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Proposals for improving the street space of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street in the context of a complete street background

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摘 要

天河南一路是广州珠江新城城市轴线中部“天河城、天环与正佳”三个商业综合体与六运住宅小区之间的分界道路。基于现代城市规划思想，这三个商业综合体都是内向性、封闭式的商业空间，其周边的道路是交通性的；然而，由于商业综合体带来的巨大人流，使得六运小区比邻商业建筑的界面逐渐演变成商业店铺，从而出现目前交通与商业混杂的状态。六运小区处于天河商圈与珠江新城花城广场地下商业空间之间，为加强商业联系并贯通中轴线，在其中开辟了一条商业步行街。天河南一路与六运小区中轴步行街所构成的“T”形街道是广州城市轴线最重要的公共开敞空间之一。但是，这片区域的规划目标与现实使用错位，人车混行，交通与商业混杂，功能与形态不统一，空间使用及其形态与其区位和城市形象不匹配，迫切需要改造提升。为此，本文选择这片功能与形态错位的空间区域作为研究对象，采用包容性设计思想和完整街道的设计理念，并结合国内外相关优秀案例的时间经验，提出概念性的更新改造设计，试图前瞻性地探索应用“完整街道”的设计思想与方法，以设计方案的方式提出改造的建议。

本项研究以“完整街道”设计思想为指导，将天河南一路定位为广场式的混合街道，并据此目标用定量和定性相结合的方法对场地进行评价，通过对完整街道设计理念的研究、分析，并结合实际案例提出天河南一路和天河南步行街街道空间提升的建议和具体的改造设计。

文中共分六章，第一章为绪论，介绍研究背景及目的，确定研究方法和框架。第二章为文献综述，介绍街道设计思潮从以车为本演变到完整街道的过程，以及完整街道相关理论研究，包括完整街道理念的发展历程、要素及评价标准，并分析各国完整街道设计目标和元素。第三章为完整街道背景下的街道空间改造案例研究，总结洛杉矶、纽约和三亚的完整街道改造案例，为天河南一路和天河南步行街的街道空间更新设计提供参考。第四章提出完整街道背景下的街道空间更新建议，包括完整街道设计要素，并结合案例分析提出街道空间更新的 4 个具体策略。第五章为完整街道背景下的天河南一路和天河南步行街的场地分析，并采用 AHP 层次分析法和问卷调查对街道空间进行定量与定性研究。第六章为完整街道背景下的天河南一路和天河南步行街街道空间更新设计，从慢行空间、车行空间、景观绿化和街道设施这四点来进行街道空间提升设计。

关键词：完整街道； 天河南一路； 活力； 更新改造

ABSTRACT

Tianhe Nanyi Road is the dividing road between the three commercial complexes of "Tee MAll, Parc Central and Zhengjia Plaza " and the Liuyun residential area in the middle of the urban axis of Guangzhou's Zhujiang New Town. Based on modern urban planning concepts, these three commercial complexes are inward and closed commercial spaces, surrounded by traffic-oriented roads. However, due to the huge influx of people brought by the commercial complexes, the interface between the Liuyun residential area and the neighboring commercial buildings has gradually evolved into commercial shops, resulting in the current mixed state of traffic and commerce. The Liuyun residential area is located between the Tianhe business circle and the underground commercial space of the Zhujiang New Town Flower City Plaza. In order to strengthen commercial connectivity and connect the central axis, a commercial pedestrian street has been opened up. The "T"-shaped street formed by Tianhe Nanyi Road and the Liuyun central axis pedestrian street is one of the most important public open spaces in the Guangzhou urban axis. However, the planning goals and actual usage of this area are mismatched, with mixed pedestrian and vehicular traffic, inconsistent functions and forms, and space usage and forms that do not match their location and urban image, urgently requiring transformation and improvement. Therefore, this paper selects this space area with mismatched functions and forms as the research object, adopts an inclusive design concept and a complete street design concept, and combines the time experience of relevant excellent cases at home and abroad to propose conceptual updated transformation design, attempting to explore the prospective application of the "complete street" design concept and method, and propose transformation suggestions in the form of design proposals.

This study is guided by the "complete street" design concept, positioning Tianhe South Road as a plaza-style mixed-use street. Based on this goal, a combination of quantitative and qualitative methods were used to evaluate the site. Through research and analysis of the complete street design concept and real-world examples, this study proposes suggestions and specific design improvements for the street space of Tianhe South Road and the Tianhe South Pedestrian Street.

The paper is divided into six chapters. Chapter one is the introduction, which describes the research background and objectives and establishes the research methods and framework. Chapter two is the literature review, which introduces the evolution of street design concepts

from car-oriented to complete street, as well as the related theoretical research on complete streets, including the development process, elements, and evaluation standards of complete street concepts, and analyzes the complete street design goals and elements in various countries. Chapter three summarizes case studies of street space improvement under the complete street concept in Los Angeles, New York, and Sanya, providing references for the street space improvement design of Tianhe South Road and Tianhe South Pedestrian Street. Chapter four proposes suggestions for street space improvement under the complete street concept, including complete street design elements, and provides four specific strategies for street space improvement through case analysis. Chapter five analyzes the site of Tianhe South Road and Tianhe South Pedestrian Street under the complete street concept, using the AHP hierarchical analysis method and questionnaire surveys to conduct quantitative and qualitative research on the street space. Chapter six proposes design improvements for the street space of Tianhe South Road and Tianhe South Pedestrian Street under the complete street concept from four aspects: slow movement space, vehicle movement space, landscape and greenery, and street facilities.

Keywords: Complete Street; Tianhe Nanyi Road; vitality; renovation and upgrade.

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Chapter 1 Introduction

1.1 Research Background

1.1.1 The design concept of streets has shifted from a "car-oriented" approach to a "people-oriented" approach

After the reform and opening up, with the development of the economy and the continuous acceleration of the urbanization process. However, at the same time, motorised urban development has also brought about a series of problems, such as air pollution, worrying quality of living environment for citizens, squeezed sidewalk space, threatened pedestrian safety and loss of street vitality.

In the face of these problems, China has, since 2012, promulgated relevant decrees to encourage green modes of travel and to improve the planning and construction level of slow-moving transportation systems and the travel environment, with the traditional car-oriented view of urban development gradually being replaced by a human-centred street design concept. In 2013, the Ministry of Housing and Construction issued the Planning Guidelines for Urban Pedestrian and Bicycle Transportation Systems, which set out the principles of pedestrian and bicycle transportation planning, system control indicators, technical guidelines for each element and an outline for planning and preparation. Policy research has shown that the government is not only paying more attention to street design, but also shifting the focus from 'car-oriented' to 'people- oriented'.

Internationally, almost all significant cities see street revitalisation as an important tool for urban regeneration, and governments everywhere are beginning to increase their focus on walking, bicycling, public transport and urban living, arguing that streets should belong to all citizens and include people of all ages and abilities. in 2003, the United States introduced the concept of complete streets, streets that integrate pedestrians, bicyclists, public transport and motor vehicles, rather not just considering the priority of small cars.Complete Streets is a human-centred street design concept that has been popularised in the USA and has influenced street design around the world.

1.1.2 The support of street construction policies

China's urban development is currently in a historical period. In September 2013, the Opinions of the State Council on Strengthening Urban Infrastructure Construction clearly stated that urban transportation should establish the concept of limited pedestrian access,

improve residents' travel environment, ensure travel safety, and advocate for green travel. This marks a practical transformation of the traffic development model that over-relied on cars, and the first time that pedestrian and bicycle traffic have been elevated to the national policy level, establishing the status of pedestrians in the transportation system and having significant guiding significance for the construction of transportation infrastructure in various regions. On February 6, 2016, the Opinions of the Central Committee of the Communist Party of China and the State Council on Further Strengthening Urban Planning and Construction Management Work proposed to promote the development of open, convenient, appropriately scaled, and harmonious living blocks, and to clearly establish the urban road layout concept of "narrow roads, dense network", strengthening the construction of bicycle and pedestrian systems in the city.[1] In 2017, the central government proposed a people-oriented new type of urbanization, advocating a return to the essential functions of cities, that is, to make the lives of urban residents better. Urban researchers began to gradually pay attention to the research on the functions of street public spaces.

In June 2015, the Guangdong Province issued the Implementation Opinions on Accelerating Urban Infrastructure Construction in order to further improve urban infrastructure, enhance the overall carrying capacity and operational efficiency of cities, and improve the quality of urban development. The document emphasized the principle of "pedestrian priority" and called for the renovation or construction of urban road sections, the establishment of a continuous and integrated pedestrian and bicycle transportation system, and the seamless connection of pedestrian and bicycle transportation systems with residential areas, public transportation hubs, important cultural and sports facilities, and commercial areas. The key focus was on strengthening the construction of pedestrian crossing facilities, bicycle parking facilities, road greening, lighting, and other facilities to effectively improve the travel environment and continuously increase the proportion of walking and cycling.

Starting from October 2014, Guangzhou has been pushing forward urban environmental governance and construction, aiming to build a clean, tidy, safe, and orderly urban environment. In 2016, the 19th plenary session of the Guangzhou Municipal Committee proposed the Implementation Opinions on Further Strengthening Urban Planning, Construction and Management Work, which pointed out the need to further improve the level of urban design, refine the construction of public spaces, and build a standardized, refined and high-quality living environment. As a key object of this effort, urban streets are an important

entry point for current work. In 2021, the Municipal Planning and Natural Resources Bureau stated that by 2035, on the basis of completing approximately 2000 kilometers of urban rail transit, the city's "6080" passenger transportation goal would be achieved, which means the proportion of public transportation in motorized travel within the city would reach 60%, and the proportion of rail transit in public transportation would reach 80%. At the same time, the city will be built to be pedestrian and bicycle-friendly, with a spatial pattern dominated by small blocks and dense road networks, creating an attractive pedestrian transportation network. [2]

1.1.3 Problems faced by Tianhe Nanyi Road and Tianhe Nan Pedestrian Street

As the boundary between the commercial and residential areas of Guangzhou, Tianhe Nanyi Road was designed with the attributes of a road in mind. As people's needs for the street changed and the commercial outreach led to an increasing conflict between traffic and commerce here. The Tianhe Nan pedestrian street, an internal road within the Liuyun Community, was later opened up as a commercial pedestrian street, transforming the traditional private internal road of the community into a public urban pedestrian street, where the properties of the street changed. The misalignment between the planning objectives and the real use has led to mixed pedestrian and vehicular traffic, mixed traffic and commerce, inconsistent function and form, and a mismatch between the use of space and its form and its location and urban image, which urgently needs to be renovated and upgraded. In the face of these problems, this paper discusses proposals for the spatial upgrading of the streets of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street based on the context of complete streets.

1.2 Definition of related concepts

1.2.1 complete streets

(1)Origin of Complete Streets

In the 1960s and 1970s, European and American countries experienced rapid industrialization and motorization, and speed became the main principle for urban street renovation and renewal. In this context, cars became the primary means of transportation, and the rise of wide roads and large interchanges led to urban sprawl and street desolation. In order to address frequent traffic accidents, conflicts between pedestrians and vehicles, and street safety issues, the United States proposed the concept of "Complete Streets", aiming to change the approach to street design that only considers motor vehicles and emphasizing the idea of equal sharing of street space between motor vehicles, non-motorized vehicles, and pedestrians. The design of Complete Streets provides a fair road system for all modes of transportation through

measures such as rights-of-way allocation, traffic organization, cross-sectional design, and facility design.

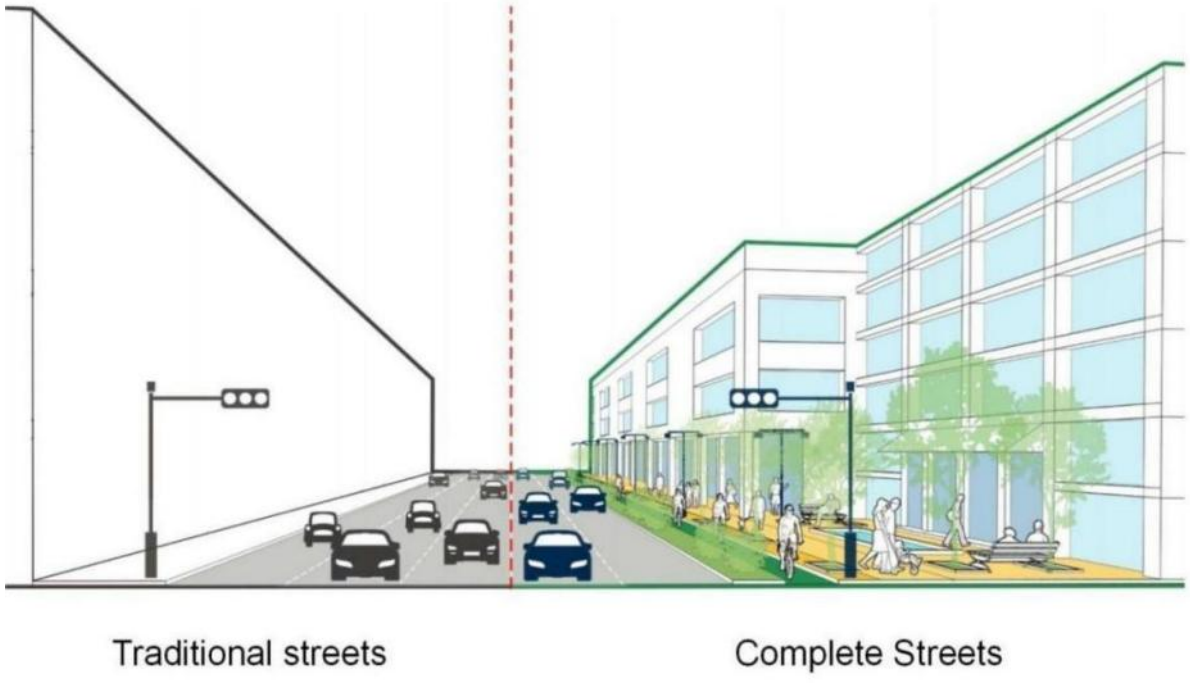


Fig. 1-1 Traditional Streets and Complete Streets(Source: Google)

(2)Definition of Complete Streets

In the 1970s, the United States introduced a policy of "complete streets". The National Complete Streets Coalition defined a complete street in the USA :Complete Streets are streets for everyone. Complete Streets is an approach to planning, designing, building, operating, and maintaining streets that enables safe access for all people who need to use them, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities.

Building complete streets also means that urban street construction must change from the traditional car-first street design principle to a people-first urban street design principle that ensures safe travel for all.

Complete Streets is a design approach and transportation policy that addresses travel needs and safety requirements through the sound planning, design, operation and maintenance of streets to safeguard the rights of way for all modes of travelers on the street. Complete Streets aims to provide a safe, comfortable. and convenient travel environment for users of all ages, all modes of travel and all levels of health.

Fig. 1-2 Before and after complete street transformation(Source:Complete Streets - Smart Growth America)

(3)Complete Streets Policy

Since the inception of the Complete Streets concept, all levels of government in the United States have been encouraged to pursue Complete Streets policies in order to enable better implementation of Complete Streets. Complete Streets policies are rich in content and include: ordinances and resolutions; street design guidelines; inclusion in comprehensive plans; internal memos from transportation agency heads; policies adopted by city and county councils; and executive orders from elected officials such as mayors or governors. The National Complete Streets Coalition(NCSC), in an effort to standardize complete streets policies, has identified 10 complete streets policy elements to help communities develop and implement policies and practices that ensure streets are safe for people of all ages and abilities, balance the needs of different modes, and support the local land application, economy, culture, and natural environment. The ideal complete streets policy should contain the following ten elements:

1． Establishes commitment and vision.How and why does the community want to complete its streets? This specifies a clear statement of intent to create a complete, connected network and consider the needs of all users.

2． Prioritizes underinvested and underserved communities.Requires jurisdictions to define who are their most underinvested and underserved communities and prioritize them throughout.

3． Applies to all projects and phases.Instead of a limited set of projects, the policy applies to

all new projects, retrofit or reconstruction projects, maintenance projects, and ongoing operations.

4．Applies to all projects and phases.Any exceptions must be specific, with a clear procedure that requires high-level approval and public notice prior to exceptions being granted.

5．Applies to all projects and phases.Requires private developers to comply, and interagency coordination between government departments and partner agencies.

6．Adopts excellent design guidance.Directs agencies to use the latest and best design criteria and guidelines, and sets a time frame for implementing this guidance.

7．Requires proactive land-use planning.Considers every project’s greater context, as well as the surrounding community’s current and expected land-use and transportation needs.

8． Requires proactive land-use planning.Establishes specific performance measures that match the goals of the broader vision, measurably improve disparities, and are regularly reported to the public.

9．ets criteria for choosing projects.Creates or updates the criteria for choosing transportation projects so that Complete Streets projects are prioritized.

10． Creates a plan for implementation.A formal commitment to the Complete Streets approach is only the beginning. It must include specific steps for implementing the policy in ways that will make a measurable impact on what gets built and where.[3]

1.2.2 street space

The earliest form of streets was created to meet the needs of production and daily life. People built houses next to each other, forming a linear space between the houses that could serve various social functions. According to the Modern Chinese Dictionary, streets are defined as public thoroughfares within cities, towns, or villages. Marshall S.'s book Streets and Patterns [4]describes streets as roads that can be viewed as having urban attributes or as serving as urban places for transportation. Streets are a type of road and a linear open space in cities, with a strong urban character that not only serves as a transportation route, but also provides a place for daily life activities for urban residents.

A street is composed of "street" and "road" , which correspond to "street" and "road" in English, respectively. Generally speaking, roads are often used as transportation routes connecting different areas of a city, and as a means of transportation between the city and

outside areas. Roads emphasize their role in transmitting people and things between two points, with no spatial enclosure requirements, and the primary users are motor vehicles. In contrast, streets not only serve as transportation routes in cities, but also carry out various urban daily activities, such as commercial, social, and recreational functions. The street space is delimited by a relatively continuous building interface, and the primary users are people who are closely associated with the activities taking place within the space. Therefore, roads are mainly used for transportation, whereas streets are mainly used for activities involving people, and it is the human participation that distinguishes streets from roads.

Table. 1-1 Streets and roads identification（Source: Completed by author)

	street	road
Functions	Provide space for people's daily life and interaction; undertake transportation functions	Undertake transport functions
Main objects of use	People, non-motorised vehicles, motorised vehicles	motorised vehicles
Spatial interface	The street space is defined by a more continuous architectural interface	No spatial enclosure required, generally flanked by landscaping

The characteristics of streets are generally divided into traffic, place, and social functions. Urban interactions between different locations require the connection of streets, which are the main channels for the transmission and exchange of people, vehicles, goods, information, and other elements in daily urban life. Traffic function, as one of the main characteristics of streets, plays a huge role in daily urban life. The place function of streets is mainly reflected in providing space for people's daily transportation and communication needs. As the largest and most important public space in the city, streets carry the daily and social life of urban residents. The place function means that streets are treated as destinations, not just as a means of connecting various locations. [5]

In addition, streets are also carriers of social life, providing containers for social interactions, and are important places for creating urban life. The long-term daily life of streets leaves traces of the city, carrying the history and cultural genes of the city, and having a certain degree of social significance.

The *Global Street Design Guide* states that the street is the basic unit of urban space through which people experience a city. Streets are, in fact, multidimensional spaces consisting of many surfaces and structures. They stretch from one property line to another, including the

building edges, land uses, and setbacks that define each side. They offer space for movement and access and facilitate a variety of uses and activities. Streets are dynamic spaces that adapt over time to support environmental sustainability, public health, economic activity, and cultural significance.[6]

The spatial elements of a street mainly include the vertical and horizontal interfaces. The vertical interface defines the functional attributes of the street space, including building height and setbacks. The horizontal interface serves as the transportation corridor of the street, including sidewalks, bicycle lanes, and vehicle lanes. In street design, sidewalks are usually divided into building frontage zones, walking zones, facility zones, and curb zones.

From the perspective of the material composition of the street space elements, the side interface of the street influences the urban impression and serves as a connection between the street and buildings or blocks; the bottom interface of the street provides a spatial container for greenery, pedestrian activities, and necessary furniture and lighting. The material functional elements of the street side interface mainly include the color, form, sunshade and rain shelter, entrance and exit elements of the building interface, while the material spatial elements of the street bottom interface mainly include the ground paving, roadside trees, barrier-free facilities, bus stops, non-motorized vehicle parking, streetlights, urban furniture, etc.

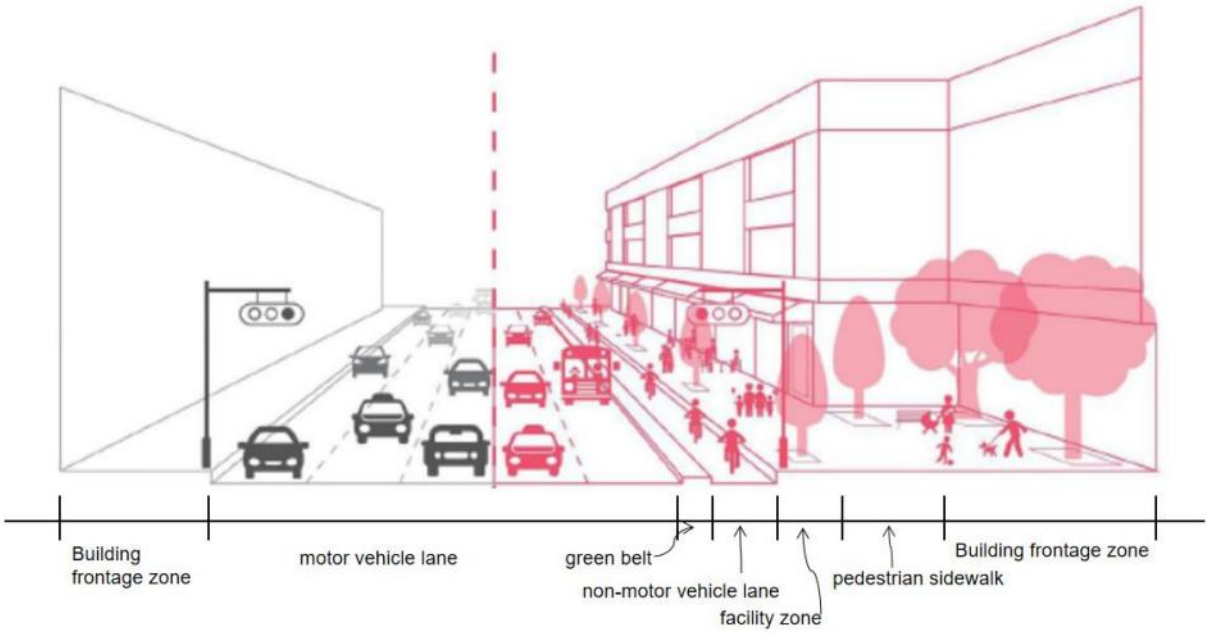


Fig. 1-3 Diagram of the spatial composition of the street（Source: Completed by author）

1.3 Purpose and Significance of the Study

1.3.1 Purpose

1.Explore the proposed street space enhancement of Tianhe Nanyi Road in the context of complete streets, realising the transformation of Tianhe Nanyi Road as a road into Tianhe Nanyi Road as a vibrant street.

2. Exploring the proposed street space enhancement of Tianhe Nan Pedestrian Street in the context of complete streets, to realise the transformation of Tianhe Nan Pedestrian Street as an internal community road into a public urban commercial pedestrian street.

1.3.2 Significance

(1)Theoretical significance

With the change of street design thinking from "car-oriented" to "people-oriented", more and more researchers have started to focus on the design and optimisation of street space. In this context, this paper takes the perspective of complete streets as the starting point, evaluates the street space from the perspective of complete streets, and proposes corresponding optimisation strategies to enrich the theoretical study of street space.

(2)Practical implications

Countries such as the USA have started earlier to design and transform street spaces with a human-centred perspective. As China is in the stage of rapid urbanization, the development of street transformation from the perspective of complete streets is relatively slow. This paper takes Tianhe District, Guangzhou City, Tianhe Nanyi Road and Tianhe Nan Pedestrian Street as examples, based on the investigation and research of the current situation data, as well as field research and observation interviews to identify problems and explore corresponding transformation strategies and implementation methods, so as to provide references and lessons for other similar types of street space transformation in the future.

1.4 Research Methods

(1)Literature review method: The author first consulted relevant materials, sorted out the research on complete streets at home and abroad, analyzed the research status at home and abroad, sorted, classified, summarized, and analyzed the collected data. By summarizing and summarizing relevant journal articles, papers, books, etc. on complete streets at home and abroad, the connotation of complete streets was summarized, and the development of the theory was reviewed in detail. In the process of data analysis and integration, mature methods and related theories of complete streets from domestic and foreign scholars were referenced.

(2)Case study: Based on theoretical research, through the study of excellent complete street cases in various countries, the design methods and strategies of complete streets were sorted out to provide theoretical and design basis for subsequent design.

(3)Field research: Based on theoretical research, field research was conducted on Tianhe Nanyi Road and Tianhe Nan Pedestrian Street. The problems of street space were summarized, and suggestions for updating the street space of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street were proposed in combination with relevant content of complete streets.

(4)Combination of qualitative and quantitative analysis: The design elements of street space are complex. Using qualitative or quantitative methods alone to analyze field research data cannot comprehensively and scientifically reflect the current situation of street space. Therefore, this article uses a combination of AHP hierarchical analysis method and questionnaire survey to conduct qualitative analysis and subjective perception evaluation of street space on Tianhe Nanyi Road and Tianhe Nan Pedestrian Street.

1.5 Research Framework

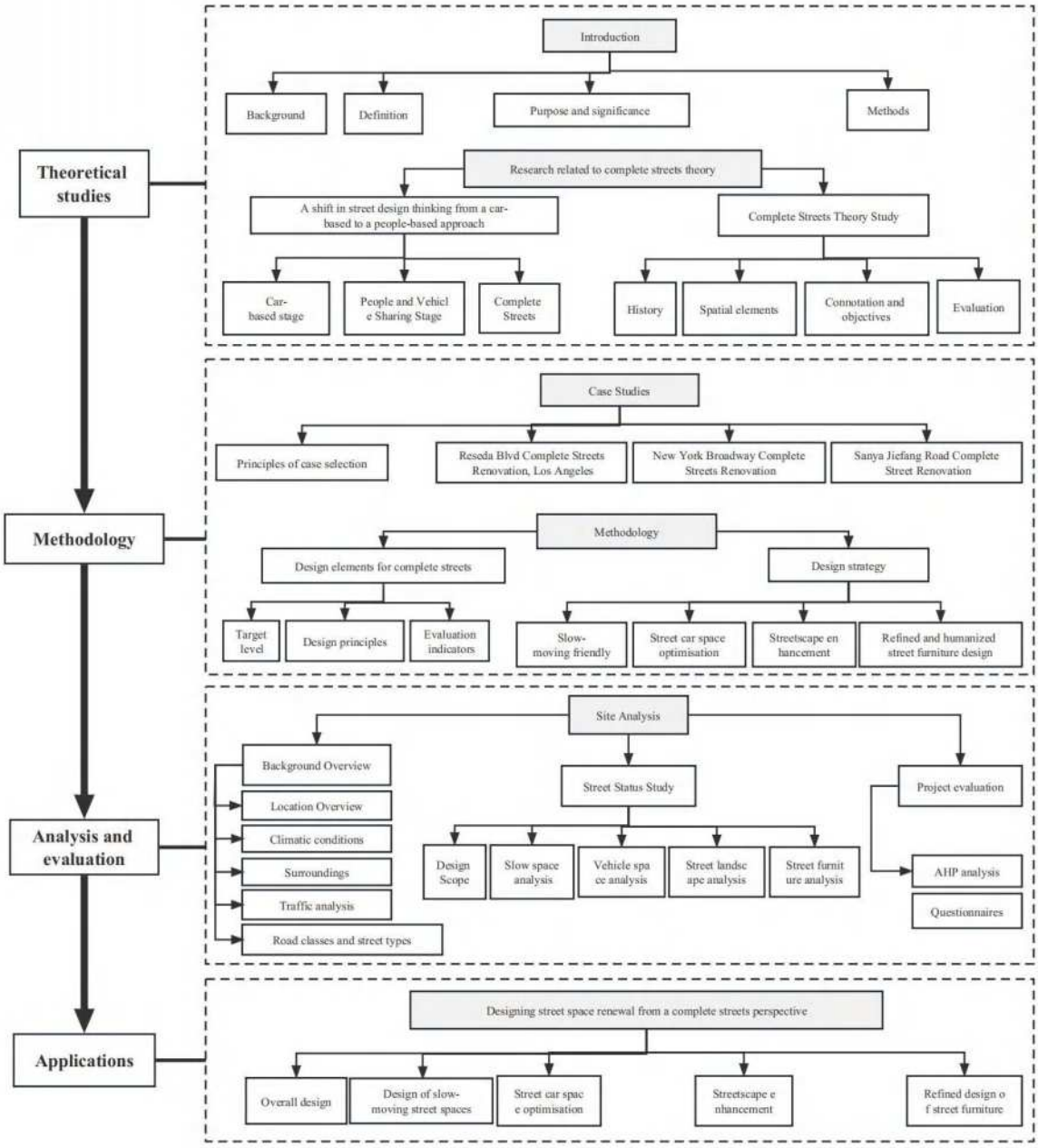


Fig. 1-4 Research framework（Source: Completed by author)

[1]Xinhua News Agency．Several Opinions of the Central Committee of the Communist Party of China and the State Council on Further Strengthening the Management of Urban Planning and Construction[EB/OL]．http://www.gov.cn/zhengce/2016-02/21/content_5044367.htm, 2016.02.06

[2]Guangzhou Daily．Guangzhou Transport Development Annual Report 2020 released [EB/OL]．https://gz.gov.cn/zwgk/sjfb/tjfx/content/post_7722536.html, 2021.08.17

[3] NACTO. Complete Streets policy development[EB/OL]. [20190310]. https://smartgrowthamerica.org/program/national-complete-streets-coalition/publications/policy-development/.

