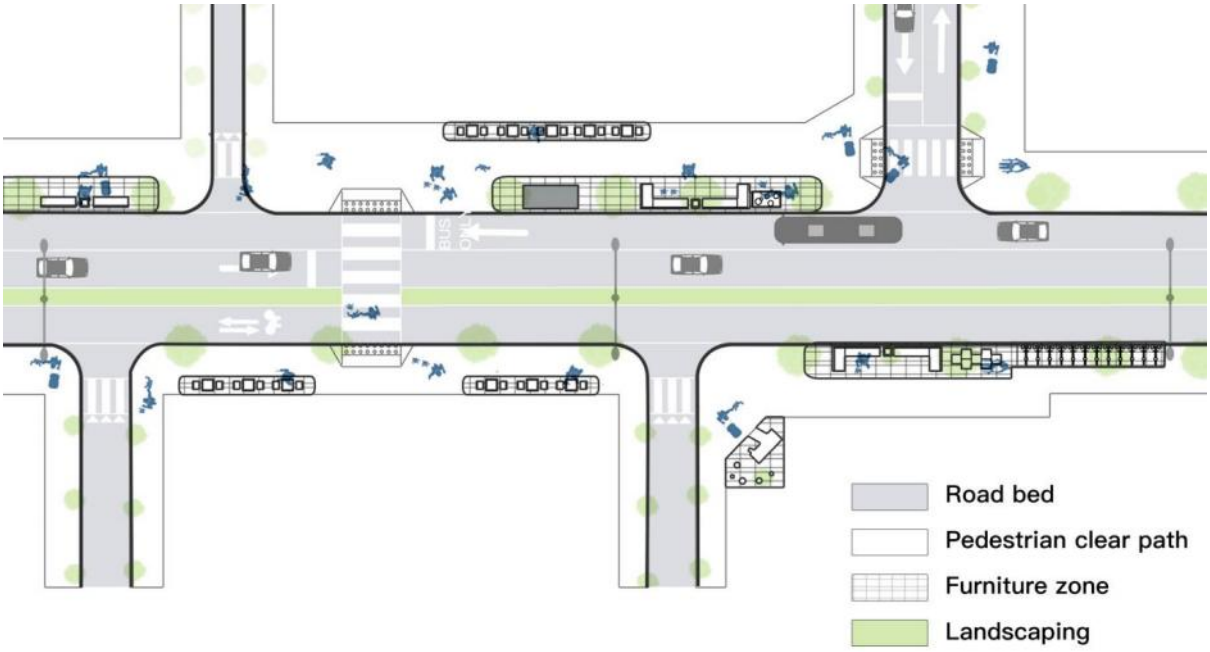


Fig.6-33 Yingyuan road optimization plan（Drawn by author）

Fig.6-34 Perspective view of Yingyuan Street（Drawn by author）

6.2.4 Thoroughfares

Urban roads generally perform the function of fast moving vehicles and are the main corridors of urban traffic. The long distances between junctions and the lack of adequate pedestrian crossings due to fast-moving vehicles often cut off the links between the neighborhoods on either side; in addition to this, the pavements and cycle paths alongside these roads are narrow due to fast-moving vehicles taking up space on the road, and the fast-moving vehicles also affect the psychological perception of pedestrians passing by, with children often not having the opportunity to play and travel safely on these streets.

Challenges and current situation

Xiaobei Road is an urban secondary road, 30 m wide, a two-way six-lane road, with a large traffic flow and pedestrian flow. Therefore, the existing problems of Xiaobei Road are as follows (Fig. 6-31):

I. Lack of adequate crossing facilities, resulting in weak links between the east and west sides of the neighbourhood

II. The presence of a large number of large vehicles on the road as it is a secondary urban road, resulting in poor air quality and some noise pollution in the vicinity of the street.

III. Pedestrians must always be aware of the fast-moving vehicles around them, and due to the large turning radius and number of junctions, the pavement is not continuous and not friendly enough for prams or wheelchair users.

IV. The lack of space for cycling leads to cyclists competing with pedestrians for road space with children and pedestrians.

V. Traffic congestion due to public buses sharing lanes with other vehicles; also shelters are not sheltered and do not have enough seats for children and elderly people.

VI. There are large, mono-functional buildings on the ground floor of the street, and the continuous closed facade is singularly boring.

VII. At night, the visibility of the road is poor, making the road conditions more dangerous.

VIII. Local sections have elevated bridges, which also have a negative impact on the street

scene due to the lack of management of the elevated bridges and the piling up of waste and unused vehicles, resulting in negative and under-utilized space attributes.

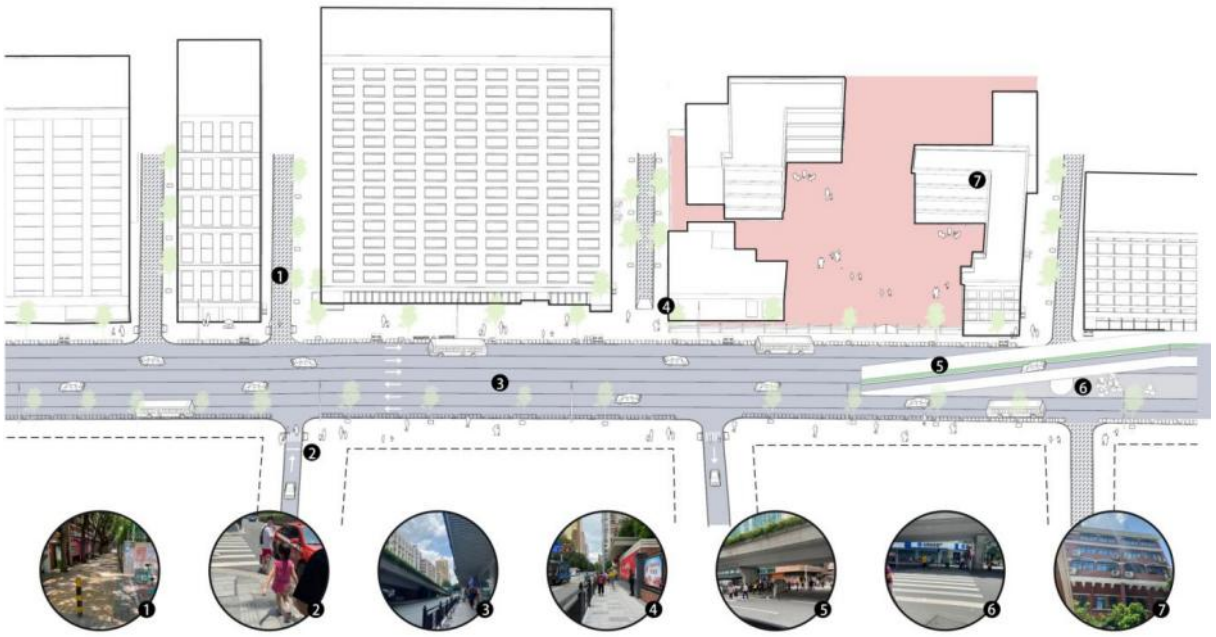


Fig.6-35 The present situation of the street space of Xiaobei Road（Drawn by author）

Optimization strategies:

The improvement will be carried out in four main ways: firstly, the street interface needs to be redesigned to control the scale of motor vehicles and to use the reclaimed space for public transport as well as for cycling and walking spaces; secondly, to increase and optimize the activity spaces available for children on the street; to extend the coverage of child-related functions on both sides of the street, to expand the coverage of these areas and to increase their use; and finally to secure the design to meet children's needs, such as playing and resting, in micro-spaces by adding street furniture.