[4] Marshall S. Streets and patterns[M]. Routledge, 2004.

[5] JONES P, BOUJENKO N. Link and Place: A New Approach to Street Planning and Design[R]. London: Centre for Transport Studies, 2009.

[6] Officials NAOC. Global Street Design Guide[R].National Association of City Transportation Officials, 2015.

Chapter 2 Literature Review

2.1 The evolution of street design philosophy:from 'car-oriented' to "people-oriented"

Fig. 2-1 Car-oriented street space versus people-oriented street space.(Source: Institute of City Planning and Urban Design)

2.1.1 'car-oriented' stage

In the early 20th century, after the industrial revolution, the advent of the automobile changed the original mode of transport, which was predominantly on foot. In the pursuit of convenience and efficiency, Western countries began to design their roads with cars as the mainstay. The dominance of car space led to wider and wider streets to facilitate the passage of more cars. At the same time, the space for walking was repeatedly compressed and the human behaviour on the streets gradually disappeared. A number of scholars of the time also put forward guiding theories on the subject, the most representative being the architect Le Corbusier, who suggested designing three-dimensional traffic, reducing turnouts, increased road widths, etc. The car-first model of street renewal, which pursues absolute traffic efficiency and ignores the experience of people in the street, has led to increasing conflicts between people and vehicles, and eventually the streets have lost their former vitality.

2.1.2 share streets stage

After 1950, in order to solve the conflicts between pedestrians and vehicles on the streets, the loss of urban character, and the increasing indifference towards street activities caused by excessive pursuit of efficiency and hierarchy, Western countries began to explore the street renewal model that shared by pedestrians and vehicles. At this time, many scholars have advocated the street renewal design concept of "giving streets back to pedestrians" and "pedestrians first", hoping that pedestrians have priority use rights in the streets and certain

restrictions are imposed on motor vehicles. After 1960, a new street design concept began to emerge, which is the shared street. In this concept, people on the street began to be gradually valued, and the emphasis was placed on advocating the harmonious coexistence of people and vehicles by putting vehicle traffic in a secondary position. Specific strategies include certain traffic restrictions and landscape design of the street to create a comfortable. pedestrian environment. The "Woonerf" street design model proposed by Dutch planners is particularly representative in practice. Shared Streets believes that the coexistence of people and vehicles helps to solve the human-vehicle conflict. Shared streets involve road traffic, pedestrian activity, street quality, and street management design. There are two common strategies: the first is a city-wide master plan, which addresses the problem of mixing traffic and street-level activities through a rational planning of the street network; the second is a specific design strategy, such as street narrowing. This concept was an important inspiration for the 'complete streets' era that later entered the twenty-first century.[7]At this stage, street design thinking gradually evolved from being car-oriented to being shared by pedestrians and vehicles, and street space also transformed into shared space.

Fig. 2-2 Shared Streets in Chicago(Source:Google)

2.1.3 complete streets stage

Since the 21st century, the development of street design has been enriched and refined. In

1990, sustainable development became the most important issue in the world.At the 1992 Global Environment Conference in Rio de Janeiro, the concept of sustainable urban development called for the promotion of urban public transport systems, bicycle transport and pedestrian transport. In 2003, the concept of Complete Streets was introduced, which encourages all street users to travel by any mode of transport and promotes the improvement of pedestrian and social relationships. In 2005, The National Complete Streets Coalition was formed and the Complete Streets movement spread rapidly across the United States. Since then, the Complete Streets concept has spread around the world and the 21st century street is no longer just a road for motor vehicles, but a street for all street users, a street that is healthy and green and even a street that incorporates smart city development.

Fig. 2-3 Complete streets of Albany city(Source:Google)

In 1971, Oregon enacted its first Complete Streets-like policy called "Routine Accommodation".In 2003, Barbara McCann proposed replacing the concept of Routine Accommodation with Complete Street. In 2005, the National Complete Street Coalition was formed.

In fact, the concept of "complete streets" in the United States is well documented.In Europe, courtyard roads were introduced(Woonerven), traffic peace, shared streets and other concepts, the United States was already under urban sprawl dominated by the small car. In rural and suburban communities, the car was their only means of transport, and walking, cycling and public transport became out of reach. In such circumstances, it was difficult to ignore the car

altogether and simply emphasise walking, cycling or public transport on America's streets.

As a result, the 'complete street' has become the contemporary .The most important means of street revitalization in the United States. Complete Streets requires safe, convenient and comfortable. travel and access opportunities for all ages and all abilities, requiring consideration of safe travel that includes walking, bicycling, traveling by small cars, taking public transportation or providing goods.

The Complete Streets concept makes sense, and many proponents argue that street design guided by the concept can improve street safety, reduce transportation costs, provide a diversity of transportation options, promote healthy citizenship by encouraging transportation options such as walking and cycling, stimulate local economic development, improve community interaction, and promote home value appreciation. As China has experienced rapid economic growth and rising living standards over the past few decades, at the same time, similar to the situation in the United States, the overemphasis on motor vehicle development has led to urban sprawl, with cities facing uneven street development, oppression of pedestrian, bicycle and transit space, a gradual decline in the quality of urban public space, a lack of sense of place, pedestrian safety, bicycle safety The quality of urban public space is gradually declining, the sense of place is missing, and pedestrian and bicycle safety is at risk.

A series of problems. In this context, the introduction of "complete streets" is necessary for the construction of streets in our cities. Complete Streets are also the trend for streets in this era, where streets no longer belong only to motor vehicles, but to pedestrians, cyclists and bus riders. The 21st century street should be complete, where the car is no longer the only factor dominating the urban form, but serves the whole user and has a new era of meaning .

2.2 Complete Streets Basic Research

2.2.1 The evolution of the Complete Streets concept

In 1971, the first Complete Streets policy was enacted in the US state of Oregon, requiring new or modified roads to accommodate bicycles and pedestrians, and requiring state and local governments to invest in pedestrian and bicycle facilities. In 2003, Barbara McCann, former Executive Director of the National Complete Streets Coalition, suggested the term complete streets instead of routine accommodation.[8] 2005 saw the formation of the Complete Streets

Coalition in the USA, including some of the AARP In 2005, the Complete Streets Consortium was formed in the USA, including some of the American Association of Retired Persons, the American Planning Association and the American Society of Landscape Architects. The Complete Streets movement quickly spread across the United States. By the end of 2016, 1232 policies had been adopted nationwide, and 33 state governments, 77 regional planning organisations and 955 independent municipalities had introduced laws, policies, codes and guidelines to support complete streets.

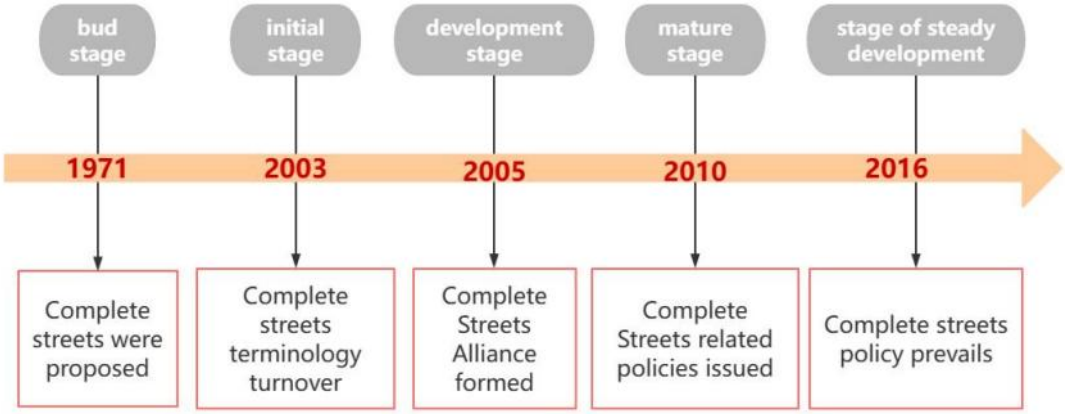


Fig. 2-4 Complete Streets' development history（Source: Completed by author）

The Complete Streets America Coalition is part of the Smart Growth organization and is dedicated to creating safe and accessible streets. The Alliance focuses on implementation strategies for Complete Streets USA and provides cities, planners and designers with tools to develop and implement policies and programs. Proven project practices show that Complete Streets increase street safety, encourage healthier and greener travel, and build more friendly communities.[9]The Complete Streets concept was clearly defined in December 2003. The Alliance was initially led by the American Bicycle Association and later joined by the American Planning Association, the American Public Transportation Association, the American Society of Landscape Architects and the American Heart Association. The American Planning Association, the American Public Transportation Association, the American Society of Landscape Architects and the American Heart Association joined the Alliance in 2005 to form the American Complete Streets Coalition. The Alliance promotes the design of safe streets that serve all users.[10]

2.2.2 Complete street space elements

1. Complete street space elements

Complete Streets contain a variety of transport modes and are classified according to the function they serve. Complete Streets design elements include six components: pavements, carriageways, cycle lanes, green belts and green space. The street space also contains street furniture i.e. pedestrian facilities, traffic calming facilities, non-motorized facilities, vehicular facilities and public transport facilities.

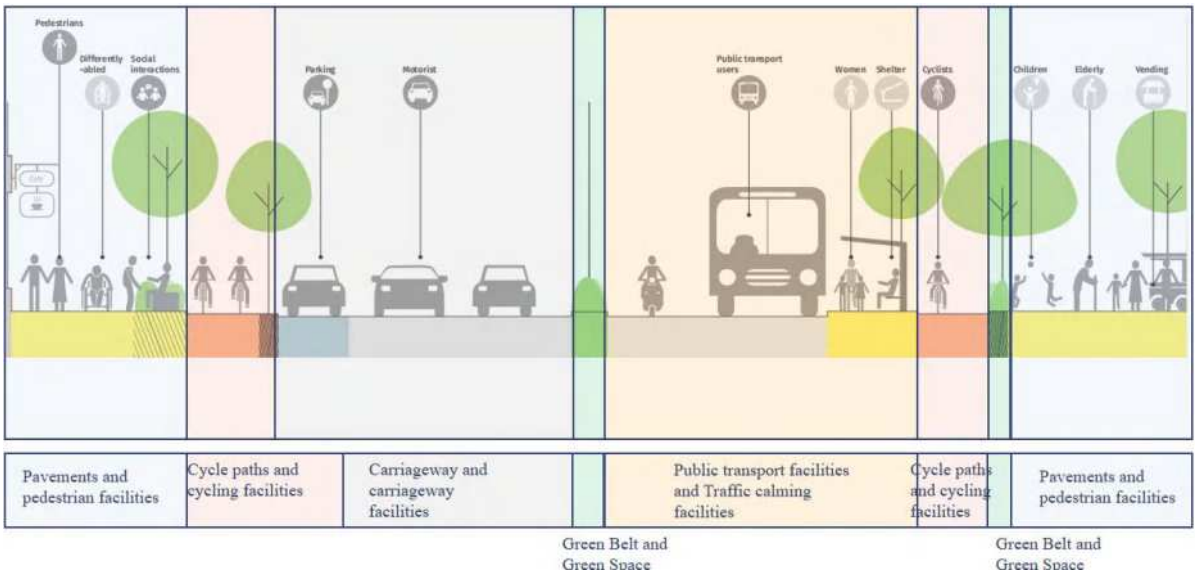


Fig. 2-5 Complete street space elements（Source: Completed by author）

(1)Pavements and pedestrian facilities.

The pavement can be divided into the building frontage area, the pedestrian area and the pavement facilities area. The building frontage area is the space between the street pedestrian area and the building, including the gateway to the building extension, leisure seating, landscaped areas, etc. It contains the outdoor space used by the building on the street for its own use. The pedestrian zone is the area for pedestrian movement, to ensure its width, walking is the basic function of the pavement. The pavement facilities area is in the middle of the kerb and the walking area, and mainly includes facilities such as green belts, utility poles and lampposts, supplemented by certain leisure seating, etc.Pedestrian facilities include pedestrian crossings, traffic islands and other ancillary pedestrian facilities(signage, signals) etc. Pedestrian crossings are simply marked out as crossing lines. Traffic islands serve as safe areas for people to stay temporarily when the motorway is wide. Signs and signals are auxiliary facilities to ensure the orderly and organised movement of the different traffic modes.

Fig. 2-6 Complete street space elements（Source: Montgomery county complete streets p108）

(2)Carriageways and vehicular facilities.

Pedestrian carriageways take up more passing space, so the number of carriageways should be arranged appropriately. Vehicular facilities mainly refer to on-street parking, and complete streets require that on-street parking is minimised and does not affect the vitality of the street.

(3)Cycle paths and bicycle facilities.

Bicycle facilities mainly refer to bicycle parking areas and Bicycle-related signage. In recent years, the number of shared bicycles in popular cities has grown rapidly, and increasingly they are facing problems such as no road access in the city, poor security and confusing parking. Complete streets require separate cycle lanes where necessary, segregated zones to separate bicycle and motor vehicle traffic, and fixed cycle parking areas.

Fig. 2-7 Cycle paths and bicycle facilities（Source: Toronto complete streets guidelines p97-99）

(4)Public transport facilities and traffic speed reduction facilities.

Bus access is generally provided by bus lanes, public transport facilities include bus rapid transit and bus shelters to ensure that public transport can travel easily and safely and does not interfere with other modes of transport. Traffic reduction facilities include central green belts, speed control signs, curved carriageways and intersection changes. For example, the transformation of an X-shaped intersection into a T-shaped intersection can reduce the speed of turning vehicles and increase the range of visibility.

Fig. 2-8 Transit lanesand bus shelters（Source: Toronto complete streets guidelines p105-106）

(5)Green belts and green spaces.

Green belts contain street trees and streetscape features that provide shade for pedestrians, separate people from cars and create a more pedestrian-friendly spatial environment. Green space refers mainly to individual green spaces such as street green parks. Street green spaces facilitate access to nature and encourage social interaction, providing open space for the people living in the neighbourhood.

Fig. 2-9 street trees and streetscape features（Source: Google）

2. Complete Streets versus Traditional Streets

In contrast to traditional streets, complete streets integrate the harmonious sharing of different modes of transport, as shown in the Table. below. Complete Streets policies contribute to

traffic safety, health improvements, a low carbon economy and environmental improvements.

Table. 2-1 Traditional street design VS complete street design（Source: Completed by author）

	Traditional streets	Complete Streets
Overall transport objectives	Motor vehicle - movement of transport(mainly motor vehicle trips)	Accessibility - people's ability to access desired services and activities ability to carry out activities
Transport planning objectives	Maximum speed of travel	Maximising overall accessibility
Performance indicators	Level of road service, average speed, traffic delays, etc.	Multi-modal service levels, access to services for different groups of people or the time and cost required to carry out activities
Priority design considerations	Vehicle travel speed, traffic flow	Accommodates a wide range of transport modes
Typical design speed(km/h)	50-80	30-40
Degree of road network connectivity	Low level of road network connectivity	High level of road network connectivity and inclusion of footpaths

Table. 2-2 Priority Order of Design Elements for Traditional Street Design and Complete Street（Source: Completed by author）

	Traditional street design	Complete street design
1	Motor vehicle traffic	Walking
2	Public Transport	Non-motorized vehicles
3	Non-motorized vehicles	Public Transport
4	Walking	Motor vehicle traffic

2.2.3 Complete Streets connotations and objectives

(1)Complete Streets connotations

Complete streets are divided into the integrity of the people who use them, the integrity of the modes of travel, the integrity of the functions served, the integrity of the spatial sphere, the integrity of the temporal sphere and the integrity of the institutional sphere.

①The "integrity" of the people who use it. Complete Streets accommodates people of all modes of travel, ages and abilities. Age is generally divided into children, adults and the elderly. The emphasis is generally more on people with disabilities. The allocation of space on urban streets should focus on the feelings of the vulnerable groups of street users - slow-moving transport users - and prioritise the allocation of road resources to them. Thus, a 'complete street' is a street in which all modes of transport are coordinated and balanced.

②The 'completeness' of the mode of travel. This includes all modes of travel on the street,

which generally include walking, cycling, public transport and driving.

③Integrity of service functions Complete Streets advocates the integrity of the street service function, mainly including the traffic function, public space function, urban landscape function and stormwater management function, in order to meet the basic life requirements of urban residents. The traffic function is the most basic function of the street, the original value of the street is that it provides a passage space for people and goods to circulate and stop. The public place function of the street means that the street in the city often undertakes the task of providing a space for people to travel and interact, and the activities and interactions on the street enhance the public nature of the street, which in turn enhances the vitality of the neighbourhood. On the other hand, urban streets are one of the most intuitive manifestations of the urban landscape for citizens and visitors, and as the basic skeleton of the urban landscape, they assume an important landscape function. Street stormwater management generally makes streets greener, reduces energy and resource wastage and mitigates the urban heat island effect through green street furniture and landscape planting.

④The "integrity" of the spatial dimension. The street space is the linear public space of the city defined by the buildings on either side, the urban street consists of pavements, parking strips, carriageways and median strips. Whereas the integrity of street space is not limited to the two- dimensional spatial extent of the street, the Instead, the overall space of the street, i.e. the space of the building push lines and the street façade, is designed in an integrated way to enhance the quality of the city.

⑤The 'integrity' of the temporal context. Complete streets are designed to take time into account, to provide flexibility in the design of streets based on the characteristics of the people who use them at different times of the day, and to encourage the time-sharing of streets, for example by differentiating between peak and off-peak hours of the day, between weekdays and rest days of the week, and between holidays and non-holidays of the year, based on the travel characteristics of residents.

⑥The 'integrity' of the institutional context. The street design system under the concept of complete streets includes the design guidelines, approval system and management system of the street, as well as the obligation of people who share the power of the street space to build, govern and manage the street together, so that the urban street design system can be improved and multiple actors can participate in collaborative governance.

Fig. 2-10 Complete Streets inclusions（Source: Completed by author）

(2)Complete Streets goals

Complete Streets policies contribute to traffic safety, health improvements, a low carbon economy and environmental improvements, with three main objectives:

Fig. 2-11 Complete Streets goals（Source: Completed by author）

① Safe Streets.

Streets need to be pedestrian and vehicular in all directions, with orderly intersections and peaceful sharing, to ensure the personal safety of all kinds of traffic participants. The orderly conduct of traffic activities requires the coordination of people, vehicles and roads in time and space. The relationship is to reasonably control the speed of traffic, to provide spacious and unobstructed space for pedestrians to pass on foot, to provide direct and convenient crossings, to ensure safe and comfortable. pedestrian crossings and to protect the right of way for non-motorized vehicles.

② Green Streets.

Streets should promote green travel, improve the ecology of the street environment and promote the harmonious coexistence of the man-made and natural environment. A pleasant network of pedestrian and non-motorized routes and a convenient and comfortable. public transport system will be created to increase the proportion of green travel, the ecological benefits of street greening and the proportion of permeable paving.

③ Vibrant Streets.

Streets provide an open, comfortable. and accessible spatial environment that enhances civic interaction and enhances the experience of urban public life. There is a need to create pleasantly scaled street spaces, enhance the functional complex along the street and create an active spatial interface. The provision of convenient and comfortable. street spaces and environmental facilities as well as fine architectural design along the streets will meet the requirements of different activities and enhance the visual experience of walking. To reinforce the environmental characteristics of the location, to continue the cultural heritage and to show the style of the times.

2.2.4 Complete Streets Assessment

The US article Evaluating Complete Streets Project: A guide for practitioners suggests indicators and parameters for Complete Streets goals, including accessibility, economy, environment, equity, space, public health, and safety(Table. 2-3).[11]

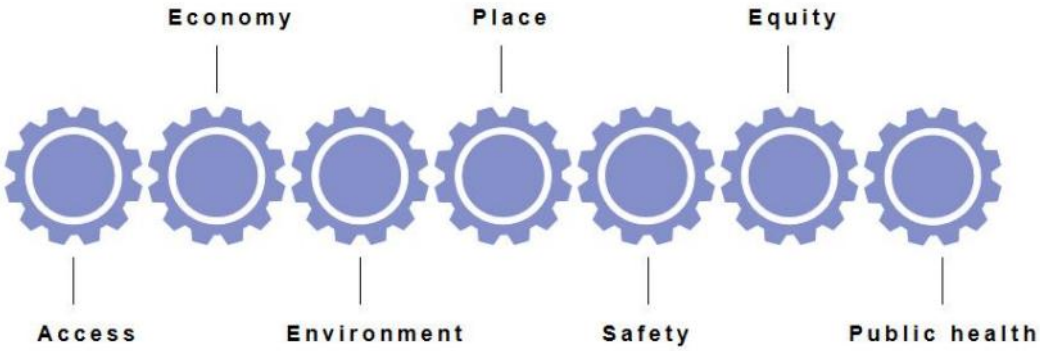


Fig. 2-12 Complete Streets Assessment Indicator (Source: Completed by author)

Table. 2-3 Assessment of Complete Streets target indicators and parameters（Source: Completed by author）

Access	Effective transportation systems allow people to access destinations safely and reliably, by foot or assistive device, bicycle, transit, car, or truck by creating comprehensive, integrated, multimodal transportation networks.
Economy	Evaluation of transportation projects can include metrics that show how the project contributes to economic performance, whether by connecting people to jobs, by providing employment in transportation construction and operation, or by boosting the value and attractiveness of abutting land.
Environment	Minimizing the impact on the natural environment can lead to fiscal savings in the cost of project materials and maintenance. It also can influence public health outcomes by minimizing pollutants.
Place	For better or worse, transportation investments influence the communitys quality of life. Being aware of the community context, including existing and planned land use and buildings, transportation needs, and residents culture, can result in streets that are vital public spaces. Place-related evaluation measures help ensure a product that fits and enhances the community.
Safety	Ensuring people are able to safely travel to their destinations is a fundamental transportation goal. With Complete Streets projects, this means prioritizing safety for all who use the street—walking, bicycling, riding public transportation, and driving cars or trucks. Safety measures should track both the characteristics related to injurious crashes and those related to perceptions of safety.
Equity	Transportation services and infrastructure often impact certain populations and neighborhoods disproportionately, with important implications for social equity. In project evaluation, agencies should look at the distribution of impacts and benefits for traditionally disadvantaged communities, including people of color, older adults, low-income households, and people with disabilities. Many equity measures can be integrated in project evaluation.
Public health	Common project-level public health measures indicate whether transportation investments allow people to have healthier lifestyles through increased access to physical activity and active transportation, decreased incidence of serious or fatal injury, and reduced exposure to pollutants.The overlap with several common transportation goals means it can be easy to integrate health indicators into transportation project evaluation.

2.3 Status of Complete Streets research

2.3.1 Overseas research status

(1)Theoretical level

The concept of Complete Streets was developed after the Second World War when, in

response to rapid urbanisation, urban roads were designed to accommodate the use of cars, even in areas with good public transport, resulting in the marginalisation of travel modes such as cycling, public transport and walking. The concept of Complete Streets emerged in the 1970s in the USA, and since 2000, slow mobility, street vibrancy and green and healthy mobility have become the mainstay of urban transport research. In 2003, Goldberg in the USA introduced the concept of Complete Streets, advocating for improved slow-moving transport facilities and encouraging people to walk, cycle or use public transport. [12]In 2005, the Complete Streets Coalition was formed and the Complete Streets movement spread across the US.2005 Lang focused on the design of bicycle-led street spaces. [13]As of early 2014, 610 regional departments in the US have adopted Complete Streets policies, such as the Massachusetts Department of Transportation, which provides examples of Complete Streets designs that emphasise adequate pedestrian space, separate bicycle lanes, and adequate roadway space for street trees, lighting and street furniture to create a people-centred, vibrant community space . [14]The Massachusetts Department of Transportation's Complete Streets Grant Program has been in place for four years, with a total of $84 million allocated to fund 272 projects in the first four months of 2020 alone.[15] In 2019, California began a major push for Complete Streets design, requiring that new communities across the state be designed with Complete Streets in mind, and implement the SHOPP toolkit as a design guideline for new projects evaluation.[16]

(2)Practical level

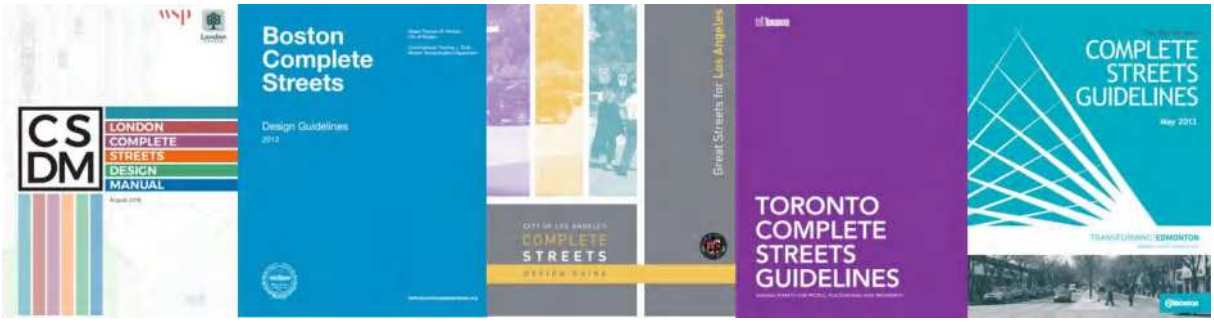


Fig. 2-13 Overseas Complete Streets Design Guidelines (Source: Google)

With the rise of the Complete Streets concept and a shift in planning thinking, regional cities have developed street design guidelines that are in line with their own transport developments(Table.2-4)(Table.2-5). Some representative examples are the Chicago Department of Transportation's 2006 "Chicago The Chicago Complete Streets Policy, which details the steps, criteria and expected outcomes of the project. Building on the 2006 policy, in 2013 the Chicago Department of Transportation reissued Complete Streets Design Standards, which constructed a Complete Streets Design Decision Tree, divided streets in the city into

six categories, and proposed recommended design standards for streets according to local streets, auxiliary roads, and arterials. [17]In 2009 the City of Tacoma adopted the City of Tacoma's Complete Streets Design Guidelines, a program focused for improving the community's travel environment for different modes of transportation, especially slow-moving transportation, and for providing a good living and travel environment for community residents by implementing measures such as green stormwater and greenways to improve environmental quality and improve stormwater runoff. America Needs Complete Streets, publishedby Dan Burden and Todd Litman in the ITE Journal in 2011, uses Hillsborough Street and Washington D.C as examples of how the Complete Streets concept can improve safety and population health.[18] In 2013 Boston introduced the Boston Complete Streets Guidelines, which include the following The Boston Complete Streets Guidelines, published in 2013, classify urban streets into nine categories: downtown commercial streets, downtown mixed- use streets, community arterials, inter-community, residential, industrial, shared- use, parkways and boulevards, and provide detailed design guidelines for each category. In 2014, the Los Angeles Department of City Planning proposed the Los Angeles Complete Streets Design Guidelines, which provide detailed design guidelines for different street types to make streets more complete for different street types.[19] In the United States, Chicago, Los Angeles, Canada and others, the exploration and implementation of complete streets have also yielded some results.

Table. 2-4 Names of complete street practices in each country and the departments to which they belong (Source: Completed by author)

Competent authorities	File name	Main content
Philadelphia City Planning Commission Philadelphia Street Department	Philadelphia complete streets design handbook[20]	Propose the need to implement complete streets,classify Philadelphia streets according to pedestrian flow and function, and implement each type of complete street The technical specifications.
California State Department of transportation	Performance Measures for Complete, Green Streets: A Proposal for Urban Arterials in California[21]	Building safe, green, convenient, efficient
New York City Department of Transportation	First & Second Avenues Complete Street Extension Community Board [22]	Additional cycle lanes, pedestrian crossing safety safety islands to enhance pedestrian and cycling safety.
Toronto Center for Active Transportation	Complete Streets by Design: Toronto Streets Redesigned for All Ages and Abilities[23]	A return to people-centred street design, with an emphasis on public participation.
North Carolina Department of Transportation	Complete Streets Planning and Design Guidelines[24]	Integrating land use and street functions, different types of streets propose different complete streets implementation strategies.

Table. 2-4 Names of complete street practices in each country and the departments to which they belong (Source: Completed by author)(continuous)

Competent authorities	File name	Main content
Maryland Department of Transportation	Complete Street Policy and Implementation[25]	Different standards for different streets, uniform and complete The street design elements are integrated.
City Council General Issues Committee	Complete Streets Policy for Hamilton[26]	Reduce private car use and call for walking walking, cycling and public transport.
Chicago Department of Transportation	Complete Streets Chicago[27]	presenting a complete street design decision tree. Four types of transport: pedestrian > public pass > bicycle > private car.
Los Angeles Department of City Planning	City of Los Angeles Complete Streets Design Guide[28]ES	Enhancing the safety, convenience and liveliness of the streets Vitality. The street widths are classified according to different design strategies.