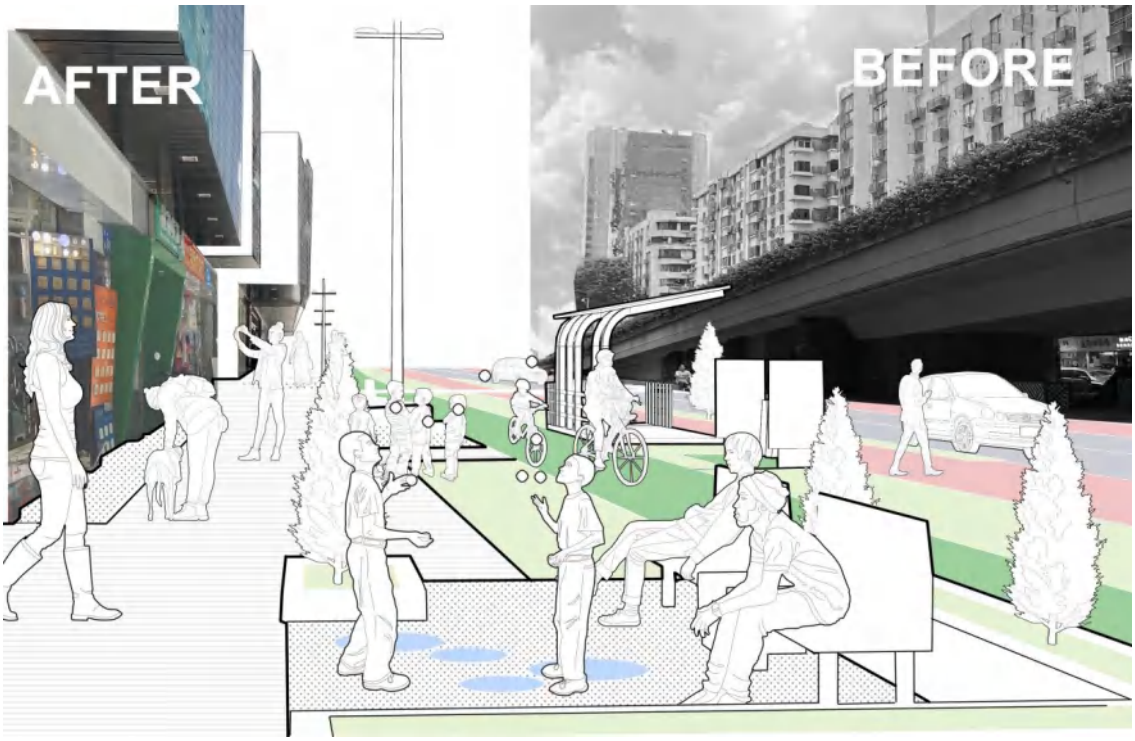


Fig.6-36 Before-and-after image of Xiaobei Road (Drawn by author)

Strategy I. Redesign the street interface:

The motorway is re-routed to reduce three lanes in each direction to two lanes in each direction, adding a one way non-motorway lane and a one way bus lane in each direction. The reclaimed pavement space is widened to ensure that the width of the passing area on the street is greater than 2.4 m (Fig. 6-33).

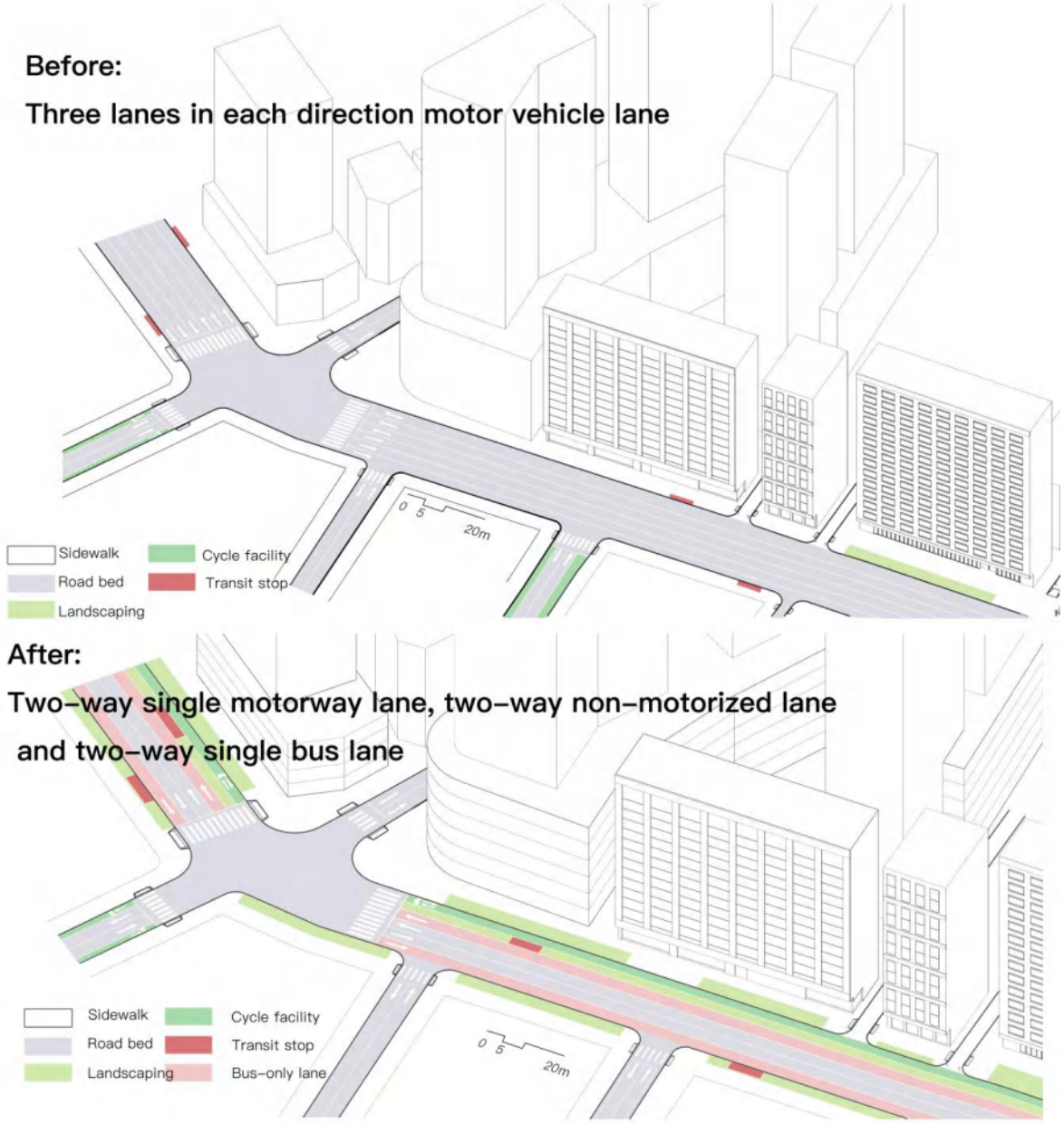


Fig.6-37 The process of reducing space for motor vehicles (Drawn by author)

Strategy II. Reclaim road space and reduce travel difficulty for children

The existing crossing facilities are too far apart and the number of crossings needs to be increased to reduce the difficulty for children to travel. And the distance children have to cross the road needs to be reduced by partially extending the pavement and adding traffic islands. For crossings and pavements in front of bus stops, partial elevation could be used and signs added to alert passing drivers (Fig.6-34).