Table. 2-5 Complete streets objectives and design elements for countries/cities(Source: Completed by author)

Country / City	Objective	Design elements
Montgomery	safety; sustainability ; vitality[29]	active Zone; street Zone; bikeway; intersections; green Streets; speed management
Eugene	provide livability; ensure health and safety for all users; accommodate all modes of travel; support neighborhoods and economic vitality; designed sustainably[30]	pedestrian realm; roadway; intersections
Toronto	streets for people; streets for placemaking; streets for prosperity[31]	street design for pedestrians;street design for cycling;street design for green infrastructure;street design for roadways;street design for intersections;
Boston	multimodal; green; smart[32]	sidewalks; roadways; intersections; smart curbsides
Los Angeles	safe;accessible; vibrant streets[28]	sidewalk area;roadway;intersections and crossings
London	more complete streets; meeting the needs of all types of users; supporting sustainable modes of transport; [33]	pedestrian realm and place design; cycling facility design; transit facility design; motor vehicles; green infrastructure; utilities and municipal services; intersections
Saskatoon	supports people of all ages and mobility levels mobility; provide appropriate facilities to support pedestrians, cyclists, transport and motor vehicles; integrate the street environment with existing and future land uses.[34]	sidewalks; streets; intersections
Abu Dhabi	safety;land use context efficiency;sustainability;public health;public enjoyment;economic development & tourism;culture & image[35]	street; junction; streetscape

2.3.2 Domestic research status

(1)Theoretical level

Most domestic research on complete streets is a continuation and expansion of foreign research. The Shanghai Street Design Guidelines, introduced in 2016, put forward the concept of localized complete streets.[36] The Research and Application of Urban Complete Streets and Green Transportation Design Technology proposed a localized complete street concept with a slow walking system as the core, and proposed 14 key elements and design points oriented to complete rights-of-way. Shen Leihong and Jiang Yinghong proposed the construction of complete streets in terms of multiple neighbourhood networks, shared street space, optimisation of road sections and intersection space, and refined street design.[37] Xu Lanhua proposed targeted traffic space design methods for different types of urban streets, on the basis of which a complete street evaluation model was established to determine street integrity.[38] Hu Wanru proposes that the integrity of the street involves service targets and functions, space, time and institutional spheres. and institutional spheres, and focuses on creating three-dimensional, flexible and refined streets.[39]Gu Mingen, Deng Zhuo et al. used the AHP method to evaluate the completeness of existing all-factor indicators for streets.[40]Ma Junlai examines the detailed classification of urban complete streets from the perspective of exploring the path of integrated planning-design of urban area street systems.[41]

(2)Practical level

In terms of practical research on complete streets in China, it is mainly divided into design aspects and guideline aspects.

In the practice of design, it mainly includes exploration of complete streets at the urban design level and exploration of complete streets in urban transportation. At the urban design level, based on the concept of street sharing, Xu Yan constructed a two-dimensional street classification system that takes into account both urban traffic and spatial functions, and proposed a competitive allocation method to alleviate the conflicting spatial needs of different types of street users. [12]Ye Zhen and Li Ruimin focus on the concept and development history of complete streets, theoretical research comparing them with traditional streets, and study the practical case of Tacoma in the United States, as well as design strategies that can be learned from it. [42] Cao Ruihuan published a complete street design strategy that prioritizes pedestrians' rights in "Architecture and Culture" under the condition of road right-of-way regression.[43]Wang Long and Wei Guifen analyse the problems of Suzhou Shiquan Street in

terms of traffic system, landscape space and cultural architecture, and propose a renovation plan to improve the quality of the historical and cultural street.[44] Ou Chaolong summarised and analysed the design concept of "complete streets" and actual cases in western countries, and proposed a design method for road renovation.[45] Wu Yaping, based on the theory of complete streets, researched the characteristics of public space in waterfront streets and proposed development principles of people-oriented, ecological and green, functionally compound, and culturally infused. [46]Huo Haiying combines the concept of complete streets and explores factors that influence the vitality of pedestrian space from the aspects of pedestrian passageways, building frontage zones, and equipment zones. [47]Wu Xiang takes the ancient city of Suzhou as the research object and proposes the principles of slow traffic design in the historic city based on the concept of complete streets. He discusses the optimization of slow traffic in the ancient city of Suzhou from four aspects: slow traffic system, road interface, traffic safety and landscape facilities. [48]Hu Xiaoxiao discussed the concept and classification of complete street design from the perspectives of policy orientation, concept, and classification, summarized and organized street design guidelines in six regions, and sorted out the content of full-factor design.[49]

From the perspective of transportation usage, Zhang Zidong introduced the concept of complete street design and explored the use of trams in space. He proposed design strategies from three aspects: planning, road, and engineering. [50]Deng Huizhang and Xu Yan published an article in "Shanxi Architecture" that classified streets based on their transportation functions and gave quantitative ranges for the spatial scale of streets.[51] Chen Zhi and Liu Cuipeng published an article in "Shanghai Urban Planning" that analyzed the key points of Los Angeles' complete street policy and its implications for transportation design in China. [8]
Fan Weiqiang emphasized street design for bicycle travel under the concept of complete streets.[52] Cao Haorong used the Huangxing Road renovation project in Changsha as an example to propose specific strategies for street renovation using the complete street design concept.[53] Du Jiangjun started from the perspective of complete street design and promoted the concept in domestic urban road renovation projects using the example of the upgrading of the Purui Avenue in Changsha. [54]Li Yangyu studied urban transportation and road systems in detail from the concept of complete streets and proposed targeted renovation strategies.[55]
Regarding urban street design guidelines.In 2013, the Ministry of Housing and Urban-Rural Development issued the *Guidelines for Planning and Design of Urban Pedestrian and Bicycle Traffic Systems*, [56]and Shenzhen introduced the *Shenzhen Pedestrian and Bicycle Traffic*

System, both aiming to shape high-quality pedestrian environments, create vibrant urban spaces, promote sustainable development, and advocate green travel through the construction of harmonious transportation. [37] In the same year, Shenzhen issued the *Luohu Complete Street Design Manual*, emphasizing the prioritization of slow travel and the vigorous development of green transportation to guide the orderly development of street spaces and restore their vitality.In 2017, Guangzhou proposed the *Guangzhou Complete Street Design Manual*, emphasizing the transformation of traditional urban street design and management towards refined and high-quality street design and management.[57]Also in 2017, the *Zhuzhou Complete Street Design Manual* was introduced, which tailored the transformation of urban streets from traffic function and efficiency-oriented to a balanced emphasis on transportation, living, and economic activities based on local characteristics. The street design shifted from an engineering and technical focus to a comprehensive urban public space design, striving to create a vibrant and ecologically livable urban space.In 2018, Yuxi City's *Yuxi Central City Area Street Design Guidelines* classified streets based on their functions, positioning, and other differences, and adopted targeted and detailed designs for each type of street, highlighting the refinement and humanism of street design.

Fig. 2-14 Domestic Complete Streets Design Guidelines(Source: Google)

In general, research on urban complete street design at home and abroad has produced certain results and covered a wider range of dimensions. However, there are still certain problems:

1．Domestic theories on complete streets are based on existing foreign research results, and have not yet developed suiTable. local theories and results.

2． The macro level of research on street design is more The study of complete streets in China is based on existing research results from abroad.

3．The application of complete streets in China is more from the perspective of urban traffic, but less from the perspective of urban design.

4．The evaluation of complete streets is mainly qualitative, but less quantitative.

2.4 Summary

This chapter first elaborates on the evolution of street design ideas from a car-centric approach to a people-centric approach, which went through the stages of car-centric design, shared space for people and cars, and finally to the complete streets approach in the 21st century. Then it focuses on the development process, spatial elements, connotations, goals, and evaluation criteria of the complete streets concept. Finally, it discusses the current research status of complete streets both domestically and internationally, analyzes and summarizes the objectives and elements of complete street design in various cities, and provides support for proposing street space improvement suggestions for Tianhe Nanyi Road and Tianhe Nan Pedestrian Street under the context of complete streets.

[7]Lu Ke, Pan Haixiao. The development of urban pedestrian transport - measures to improve the urban walking environment in the UK, Germany and the USA [J]. Urban planning abroad, 2001 (6): 39-43.

[8] ChenZhi，Liu Cuipeng. From Car Oriented to Complete Streets: An Overview of Complete Streets in America [J]. Shanghai Urban Planning, 2017(Period 3):p140-p144.

[9] Smart growth america. Safer Streets, Stronger Economies [R]. United States： Smart Growth America's National Complete Streets Coalition, 2015

[10] Mccann B, Rynne S. Complete Streets: Best Policy and Implementation Practices[J]. Apa Planning Advisory Service Reports, 2010(5): 139-143.

[11] AARP, Smart Growth America. Evaluating Complete Streets Projects: A Guide for Practitioners [EB/OL]. https://snaped.fns.usda.gov/library/materials/evaluating-complete-streets-projects-guide-practitioners,2016.09.26

[12] XuYan. A study of complete street design based on the concept of sharing [D]. Nanjing University, 2014: 35.

[13] Lang J. Urban Design: A Typology of Procedures and Products. Illustrated with over 50 Case Studies[M]. Abingdon: Oxford& Builington, MA: Architectural Press,2005:75-100.

[14] Massachusetts Department of Transportation. Complete Streets Funding Program Guidance[R]. 2016,1.

[15] Massachusetts Department of Transportation. Complete Streets Funding Program Awardees -Fy20 Round[R]. 2020,4.

[16] Smart Mobility and Active Transportation Branch Office of Smart Mobility and C

limate Change Division of Transportation Planning. Complete Streets Elements Toolbox Version 2.0 [R]. 2018.7.23.

[17] Ye Zhen, Li Ruimin(Compilation). Complete Streets Design Guidelines - Chicago as an example [J]. Road Traffic Science and Technology,2015(1): 52-58.

[18] Dan Burden, Todd Litman. America Need Complete Street[J]. ITE Journal,2011(4): 36-43.

[19] Los Angeles Department of City Planning. Complete Streets Design Guide:Great Streets for Los Angeles[R]. Los Angeles: LADCP, 2014: 1-161.

[20] Philadelphia City Planning Commission & Philadelphia Street Department.Philadelphia Complete Streets Design Handbook[R]. Philadelphia, 2009:9-158.

[21] California State Department of Transportation. Performance Measures for Complete, Green Streets: A Proposal for Urban Arterials in California[R].California, 2010: 1-106.

[22] New York City Department of Transportation.First & Second Avenues Complete Street Extension Community Board 11[R]. New York, 2011: 3-23.

[23] Toronto Center for Active Transportation. Complete Streets by Design: Toronto Streets Redesigned for All Ages and Abilities[R]. Toronto: TCAT, 2012: 2-24.

[24] North Carolina Department of Transportation. Complete Streets Planning and Design Guidelines[R]. North Carolina, 2013: 3-163.

[25] Maryland Department of Transportation. Complete Street Policy and Implementation[R]. Maryland, 2013: 2-9.

[26] City Council General Issues Committee. Complete Streets Policy for Hamilton[R]. Hamilton, 2013: 2-8.

[27] Chicago Department of Transportation. Complete Streets Chicago[R]. Chicago,2013: 5-133.

[28] City of Los Angeles Department of Transportation. City of Los Angeles Complete Streets Design Guide [EB/OL]. https://losangeles2b.files.wordpress.com/2012/12/city-of-la-adopted-complete-street-design-guide.pdf,2018

[29] Montgomery County Department of Transportation, the Montgomery County Planning Department. Montgomery County Complete Streets Design Guide [EB/OL]. https://montgomeryplanning.org/planning/transportation/complete-streets/,2018

[30] City of Eugene Public Works Department. Quick Reference Guide for the Design Standards and Guidelines for Eugene Streets, Sidewalks, Bikeways and Access Ways Eugene's Complete Street Design Standards [EB/OL]. https://www.eugene-or.gov/4106/Complete-Street-D

esign-Standards,2020.10

[31] City of Toronto. Toronto Complete Streets Guidelines[EB/OL]. https://www.toronto.ca/services-payments/streets-parking-transportation/enhancing-our-streets-and-public-realm/complete-streets/complete-streets-guidelines/,2017.11

[32] Menino T M. Boston Complete Streets Design Guidelines[R].Boston Transportation Department, 2013.

[33] Transport for London. London Complete Streets Design Manual[EB/OL]．https://london.ca/sites/default/files/2020-09/Complete%20Streets%20Design%20Manual.pdf,2018.08

[34] City of Saskatoon. Complete Streets Design & Policy Guide [EB/OL]. https://vdocuments.net/complete-streets-design-and-policy-guide-saskatoon-522-transit-complete.html?page=1, 2017.12

[35] Abu Dhab Urban Planning Council. Abu Dhabi Urban Street Design Manual[S]. 2009.

[36] Shanghai Municipal Planning and Land Administration, Shanghai Municipal Transportation Commission, Shanghai Urban Planning and Design Institute. Shanghai Street Design Guidelines [M]. Shanghai：Tongji University Press,2016.

[37] Shen Leihong, Jiang Yinghong. A First Look at a Localized Complete Street Design System - A Look at the Preparation of Shanghai Complete Street Design Guidelines [C]// 2018 Proceedings of Urban Development and Planning, 2018.

[38] Xu Lanhua. A study of street traffic design methods based on the complete streets concept [D]. Nanjing Forestry University, 2017.

[39] Hu Wanru. Complete Streets Integrity Design Thinking [C]. Chinese Society of Urban Planning、Chongqing Municipal People's Government. Vibrant Cities and Villages for Better Living——2019 Proceedings of the Annual China Urban Planning Conference（07 Urban Design）. Chinese Society of Urban Planning、Chongqing Municipal People's Government: Chinese Society of Urban Planning,2019:915-923.

[40] Gu Mingen,Deng Zhuo,Tang Zude, et al. Quantitative evaluation of complete streets based on fuzzy integrated hierarchical analysis [J]. Roads,2020,65(09):226-231.

[41] Ma Junlai. Detailed classification of complete streets for the planning interface [J]. Urban Transport,2021,19(04):100-111.DOI:10.13813/j.cn11-5141/u.2021.0403.

[42] Ye Zhen,Li Ruimin. Complete Streets Policy Development Overview [J]. Urban Transport, 2015(1): 17-24.

[43] Cao Ruiheng. Based on the "return" of road design - complete street design thinking [J].

Architecture and Culture,2017(7): 237-238.
[44] Wang Long,Wei Guifen,Wang Yuhuan. Analysis and discussion on the design of complet e streets in historical and cultural streets - the example of the design of Shiquan Street in Suzh ou [J]. Traffic and Transport,2019,32(S1):52-55.
[45] Ou Chaolong. " Complete Streets " Design and Practice - The Case of Yanping Old Tow n [J]. Architectural design management , 2017, 000(012):85-87.
[46] Wu Yaping. Public space design for waterfront streets under the complete streets concept [J]. Traffic and Transport,2020,33(S1):267-271.
[47] Huo Haiying,Li Jia,Wang Shikun, et al. A Study on the Vitality of Pedestrian Space in Ol d Town Streets under Complete Streets - A Case Study of Chengnan Street in Handan City [J]. Urban architecture,2020,17(31):21-23.DOI:10.19892/j.cnki.csjz.2020.31.05.
[48]Wu Xiang. Exploring the design of slow traffic in historic urban areas under the complete streets concept - an example from the ancient city of Suzhou [J]. Architecture and Culture,202 1(06):129-130.DOI:10.19875/j.cnki.jzywh.2021.06.046.
[49] HuXiaoxiao,Jin Wei. A study of complete streets design concepts - an example from the J inan Airport project [J]. Urban Roads and Bridges and Flood Control,2023(03):11-15+327-32 8.DOI:10.16799/j.cnki.csdqyfh.2023.03.003.
[50] Zhang Zidong . Approach to tram route planning and design under the complete streets c oncept [J]. Planners,2016(10): 22-27.
[51] Deng Huizhang, Xu Yan. Study on the functional classification of traffic in complete stre ets [J]. Shanxi Construction, 2016(3): 8-9.
[52] Fan Wei. Bikeway design under the complete streets concept - the example of Miami, US A [J]. Architecture and Culture,2021(08):33-34.DOI:10.19875/j.cnki.jzywh.2021.08.010.
[53]Cao Haorong,Cheng Peng,Liu Jie, et al. Study on urban road renovation strategies under the complete street concept - Huangxing Avenue renovation project as an example [J]. Urban architectural spaces,2022,29(12):55-57.
[54] Du Jiangjun,He Jian,Li Jianchao. Exploring urban road improvements based on the comp lete streets concept [J]. Chinese and foreign architecture,2022(12):97-101.DOI:10.19940/j.cnk i.1008-0422.2022.12.016.
[55] Su Yangyu,Liu Mengzhao，et al. Transformation of urban traffic and road systems based on complete streets theory [J].Shanxi Construction,2023, 49(06):3538+45. DOI:10.13719/j. cnki.1009-6825. 2023.06.009.
[56]Ministry of Housing and Urban-Rural Development of the People's Republic of China. Pl

anning and Design Guidelines for Urban Pedestrian and Cycling Transport Systems [R]. Beiji ng: Ministry of Housing and Urban-Rural Development of the People's Republic of China,201 3

[57]Guangzhou Housing and Urban-Rural Development Committee，Guangzhou Urban Plan ning and Survey Design Institute. Guangzhou Complete Street Design Manual [M]．Beijing： China Construction Industry Press,2017．

Chapter 3 A case study of street space transformation in the context of complete streets

3.1 Principles of case selection

This paper examines the street space regeneration strategies of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street in the context of complete streets. Tianhe Nanyi Road and Tianhe Nan Pedestrian Street serve as commercially oriented streets in the urban centre of Guangzhou. The case studies chosen for this paper are Reseda Boulevard in Los Angeles, chosen to change the case because of its location as an urban centre and the similar location of the project study site, both in the urban centre. Broadway Street in New York was chosen as a case study because Broadway Street is the same type of street as Tianhe Nanyi and Tianhe Nan Pedestrian Street, both of which are commercial streets and can guide the subsequent design more intuitively. Sanya Jiefang Road was chosen as a case study because it is a famous example of the 'complete street' design concept in China, which provides a reference for the subsequent application of complete streets.

3.2 Reseda Boulevard, Los Angeles

3.2.1 Background

Reseda Boulevard is a north-south arterial street in the heart of the city, running through the western San Fernando Valley of Los Angeles, California. 2.9 miles in length, the Reseda Boulevard project area contains a variety of land types, including commercial land uses, residential areas, schools and community institutions. The street width ranges from 22.5 to 24.4M, with four lanes in each direction, with turn lanes in the middle and parking on both sides of the street. In terms of the street program, Los Angeles' streets share the common disadvantage that they were designed for cars and most sections have a cross-sectional form that is extremely unfriendly to pedestrian or bicycle travel, and Reseda Boulevard is no exception. As a result, Reseda Boulevard does not provide a comfortable. walking environment for pedestrians and a friendly cycling environment for cyclists due to the lack of a proper right-of-way allocation, and traffic is often chaotic and people have to avoid it. According to LADOT data, there were 64 traffic accidents on Reseda Boulevard in the decade 2009-2019, and the street was included in the City's High Injury Network, so addressing traffic accidents was the optimal solution for the street's transformation.

Fig. 3-1 Reseda Boulevard after renovation(Source: Google)

The Reseda Boulevard Complete Streets transformation improves pedestrian safety through key safety improvements on the street, creates a sustainable and green street environment; improves the efficiency of bus operations along the route and enhances the shopping experience. The main objectives of the street transformation are: to save lives; to ensure accessibility for everyone; to introduce sustainable green features; to improve the efficiency of public transport operations; and to drive local economic growth.

3.2.2 Transformation strategy

(1) Improving street safety

Focus on repairing damaged pavements and roadbeds and installing pedestrian refuge islands in the streets to improve the safety of pedestrian crossings. Installing bus-ride islands can shorten the distance pedestrians have to cross the street, separate buses from cycle lanes, reduce conflict between buses and cyclists, and improve the safety of crossing the street and the efficiency of street use. [58] Installing protected cycle lanes, using on-street parking, planters, kerbs or bollards to separate motor vehicles from bicycles on the street, improves street safety.

Fig. 3-2 Repair of damaged pavement(left),installation of pedestrian refuge islands(right),protected cycle paths(Source: SFMTA)

(2)Improved street comfort

For every street tree removed, 2 street trees are planted. Helps to reduce the urban heat island effect and improve the safety and comfort of the streets. Installation of bio-ponds and storm water treatment systems as part of the street renovation. [59]

Fig. 3-3 Installation of bio-pit rain gardens(Source: SFMTA)

(3)Improving street dynamics

Artists are invited to transform street furniture and street furniture. To enhance the sense of place and community and stimulate local economic growth. The local councillor's office and Great Streets invited the not-for-profit design company LA Más to transform Reseda's pavements into a vibrant venue for community gatherings, with a transformation strategy that included the installation of new furniture and street furniture.

Fig. 3-4 Before and after pavement reconstruction(Source: Google)

In order to improve the problems caused by the traditional car-based approach to street rights of way, LA Más has divided the pavements, cycling lanes and carriageways by painting the ground, so that the function of the street is clearly defined. [60]The street furniture is painted to enhance the interest of the street space, and the street furniture is reorganised and placed according to the needs of the different shops and spaces, so that the street furniture can play an active role. The street furniture has been reorganised and placed according to the needs of the different shops and spaces. In addition, LA-Más has also established a link with the street

businesses by revitalising the walls of the shops in the grey spaces under the canopies, replacing the awnings on the facades with antique theatre tents and using a uniform blue colour scheme to give the street a unique blue colour. This makes for a cooler and more pleasant experience for those who stop and walk under the eaves. The yellow street furniture and the blue walls have become the unique 'calling card' of the streets of Reseda. The renovated Reseda has ample and well-distributed space for walking and cycling.

Table. 3-1 Summary of strategies and practices（Source: Completed by author）

Strategies	Implementations
Improving street safety	Repairing damaged roadbeds and pavements
	Provision of pedestrian refuge islands in the streets
	Adjustment of traffic signals
	Installation of bus islands
	Upgrading existing cycle lanes, separating motorised traffic from cycle lanes on the street using planters etc.
Enhanced street comfort	Street trees are planted on both sides of the street to provide shade for pedestrians and cyclists
	Installation of bio-ponds and storm water treatment facilities for better street environment
Boosting street dynamics	Invitation to artist activists
	Painting of street furniture
	Cooperation with shops along the street

3.3 Broadway Street, New York

3.3.1 Background

After the Second World War, the international community came to recognise the value of street space and the negative impact of excessive car development on the economic vitality, social equity and resources of cities. "In 2005, the Complete Streets Coalition was formed.

The Complete Streets movement is rapidly expanding across the United States. The transformation of Broadway by the Department of Transportation(DOT) in 2008 is a prime example of a Complete Streets case study. Broadway Street is one of New York's most famous streets, running north-south through the entire core of Manhattan. Despite repeated renovations throughout its history, Broadway Street still suffers from traffic congestion, intense pedestrian and vehicular conflicts, and loss of street life. In a study conducted in 2000, Jan Gehl found that vehicles took up so much space on the street that only 10% of it was available for pedestrian movement. And as the number of visitors increases, the already cramped pedestrian space becomes even more crowded. At the same time, the survey found

that the accident rate on Broadway was 1.4 times higher than that of the surrounding streets, indicating the seriousness of the problems faced by the street space before the renovation.

Fig. 3-5 Before and after the renovation of Broadway Street, New York(Source: Google)

3.3.2 Transformation strategy

This street transformation project is using the priority hierarchy of street users to guide the transformation of motorways and parking strips in the streets and focuses on three aspects of the transformation of streets in the old city:

Firstly, the public nature of the street space will be recreated. The spatial functions of the old city streets will be reorganised, the rights of way of the street spaces will be redistributed to increase the space for pedestrian activities, and street furniture and green landscaping will be humanely installed in the pedestrian areas to enhance the vitality of the streets.

Secondly, the safety of the streets is enhanced. Small turning radii are used for pinched intersections to shorten crossing distances for pedestrian safety; and slow-moving traffic is properly segregated from motorized traffic by landscaping measures such as public amenity strips.

Thirdly, the accessibility of the whole neighbourhood is improved. One-way cycle lanes have been added and public transport has been developed to relieve traffic pressure by unifying the bus routes in the neighbourhood.

Fig. 3-6 Comparison of Times Square Before and After Renovation (Source: Google)

Transformation effect

One year after the renovation, 45,000 m² of new public space was added, according to a report by the New York Department of Transportation. The number of pedestrians has increased by 11%, the injury rate for pedestrians has decreased by 35% and the number of people walking in the motorway has decreased by 80%. The incidence of traffic accidents has been reduced, while locations along the route have actually increased in value by 29% during the financial crisis. And while the area's retail sector has grown rapidly, traffic speeds in its surrounding neighbourhoods have not suffered as a result - in essence, the time taken by cars to travel in central New York has actually been reduced. In a survey sponsored by the Times Square Alliance, 74% of respondents agreed that the results of the renovation were a "dramatic improvement".

Table. 3-2 Summary of strategies and practices（Source: Completed by author）

Strategies	Implementations
Improve street traffic	Installation of cycle lanes
	Realignment of bus routes
Improving street safety	Altering the street alignment at intersections, providing additional crossing pedestrian safety islands and enlarging kerbs to reduce pedestrian crossing distances.
	Installation of parking strips, buffer strips or streetscape features along the street
Boosting street dynamics	Large number of movable seats added to all pedestrian areas
	Use of coloured paints for street furniture
	Rationalise the allocation of rights of way, using a reduction in motorways and parking strips to increase pedestrian movement and open space.

3.4 JieFang Road, Sanya

3.4.1 Background

Jiefang Road is one of the most characteristic streets in Sanya, located in the Hesi area of Tianya District, with a total length of 4.3 kilometres. In recent years, as urbanisation continues to accelerate and the city expands, Jiefang Road has gradually developed problems such as disorganised traffic flow, serious conflicts between pedestrians and vehicles, disorganised street facilities and low quality street space. The section selected for this case study is the demonstration section of Jiefang Road, with a length of about 425m, and its transformation is based on the "complete street" design concept, which is an integrated transformation of the space inside and outside the red line of the street. The specific renovation measures are as follows:

Fig. 3-7 Before and after reconstruction of Jiefang Road(Source: Google)

3.4.2 Transformation strategy

Jiefang Road takes full advantage of Sanya's tropical location and rich vegetation, highlighting the creation of open spaces, forming a number of street corner parks, resting squares and other pedestrian nodes. In terms of improving the pedestrian environment, in addition to improving the ground pavement and street greenery, the street has been combined with the improvement of the building facades on both sides to create a riding space along the street, effectively improving the comfort of the slow walking environment and reflecting the local characteristics of Sanya.

1．Improving street traffic

By improving and optimising the surrounding traffic road system so that it shares some of the

traffic pressure of Jiefang Road, the traffic function of the Jiefang Road model is weakened. Walking and cycling are also encouraged, gradually transforming Jiefang Road into a lifestyle road. At the level of vehicular traffic, by systematically addressing the wider road network system, the traffic organisation will be optimised and the traffic pressure on Jiefang Road reduced, while the diversion of motorised and non-motorized traffic will be achieved. In terms of parking, the current situation of occupied parking will be changed by increasing parking space in the underground and on the side streets. Finally, the system will be strengthened to ensure that parking is regulated.

2．Create a complete street

By optimising the pedestrian space, enhancing the green landscape and improving the street facilities, Jiefang Road is transformed from a simple traffic space into a safe and comfortable. green street space. This includes subdividing the pedestrian space into three categories: continuous circulation space, relatively continuous slow-moving space and nodal block resting space by combining ground paving changes and street greening separation. It also combines with the improvement of the building façade on both sides to create a riding space along the street that can shelter pedestrians from the sun and rain, enhancing the comfort of the slow-moving environment.

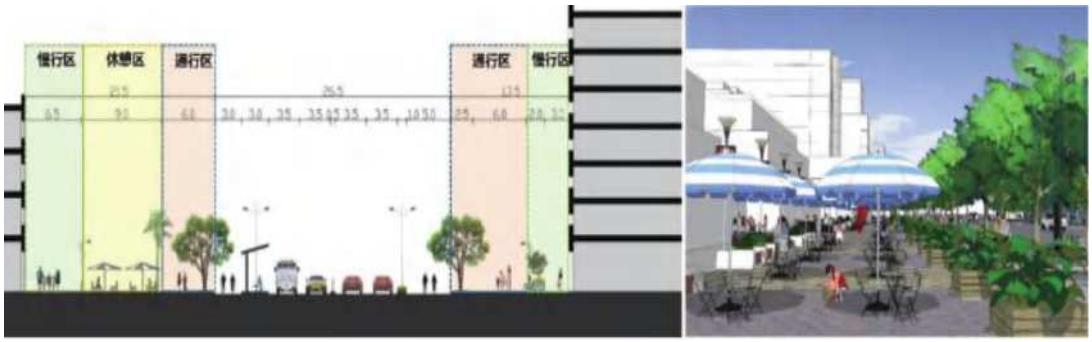


Fig. 3-8 Illustration of the refinement of the pedestrian space(Source: Sanya Jiefang Road Integrated Environmental Construction Guided by Urban Repair Concept)

3．Street dynamics are enhanced

①The street façade of Jiefang Road is shaped. The façade of the building takes a different approach to the renovation of the podium and the main building. The podium, as a perceptible space for pedestrians, has been given more attention to the creation of architectural features and pedestrian comfort. In addition to retaining the original building structure, the introduction of the architectural element of the ramp space not only highlights the local architectural style and retains the historical memory of Hainan residents going to the South Seas, but also meets the requirements of sun and rain shading in the tropical area of Sanya and

enhances the comfort of walking.② Remediation and enhancement of urban furniture and signage systems. On the basis of ensuring functionality, safety and comfort, local materials that are eco-friendly are selected and combined with decorative patterns that reflect local culture to reinforce Sanya's urban characteristics. For example, local environmentally friendly materials such as permeable bricks, permeable concrete and volcanic stone are selected as street paving materials.③ Improve advertising plaques and optimise street night lighting. Pay attention to the concealment of lighting fixtures and the safety of their use to avoid landscape lighting damaging the building facades along the streets.