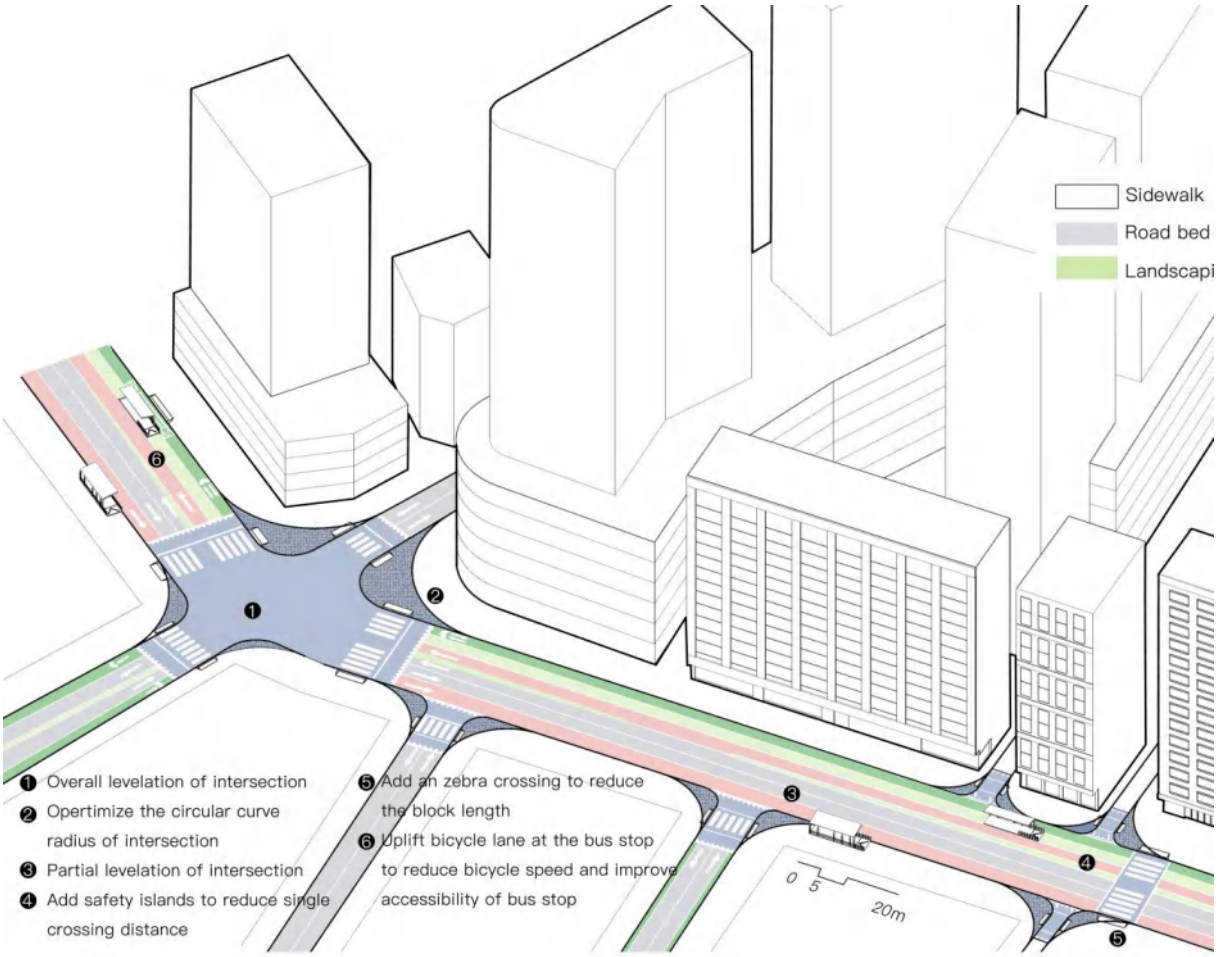


Fig.6-38 Reduce turning radius and use pavement different from roads for highlight（Drawn by author）

Strategy III. Optimize the children's activity space on the street

Making the best use of unused spaces and transforming them into parks and squares. Creating linear parks on one side of the street will not only accommodate amenity strips and children's play areas, but will also provide shade and buffer the road from noise pollution. Besides, finding space on the street to add children's play areas to accommodate children playing and stopping for rest spaces. Integrating bus shelters with street lights and benches and play facilities to ease children's anxiety about waiting for the bus (Fig.6-35).

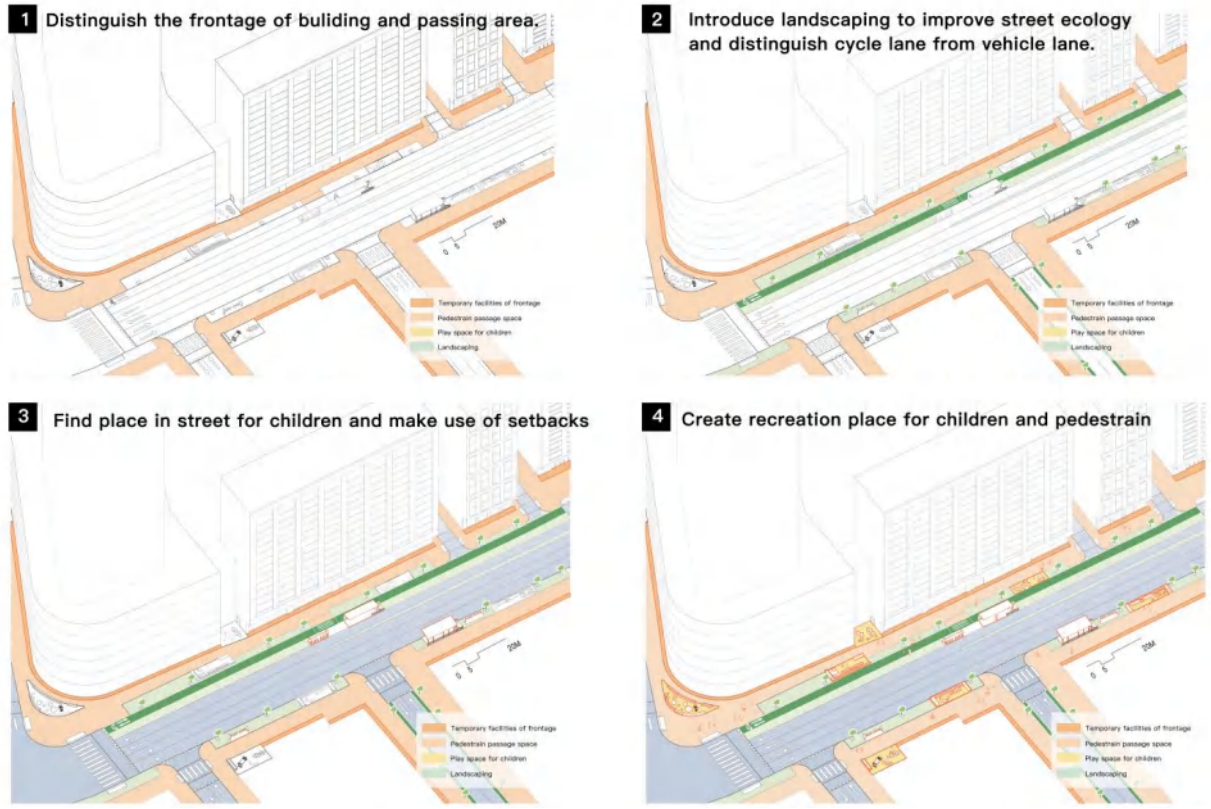


Fig.6-39 The process of optimizing children's street activity spaces（Drawn by author）

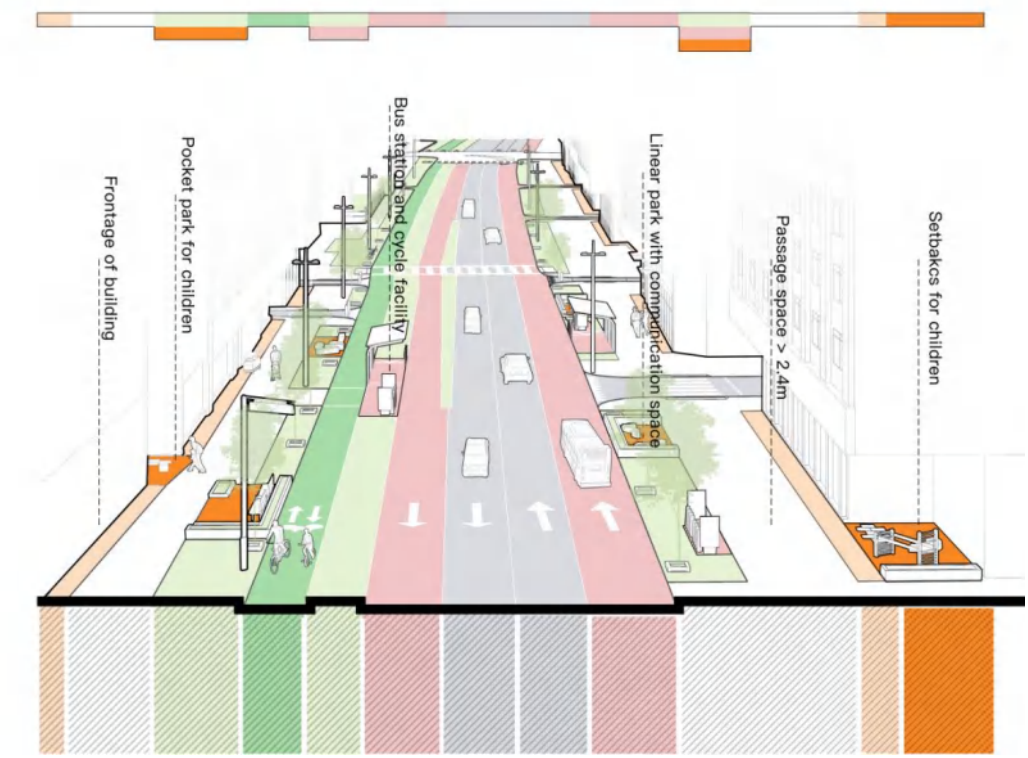


Fig.6-40 Xiaobei Road functional zone profile（Drawn by author）

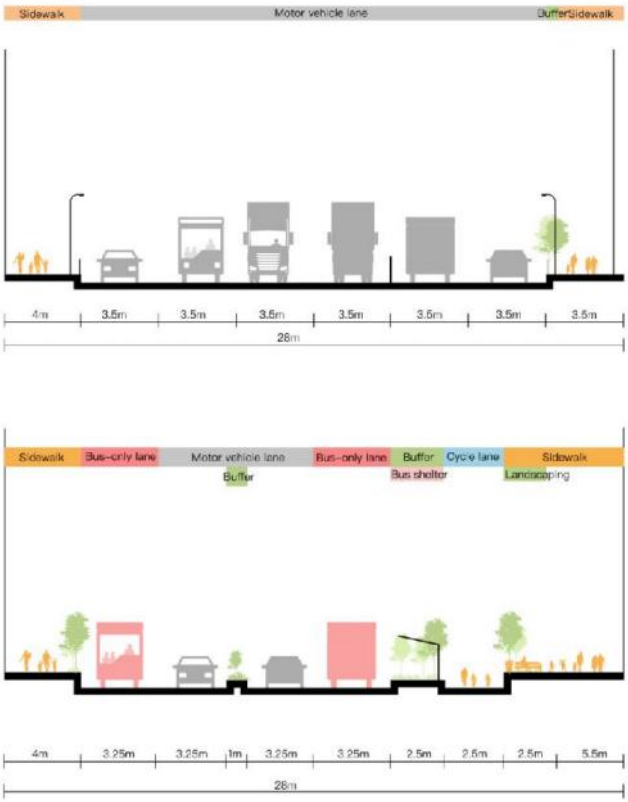


Fig.6-41 Original section and renewal section of Xiaobei Road（Drawn by author）

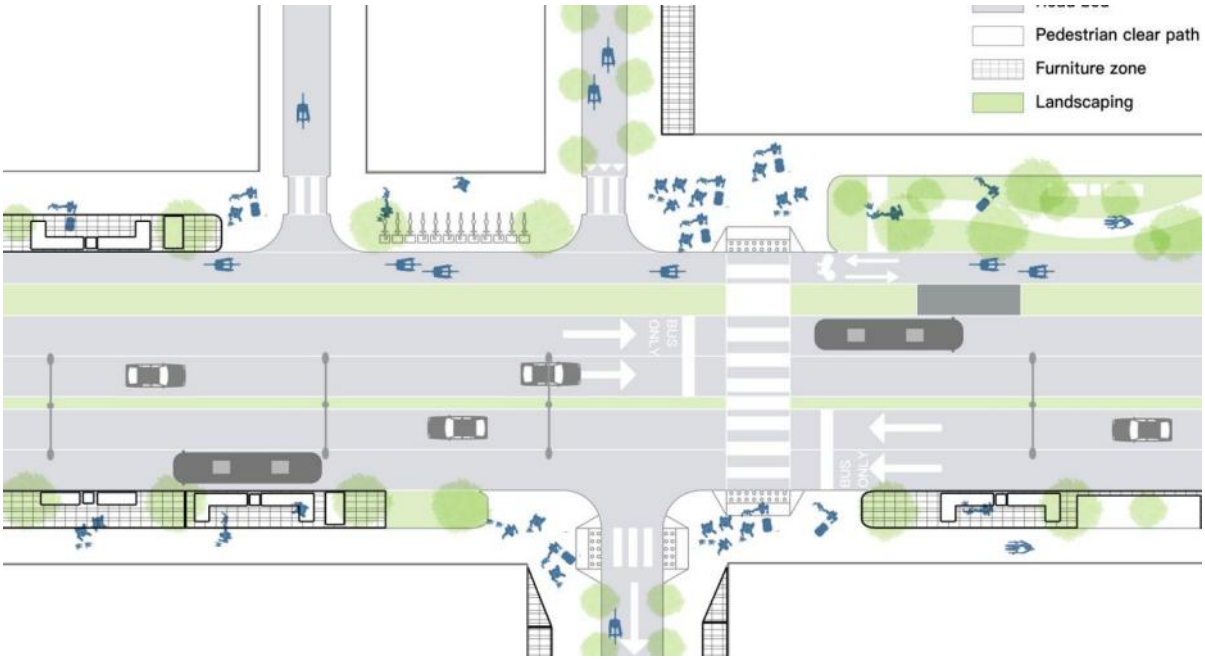


Fig.6-42 Xiaobei Road optimization plan (Drawn by author)