Fig. 3-9 Before and after building facade renovation(Source: Sanya Jiefang Road Integrated Environmental)

4．Institutional construction to protect street operations

In the process of promoting the renovation of Jiefang Road, Sanya City has also simultaneously issued two institutional standards, namely the "Regulations on the Management of Architectural Style and Appearance in Sanya City" and the "Technical Standards for the Setting of Outdoor Advertising Signs in Sanya City". The regulations regulate the overall architectural style and the setting of outdoor advertising signs in Sanya, providing a basis for the shaping of architectural style and the rectification of advertising signs on Jiefang Road, and also helping to better operate and maintain the completed renovated streets.

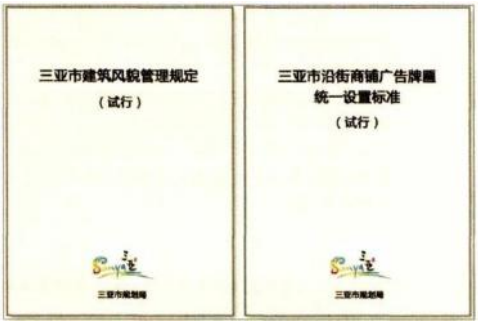


Fig. 3-10 Managemnet regulations and standards(part)(Source: Sanya Jiefang Road Integrated Environmental Construction Guided by Urban Repair Concept)

Table. 3-3 Strategy Summary（Source: Completed by author）

Strategies	Implementations
Improving street safety	Addressing the wider road network system and optimising traffic organisation to reduce traffic pressure
	Use of underground space and feeder streets around streets to increase parking space
	Institutional management to strengthen parking management and ensure regulated parking
Enhanced street comfort	The pedestrian space is divided into three categories, taking into account the variation in ground cover and the separation of the street greenery
	The renovation of the façade along the street has created a continuous space of rides along the street, enhancing the comfort of walking
Street Vitality Boost	The street facades have been renovated in a small-scale, incremental manner, in accordance with local conditions, and different approaches have been adopted for the "podium" and "main body" of the buildings.
	Remediation and enhancement of urban furniture and signage systems. On the basis of ensuring functionality, safety and comfort, local materials that are ecologically friendly are selected and combined with decorative patterns that reflect local culture to reinforce Sanya's urban characteristics.
	Rectification of advertising plaques and optimisation of street night lighting.
Introducing a system to protect	Sanya City Building Style Management Regulations and Sanya City Technical Standards for the Setting of Outdoor Advertising Boards for Buildings

3.5 Summary

In this chapter, three typical cases of urban street renovation in the context of complete streets are selected, the principles of case selection are explained and the design strategies are summarised and analysed. A comprehensive comparison of the three cases is presented to explore how streets can be retrofitted in the context of complete streets.

Reseda Boulevard, located in the heart of California, uses complete streets design thinking and theory to improve pedestrian safety through key safety improvements on the street, creating a sustainable and green environment along the street; improving the efficiency of bus operations along the route and enhancing the shopping experience.

Broadway Street in New York is a prominent commercial-oriented street in the heart of New York City. A large-scale renovation guided by the ideas and theories of complete street design has been carried out to redesign the road space long encroached by motor vehicles in a new section, freeing up street space for pedestrians and bicycles and promoting the creation of a more humane public space on Broadway Street.

Jiefang Road is located in Sanya, Hainan Province and is one of the most distinctive streets in

the city. The whole transformation is based on the 'complete street' design concept, which is an integrated transformation of the space inside and outside the red line of the street.

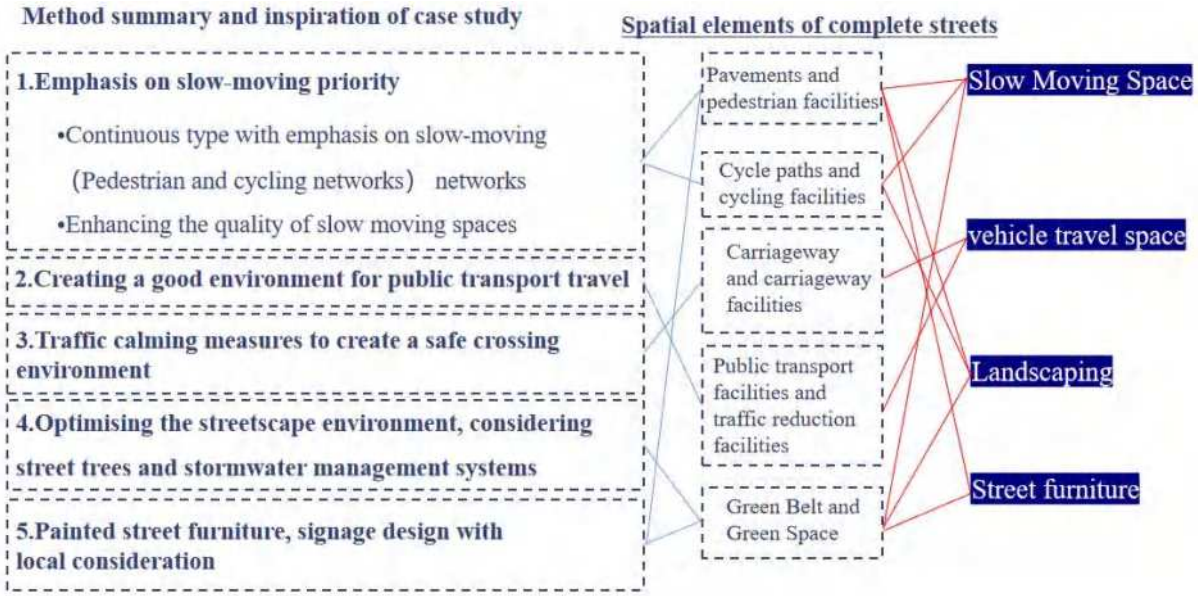


Fig. 3-11 Case summary and complete street theory combined with analysis（Source: Completed by author）

[58] Reseda blvd street improvement project [EB/OL]. https://blumenfield.lacity.org/reseda_blvd_street_improvement_project, 2023.02.22

[59] Joe Linton. Eyes on the Street: Reseda Blvd's Under Construction Complete Streets Upgrades [EB/OL]. https://la.streetsblog.org/2022/07/22/eyes-on-the-street-reseda-blvds-under-construction-complete-streets-upgrades/,2022.07.22

[60]Urban Planet Institute. How can the tried and tested streets of Los Angeles win back hearts and minds? [EB/OL]. https://ishare.ifeng.com/c/s/7q6BxvBKt8a, 2019.09.19

Chapter 4 Methodology

4.1 Complete street design elements

4.1.1 Target level

The integrity of the street lies in its ability to accommodate all types of travelers. Jan. Gayle has made the activity of public space. It is divided into 3 categories: necessary activities, optional activities and social activities.[61] Further, complete street design takes human behavioural characteristics and activity needs as the starting point, and through the design of the spatial environment and the organisation of the constituent elements, explores the possibility of more optional and social activities on the basis of necessary activities, and balances the conflicts between the various users occurring in the street, so as to achieve coordination and efficiency between motor vehicles, public transport, non-motor vehicles and pedestrians. The hierarchy of Complete Streets design objectives is divided in order from optimising traffic to improving the urban public space: safe separation and priority order, easy access and functional improvement, caring for the vulnerable and improving facilities, cultural atmosphere and environmental characteristics, maintaining urban vitality and sustainability.

First and foremost is the separation and prioritisation of security in an orderly manner. The safety of all users on the street is a fundamental requirement. The change in design philosophy is firstly reflected in the priority of access to streets, where the 'people-centred' design of streets emphasises the priority of pedestrians and public transport, but also the rights of cyclists and, finally, the right to travel by motor vehicle.

The second is ease of access and functionality. In addition to the safety of the street, users value the ease of movement. Through the division of space and the setting up of intersections, it is important to provide easy access to the street for different types of travellers. Different types of street should provide different public spaces and functions, and be coordinated with each other so that the street becomes a public space in which citizens can participate.

The third is the care of the vulnerable and the humanisation of facilities. Complete streets emphasise the 'integrity' of the people who use them, including vulnerable groups such as the elderly and children. The design of the street should include attention to vulnerable groups, emphasising accessibility and child-friendly design.

The fourth is the cultural atmosphere and environmental characteristics. The standardisation and popularisation of street design has made many street spaces lacking in vitality. The design of complete streets should be done by means of historical and humanistic, architectural and landscape culture, so that the culture of the neighbourhood is combined with the environmental characteristics to form a good and comfortable. street space with regional characteristics.

Lastly, it is important to maintain vitality and sustainable development. Through the street space to introduce a variety of activities, to encourage along the street Businesses and citizens are involved in the construction of the streets and the artistic creation of street spaces is encouraged. The streets are also made to meet the requirements of sustainable development by means of sensible greening and municipal facilities. The streets are designed to reduce hardened surfaces, reduce emissions and air pollution from cars, reduce energy consumption, maximise rainwater infiltration and reuse, and encourage the use of green modes of transport such as walking, cycling and public transport to create green and healthy travel patterns.

Fig. 4-1 complete street space design target level（Source: Completed by author）

4.1.2 Design principles

(1)Security

Complete Streets emphasises the design of safe streets for all users, prioritising the safety of pedestrians, cyclists and vulnerable groups, including children, the elderly and people with disabilities. Safe streets need to reduce speeds and human-machine conflicts; provide natural surveillance, ensure safe lighting on the street, etc.

(2)Comfort

The rapid development of street infrastructure has accelerated the heat island effect in cities, reducing the comfort of people using the streets. Complete Streets intends to mitigate this impact and create a comfortable. and convenient street experience for all modes. Street shading reduces the exposure of pedestrians and cyclists to the sun and reduces the heat island effect, increasing the comfort of street use. Streets are designed so that pedestrians can pass unhindered through the street. Expanded availability of public seating and bicycle parking areas.

(3)Sustainability

Complete streets can promote sustainable modes of transport and improve local climatic conditions. The microclimate and microenvironment of the street space can be improved by shaping the plant richness of the street landscape space and the form of the green space, thus reducing the urban heat island effect. The principles of sustainability are integrated into the design of complete streets by minimising environmental pollution and carbon emissions, and by supporting efficient energy sources. Steps are generally prioritised at street design level Active transport modes such as walking and cycling. Secondly, ecological considerations are taken into account in the design of the streetscape, with the plan provide shade for pedestrians and the use of permeable paving blocks to promote a good ecological cycle.

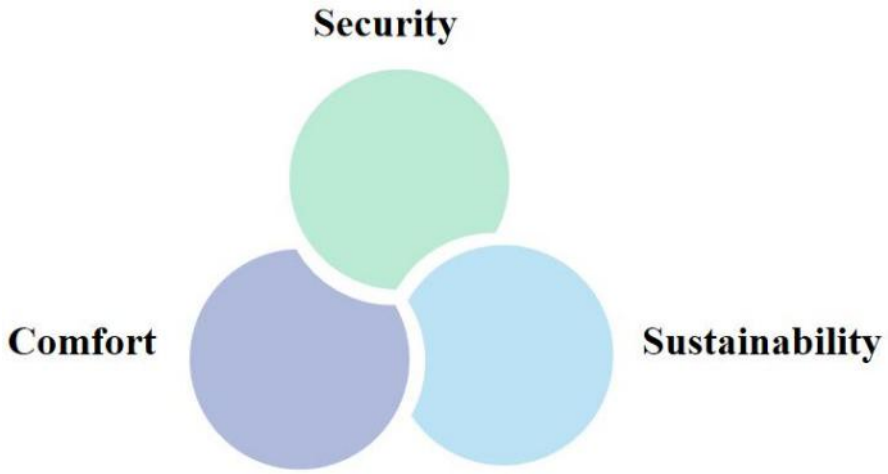


Fig. 4-2 Complete streets design principles（Source: Completed by author）

4.1.3 Evaluation indicators

There is no unified evaluation index to evaluate the design effectiveness of complete streets. And Gu Mingen in the paper Quantitative evaluation of complete streets based on fuzzy analytic hierarchy process, several evaluation indexes are proposed for evaluation, namely carriageway, pedestrian walkway, urban furniture, greening system and building façade, and by quantifying the above indexes, the overall integrity of urban streets, traffic function and

service level of streets are systematically evaluated quantitatively. [40] Most of the other papers have chosen to evaluate the results in the form of satisfaction surveys.

This paper focuses on the analysis of urban street design led by a complete street perspective, selecting the evaluation indicators and weights from Gu Mingen Quantitative evaluation of complete streets based on fuzzy analytic hierarchy process's article and adapting them to the evaluation of the street space of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street, while using a questionnaire survey to evaluate the streets in the area where the project is located as a supplement to guide the subsequent transformation of the street space.

Fig.4-3 Complete Streets Evaluation Indicator(Source: Completed by author)

4.2 Design strategies for complete streets

4.2.1 Re-establishing slow-moving friendly street spaces

(1)Improving the continuity of slow-moving roads and ensuring a safe slow-moving environment

Integrated planning of road cross-sectional form, optimise the spatial layout of the road red line within each lane, widen the width of the slow passage as far as possible, in addition to increasing the separation zone between the motorway and non-motorway or divided by the height difference in the road surface, use bright colours to clarify the right of way for non-motorized vehicles, and strengthen the priority of pedestrian and non-motorized traffic.

Firstly, speed is one of the most important factors affecting street safety. Many European cities have adopted a 'shared street' approach, encouraging pedestrians, cyclists and motorists to share street space and forcing motor vehicles to reduce their speed. For example, London's Exhibition Road has been transformed by removing warning signs, traffic lights and barricades to create a spacious, flat 'shared space' where cars can travel at a speed limit of 20 miles per hour, about 1/3 slower than on a normal road, giving visitors a new experience. At the same time, street intersections should be designed to keep them as compact as possible, using small turning radii to reduce pedestrian crossing distances, forcing motor vehicles to reduce their turning speeds and safeguarding pedestrian crossing safety. In addition, the installation of safety features, signals and lighting can have a significant impact on street safety. In the US, the Complete Streets Policy was introduced in 2012 to improve the safety of pedestrians and cyclists by adding central islands, improving bus stops, providing better lighting and installing traffic calming measures in the design of streets.

Fig. 4-4 The transformation of London's Exhibition Road(Source:Google)

Secondly，building a complete network of slow-moving paths and pleasant streets. Complete Streets emphasises the priority provided by a pedestrian-first slow road network system, resulting in a safe, continuous, accessible and enjoyable network of walking and cycling paths, with Public transport facilities are seamlessly connected. Attractive streets, squares and other public spaces and public life that make people want to arrive on foot and by bicycle or public transport, even if these places are restricted to motor vehicles.

(2)Improving the quality of slow-moving street spaces

Pedestrian space

①Provide spacious, unobstructed and attractive spaces for pedestrian movement. Complete Streets emphasise the priority of pedestrians and the design of the pavement should give priority to ensuring that the width of the roadway available for pedestrians is safe and smooth, while other functions need to be coordinated with each other. In addition the width of the pavement can vary depending on the type of street, and the recommended values for the pavement width and its sections for different types of streets are shown in the Table. below.

Table. 4-1 Pavement widths by type of street.（Source: Completed by author）

Street type	Width of pedestrian zone/M	Width of facility strip / M	Pavement width/M
Commercial streets	3.0 - 5.0	2.0 - 2.5	5.0 - 7.0
Living Streets	3.0-4.0	2.0 - 2.5	5.0 - 6.5
Traffic-oriented streets	2.0 - 3.5	1.5 - 2.0	3.5 - 5.5
Landscaped streets	2.0 - 4.0	2.0 - 2.5	4.0 - 6.5
Industrial streets	2.0 - 3.0	1.5 - 2.0	3.5 - 5.0

② Improving pedestrian paving. As the bottom interface of the street space, the material, quality and pattern of the pedestrian pavement not only affect the safety and comfort of pedestrians and cyclists, but also have a certain impact on the psychological feeling of the crowd and the content of their activities. According to the China Construction Yearbook, the pavement area in Guangzhou accounts for approximately 20% of the road area, while in major foreign cities like Paris and New York, this indicator is above 25%. Pavements on city roads are not only the first choice for people to get around, they are also an important carrier of the city's external image, and people get to know the city through the space and image of the pavement. The pavement should act as a neutral 'carpet' connecting adjacent buildings rather than highlighting its own style and thus influencing the character of the area in which it

is located; the pavement should be designed as an integrated part of the retreating space, unifying the material and form of the paving so that the street space forms a whole. The choice of paving material should be determined by the class and type of road.

③The pavement is mainly for pedestrians and is the most important part of the slow-moving pavement. The pavement should avoid height differences as far as possible, be smooth, wear-resistant and conducive to drainage, while at the same time taking into account the artistic and ornamental qualities of the pavement, shaping the characteristic culture of the street and meeting people's aspirations for a better street environment. The pavement has a wide area and a long continuity, so in order to increase the visual harmony and aesthetics of the pavement, it is necessary to matching the architectural landscape around the street. Pavement surfacing generally follows three main types, monolithic surfaces of concrete, granite and block surfaces of permeable blocks.

Cycling space

① Non-motorized lane widths. Complete streets encourage cycling and the width of non-motorized lanes is the most essential element of cycling space and is important in creating a good cycling environment. Non-motorized lane widths should be no less than 2.5 metres, and may be reduced if conditions on the altered street are limited, but should not be less than 1.5 metres. Where the total width of the pedestrian space is less than 5 metres, it is appropriate to provide non-motorized lanes by reducing the number or width of motorised lanes.

②The non-motorized path paving is intended to provide cyclists with a service function of travel, iconography and visual guidance, but also to undertake it is an environmental landscape function that shapes the space for interaction and needs to be both convenient for traffic and artistic for the environment. In addition, the damaged paving should be replaced in a timely manner to improve the cleanliness of the cycling environment, and a ground material with a strong coefficient of friction, such as plastic granules, should be used to improve the smoothness and comfort of cycling. When paving non-motorised roads, not only should the cost and construction costs be taken into account, but also a comprehensive selection of durable, anti-slip and recognisable materials, which are divided into three main types: cement concrete, asphalt concrete and plastic paving. In the process of street renovation, non-motorized road surface paving tiles are coloured to harmonise with the surrounding spatial environment, which can improve the aesthetics of the street and strengthen the separation of rights of way. To prevent non- motorized cycling from being affected by water on the road

due to rain, when using asphalt concrete paving materials, materials with high permeability and porosity should be used and natural stone with poor slip resistance and loose surface layers, such as gravel and sand, should be avoided as paving or surface materials.

Fig. 4-5 Non-motorised paving(Source:Google)

③Improve non-motorized bicycle parking facilities. Improve the planning of shared bicycle parking on streets, when some roads have worn out parking lines for timely maintenance, set up parking points on the principle of small scale and high density, and the parking lines should not be set too long to prevent pedestrians from crossing the street normally. Bicycle parking should be dispersed as far as possible and located close to destinations, making full use of open spaces in streets and lanes. The entrances and exits of the bicycle parking points should not be directly adjacent to traffic arteries; the bicycle parking points should be set up in accordance with the principle of small scale and high density, and the service radius should not be greater than 50 metres; the bicycle parking points should be visible and allow for the use of the street. The setup of bicycle parking areas on the street generally takes the form of a flat set-up, generally in a straight row. The dimensions required for individual bicycle parking are 2.0m*0.6m. The length of a single flat parking area should not be greater than 20 metres. Where multiple adjacent groups are consecutively combined into a parking area, the distance between adjacent groups should be no less than 4 metres. Easily identifiable for passers-by, thus allowing for the promotion of bicycle use. Currently, with the rapid development of smart bicycle sharing and the increasing sophistication of relevant data platforms, the demand, location and scale of bicycle parking can be accurately and reliably informed by big data, which can be further tapped into with relevant resources and industry cooperation to create an intelligent platform for urban bicycle traffic.

(3)Improving street accessibility

The Guangzhou Municipal Bureau of Housing and Urban-Rural Development has released the "Guangzhou Development Plan for Barrier-Free Environment(2021-2035) for Public Consultation"(hereinafter referred to as the "Draft for Public Consultation"), which proposes

to make Guangzhou a national benchmark city for barrier-free environment construction. The design of barrier-free facilities is an important element of a complete street, which reflects the importance of the street space for people. The design of accessibility facilities can reflect equity and enable people to use the street space safely, as it is inclusive of all levels of people: the elderly, the young, children, people with disabilities, etc. Their needs for space are diverse. The design of accessible facilities should therefore focus on the safety and comfort of people in the process of using them. The main accessibility services on the street include blind alleys and kerb ramps.

①Blind paths should meet the design principles of safety, continuity and unobstructed flow, with fewer turns and no obstructions such as poles, facilities or trees; blind paths should be laid to avoid trees(caves), poles, wires and other obstacles, and other facilities should not occupy the blind path. Blind lanes include both striped lanes to guide the direction of walking and dotted lanes to indicate turns and starting and ending points. The surface of the blind walkway should be non-slip.

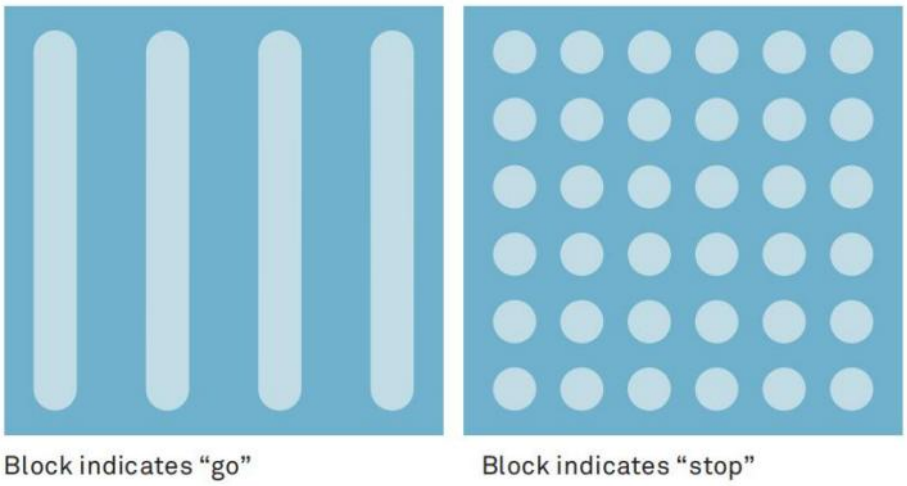
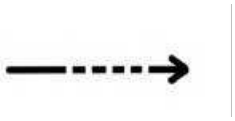


Fig. 4-6 Block indicates “go” and block indicates “stop” (Source: Global Street Design Guide)

There is also a need to consider the travel needs of people with visual impairments. The study of the travel characteristics and environmental requirements of various groups is a prerequisite for the design of blind lanes. Different groups of travellers have different travel characteristics and environmental requirements due to the limitations of their vision, as shown in the table below:

Table 4-2 Travel characteristics of various travel groups and design requirements (Source: Completed by author)

Travelling groups	Blind	Partially sighted and mildly visually impaired	Red-Green Blindness
			
Route accessibility	The ability to perceive orientation, direction, location and surroundings is at its weakest, and one can only feel what is within the reach of the cane and has to go through a lot of trouble in order to reach one's destination. Walking for the blind is tentative	Weak perception of orientation, direction, location and surroundings, reflective and demanding of strong light sensations and colours, needs to move while observing	Need to wait and watch at signalised road crossings
Design requirements	That the perceptiveness of the blind walkway be strong; blind paths to be set up continuously; Blind lanes are orientable and identify their surroundings	Extremely vibrant colours or stronger colour ratios; Stronger illuminated facility cue messages	Adding specific colours to the red and green lights to avoid an exclusively red or green colour display

②Curb ramps. The kerb ramp is an important part of the city's refined and humane design. The kerb ramp makes the pavement and motor vehicle roadway smoothly over, solving the obstacle to passage caused by the pavement kerb, and is also an important consideration in the transformation of complete streets. Its design must meet the requirements of barrier-free design, to achieve a comfortable. A suiTable. slope with a smooth articulation, flush with the pavement at the top and the motorway at the bottom. Pedestrian ramps usually consist of three units: the slope, the top ground and the side slopes. Slopes are usually of non-slip material with a maximum slope of 1:10(10%) and an ideal slope of 1:12(8%). The width of the slope should be the same as the access area, with a minimum width of 1.8 metres and a recommended width of 2.4 metres. The top surface should be as wide as the passing area, with a minimum width of 1.8 metres. The side slopes are intended to prevent pedestrians from tripping and should not exceed a slope of 1:10. The top and bottom sections must be perpendicular to the direction of the ramp. Where space is limited and a top surface is not possible, pedestrian ramps may be parallel to the pavement with a minimum horizontal surface length of 1.8 m to facilitate access for wheelchair users. The slope of the kerb ramp should be flat and non-slip.

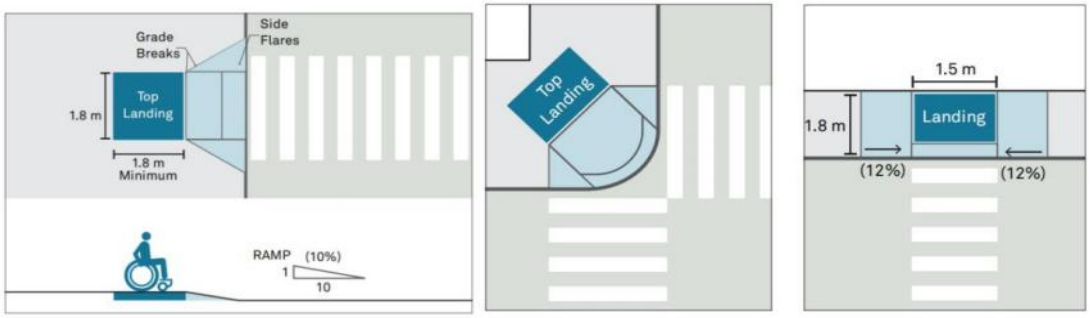


Fig. 4-7 Diagram of Pedestrian Ramps(Source: Global Street Design Guide)

4.2.2 Street car space optimisation

(1)Transit Network

Complete Streets provides a reliable and efficient public transport travel system for all travellers. Firstly, public transport can reduce the number of traffic accidents and CO2 emissions, contributing to the construction of safe and green cities; secondly, public transport can increase the physical work of travellers, improve public health and enhance the health of residents. By creating a public transport system for all travellers, it helps to increase the connectivity and safety of streets. The design of streets that encourage public transport travel takes into account the following aspects:

①Ensure priority of public transport in the right of way. To meet the travel needs of residents, promote public transport travel and ensure the superiority and convenience of public transport, bus-only lanes need to be set up in some urban sections, using traffic management tools to control the bus-only lanes. Bus lanes should be clearly marked to provide information, and surveillance cameras can be installed along the street or before the bus for the exclusive control of bus lanes. The management should be based on the actual situation and selective opening of bus lanes to private cars according to the size of public transport traffic to ensure the efficiency of the overall urban transport system. Increased station coverage and more efficient interchanges

②The integration of major public transport stations and their surrounding bus, slow-moving and taxi interchange facilities with on-street interchange 'micro- hubs' can reduce the walking distance for public transport passengers by more than 30m and the interchange time by more than 3min. The proposed design method of shared lanes and platforms for surface trunk buses and conventional buses will improve the efficiency of bus lanes by 20% and reduce walking time by 80%.

③The design of waiting platforms is based on demand. A well-designed and well- equipped platform will be more attractive to public transport travellers and will provide a comfortable.

and safe waiting environment, as well as an orderly bicycle docking station. It should also be designed to meet the needs of different levels and ages of travellers.

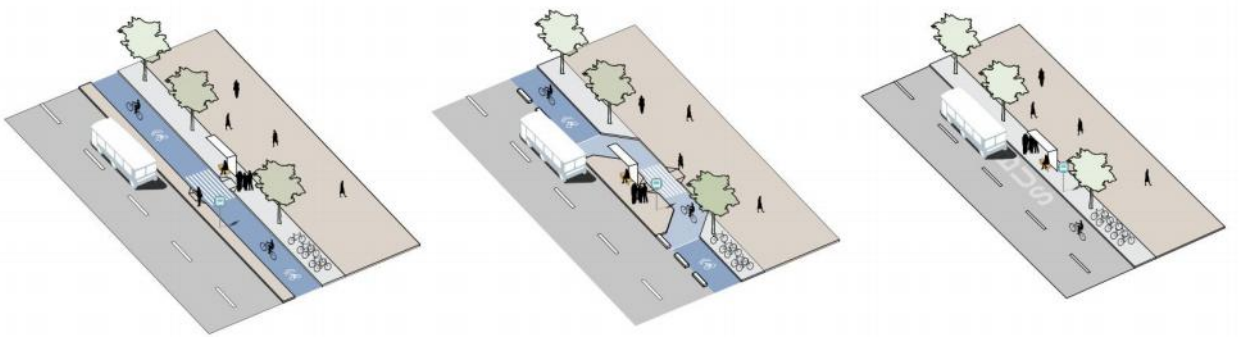


Fig. 4-8 Bus stop design(Source:Google)

(2)Vehicle Network

The Complete Streets network needs to safeguard urban transport functions, including connectivity, external traffic, organisation of the carriageway and parking, and to optimise speeds, lane widths and intersections to reflect the priority given to pedestrians within the context of street positioning requirements.

① Street improvements should reduce the width of motorways where possible and reduce them where appropriate to increase the space for slow traffic. Studies have shown that 3m lanes do not increase accident rates and have a significant impact on traffic conditions compared to wider lanes, and provide a safe street environment, leaving more space for other street furniture. Turning radii at motorway intersections should not be regulated by street class.

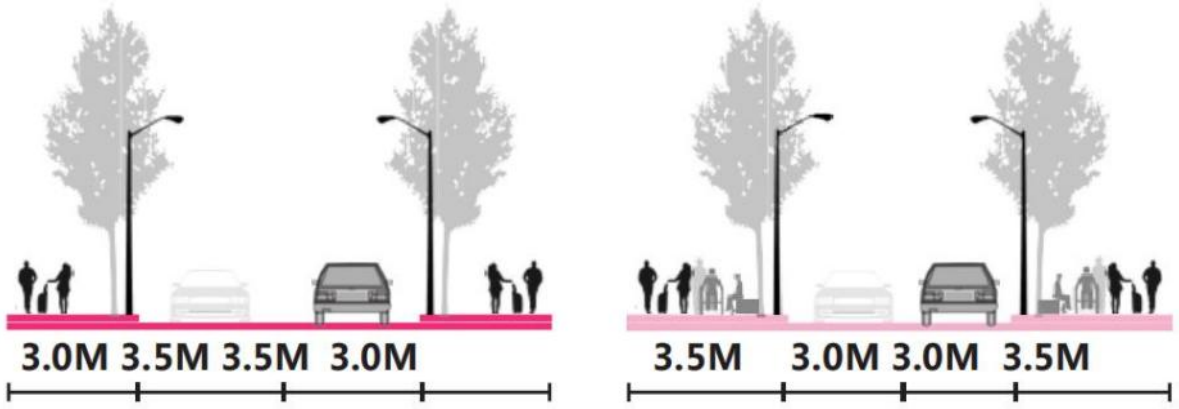


Fig. 4-9 Reduced lane width before and after(Source:Google)

②On-street parking areas are areas where parking spaces are provided on one or both sides of the street, and are an important part of the city's static traffic system. A well-designed on-street parking area can be convenient and practical while reducing interference with dynamic traffic and achieving a balance between dynamic and static street traffic. And recommends

that appropriate on-street parking areas be provided on commercial-type roads. To meet temporary parking requirements. In-street parking strips should be arranged in parallel with parking spaces of 2.5-3.25M width and 6M length.

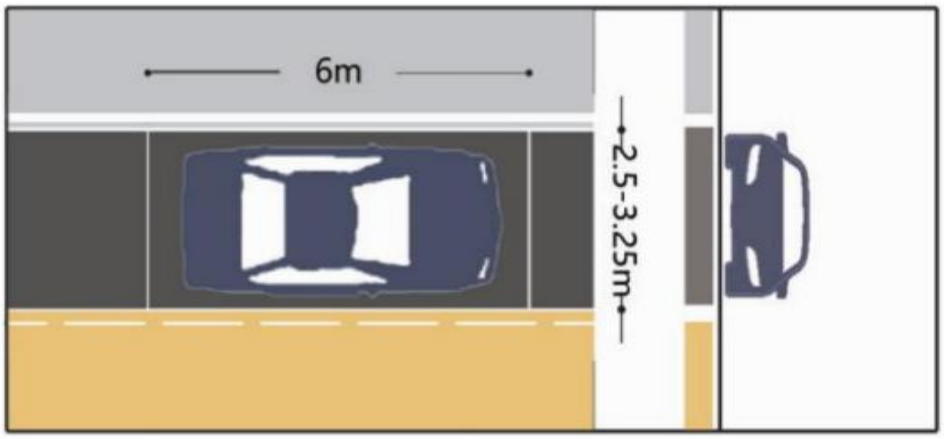


Fig. 4-10 Dimensions of in-street parking strips(Source:Google)

③At street intersections where there is no obvious need to turn right, etc., a smaller kerb turning radius is preferred, provided that the minimum turning radius and normal flow of traffic involved is guaranteed. The following recommended values for turning radii are applied to the intersection situation . This effectively avoids the safety hazards associated with excessive traffic speeds and shortens the distance between pedestrian crossings, facilitating pedestrian crossing, safeguarding pedestrian rights of way and increasing public space at street corners. In the process of redistributing and adapting the right of way at motorway crossings, the implementation of small turning radii is carried out in steps, with bollards, lines and hedges being used to guide drivers to adopt slow turning habits in the early stages, and narrowing of the crossings to implement small turning radii when operating conditions are mature .

Table. 4-3 Turn radius suggestion（Source: Completed by author）

Intersection situation	Recommended value for radius of kerb
Crossing corners with no right-turning traffic flow	0.5—1m
Junctions between slip roads, intersections with cycle tracks	≦5m
Intersections between feeder roads and major and minor roads with high traffic volumes	5—8m
Intersections where buses or other large vehicles have to make frequent turns	8—10m

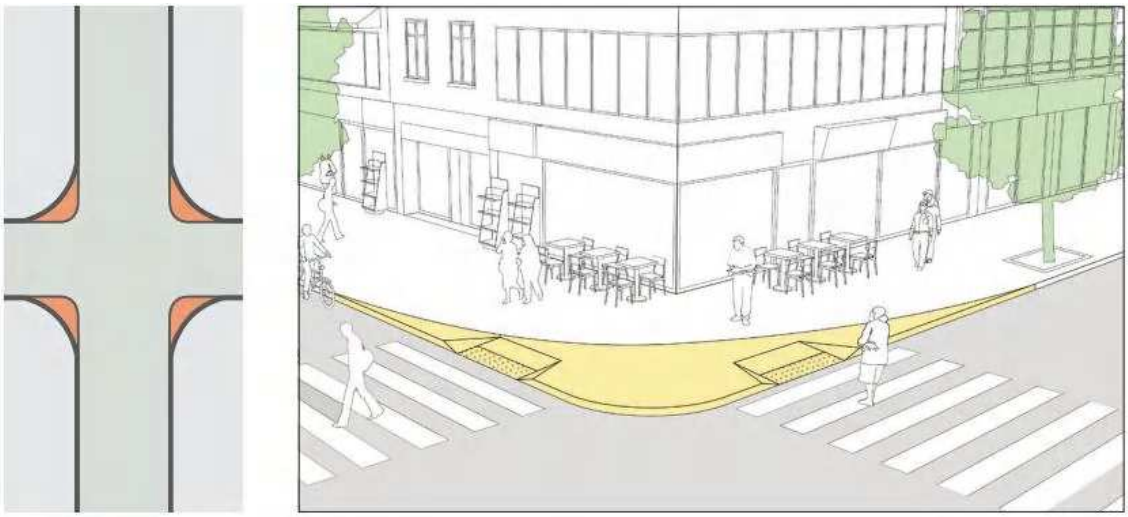


Fig. 4-11 Narrowing intersections to implement small turning radii(Source: Global Street Design Guide)

(3)Cross the street safely

①Rationalisation of street crossings. Street crossings are facilities that connect both sides of the street and their associated areas, and include both flat and three-dimensional crossings. Given the slow walking speed and limited physical strength of pedestrians, this is also a point of conflict between the rights of all parties, so it is particularly important that the crossing facilities are arranged appropriately. At the same time crossing facilities are also important facilities for sightline complete streets, and humanised and refined pedestrian crossings are the key to ensuring continuous, smooth and safe slow walking. Commercial streets generate and attract a high level of pedestrian traffic due to the function of the buildings on the street, and the two sides of the street are closely linked. 250—300m spacing between crossing facilities is appropriate to meet the large number of pedestrians crossing the street.

② Improving road crossings is an important traffic facility for pedestrian safety. Safe road crossing design focuses on reducing crossing distances and safeguarding the personal safety of pedestrians when crossing the street. In terms of reducing the crossing distance, by reducing the radius of the kerb of the road turn, the speed of the vehicle turning is effectively reduced, which can effectively avoid the safety hazards caused by excessive speed, and the distance of the pedestrian crossing is shortened, which facilitates the pedestrian crossing, protects the right of way of the pedestrians and increases the public space at the street corners.

Firstly, raised intersections, according to the University of North Carolina Highway Safety Research Center(UNC HSRC), raised intersections and crosswalks are "essentially a

deceleration platform for the entire intersection". Raised intersections allow pedestrians to cross safely and comfortably without height differences, while also forcing motor vehicles to reduce their speed and improving pedestrian safety on the street.

Secondly, the narrowing of the entrance to the crossing means t h a t the kerb at the pedestrian crossing is extended to cut into the crossing entrance road, reducing the amount of street space through which pedestrians must cross. According to the Project for Public Spaces study, the narrowing of entrances improves the safety of slow-moving pedestrians such as children and the elderly.

Third, the traffic flow is not large, mainly slow traffic branch road intersections, can be used in the form of full paving, the use of continuous pavement paving instead of pedestrian crossings, and the intersection of car road surface raised to the pavement elevation, to improve the comfort and safety of pedestrians crossing the street.

Fig. 4-12 Intersection pavement narrowing and prominent colour intersection pavement(Source:Google)

4.2.3 Streetscape enhancement

Driven by the promotion of the concept of complete streets, the role of street greening in urban construction is becoming increasingly prominent. A safe, beautiful and ecologically sustainable urban road greening landscape not only reflects the cultural connotation and advanced level of a street, a region and a city, but also promotes urban development and increases the vitality of the city as a space for citizen communication. Street greening is the most basic component of urban greening and plays an important role in beautifying the urban environment, enriching the urban landscape, purifying the urban air and providing shade for pedestrians from the sun. The enhancement of landscape greening from the perspective of complete streets is carried out in two main ways.

(1)Strengthen the maintenance and management of existing greenery

In terms of the growth of plants, they should be replaced and pruned in a timely manner.Trees

and shrubs with poor ecological potential and which pose a safety hazard to pedestrian traffic. The design of the tree pond is based on the creation of a sub- street for the growth of plants, avoiding rigid treatment, reducing exposed areas, using openwork carvings and cultural symbols to beautify the appearance of the street facilities, or choosing timber and pebble paving to create a good environment for the growth of plants. The environment. For the maintenance and management of flowerbeds in open spaces, the height of the inner edges of flowerbeds should be increased appropriately so that the plants can avoid the impact of the resting people on them as much as possible.

Fig. 4-13 Maintenance methods for street greenery(Source: Google)

(2)Revitalisation of existing green space.

At the level of pedestrian activity space, the green space can be revitalised in conjunction with the amenity areas, using the expression of green belts to enrich the spatial levels of the street amenity areas, creating a degree of barrier in the pedestrian sightline connection and enhancing the psychological safety of walking. In terms of the street interface, the monotony of the street space can be weakened by shaping the façade greenery so that pedestrians can move from one step to another and change their sensory stimulation in the process of walking, and interesting micro-green spaces can be created on the façade buildings of the ground floor shops along the street to deepen pedestrians' recognition of the commercial services. For the combination of street furniture and green space, this can be combined with existing pocket parks, creating natural spaces with matching plants in the space and setting up edges for sitting flower beds to establish the most intuitive connection between pedestrians and greenery. At the level of the existing street greenery, by adding different types of plants to the mix, it will create street spaces with differentiation, and through the design of different forms of combinations) guide the opening and closing changes of the pedestrian space and enhance the aesthetic and comfortable. atmosphere of the street environment. The choice of species should be combined with local climatic conditions, choosing plants that improve the air microclimate of the street and show regional characteristics.

Fig. 4-14 Raised Tree Ponds(Source: Google)

4.3.4 Refined design of street furniture

The three main levels of improvement are open space, sanitary facilities and other facilities.

(1)Provide additional leisure facilities.

For pedestrian spaces where conditions are good, public seating and resting nodes can be provided along the pedestrian space to encourage the formation of places for pedestrians to stay and interact, enriching the spatial experience. In pedestrian spaces with a high pedestrian flow, walking spaces can be created in conjunction with green belts, parking belts and amenity belts, and leisure facilities can be flexibly installed. Flower beds, steps, low walls and tree ponds can be designed at a height suiTable. for people of all ages to sit and rest. When the space for slow walking is narrow, the scale of the pavement is combined with the design of shaped street furniture to provide a small temporary resting place for pedestrians. In addition, the choice of seating materials should take into account the climatic characteristics of Guangzhou. It is best to choose a simple and breathable shape for the seats to avoid excessive modelling, which can breed insects and mosquitoes and harbour cold. In Guangzhou, where it is rainy in spring and hot and humid in summer, weatherproof pavilions and corridors for resting at nodes of the pedestrian space are appropriate, providing temporary shelter for slow walkers in summer and on rainy days. These pavilions, which provide shelter and information, offer the possibility for people to sit down, and conversations with strangers are more likely to occur when sitting down and relaxing.

There are many different types and forms of street seating, the design principles of which are divided into three main points, one is that the seat must ensure the seat should be slightly tilted back to prevent the elderly from slipping; secondly, the seat should be arranged in a

suiTable. location in the street that can effectively meet the needs of pedestrians; thirdly, the seat should not be an obstruction to walking and cycling on the street, etc. Materials used for street seating include metal, concrete and wood, with metal seating being more durable, concrete seating being more economical and wood seating being warmer and more comfortable.. Due to the wide variation in height of users, street seats are not specified in terms of height, but are generally between 420mm and 480mm, with backrests or armrests to facilitate seating for the elderly. To improve walking comfort during street space renovation a sufficient number of seating facilities should be ensured on the streets to provide space for pedestrians to rest and residents to interact and move around. The improvement should be based on the characteristics of the road section and urban features, and should be designed in a variety of forms to enhance the image of the street.

(2)Sanitation Facilities.

The Complete Streets objective level emphasises the improvement of facilities and the maintenance of vitality and sustainability. Proper design of sanitation facilities helps to maintain the cleanliness and beauty of the city streets and provides a good urban environment for the citizens. The rational design of sanitary facilities helps to maintain the cleanliness and beauty of the city streets and provide a good urban environment for the public. It encourages the combination of functions to separate different types of waste and the expansion of smart interconnected, powerful compressed and green energy smart bins to have a positive impact on the landscape appearance and overall quality of the streets. The service radius of the sanitation facilities should be 30-50M in areas with high traffic flow on streets such as lifestyle, commercial and integrated streets, and 100M on other streets. maintenance and management should also be strengthened to keep the bins in normal operation.

Fig. 4-15 Techno-Pods bins in the UK and otherfacilities at Smart Bins in Melbourne(Source: Google).

(3)Other facilities.

The intensive and refined design of facilities. For the traffic facilities and ancillary functional

facilities in the streets, the separate forms of setting are not enough to enhance the overall appearance level of the street environment. The intensive and integrated design of street facilities not only unifies the form and style of the facilities, but also saves the occupation of the street space and improves the neatness of the street space. The form of integration of facilities encourages the use of one pole for multiple uses and the merging of multiple boxes, the centralised layout of street lights, cameras, traffic signs and information signs, and the multi-purpose design of rubbish bins, substation boxes and flower beds, for example, the integrated smart poles launched in Singapore and Japan(pictured below), which integrate multiple functions such as LED street lights, cameras, 5GAAU, advertising signs and USB charging, improving the use of street The interaction between people and facilities enriches the pedestrian's experience of living on the street in detail.

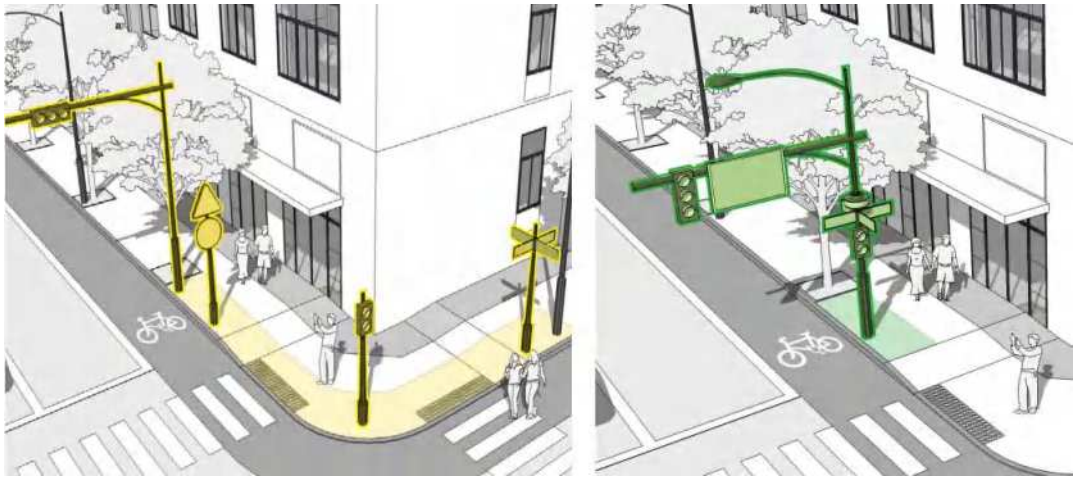


Fig. 4-16 Multi-pole in one(Source:Google)

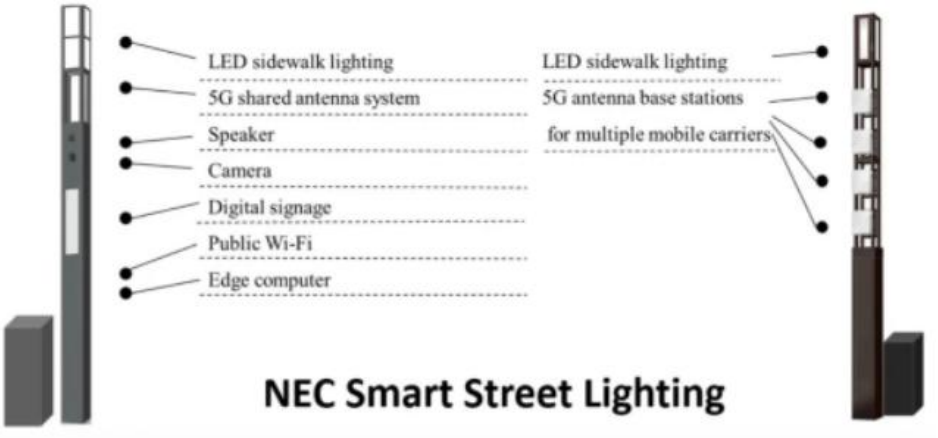


Fig. 4-17 NEC smart Street Lighting(Source: Google)

4.3 Summary

This chapter first identifies the elements of complete streets design, including the target level, design principles and evaluation indicators. Through case studies and evaluation indicators of

complete streets, a strategy for the regeneration of street space from the perspective of complete streets is proposed. Firstly, it identifies the rebuilding of a slow-moving friendly street space model, and realises the design connotation of slow-moving priority in complete streets by improving the chronic network and enhancing the quality of chronic spaces. The second is to optimise the vehicular space, through optimising the public transport travel environment, the motor vehicle travel environment, and the safe crossing of streets through the rational arrangement of crossing facilities and the improvement of road intersections, these three approaches are used to optimise the traffic structure of complete streets and to meet the design principles of safe, comfortable. and sustainable complete streets. The third strategy is the enhancement of streetscape greenery, through two strategies: strengthening the maintenance and management of existing greenery and upgrading existing green space to achieve the goal of maintaining the vitality and sustainability of Complete Streets. Finally, at the micro level, the pursuit of refined and humanised street furniture is the key elements as a means of achieving a refined design of complete streets and improving street amenity. These street improvement recommendations are then applied in the subsequent design of the site enhancement.

[61] Gehl J. Life between buildings[J]. 2011.

Chapter 5 Analysis and evaluation of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street in the context of complete streets

5.1 Background Overview

5.1.1 Location Overview

Tianhe Nanyi and Tianhe Nan Pedestrian Street are located in Tianhe District, Guangzhou City, Guangdong Province, China. It is also located on the city's central axis, with the most prosperous and active commercial area of Tianhe District and Guangzhou City to the north and the Guangzhou CBD and Guangzhou Tower to the south.

Fig. 5-1 Location analysis(Source: Completed by author)

The site is located on the new central axis of Guangzhou. The spatial sequence from north to south is in turn; Yanling Park, GuangZhou East railway station, Tianhe Sports Center, Parc Central, Liuyun Community, Zhujiang New Town and Haixinsha island. The site plays an important role in the daily life and travel of Guangzhou citizens.

Fig. 5-2 Space sequences of axis of Guangzhou(Source: Completed by author)

5.1.2 Climatic conditions

Guangzhou is a southern subtropical monsoon climate zone. The surface receives a high amount of solar radiation and is characterised by warm and rainy days, abundant light and heat, long summers and short frost periods. The hotter phase of the year lasts 7.8 months, from 16 March to 9 November, during which at least 26% of the time the comfort level is muggy, oppressive or uncomfortable. 26% of the time. The month with the highest number of muggy days in Guangzhou is July, with 31.0 muggy or worse days. These climatic conditions make it necessary to take into account human comfort and health in the design of streets. Street design should focus on shade facilities and stormwater management facilities. Shade provides shade, makes the street more attractive and provides opportunities for public art activities.

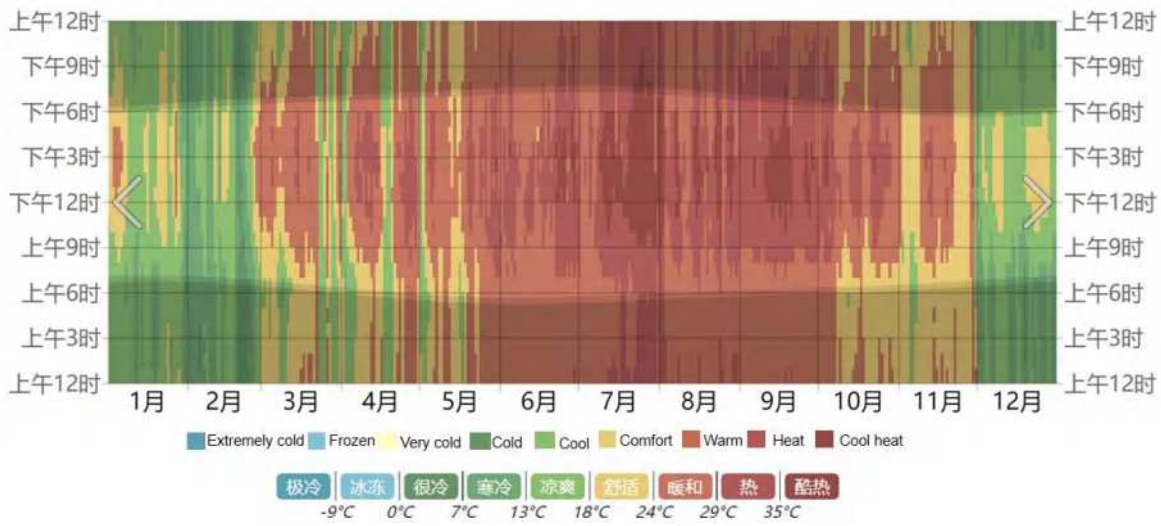


Fig. 5-3 Hourly temperatures in Guangzhou in 2022(Source: Weather Spark)

5.1.3 Project Surroundings Analysis

The project is located in the vicinity of the Tianhe business district, with several large shopping malls such as Guangbai Department Store, TeeMall, Parc Central, Zhengjia Plaza, Onelink Walk and TaiKoo Hui, as well as several primary and secondary schools and kindergartens such as Tianrong Middle School, Liuyun Kindergarten, Sports West Road Primary School, Sports East Road Primary School, Guangzhou Middle School and Huakang Primary School. Across the Huangpu Avenue from Tianhe Nan Pedestrian Street is Guangzhou's famous Huacheng Hui Square.

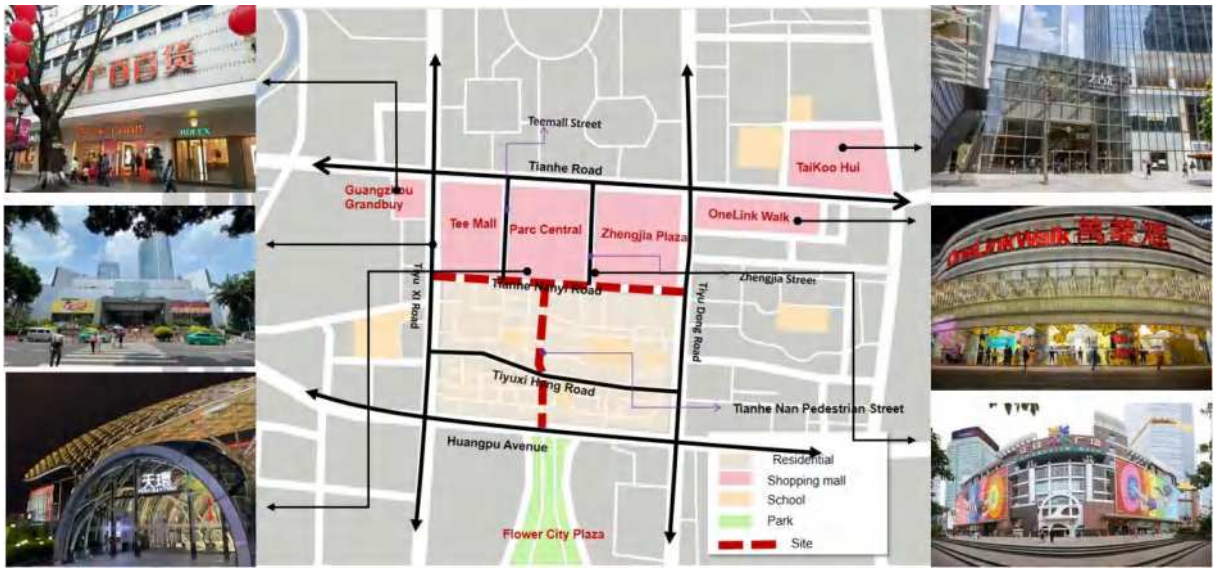


Fig. 5-4 Project Surroundings Analysis(Source: Completed by author)

5.1.4 Traffic analysis

Pedestrian network:

The project is located in an area with a dense pedestrian system. There are pedestrian paths

along both sides of the street along the south side of the Tianhe Nanyi Road with shopping malls and shops. The neighbourhood of Liuyun Community, which is adjacent to Tianhe Nanyi Road, has many pedestrian entrances and exits on this street. A zebra crossing across Tianhe Nanyi Road connects the south entrance of TeeMall to Exit B of the Tiyu Xi road underground station. Another zebra crossing connects Tianhe Nan pedestrian street with the southern entrance of Parc Central. The overall pedestrian system of Tianhe Nan pedestrian street is well developed and well connected to the surrounding residential areas. The bollards make it possible to prohibit the use of electric vehicles.

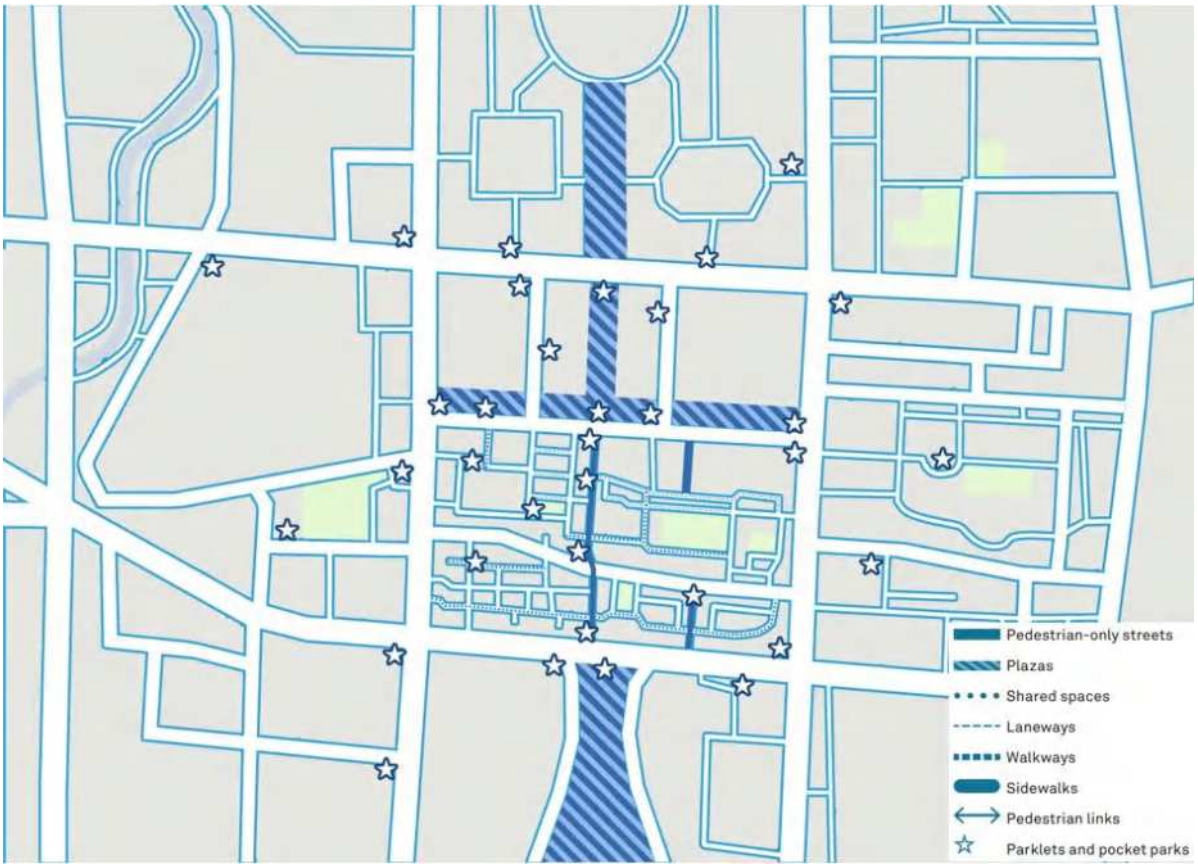


Fig. 5-5 The pedestrian network in the project area(Source: Completed by author)

Bicycle network:

The project is located in an area with a discontinuous cycle network. There are dedicated cycle lanes on Tiyu Xi road and Tiyu Dong road. The cycle lane on Tianhe Nanyi Road is too narrow and not separated from the motor vehicle lane, resulting in the cycle lane often being occupied by motor vehicles and making the cycling experience poor. There are no bicycle lanes on TeeMall Street and Tiyu Xiheng Street, where motor vehicles and bicycles mix and traffic is chaotic.