Fig.6-43 Perspective view of Xiaobei Road（Drawn by author）

6.3 Detail Scale: Street Furniture and Facility

6.3.1 Intersection

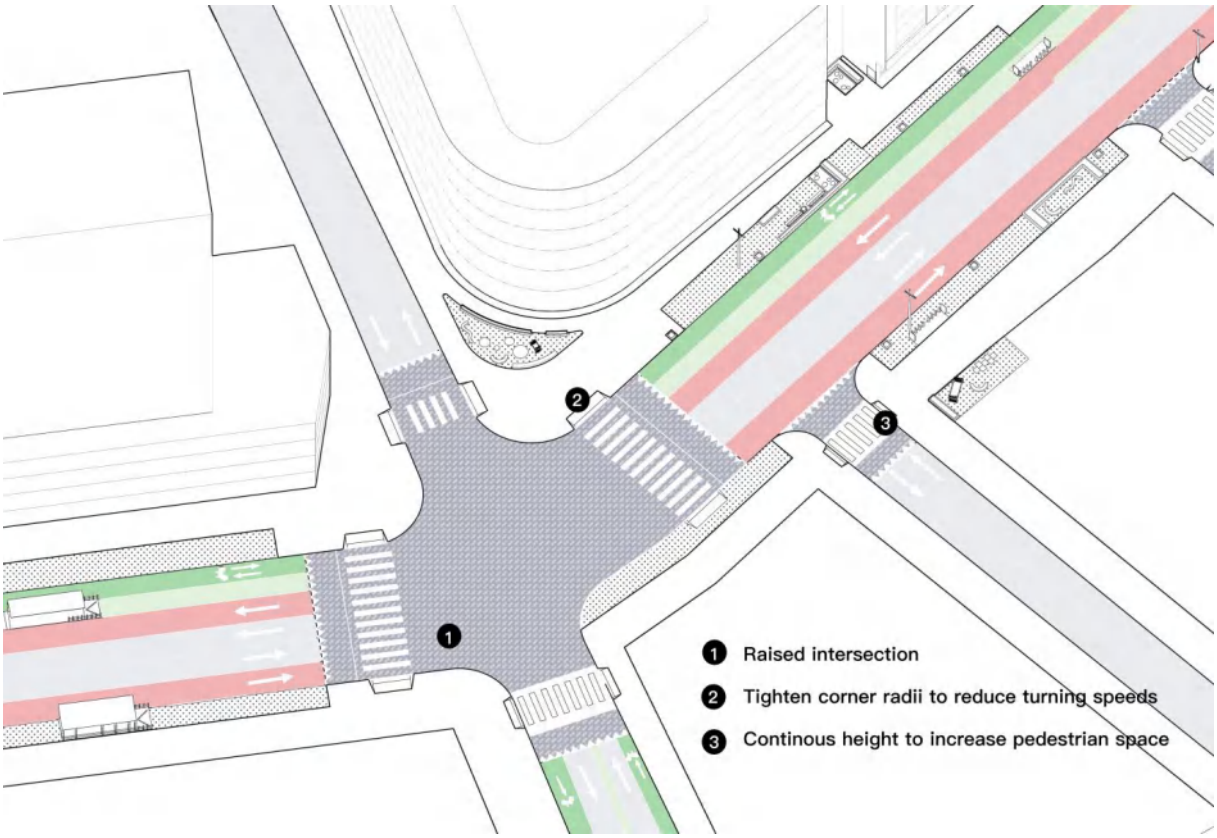


Fig.6-44 Key points of intersection design（Drawn by author）

I. Design compact intersections:

Compact intersections reduce exposure, slow traffic near conflict points, and increase visibility.Make intersections compact, tighten corner radii to reduce turning speeds, and limit turn lanes where possible.

II. Simplify geometry:

Complex intersections can be simplified into multiple smaller intersections to increase legibility, uniformity, and safety. Prioritize perpendicular intersections.

III. Increase pedestrian space:

Redesigning intersection geometry can increase pedestrian space. Use interim plazas and low-cost elements and materials to quickly enhance public life.

Fig.6-45 Child friendly intersections (Source: https://globaldesigningcities.org)

6.3.2 Pedestrian crossing

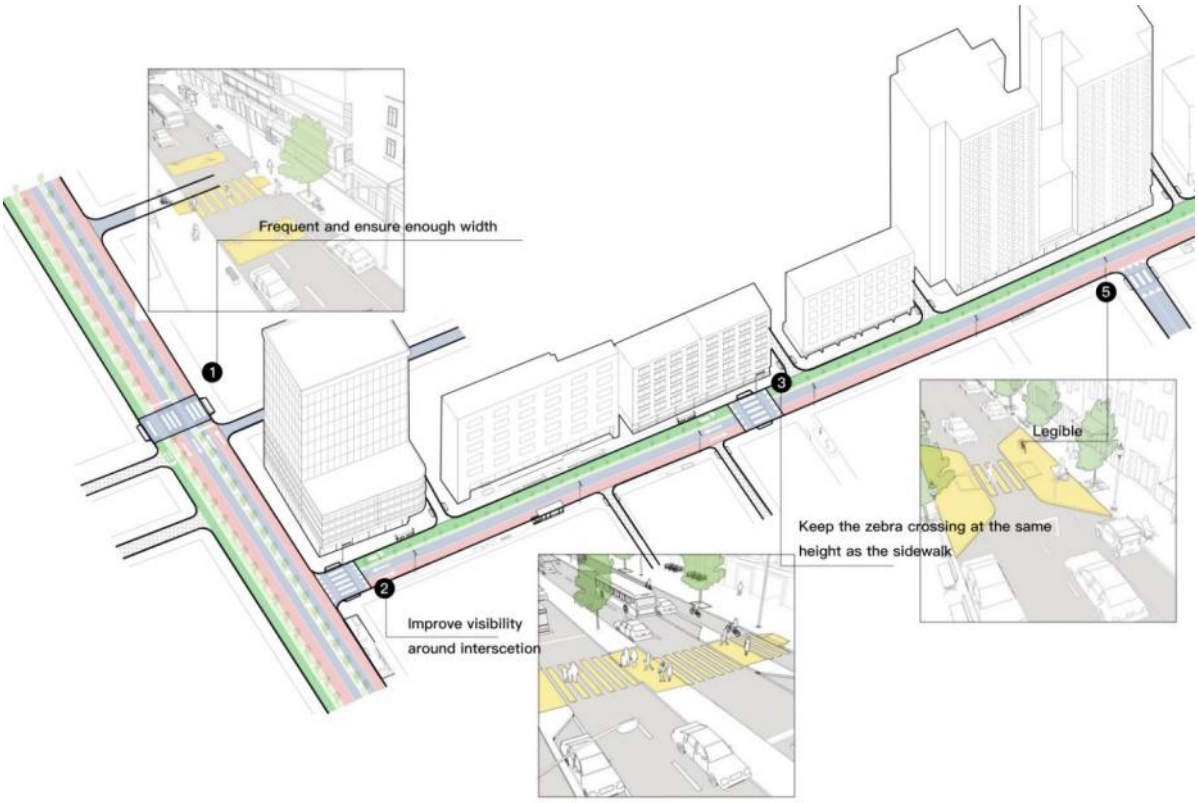


Fig.6-46 The design principle of pedestrian crossing（Drawn by author）

I. Frequent

For neighborhoods with high population density, crossing facilities should be provided at intervals of 50 to 100 m, with the furthest distance not exceeding 200 m, to ensure permeability of the pedestrian network. In addition, zebra crossings should be no less than 3

m wide, or wider for areas of high pedestrian traffic.

II. High visibility

There should be no parking for motor vehicles within 6 to 8 metres of the intersection, and it is possible to widen the pavement with parking lines at least 3 metres from the intersection and to ensure a clear and unobstructed view within 3 to 5 metres of the intersection; pedestrian crossings must be sufficiently visible. In areas close to schools, parks, etc., pedestrian crossings may use bright colours and interesting patterns, provided that traffic claming is available.

III. Continuous with the sidewalk space

All pedestrian crossings should be matched with the height of road or pavement; pavement to provide a shortest route for children to cross the road. Pedestrian crossings should be equipped with ramps, speed bumps and clear zebra crossing landmarks on both sides that connect to the pavement. In addition to this, underpasses and footbridges should be avoided; zebra crossings should be positioned with pedestrian route preferences in mind, aligning the crosswalk with a clear pavement as far as possible.

Fig.6-47 The colorful pedestrian crossing in Fortaleza (Source:https://globaldesigningcities.org)