Fig. 5-6 The bicycle network in the project area(Source: Completed by author)

Public transport network:

The project is located in an area with good public transport links and full public transport coverage within 300 metres. Metro lines 1, 3 and APM pass through the project, and there are three entrances and exits within the design area, including the Tiyu Xi Road Metro Station and Tianhe Nan Metro Station. There are many bus stops in the vicinity of the project, but there is no bus stop within the design area at the moment, but it is currently full. A public transport service radius of 300 metres. The project is well served by public transport to meet travel needs.

Fig. 5-7 The public transport network in the project area(Source: Completed by author)

Vehicle network:

The project is located in a relatively well-connected area, with Tiyu Xi road and Tiyu Dong road both having eight lanes in both directions and TeeMall Street having four lanes in one direction, heading south. ZhengJia Street is two lanes in one direction, heading north. Tianhe Tianhe Nanyi Road is a one-way four-lane road in the TeeMall - Parc Central part, heading east, and a two-way four-lane road in the Zhengjia Plaza part. Tiyu Xiheng Street is two lanes in both directions and has a parking strip on the south side of the street. The Tianhe Nan pedestrian zone is a car-free zone.

Fig. 5-8 The vehicle transport network in the project area(Source: Completed by author)

5.1.5 Road grades and street types in the vicinity of the project

According to the *Guangzhou Complete Street Design Manual*, streets are classified into four categories: expressway, artey, sub-artey and branch; streets are classified into seven types: living, commercial, traffic, landscape, industrial, comprehensive and specific. And as described in the *Guangzhou Complete Street Design Manual,*a pedestrian street is a pedestrian-only roadway in a central area of the city where traffic is concentrated, restricting or prohibiting motorized and non-motorized traffic in principle, and is a priority activity area for pedestrians. Pedestrian streets are road types that liberate people from the motorised traffic of the city and establish the dominance of people in the space.

The road classes of Tiyu Xi road and Tiyu Dong road, which connect Tianhe Nanyi Road, are urban sub-artey with commercial street types; the road classes of Huangpu Avenue are artey with traffic street types; the road classes of Tianhe Road are artey with commercial street types; the road classes of TeeMall Street and ZhengJia Street are sub-artey with commercial street types; and the road classes of Tiyu Xiheng Street are branch with living street types;The road class of Tianhe Nanyi Road is classified as a sub-artey and the street type is commercial.

The road class of Tianhe Nan Pedestrian Street is pedestrian and the street type is commercial.

Fig. 5-9 Road class in the area where the project is located(Source: Completed by author)

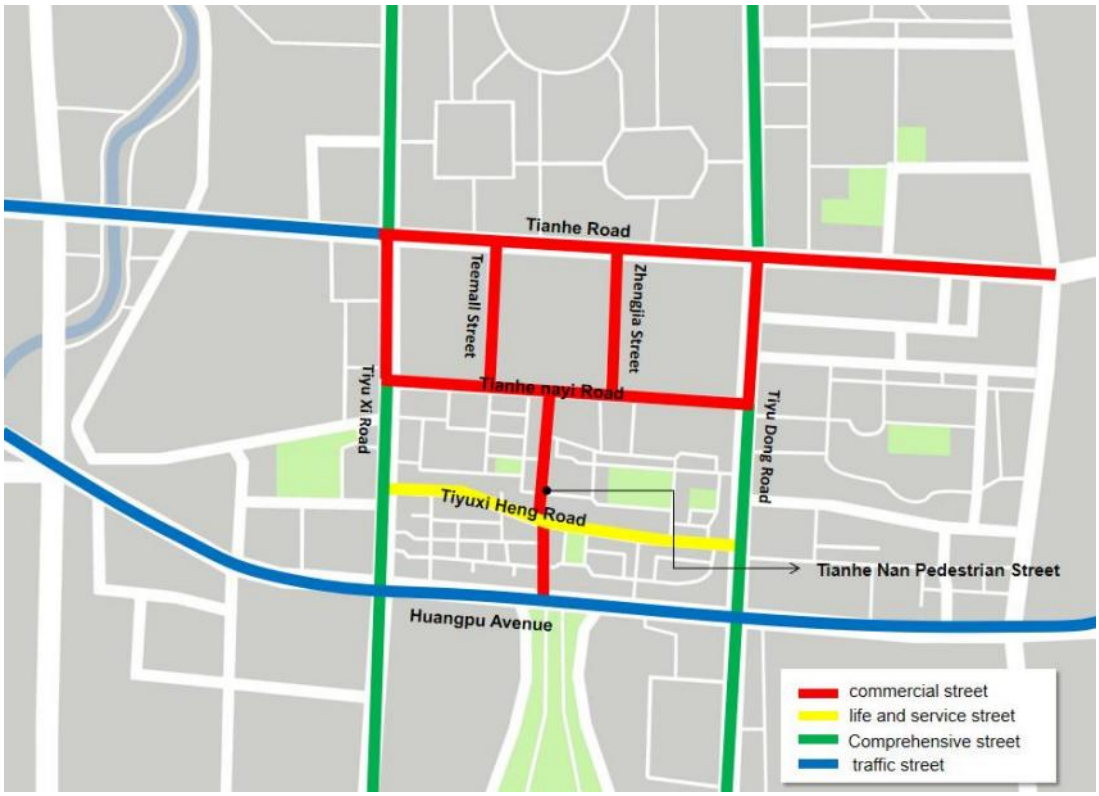
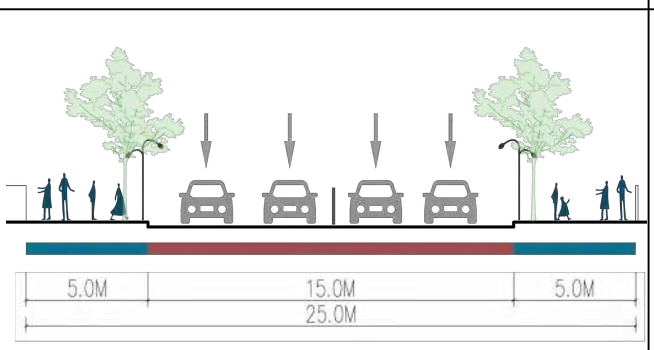
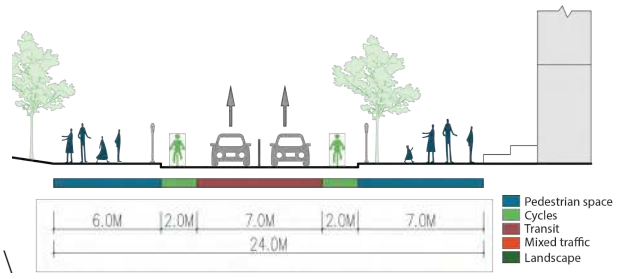
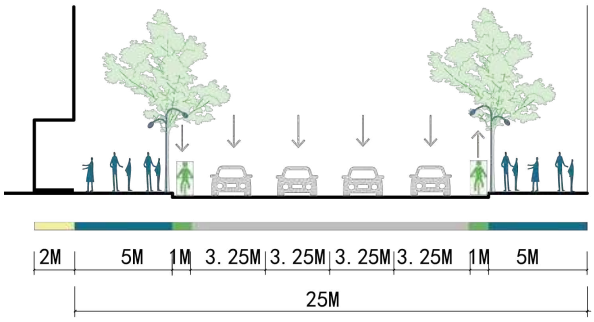
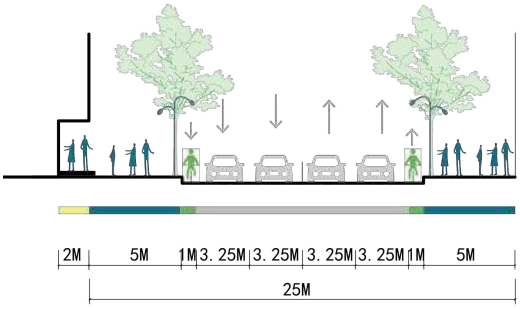
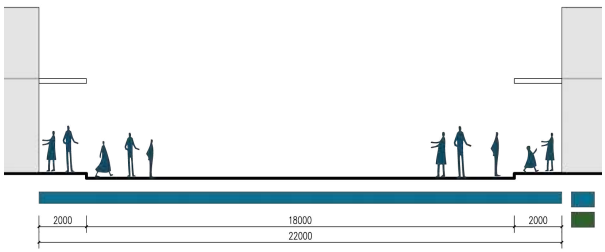
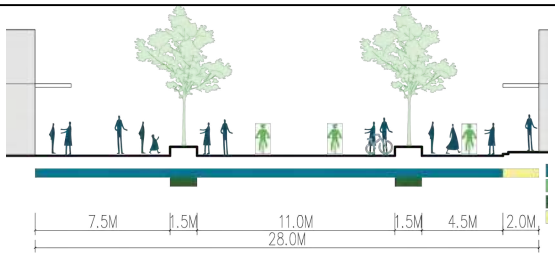


Fig. 5-10 Street type in the area where the project is located(Source: Completed by author)

In addition, the existing street profile and its current condition were analysed on the basis of on-site research and mapping.

Table. 5-1 Street section and current status in the vicinity of the project(Source: Completed by author)

Name	Section	Photo
TeeMall Street		
Zhengjia Street		
Tianhe Nanyi road(TeeMalll-Parc central part)		
Tianhe Nanyi road(Zhengjia plaza part)		
Tianhe Nan Pedestrian Street(Northern Section)		

Tianhe Nan Pedestrian Street(Southern Section)		

5.2 Street Status Study

5.2.1 Design Scope

The design area of the project is enclosed by the architectural interface of the area where Tianhe Nanyi Road and Tianhe Nan Pedestrian Street are located. It runs east-west from West Sports Road to East Sports Road, intersecting with TeeMall Street and Zhengjia Street. It is 685 metres in length and has a street width of 15 metres. The width of the pavement on both sides of the street is approximately 5 metres. On the north side of Tianhe Nanyi Road, from left to right, are TeeMall, Parc Centraland Zhengjia Plaza, and on the south side is the Sixth Luck Community. The Tianhe Nan Pedestrian street is located within the Guangzhou Sixth Luck District, a pedestrian street within the community, and as part of the Guangzhou Central Axis, the community is an open community. The street runs in a north-south direction from Tianhe Nanyi Road in the south to Huangpu Avenue West in the north, with a total length of approximately 350 metres. The northern section of the pedestrian street is approximately 220 metres, and the pedestrian street southern section is approximately 130 metres.

Fig. 5-11 Design Scope（Source: Completed by author）

5.2.2 Slow space analysis

(1)Pedestrian network

The main studies and analyses are on the pedestrian network system, pavement widths, pavement paving and accessibility design.On-site research and analysis has shown that the existing pedestrian network is relatively well developed and the pedestrian system is relatively continuous on the Tianhe Nanyi Road and Tianhe Nan Pedestrian Street.

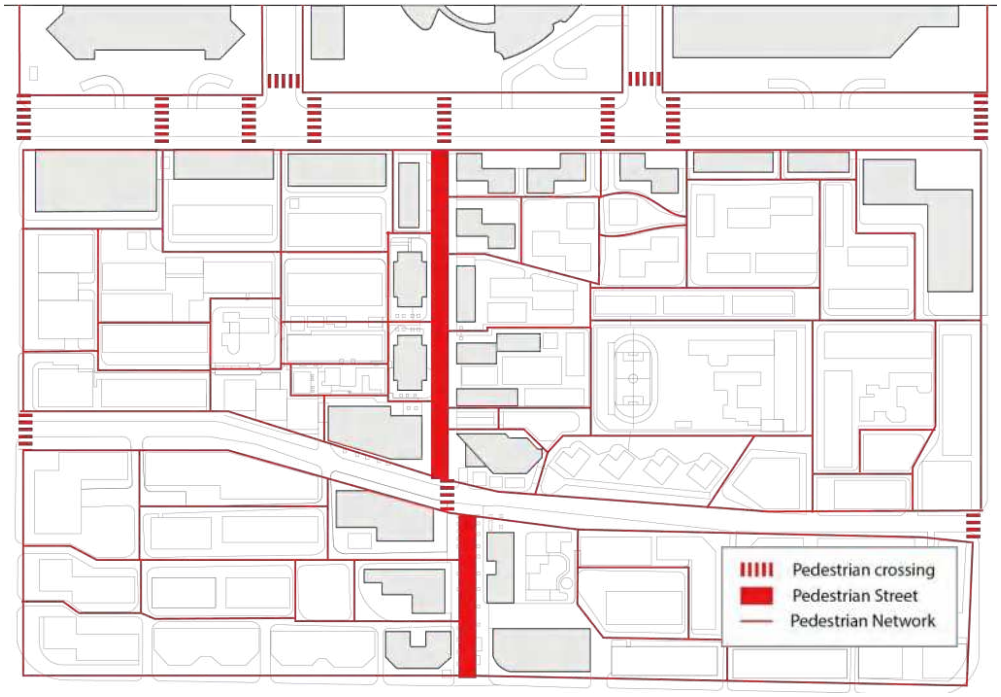


Fig. 5-12 Pedestrian network（Source: Completed by author）

①The width of the pedestrian zone

Through on-site research, we know that the width of the road red line of Tianhe Nanyi Road is 25 meters, the width of the carriageway is 15 metres and the width of the pavement on both sides of the street is approximately 5 metres. The TeeMall-Parc Central Street section is a four-lane road in one direction eastwards; the section of Zhengjia Plaza is a four-lane road in both directions. The width of the northern section of Tianhe Nan pedestrian street is 22 metres and the width of the southern section is 28m.

②Pedestrian paving.

Pavement paving not only produces a different range of scale and psychological perception through different plan forms, but also provides a guarantee for the basic function of the street. On-site research found that some of the paving along the south side of the Tianhe Nanyi Road was badly damaged, affecting the walking experience. There are some pipe manhole covers protruding in the pedestrian area, affecting the comfort and safety of the walking environment. The paving at the rainwater collection area in the southern section of the Tianhe Nan pedestrian street is badly damaged and uneven in height. The articulation between the front area of the building and the pavement of the shops along the street is too rigid and the pavement has an uneven height difference of two or three steps. There is also mixed pedestrian and non-pedestrian traffic, which affects the safety and comfort of the walking experience.

③Accessibility. A complete street means that people containing all abilities of access can pass through the street safely, comfortably and easily. In general there are three main types, namely blind lanes, accessible ramps and kerb ramps. The research found that there is a good system of blind lanes on Tianhe Nanyi Road and Tianhe Nan Pedestrian Street, but there is a risk of encroachment by various facilities, such as by non-motorized vehicles. There are accessible ramps at the entrances to the two shopping malls, Parc Central and Zhengjia Plaza, and a lack of accessible ramps at the entrance to TeeMall. There are kerb ramps at the changes in street height, but some of them are badly damaged, which affects the feeling of normal use. In addition, there is a lack of facilities to guide the visually impaired on Tianhe Nanyi Road and Tianhe Nan Pedestrian Street, which reduces the safety and comfort of the visually impaired in using the streets.

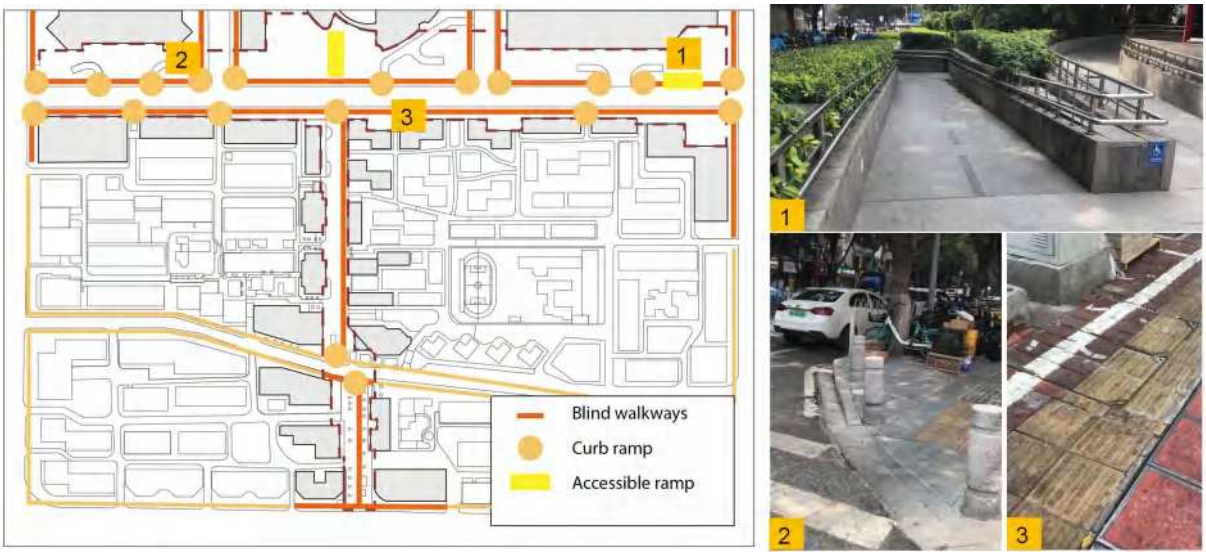


Fig. 5-13 Accessibility analysis(Source: Completed by author)

(2)Cycling network

The main focus of the study is on the cycling network, cycle paths, cycle parking, cycle path paving and cycle signage.

①The cycle network within the project design area is not continuous. There is a 1m width cycle lane on both sides of Tianhe Nanyi Road, but as the cycle lane and the motorway are co-planar and there are no segregation facilities, some on- street parking spaces encroach on the cycle lane and the safety and continuity of cycling is greatly reduced. The northern section of Tianhe Nan Pedestrian Street is pedestrian-only, while the southern section is mixed with pedestrian and bicycle traffic, resulting in a confusing street quality and reduced safety for pedestrians.

②Bicycle parking. Bicycle parking is distributed along both sides of the street along the south

side of Tianhe Nanyi Road and has a high usage rate near the underground station and near intersections. There is no bicycle parking in the northern section of Tianhe Nan Pedestrian Street as bicycle access is restricted on the street. The southern section of the pedestrian street has some bicycle parking spaces near the cross street of Sports West and a large number of bicycle parking spaces near the entrances and exits of the Huangpu Avenue underground station. However, there are also many problems with cycle parking spaces, such as the disorderly cycle parking on Tianhe Nanyi Road, which affects the cycling experience. Parking at the pedestrian crossing at TeeMall and Parc Central is a serious problem, blocking the normal cycling route. Some of the parking is unregulated, parking randomly and encroaching on the pavement or blind alley.

③The existing cycle path paving is of the same material and colour as the road and cannot be clearly distinguished. The bicycle markings are also much worn and not very recognizable.

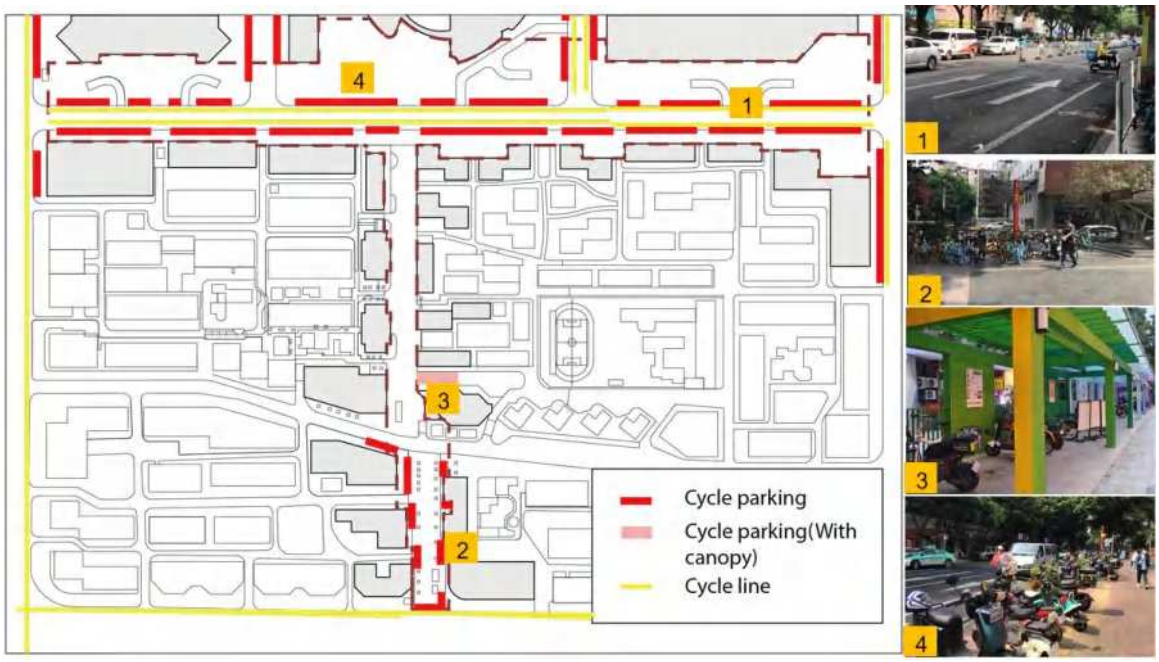


Fig. 5-14 Cycling network analysis(Source: Completed by author)

5.2.3 Analysis of car travel space

(1) Public transport

There is no bus transport system for the time being in the existing traffic in Tianhe Nanyi Road and Tianhe Nan Pedestrian Street, and the street is only near There is a metro(pictured). Metro Line 1, Metro Line 3 and APM lines are within the project area and there are existing Metro stations at Sports West Road Metro Station and Tianhenan Metro Station. Exit C of Tiyu Xi Road Metro stations is near the entrance of TeeMall. On-site research revealed that the guidance signs are not obvious and a large number of non-motorized vehicles are parked

near the Metro entrances and exits, affecting normal street use.

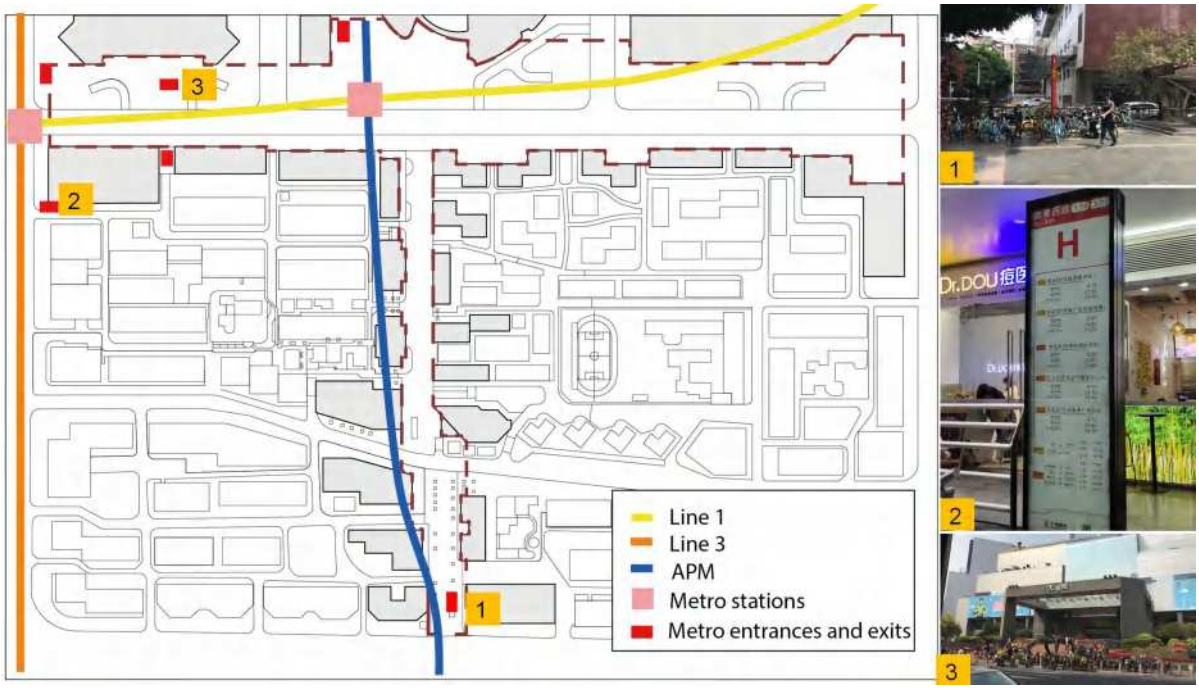


Fig. 5-15 Public Transport Analysis(Source: Completed by author)

(2) Motor vehicle traffic. The main areas of research and analysis are the motor vehicle network, road width and on-street parking.Motor vehicle network. The project is located in an area where the motor vehicle network is continuous and well developed. Tianhe Nanyi Road is a four-lane road with a road slab width of 15 metres. It is one-way to the right in the TeeMall and Parc Central sections and two-way in the Parc Central section. The current situation on the south side of the street on Tianhenan 1st Road is occupied by on-street parking, with 59 existing illegal parking spaces on the street. However, there is no separation between the parking and the cycle lane, resulting in the parking encroaching on the cycle lane and affecting normal cycling traffic. The south side of Tianhe Nan Pedestrian street is closed to motor vehicles.

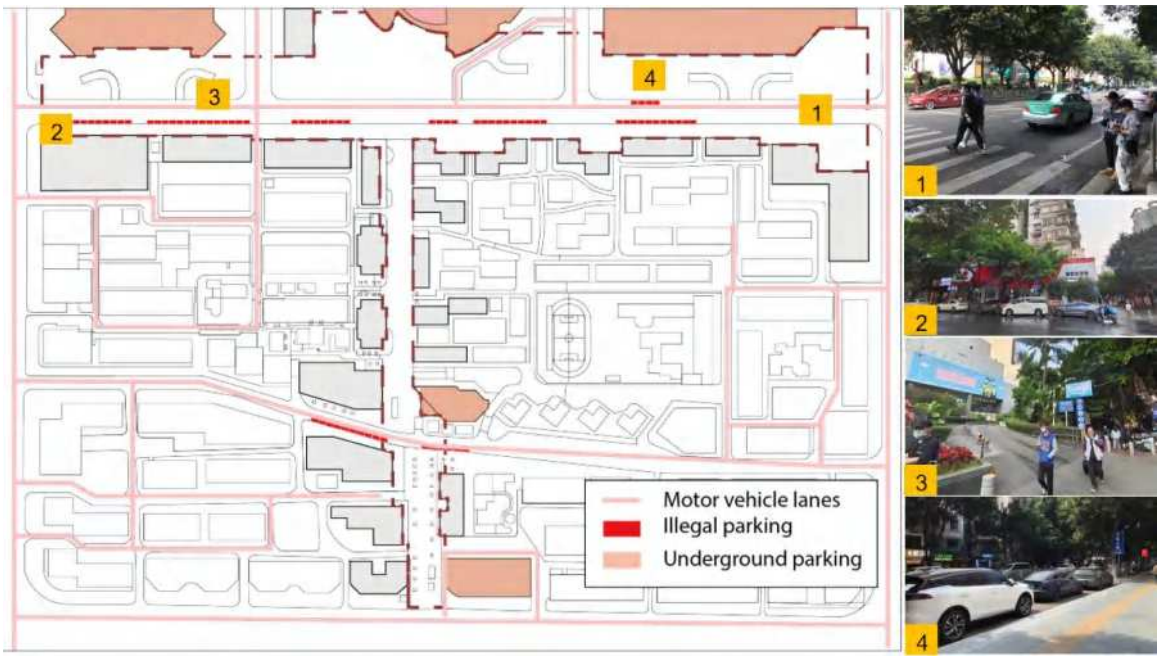


Fig. 5-16 Motor vehicle network analysis(Source: Completed by author)

(3)Intersections. Research and analysis mainly from the location and spacing of intersections. The project is at the junction of a commercial and residential area with a large number of pedestrian crossings. There are two main types of pedestrian crossings, one is where roads intersect to form pedestrian crossings, such as the one at the intersection of TeeMall Street and Tianhe Nanyi Road and the one at the intersection of Tianhe Nan Pedestrian Street and Sports Cross Street. The other type is at the streets where the main pedestrian entrances and exits to the shopping malls meet, such as the pedestrian crossing at the south entrance of TeeMall and the pedestrian crossing at the pedestrian entrance to Parc Central South.

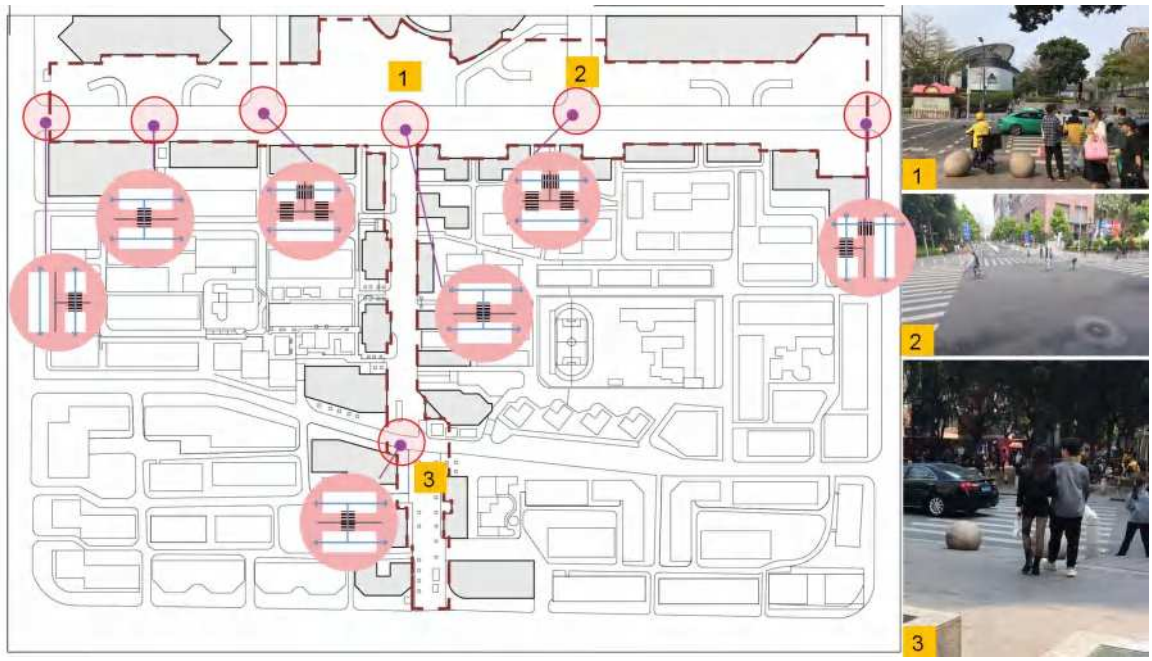


Fig. 5-17 Intersection analysis(Source: Completed by author)

5.2.4 Street greening analysis

Landscaping. The landscape green space is the main component of the street landscape environment, including the machine and non-machine separation zone, the street tree facility zone, the roadside green zone and the green landscape facilities in the building setback space. The landscape green space within the project area is analysed according to pavement greening, road greening and other greening.

The road greening within the project area mainly consists of street trees. The street trees are continuous in the TeeMall section and the Zhengjia Plaza section, and discontinuous in the Parc Central section. The setback of the buildings in TeeMall, Parc Central, and Zhengjia Plaza forms a continuous lawn for landscaping, but the landscape quality is not high, with low levels of hierarchy and viewing, and is not accessible. The greenery in the northern section of the Tianhe Nan Pedestrian Street is mostly located at the intersections between the pedestrian street and the roads within the community. There is less greenery on the pedestrian street itself, and both sides are dominated by concrete buildings that are about 15 meters high. The pedestrian space is dull, especially in hot weather, which reduces the comfort level for pedestrians. The southern section of the Tianhe Nan Pedestrian street is dominated by tree ponds, which in combination with the street seating form a good open space, but there is a large number of non-motorized vehicles parked indiscriminately affecting the quality of the street landscape.

Fig. 5-18 Street landscape analysis(Source: Completed by author)

5.2.5 Analysis of street furniture

The main categories are open space and sanitation facilities.

A comfortable. pedestrian environment should be provided with a corresponding number of sitting facilities. The current distribution of seating on the streets is mainly concentrated on the Tianhe Nan Pedestrian street, with less seating on the streets along the TianNanyi Road. Seating is mainly in the form of fixed stone benches and tree pond seats, with a high usage rate. On-site research found that there are no sitting facilities on both sides of the street on the south side of the TianNanyi Road, and existing pedestrians can only sit on the entrance steps of the merchants on both sides. The northern section of the Tianhe Nan Pedestrian street has more shops on both sides, but the number of seats is low and there are no shading facilities, and they are not closely integrated with the landscape. Existing pedestrians prefer to sit in the raised tree pools.

Fig. 5-19 Analysis of lounge seating(Source: Completed by author)

Rubbish bins. Litter bins should be set up to meet the requirements for the separate collection of pedestrian household waste; bins should be placed according to the following criteria Bins are mainly placed on both sides of the street and near the entrances and exits of various traffic facilities, public facilities, parks and squares; bins should not obstruct slow walking space and obstruct sight lines, wall-mounted bins can be used when slow walking space is restricted; the setting of bins should be coordinated with other street facilities.

TianNanyi Road and Tianhe Nan Pedestrian Street are commercial streets with a large flow of people. The maximum value of 50 metres of the service radius of 30-50 metres for sanitation facilities in areas with a large flow of people was selected for calculation, which shows that the distribution of rubbish bins on TianNanyi Road is relatively uniform and can basically meet the needs of people; the distribution of rubbish bins in the northern section of Tianhe Nan Pedestrian Street is uneven and exceeds the service radius of 50 metres, which temporarily cannot meet the needs of people. The north section of the Tianhe Nan Pedestrian street is unevenly distributed and beyond the 50m service radius.

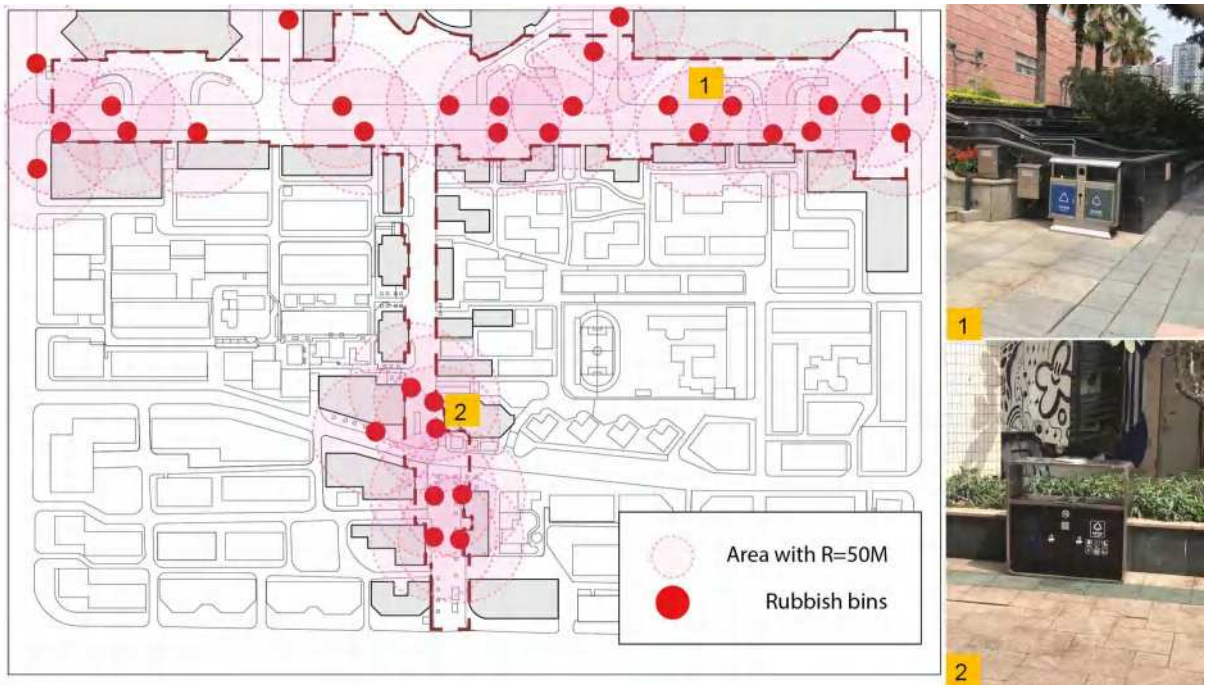


Fig. 5-20 Analysis of sanitation facilities(Source: Completed by author)

5.3 Site evaluation

This article selects Tianhe Nanyi Road and Tianhe Nan Pedestrian Street as the research objects. Based on field research and questionnaire surveys and on the basis of the basic data, it evaluates Tianhe Nanyi Road and Tianhe Nan Pedestrian Street from the perspective of the entire street and identifies problems related to the street space in combination with the results of the questionnaire surveys.

5.3.1 Evaluation and Analysis in a Complete Streets Perspective

(1)Indicator Weighting: This article focuses on the urban street design led by a complete street perspective. It selects evaluation indicators and weights from Gu Mingen's article and performs uniform processing. The adapted application is applied to the street space evaluation of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street.

Table. 5-2 Complete Streets Evaluation Indicator System and Indicator weights(before)

Guideline level	Evaluation factors
Carriageway A(0.329)	Road Basics Situation A1(0.75)
	Road related facilities A2(0.25)
Pavement B(0.333)	Pedestrian access area B1(0.55)
	Cycle path B2(0.16)
	Driveway paving B3(0.14)
	Bus stops and other facilities B4(0.15)
Guideline level	Evaluation factors
City Furniture C(0.105)	Signage C1(0.10)
	Bin C2(0.29)
	Bicycles Parking Area C3(0.56)
	Lounge seat C4(0.05)
Greening system D(0.122)	Pavement Green Belt D1(0.75)
	Road Green Belt D2(0.20)
	Other greenery D3(0.05)
Building facade E(0.111)	Billboards and other facilitiesE1(0.75)
	Street layout E2(0.25)

Table. 5-3 Complete Streets Evaluation Indicator System and Indicator weights(after)

Guideline level	Evaluation factors
Carriageway A(1.645)	Road Basics Situation A1(0.24675)
	Road related facilities A2(0.08225)
Pavement B(1.665)	Pedestrian access area B1(0.18315)
	Cycle path B2(0.05328)
	Driveway paving B3(0.04662)
	Bus stops and other facilities B4(0.04995)
City Furniture C(0.525)	Signage C1(0.0105)
	Bin C2(0.03045)
	Bicycles Parking Area C3(0.0588)
	Lounge seat C4(0.00525)
Greening system D(0.61)	Pavement Green Belt D1(0.0915)
	Road Green Belt D2(0.0244)
	Other greenery D3(0.0061)
Building facade E(0.555)	Billboards and other facilitiesE1(0.08325)
	Street layout E2 (0.02775)

(2)Data Acquisition Sources

The sources of evaluation data collection include on-site research and questionnaire surveys.

On-site research: The author conducted observations and surveys of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street, which were research sites, on December 25, 2022, February 18, 2023, February 20, 2023, and February 22, 2023, respectively. The width of the pedestrian walkway, the number and location of bicycle parking points, and the street furniture were recorded. The specific situation of each street element was summarized and analyzed.

Questionnaire survey: The survey was randomly distributed to residents of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street on December 25, 2022, February 18, 2023, February 20, 2023, and February 22, 2023. A total of 200 questionnaires were distributed, 173 were returned, and 154 were valid.

Fig. 5-21 Photos of the on-site research(Source: Completed by author)

(3)Calculation and analysis of evaluation results

Calculation and analysis of evaluation results.The evaluation results are calculated by means of a linear weighted sum, by multiplying the standardised values of the evaluation factors with their corresponding weights and then summing them to obtain the final evaluation results:

$$CS = \sum_{i=1}^{n} Wj \cdot Fi$$

$$Fi = \sum_{i=1}^{n} \frac{Vi}{Nq}$$

According to the results of the field research, evaluation factors A1, A2, B1, B2, B3, B4, C2, C3, C4 were scored by the author corresponding to the rating scale, and the rest were scored according to the results of the questionnaire survey, in accordance with the CS calculation method, to arrive at the questionnaire survey indicator factor scores, the specific results are shown in the Table. below.

According to the CS calculation method, the overall CS score for the street elements in the project area is 2.886411, where the top three lower scores are Greening system, Carriageway and City Furniture. The results of the five standard layers are shown in the Table.. The scores are from highest to lowest: Building facade, Carriageway, City Furniture, Pavement, Greening system.

Table. 5-4 Standard Tier Scores Table.(Source: Completed by author)

Guideline level	Carriageway A	Pavement B	City Furniture C	Greening system D	Building facade E	Total
Definitely	0.329	0.333	0.105	0.122	0.111	1
Full marks	1.645	1.665	0.525	0.61	0.555	5
Score	0.995225	0.914751	0.309645	0.32269	0.3441	2.886411
Scoring rate	0.605	0.5494	0.5898	0.529	0.62	57.73%

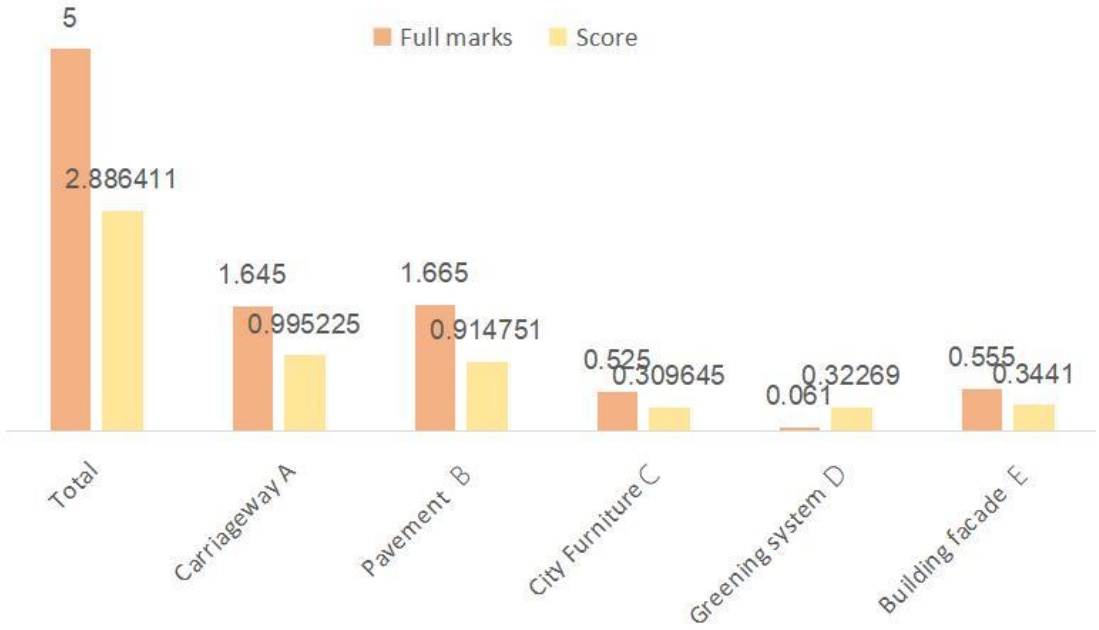


Fig. 5-22 Comparison of the scores of each evaluation criteria tier with full scores in the area where the project is located(Source: Completed by author)

5.3.2 Analysis of the results of the questionnaire research

The questionnaire survey content is mainly divided into two parts. The first part is the basic information of the respondents, including gender, age, and occupation. The second part is the investigation of the street space under the perspective of a complete street. The questionnaire was distributed randomly to residents of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street

from February to March 2023. The questionnaire is mainly divided into online and offline versions, with a total of 70 offline questionnaires and 130 online questionnaires. To ensure the authenticity and accuracy of the questionnaire, data cleaning is conducted from two dimensions: the completeness of the questionnaire and the duration of answering. First, a round of machine cleaning was carried out for the questionnaires with an answering duration of less than 2 minutes, and 173 questionnaires were obtained. Then, manual screening was conducted based on the completeness of the answers, and a total of 154 valid questionnaires were finally obtained.

1．Basic attributes of the population

To ensure the accuracy of the survey, the author conducted basic statistical analysis on the basic attributes of the res pondents, including gender structure, age structure, and occupation. Among the 154 respondents, there were slightly more female respondents than male. Specifically, there were 85 females, accounting for 55% of the total respondents, and 69 males, accounting for 45%, with a relatively balanced gender ratio. In terms of age structure, the age group of 19-59 years old accounted for the largest proportion, representing 79% of the total respondents. The proportion of respondents aged ≤18 years old was 14%, and the proportion of those aged ≥60 was 7%. The respondents were mainly office workers, students, and merchants, with office workers accounting for 37%, students accounting for 33%, and merchants accounting for 16%. These three groups together accounted for 86%.

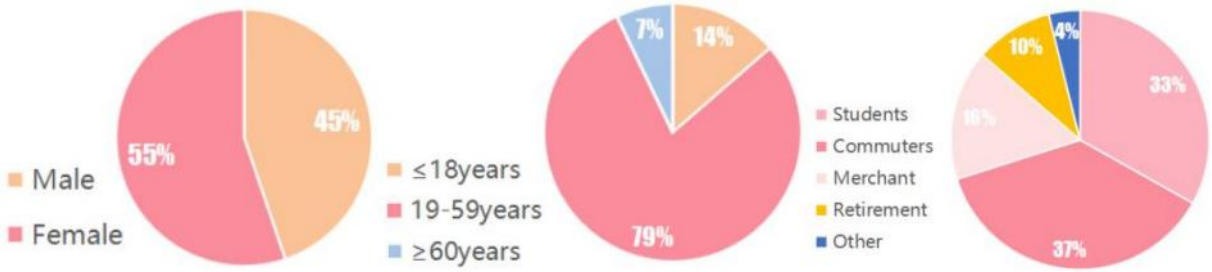


Fig. 5-23 Gender structure, age structure and mode of travel of respondents (Source: Completed by author)

2．Street space related issues

The main mode of transportation for the respondents is slow traffic, among which 40% of people choose to walk, 28% choose non-motorized transportation, 27% choose public transportation, and the remaining 5% choose to drive a car. In the subsequent renovation and design, it is important to focus on providing a good and comfortable. street space for pedestrians and non-motorized vehicle riders.

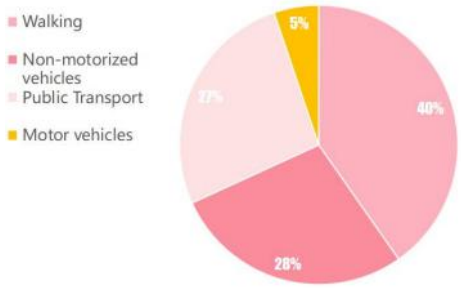


Fig. 5-24 Respondents' mode of travel(Source: Completed by author)

According to the questionnaire results, the activities conducted on the streets are mainly passing through, sitting and talking, walking, and shopping, which account for the highest proportions, namely 23%, 21%, 19%, and 21% of the respondents, respectively. In the subsequent street renovation and design, it is important to consider the spatial needs of these four types of street activities. Activities such as exercising, walking dogs, taking children out for a walk, playing cards and chess, performing and watching performances, and setting up stalls have a relatively low proportion. On the basis of meeting the spatial needs of the first four types of activities, corresponding places and spaces should be provided for these activities, which is consistent with the concept of complete street design.

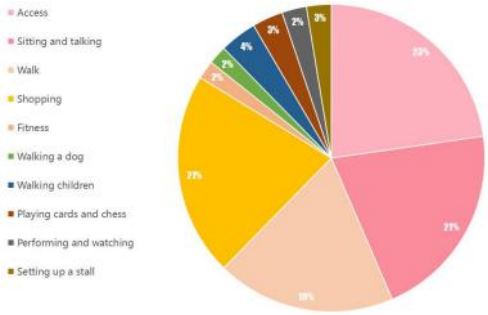


Fig. 5-25 Respondents' main activities on the street (Source: Completed by author)

The survey results show that the convenience of cycling and the lack of street rest facilities are the two main issues that need to be improved on Tianhe Nanyi Road and Tianhe Nan Pedestrian Street, accounting for 24% and 22% respectively. The next two issues are the low quality of street space and the lack of greenery and landscape, accounting for 20% and 16% respectively. The problems of chaotic management of street facilities and conflicts with motor vehicles are relatively minor, accounting for 6% and 7% respectively. In the subsequent street redesign, it is important to improve the convenience of cycling and supplement and improve street rest facilities. Additionally, the quality of street pedestrian space and street landscape greenery should be reasonably enhanced to address the issues of low quality.

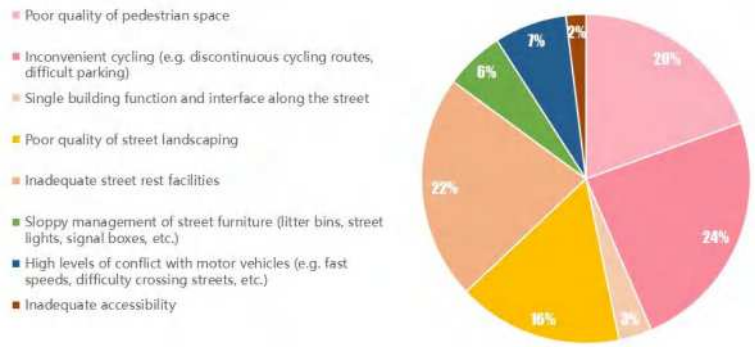


Fig. 5-26 Respondents' perceptions of what streets need most improvement(Source: Completed by author)

The respondents indicated that the main reasons for poor cycling experience are sharing the road with motor vehicles, lack of dedicated bicycle lanes, and discontinuity in bicycle lanes, accounting for 27%, 28%, and 24% respectively. In the subsequent redesign, attention should be paid to coordinating the relationship between non-motorized and motorized vehicles and adding missing bicycle lanes to form a complete non-motorized transportation network. The lack of shading facilities and insufficient cycling facilities account for a smaller proportion, at 8% and 9% respectively. In the subsequent redesign, it is important to provide continuous shading facilities, properly plan parking spots, and strengthen signage to provide cyclists with a safe, comfortable., and convenient cycling environment.

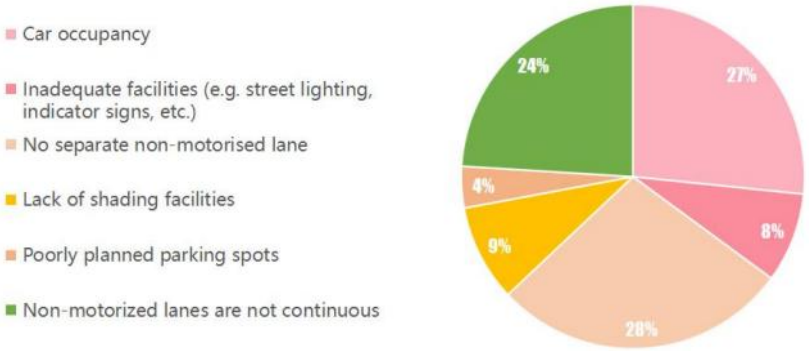


Fig. 5-27 Respondents' perceived reasons for poor riding experience（Source: Completed by author）

5.4 Summary

This chapter is divided into three main aspects to analyse and study the site. Firstly, it analyses the location of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street from a macro perspective, the climate conditions of the city, the surrounding businesses and the current traffic situation, and classifies the road levels and street types in Tianhe Nanyi Road and Tianhe Nan Pedestrian Street according to the classification method in the Guangzhou Urban Road Design Manual. Secondly, the design scope of the project, the current traffic situation,

the street landscape and greenery, and the street facilities were analysed in the context of the strategy of street space renewal and the evaluation index of each element of the complete street. Finally, the AHP hierarchical analysis method was used to quantitatively study the street space of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street, and a questionnaire survey was used to qualitatively study Tianhe Nanyi Road and Tianhe Nan Pedestrian Street. The problems and challenges of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street from the perspective of complete streets are summarised to provide a basis for the subsequent transformation and enhancement of the street space.

Chapter6 Design of street space regeneration in the context of complete streets in Tianhe Nanyi Road and Tianhe Nan Pedestrian Street

6.1 Overall design

In the context of the complete street concept, the spatial design of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street is shown in the diagram(Fig. 6-1)(Fig. 6-2). To ensure the formation of a good street network, the design supplements and improves the missing bike lanes on TeeMall street and Tiyu Xiheng street. The bike lane on Tianhe Nanyi Road will be widened to an appropriate width to form a complete cycling network in the Tianhe Nanyi Road and Tianhe Nan Pedestrian Street area. To improve the quality of the slow traffic environment, the quality of the pedestrian environment and the cycling environment will be optimized to enhance the quality of the street's slow space.

Tianhe Nanyi Road will be transformed into a street plaza. Located at the intersection of the commercial and residential areas, Tianhe Nanyi Road was originally built as a city road. With the expansion of the commercial area and the development of the city, commercial spillover has increasingly caused the residential area on the other side to gradually transform from a closed community to an open community. The ground floor of the community has also transformed from residential to commercial. The close commercial ties on both sides have made Tianhe Nanyi Road, as a road, unable to meet people's demands for its new positioning. In this case, based on the complete street concept, Tianhe Nanyi Road, as a road, will be transformed into a city street by using special paving forms and supplementary street facilities. Combined with TeeMall, Parc Central, and Zhengjia Plazza, a continuous urban public space will be formed.

Tianhe Nan Pedestrian Street will be transformed into a city public commercial pedestrian street. Originally a private internal road in the Liuyun community with privacy, Tianhe Nan Pedestrian Street gradually evolved into an open commercial street in the open community with the development of the city. The original road form cannot meet people's demands for the new positioning of Tianhe Nan Pedestrian Street, combined with its special geographical location on the new central axis of Guangzhou. Therefore, based on the complete street concept, it will be transformed into a city public commercial pedestrian street by improving the quality of the pedestrian space and the refinement of street facilities design.

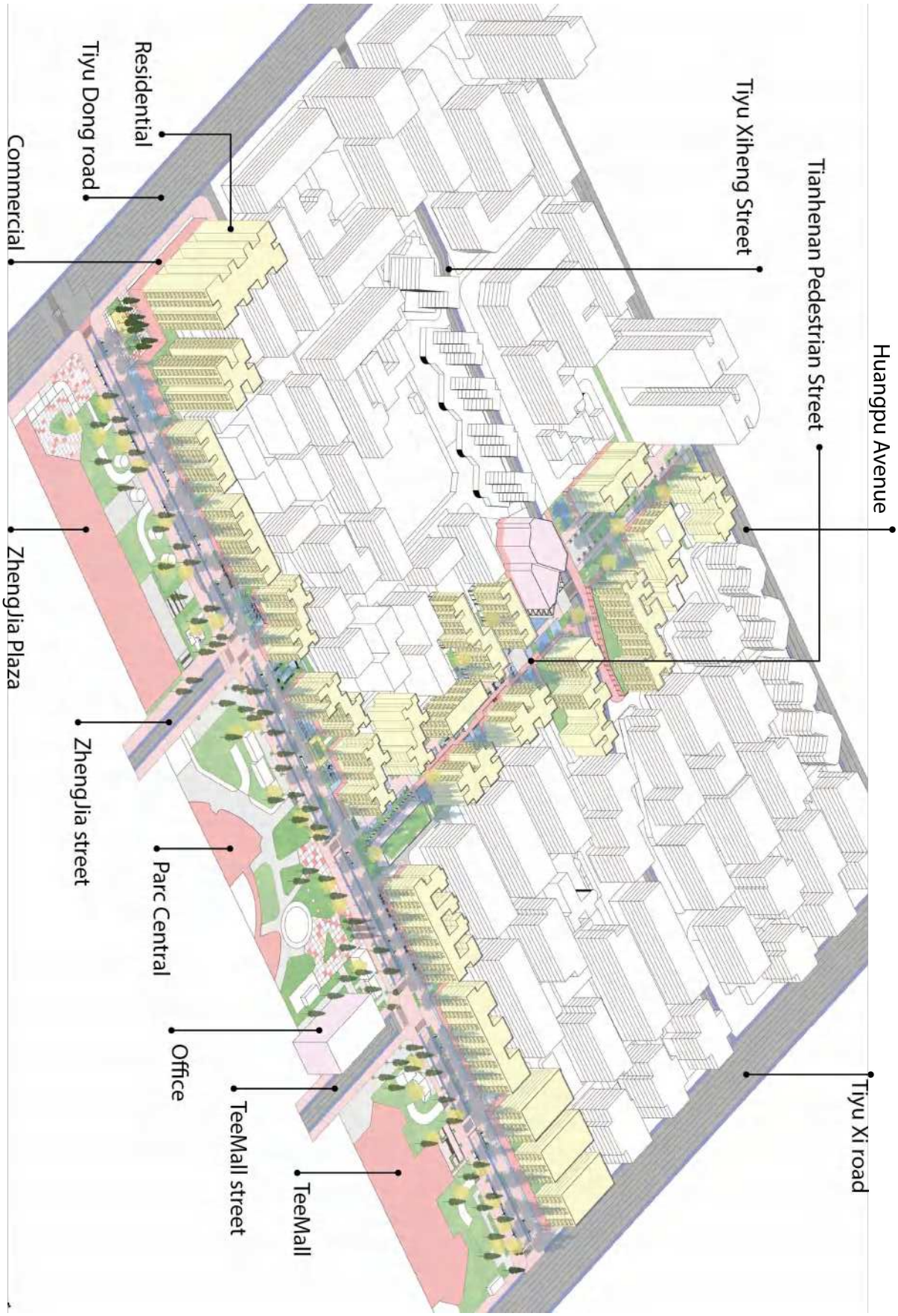


Fig. 6-1 Project axonometric view(Source: Completed by author)

Fig. 6-2 Master plan (Source: Completed by author)

6.1.1 Summary of current street issues

1.Tianhe Nanyi Road

The functions of commercial streets are usually more complex than other streets, for example, providing services for people on weekends and offering dining options for weekend shopping and eating activities. Parking lots and rest areas on these streets are often restricted by commercial activities. Therefore, the sidewalks on commercial streets need to be wide enough to accommodate a large number of pedestrian and commercial activities. On the other hand, because of the complexity of pedestrian traffic on commercial streets, people use various modes of transportation, such as walking, cycling, public transportation, and private cars, so street design needs to consider multiple modes of transportation. Tianhe Nanyi Road is an east-west road in Tianhe District, Guangzhou, connecting Tiyu Xi Road and Tiyu Dong Road, with a total length of 685 meters. There are retail shops, restaurants, and other businesses on both sides of the street, resulting in high pedestrian and vehicle traffic throughout the day. The existing problems are as follows:

Fig. 6-3 Summary of problems of the Tianhe Nanyi Road (Source: Completed by author)

01． Low-quality pedestrian walkways. The pavement of the pedestrian area is severely damaged, and mixed pedestrian and cycling traffic affects pedestrian safety.