6.3.3 Landscaping

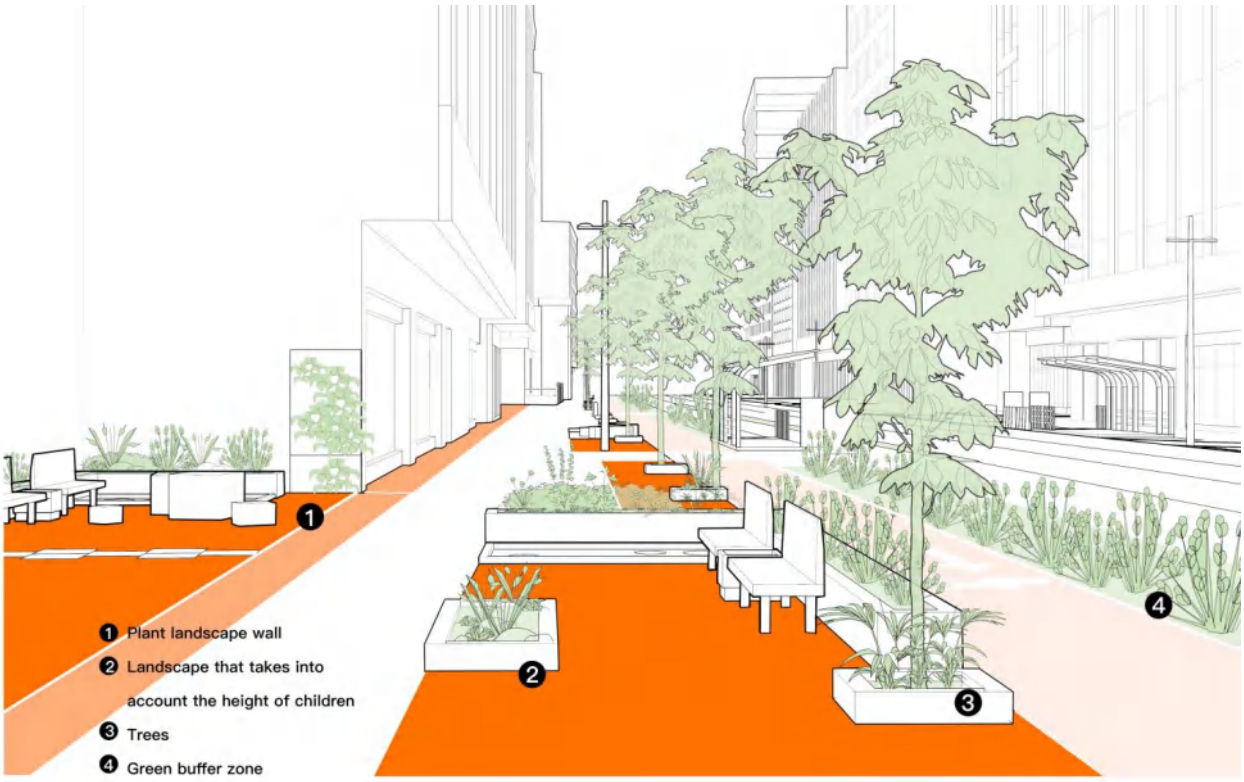


Fig.6-48 Different types of green infrastructure (Drawn by author)

Fig.6-49 Cases of street green infrastructure (Source: Designing street for kids)

Landscaping not only purifies the air and enhances the biodiversity of the city, providing habitat for native species of birds and insects, but in addition it benefits children's brain development, further improving cognition, physical coordination and also relieving the caretaker's sense of stress. When thinking about natural elements on the street, the following points should be noted:

I. Combined with other street furniture settings:

Place trees near elements such as seating or play so that they provide shade in areas where children often spend time.

II. Incorporating children's scale:

Children are more likely to see plants that are close to the ground, so the choice of plant species needs to be considered in conjunction with children's height and eye level

III. Choose plants that are non-toxic and edible:

As children are curious by nature, it is important to choose plant species that are safe, edible and thornless. In addition, plants should be able to attract small animals such as native butterflies and bees.

IV. Selection of appropriate forms according to the street scale:

For streets of sufficient width, a linear park format can be used, incorporating seating and play elements to provide a place for children to interact with nature. For streets of limited width, parking spaces can be converted into tree pits, or walls and poles can be used for three-dimensional greenery

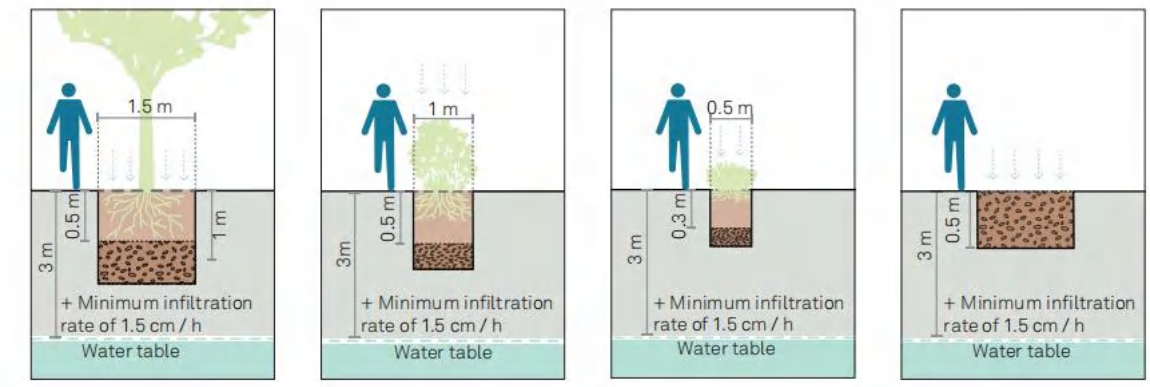


Fig.6-50 The minimum width, depth, and infiltration rates required for a variety of tree-pit types(Source:Global street design)

6.3.4 Seating

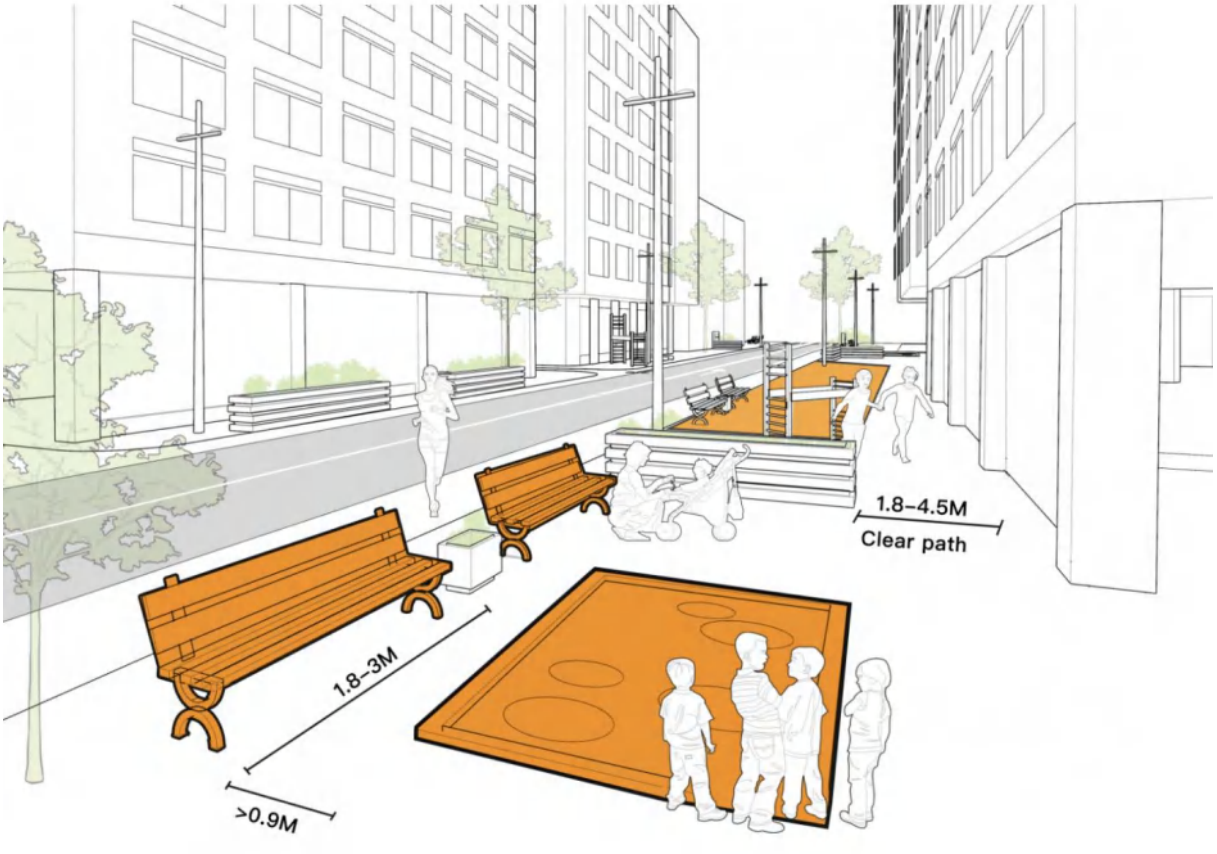


Fig.6-51 The appropriate dimensions of seating (Drawn by author)

When thinking about natural elements on the street, the following points should be noted:

I. Adopt appropriate dimension and number:

To make the seat comfortable and accessible, the seat should be 0.5 m high. The seat should be greater than 3 m in length to encourage interaction between children and adults. Space needs to be reserved around the seat for wheelchairs and prams. As children are more likely to tire, seats should be installed in every block, with a spacing of 50-100 m between seats.

II. Choose correct site：

Seating is provided close to key destinations, play spaces and street corners to meet the needs of carers watching and waiting for children to play. The seat should also be positioned at a distance from the nearest lane, as well as with space for seat placement and front foot

space that does not obstruct the clear path. Fixed seating should not interfere with entrances of buildings.

III. Adopt Appropriate Form：

Street seating includes both fixed and movable seating, and the type of seating should be appropriate to the width of the street and the volume of pedestrian traffic. For shared streets, pedestrian streets and squares, flexible seating allows people to move their orientation to suit their viewing needs. For fixed individual seating, the furniture areas on the pavement are usually in a linear configuration and are more private. For fixed social seating, it is often used in corners and alcoves to allow more children to sit together or to promote social interaction between strangers.

IV. Incorporate play elements：

Because of the random nature of children's activities, the form of seating used should meet the needs of children's play. For example, easy-to-climb handrails to attract children, and play elements can be incorporated around the seat. In addition to this, the corners of the seat should be as rounded as possible.

Fig.6-52 Different types of seating (Source:Designing street for kids)

6.3.5 Playing elements

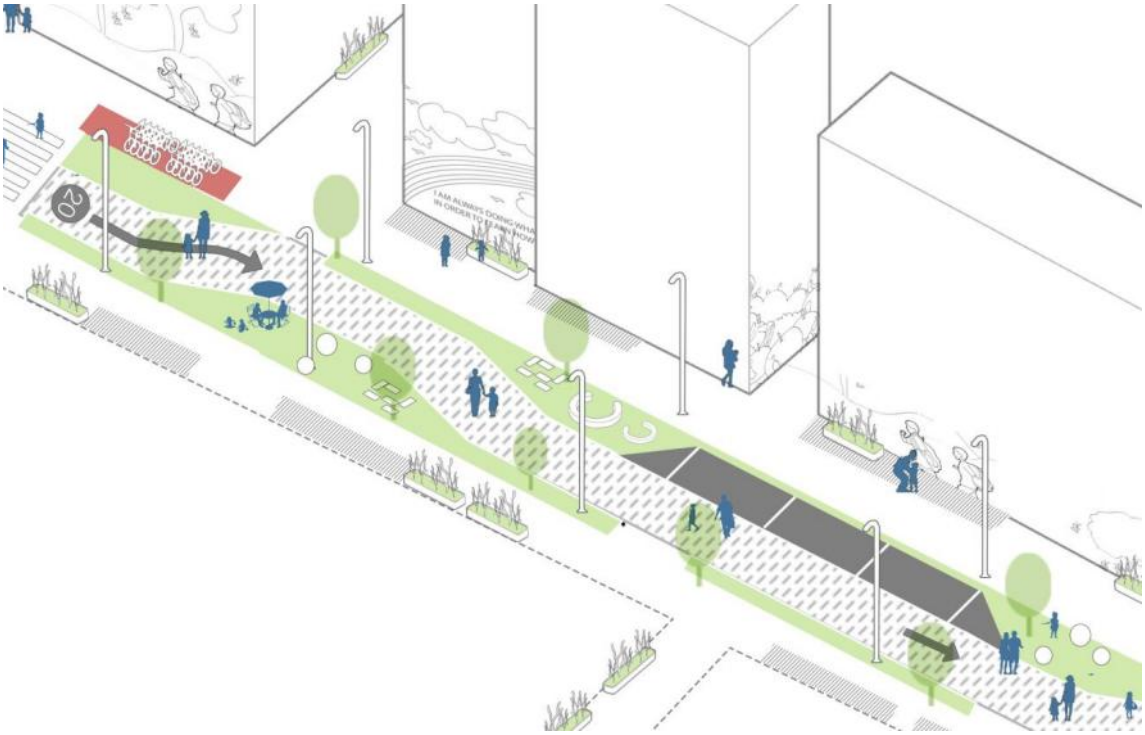


Fig.6-53 Different types of enlightening elements in street

Fig.6-54 Various game elements at different locations in the street space (Drawn by author)

I. Look adequately for different locations on the street:

Street floors, walls and street furniture can be used to incorporate play elements. For ground elements, prioritizing paving patterns along pavements, clear paths, and the edges of major buildings that invite children to linger; for vertical surfaces, painting art murals on

blank building facades, walls, windows, and other vertical surfaces; street furniture includes seating, bus stops, and bicycle parking spaces, where musical devices can be set up to play children's songs and help promote child and caregiver communication and interaction; temporary play installations at utility poles can beautify the poles and add interest at the same time.

II. Adopt different types of play elements:

These include visual elements, sound elements and natural elements. Visual elements include the use of words and pictures such as poems, idioms and simple mathematical equations to enhance children's reading and reading skills; painting children's pictures on the floor or blank walls to enhance children's sensitivity to colour and develop their imagination; incorporating semi-structural play equipment to enhance children's hands-on skills or fitness equipment to promote physical coordination.

6.4 Summary

In this chapter, try to optimize the existing community street space, based on the size and type of street used by children on a daily high frequency level, the traffic flow and speed, and the current situation of the surrounding buildings, and combine the set of elements that users intend to optimize with the focus of the optimization strategy according to the functions undertaken by different streets, so as to create a vibrant street space that encourages mobility for all. And this chapter focuses on optimizing the street space in the Xiaobei District at three levels.

The first is the neighbourhood scale, where a network of different ways of walking and cycling on the streets of the district and a daily travel path for children are planned, thus identifying four different types of regenerated streets.

The second is the block scale, which is designed at the specific street level. Selected one of the four different streets in the base, namely street near key destination, community living street, commercial street and thoroughfare, and the optimization strategies for each street are focused on “safety”, “continuity” and “comfort”, with regard to the functions and status quo of each street.

The final section is the detail scale, which focuses on street design details, including pedestrian crossings, street furniture, green infrastructure and other elements, as well as the possible selection and placement of street furniture for different road conditions.

Conclusion

Conclusion

"What is wrong with society is that planning and design is based around cars, house building and the economy rather than the environment, health and quality of life." Children need more than just playgrounds, but entire inclusive, safe and accessible cities. A safe, continuous and enjoyable street network is essential for child-friendly city building. Children are the future masters of the city and are a group that needs to be protected and cared for. Children in today's cities are often allowed to explore and play in isolated and enclosed formal spaces, making it difficult for them to develop their natural instincts in an overprotected manner. Urban streets are the most frequently used urban open spaces for children, and the quality of street space should be a concern for urban planners. The study of 'child-friendly' streets will not only improve the current urban street environment, but will also improve the experience of children exploring the city while ensuring the safety of children and other groups, and is friendly to all.

In this paper, based on a summary of the development of the theory of child-friendly cities, the connotation of the concept and the latest spatial construction guidelines of various countries, the spatial characteristics and design points of child-friendly street spaces are compiled.The paper then further combines the analysis of the psychological and behavioral characteristics of children, the differences between their behaviour and that of adults, and the latest cases of child-friendly city construction in foreign countries, and proposes the principles of child-friendly street space renewal: safety, continuity, comfort and children's participation. Based on this, a representative district in Guangzhou was selected for field research, and the characteristics of children's outdoor activities and street space environment in the district were investigated: analyzing the shortcomings of the current street space from a child-friendly perspective, and inviting children from Xiaobei to draw a route map for their daily travels. Finally, in response to the current problems, and combined with the previous theoretical foundation research and relevant overseas cases, the principles and strategies of street regeneration are proposed, and the following conclusions and results are as follows:

(1) By using typology, traffic counts and road profile mapping to analyse the spatial characteristics and deficiencies of the existing streets. A questionnaire survey of children and parents in the Xiaobei District was conducted from a child-friendly perspective and found that: 1) children in the Xiaobei District prefer to travel on foot or by bicycle; 2) parents generally believe that there are traffic and social hazards in the current state of the streets and that the condition of the streets is not adequate for children to move around safely; 3) children and parents generally believe that there lacks space for children's activities due to the age of construction, old facilities and narrow streets, and that the comfort of the streets needs to be improved. The comfort of the streets needs to be improved, and improving the safety of the streets is a priority for the future.

(2) In formulating the optimization strategies: Firstly, the current problems of the street are combined with the current situation of the street. Secondly, children's opinions are fully considered by inviting them to draw a route map for their daily travels to increase their participation. After that, from the perspective of the basic functions of the street: 1) supporting children's independent mobility; 2) providing children with space for rest and activities, five optimization strategies “Upgrade”,“Reclaim”,“Extend”,“Activate” and “Policy” are proposed to meet the transformation needs of streets undertaking different functions.

(3) Finally, the design of the streets in the Xiaobei District is practised at three levels. Firstly, the overall walking and cycling network of Xiaobei District is constructed. And by planning children's daily travel routes, the boundaries of the design are determined at the street scale level: Tianxiang Street, Hongqiao Street, Ying Yuan Road and Xiaobei Road are selected. By limiting the scale of motor vehicle space, providing the saved space for the slow-moving system, continuing the missing sidewalks, providing street crossing facilities and segregation zones to enhance the safety level of the street, and redistribute the walking and cycling space of the street; By adding children's favourite structures and play elements, fully reusing unused space on the street, providing parklets on both sides of the street to activate the street space, enhancing the functional complexity of the side interface, the road surface is extended to both sides of the street. Finally, measures to

protect children's mobility are developed to support the management of the street.

Innovation:

In terms of innovation, there are two aspects:

(1) In research content innovation, the paper studied the latest documents issued abroad on building child-friendly cities and summarized the characteristics of child-friendly streets;

(2)The working methods innovation, this paper was developed based on the methodology of "relevant theoretical research - generation of targeted principles - principles-guided design strategies - application of strategies to schemes", and also adopted a method of inviting children to draw travel routes in the design process which was rarely seen in before.

The Shortage of Research

(1) As different countries have different development situations, the planning guidelines for child-friendly city construction in each country have their own emphasis. Due to the limited time, only five planning documents from five countries were selected for the study, so the design points of child-friendly in the physical space level are limited and incomplete.

(2) The design of child-friendly street spaces covers a wide range of disciplines, including architecture, landscape architecture, child psychology, sociology and other disciplines, and due to the lack of knowledge of certain related disciplines,this paper was unable to conduct a comprehensive and complete study in the limited time available. As a result, the design strategy is not fully responsive to the actual design needs.

(3) Overseas experience shows that the regeneration of streets in child-friendly communities is a systematic project that needs to be implemented at the policy, service and spatial levels, but this paper only discusses how to update the physical space of streets from the perspective of spatial regeneration, without involving policy and service aspects, while ensuring children's participation. Further discussion is still needed on how the three levels can be linked and implemented in an integrated manner.

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Appendix I: Research Questionnaire

Child-Friendly Questionnaire in Xiaobei District of Guangzhou

Dear Parents.

Hello, I am a master's student at the School of Architecture, South China University of Technology, and I am completing my thesis on child-friendliness and would like to distribute a questionnaire to you. This questionnaire is completely anonymous and does not involve your privacy, all contents are for academic research. Your understanding and support is greatly appreciated.

I. Age of your child.

☐ 0-3 years old

☐ 3-6 years

☐ 6-12 years

☐ 12-15 years old

II. Where does your child usually like to play?

☐ At home

☐ In the community

☐ Streets, alleys

☐ Small parks in the neighbourhood

☐ Library, cultural center, science center

☐ Town squares

III. In what areas do you think the current playgrounds in the community need to be improved?

☐ Low numbers

☐ Not easily accessible (difficult to reach on foot, by bike)

☐ Not enough comfort (lack of space for guardians to rest, wait and observe children)

☐ Not interesting enough (need to add fun, children's art design)

☐ Lack of green ecology (to improve children's access to nature)

☐ Lack of play areas for children of different ages (different play areas for children of different ages)

IV. How do your children usually travel? (to school, playgrounds)

☐ Walking independently

☐ Walking with an elder

☐ By bicycle

☐ By bus alone

☐ Transport by private car

V. What do you think are the reasons that limit your child's ability to get around independently?

☐ Playgrounds, schools far from home

☐ Inadequate bus stops (no direct access to destinations)

☐ Traffic hazards (crossing the road, too many motor vehicles, fast traffic)

☐ Social security hazards

☐ Lack of signage for children (signs to indicate the presence of children in the vicinity)

VI. What do you think needs to be done to ensure that your child travels alone?

☐ Reduced space for motor vehicles, continuous walking and cycling routes for children to school

☐ Speed limit signs, look out for children signs, pedestrian crossings, etc.

☐ Parent waiting areas, parent activity areas in schools, playgrounds

☐ Enhancing the interest of children's travel paths (adding brightly coloured play and activity facilities)

Thank you for your cooperation and enjoy your life!

广州市小北片区儿童友好问卷调查

尊敬的家长：

您好，我是华南理工大学建筑学院硕士研究生，正在完成有关儿童友好的毕业设计论文，在此向您发放问卷调查。本问卷全部匿名，不涉及您的隐私，所有内容用于学术研究。非常感谢您的理解与支持。

一、您的小孩的年龄：

☐ 0-3 岁
☐ 3-6 岁
☐ 6-12 岁
☐ 12-15 岁

二、您的小孩平常喜欢在哪些地方玩耍？

☐ 在家中
☐ 小区内的活动场地
☐ 街道、小巷
☐ 附近的小公园
☐ 图书馆、文化馆、科学馆
☐ 城市广场

三、您认为当前社区的游乐场地在哪些方面需要改善？

☐ 数量少
☐ 不方便到达（步行、骑行难以达到）
☐ 不够舒适性（缺少监护人休息、等候观察儿童的空间）
☐ 不够有趣（需要增添趣味化、儿童艺术的设计）
☐ 缺少绿色生态（提高儿童接触大自然的机会）
☐ 缺少满足不同年龄儿童的游戏场所（针对不同年龄儿童设置不同游戏场所）

四、您的小孩一般以什么方式出行？（去学校、游戏场地）

☐ 独立步行
☐ 长辈陪同下步行
☐ 骑自行车
☐ 独自乘坐公交车

☐ 私家车接送

五、您认为限制您的小孩独立出行的原因有哪些?

☐ 游戏场地、学校离家远
☐ 公交站点不足（不能直达目的地）
☐ 交通隐患（过马路、机动车过多、车速快）
☐ 社会治安隐患
☐ 缺乏针对儿童的指示牌（提示附近儿童出没的标识

六、 您认为保障您的小孩独自出行需要加强哪些方面?

☐ 压缩机动车空间，设立连续的儿童步行、骑行上学路线
☐ 设置限速标识、注意儿童标识、人行横道线等
☐ 在学校、游戏场地设置家长等候区、家长活动区
☐ 提升儿童出行路径的趣味性（增添色彩鲜明的游乐、活动设施）

谢谢您的配合，祝您生活愉快!

Appendix II: Daily Travel Routes Drawn by Children in Xiaobei District

（Photoed by author)