02． Discontinuous bicycle lanes. The bicycle lane is interrupted on TeeMall Street. The bicycle lane on Tianhe Nanyi Road lacks significant cycling signs and is too narrow without any isolation measures from the motor vehicle lane, which leads to motor vehicles occupying the bicycle lane and greatly reducing the safety and comfort of cycling.

03．Disorderly bicycle parking, occupying the pedestrian area and affecting pedestrian safety and comfort.

04． The motor vehicle lane is too wide, resulting in fast driving speed and easy safety hazards.

05． Mixed traffic at pedestrian crossings. Inconvenient facilities have led to prominent conflicts between pedestrians and motor vehicles.

06．The turning radius at intersections is too large, increasing the difficulty for pedestrians to cross.

07． Existing blind roads are broken and discontinuous, greatly affecting the use of disabled people on the street.

08. Tianhe Nanyi Road lacks trees on the north side of the Parc Central section, with no shade facilities during the hot daytime, which affects the comfort experience of the street.

09． Some landscape greening is of low quality, making it difficult for landscape and pedestrians to have positive interactions.

10． There are few street seats and insufficient rest facilities along the street, making it difficult for pedestrians to stay longer, affecting the vitality of the street space.

11． Various poles such as street lamps, cameras, traffic signs, and information signs are densely distributed on the street facilities, affecting the quality of the street.

2.Tianhe Nan pedestrian street

Tianhe Nan Pedestrian Street is a primarily pedestrian commercial street located within the Liuyun Community of Tianhe District in Guangzhou, intersecting with Tianhe Nanyi Road. The street features commercial storefronts on the first and second levels, with residential spaces on the upper levels, and experiences high foot traffic. Current issues include:

Fig. 6-4 Summary of problems of the Tianhe Nan pedestrian street(Source: Completed by author)

1． The pedestrian space is too wide, lacking shading facilities and other detailed design elements, resulting in low space utilization efficiency.

2． The southern section of the pedestrian street allows for mixed pedestrian and vehicular traffic, negatively impacting pedestrian safety and greatly reducing the quality of biking experiences.

3． There is insufficient bike parking space and a lack of guidance, resulting in disorderly parking that obstructs pedestrian traffic.

4． The intersection of Tianhe Nan Pedestrian Street and Sports West Road is plagued by conflicts between pedestrians and vehicles, and lacks traffic guidance facilities.

5． The existing blind paths and rest facilities are too close together, with no buffer space, causing pedestrians to occupy the blind paths while resting.

6． The shading facilities on the north side of the pedestrian street are insufficient, reducing the comfort of pedestrian use.

7． The number and distribution of street benches are inadequate, preventing pedestrians from lingering too long and reducing the vitality of the street space.

8． There is a shortage of street trash cans, and their placement is unreasonable, leading some pedestrians to litter and reducing the comfort of pedestrian use.

6.1.2 Pedestrian networks

Complete Streets emphasises pedestrian priority and a complete, safe and comfortable. pedestrian network can provide a friendly city. Continuous, obstacle-free pavements with small block sizes make it easy for pedestrians to reach their destinations safely. Cities are part of the human habitat. People not only walk on the streets, but also rest, sit idly, play and wait on the streets. Pedestrian priority is emphasised in the design of streets and the needs of vulnerable groups(such as children, the elderly and people with low perceptual or motor skills) are taken into account. Pedestrian networks should be interconnected and permeable, accessible and comfortable., safe and in harmony with the environment.

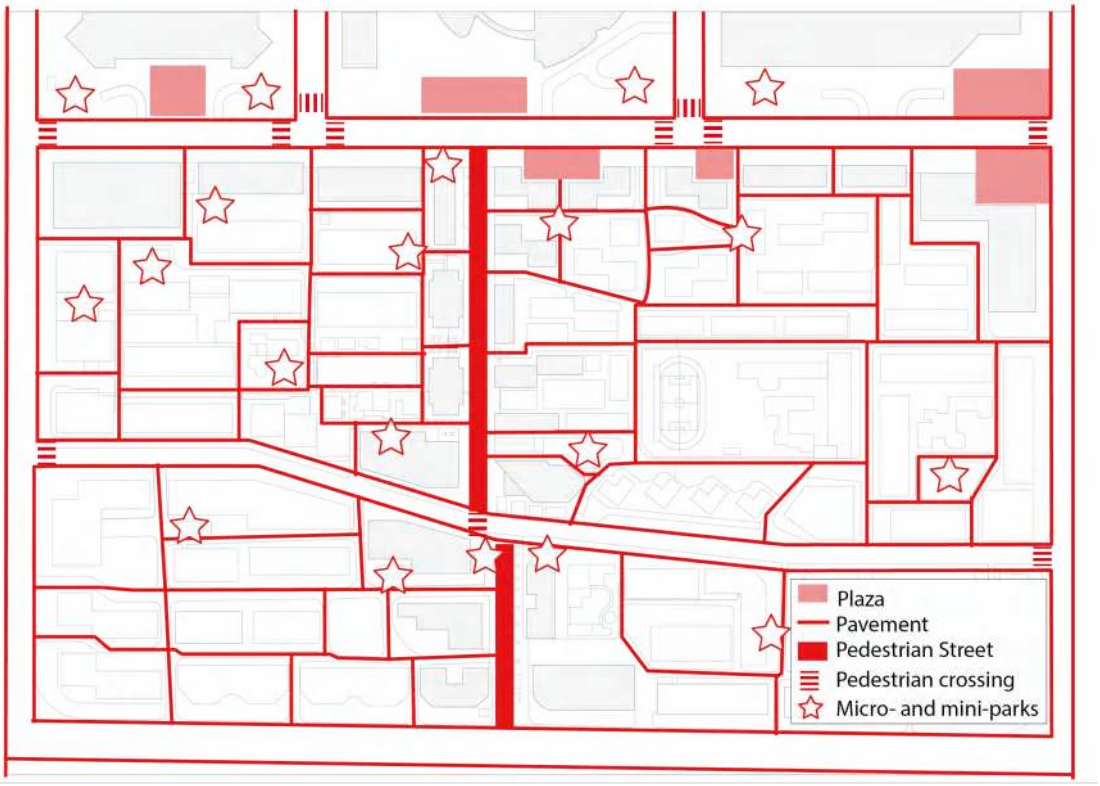


Fig. 6-5 The walking network in neighborhood scale (Source: Completed by author)

6.1.3 Cycling networks

Bicycle Network: By ensuring the comprehensive implementation of the bicycle network plan, cities should prioritize bicycle riding as a sustainable mode of transportation. A series of bicycle facilities should be established to provide safe, convenient, and interconnected routes, which can help cyclists reach their destinations without relying on motorized transportation. Supporting bicycle network facilities include bicycle lanes, bicycle parking areas, and wayfinding signs.

The bicycle lane on Tianhe Nanyi Road should be widened to provide safe and comfortable.

cycling for riders. Bicycle lanes should also be installed on TeeMall Street and Tiyu Xiheng street to form a complete bicycle network in the area. Bicycle parking areas should be reasonably located based on demand and service radius, and strengthened management should be implemented in the future. Reasonable and eye-catching bicycle signage should be set up to help cyclists identify routes more quickly.

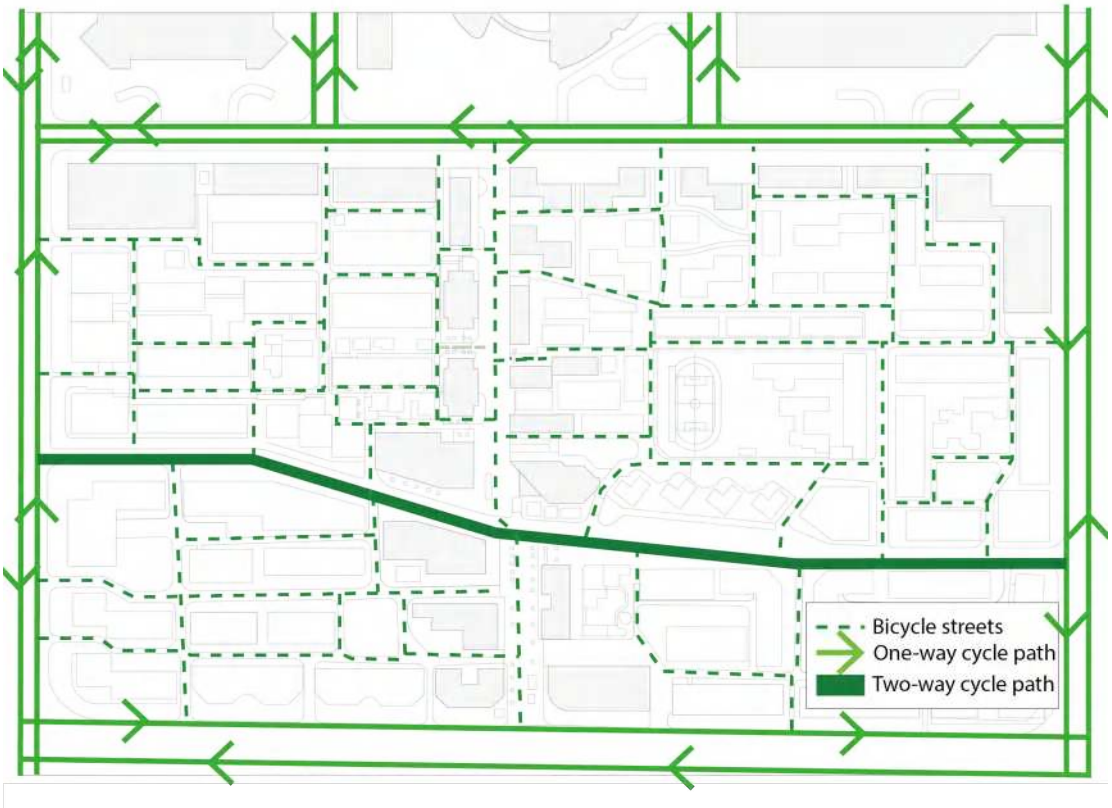


Fig. 6-6 The cycling network in neighborhood scale（Source: Completed by author）

6.1.4 Public transportation network

The public transport network has been changed to a lesser extent and the coverage of the original public transport stations meets the needs of the population. Therefore, the design is not being carried out.

6.1.5 Motor vehicle network

The design of the site includes the optimisation of lane widths and intersections. The design of the motor vehicle network on the site is good and the streets of Tianhe Nanyi Road are squared to create shared streets. The safety and convenience of pedestrians crossing the street is improved by reducing the turning radius of the kerbs and special paving at the intersections, and the safety and comfort of walking is ensured by prohibiting motor traffic on Tianhe Nan Pedestrian Street.

6.2 Design of slow street space enhancement in the context of complete streets

6.2.1 Street plaza design for Tianhe Nanyi Road

The transformation goal for Tianhe Nanyi Road is to turn it into a urban street square. Tianhe Nanyi Road was initially built as an urban road, located at the intersection of a commercial and residential area. With the expansion of the commercial area and the development of the city, the spillover effect of commerce has become increasingly strong, causing the residential area on the other side to gradually transform from a closed community to an open one. The ground level of the community has also transformed from residential to commercial. The close commercial connections on both sides make Tianhe Nanyi Road, as a road, unable to meet people's requirements for its new positioning. In this case, based on the complete street background, the specific methods for transforming Tianhe Nanyi Road into a commercialized street square are being explored.

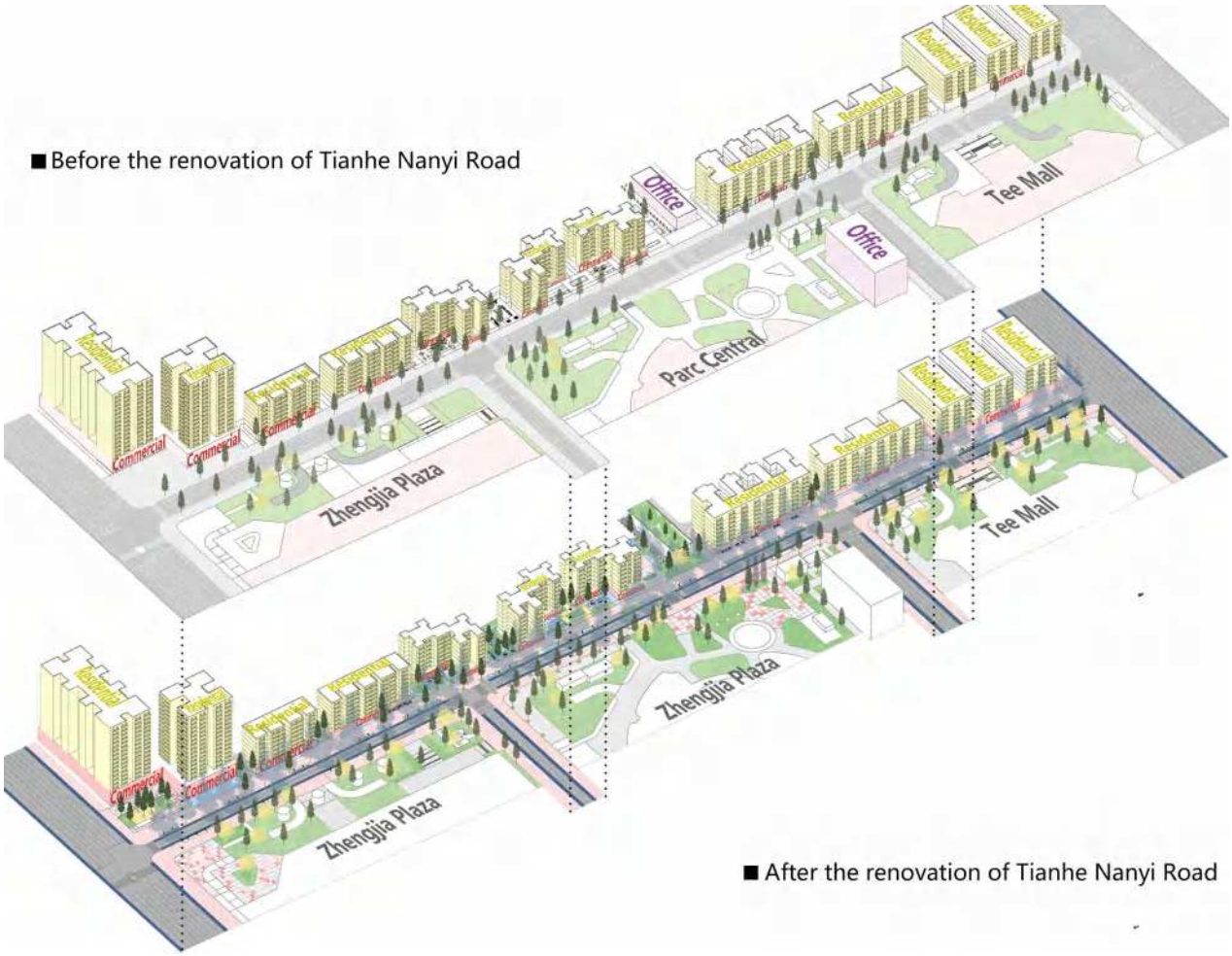


Fig. 6-7 Before and after street renovation of Tianhe Nanyi Road（Source: Completed by author）

Challenges and current situation:

Tianhe Nanyi Road is an east-west road in Tianhe district of Guangzhou city, connecting Tiyu Xi Road and Tiyu Dong Road, with a total length of 685 meters. There are retail shops, restaurants, and other businesses on both sides of the street, resulting in high pedestrian and vehicle traffic throughout the day. The existing slow travel space problems are as follows:

1. The bicycle lane is not continuous. The bicycle lane is interrupted on TeeMall Street. The bicycle lane on Tianhe Nanyi Road lacks prominent cycling signage, is too narrow, and lacks segregation from the motor vehicle lane, resulting in motor vehicles encroaching on the bicycle lane, greatly reducing the safety and comfort of cycling.

2. The motor vehicle lane is too wide, leading to fast vehicle speeds and potential safety hazards.

3. The north side of Tianhe Nanyi Road in the Parc Central section lacks roadside trees, with no shading facilities during the hot day, which affects the street's comfort experience.

4. Pedestrian area width: Tianhe Nan Pedestrian Street is too wide and lacks design, resulting in low utilization and comfort of the pedestrian area.

5. The quality of pedestrian walkway is poor. Part of Tianhe Nanyi Road has severe pavement damage, affecting the travel experience. Some manhole covers protrude in the pedestrian area, affecting the comfort and safety of the walking environment.

6. Accessibility: There is a phenomenon of blind paths being occupied by non-motorized vehicles on Tianhe Nanyi Road; the entrance to TeeMall lacks accessibility facilities; there is a lack of visual impairment guidance facilities on Tianhe Nanyi Road and Tianhe Nan Pedestrian Street.

7. Bicycle lane: The bicycle lane on Tianhe Nanyi Road is too narrow and is often encroached by motor vehicles.

8. Bicycle parking: The disorderly problem of bicycle parking on the street is serious, occupying the blind path and pedestrian area, affecting the walking experience.

9. Bicycle lane pavement: It adopts the same material and color as the motor vehicle lane, making it difficult to effectively distinguish.

10. Bicycle signage: The bicycle lane signage is not obvious, making it difficult for cyclists to distinguish effectively.

Optimization strategies:

There are a total of 8 points to address the above problems on the Tianhe Nanyi Road.

1．Compress the width of the vehicle lanes and allocate street space to walking and cycling spaces.

2．Optimize and connect the cycling routes to form a complete cycling street network. This can be achieved by widening the cycling lanes on Tianhe Nanyi Road, adding cycling lanes to TeeMall Street, and marking the cycling lanes prominently. The street cycling space environment should be optimized to connect the fragmented cycling network.

3．Extend the commercial space and add street furniture. Based on the commercial street nature of Tianhe Nanyi Road and the goal of designing it into a square, the vitality of the street can be improved by extending the commercial space and adding various humanized and refined street facilities.

4．Create various forms of street greening. Street landscape greening is an important factor that affects the quality of the street space. To achieve the goal of designing Tianhe Nanyi Road into a square, various forms of street landscape greening can be created, combined with commercial space and leisure space design, to provide pedestrians with a good street space environment and help achieve the goal of designing Tianhe Nanyi Road into a square.

5．Balance the street height difference and handle the road square design. The square design of Tianhe Nanyi Road emphasizes the accessibility of the square and barrier-free access. Therefore, it is essential to solve the problem of street height difference. The walking space, cycling space, and vehicle space should be designed at the same height. Secondly, the vehicle lane space should be paved to form a continuous and complete street square.

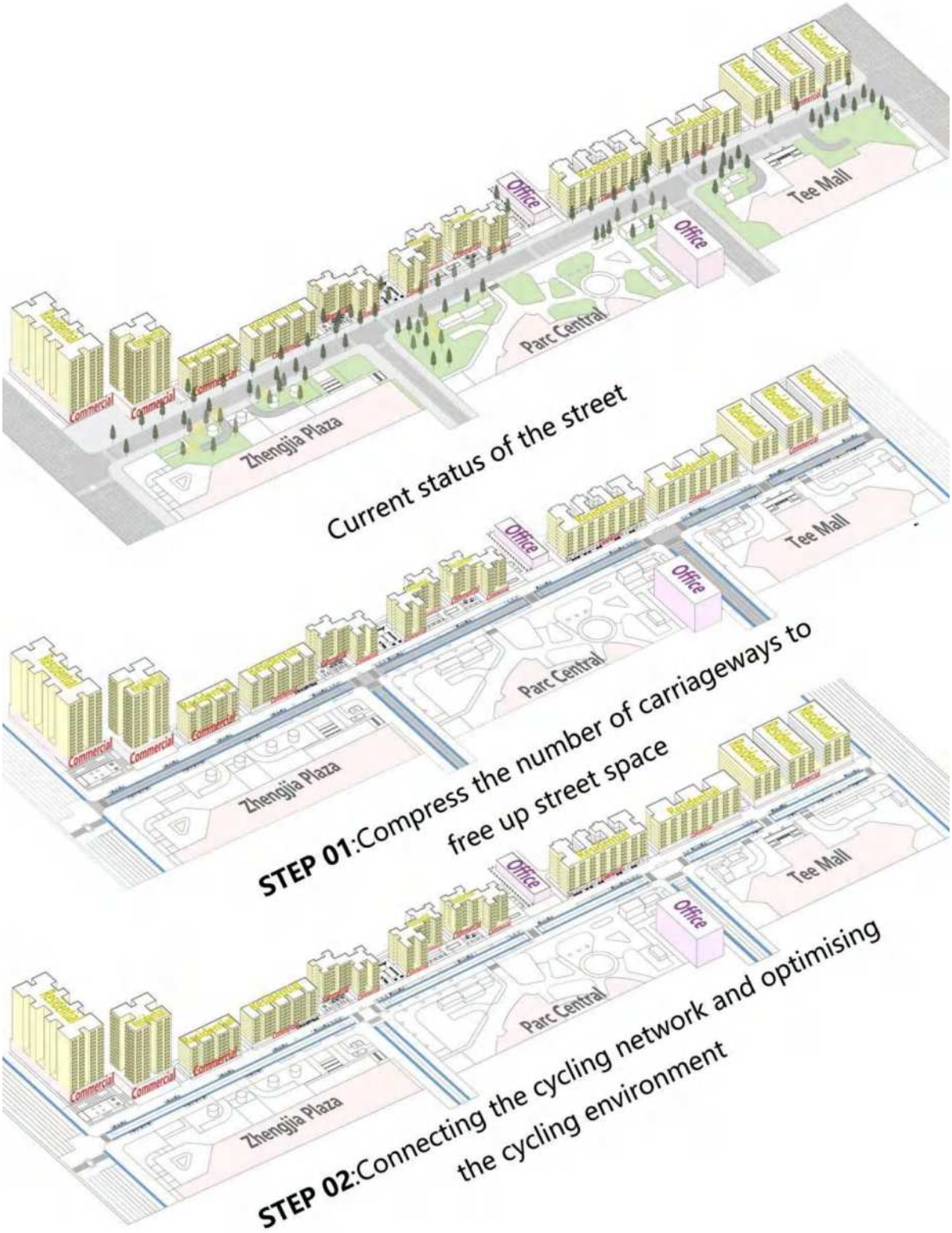


Fig. 6-8 Strategies for the transformation of the streets along the south side of the Tianhe Nanyi Road（Source: Completed by author）

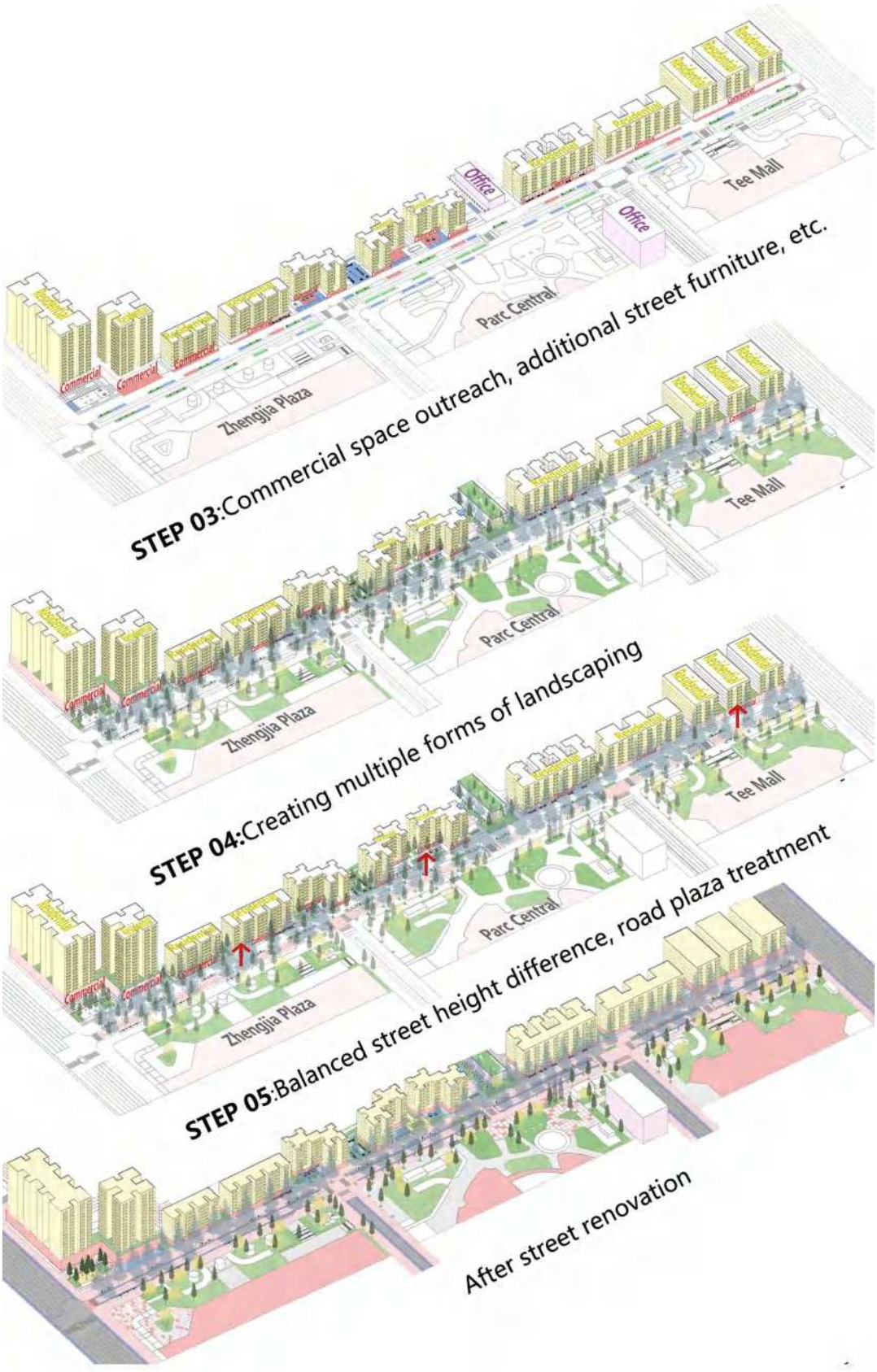


Fig. 6-9 Strategies for the transformation of the streets along the south side of the Tianhe Nanyi Road（Source: Completed by author）

6． Regarding the width and quality of the pedestrian area on Tianhe Nanyi Road, the pedestrian area should be improved by integrating commercial outdoor display, landscape greening, and recreational facilities to provide pedestrians with a rich and active walking space, improving the comfort and vitality of the street. In addition, the damaged pedestrian area pavement should be repaired and the height difference between the pipeline covers and the pedestrian area should be properly addressed.

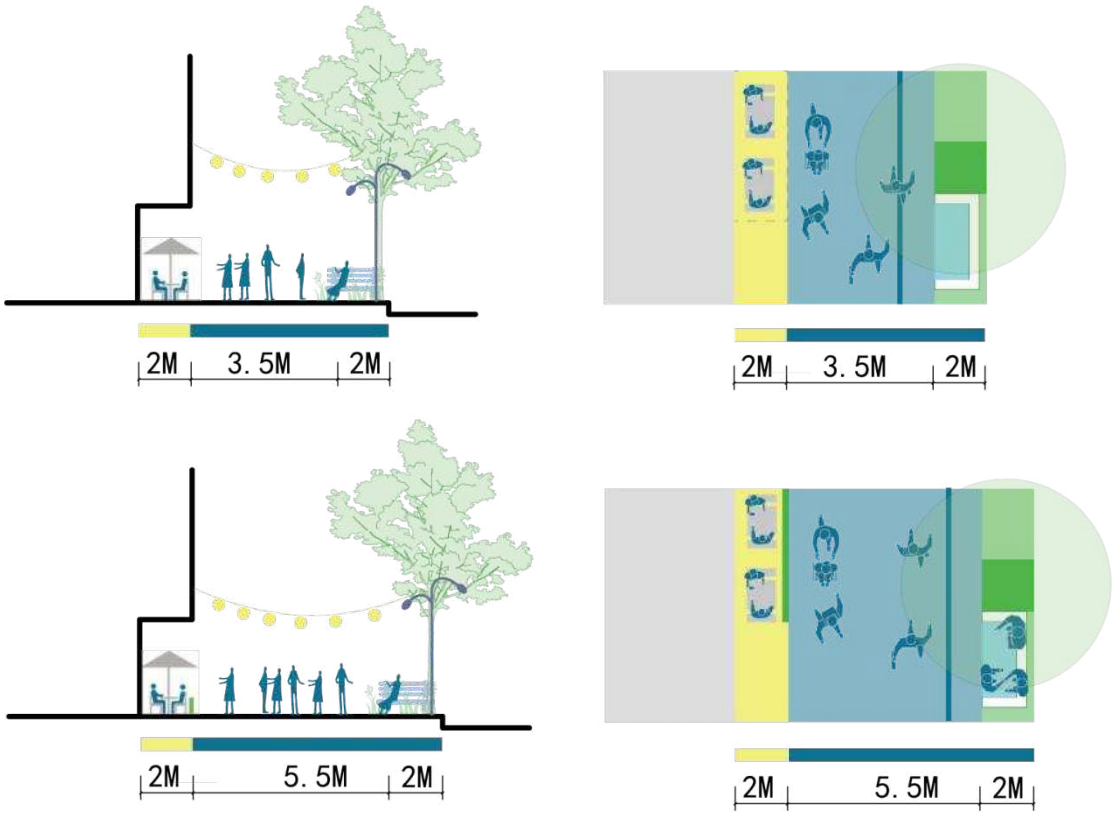


Fig. 6-10 Pavement at Tianhe Nanyi Road (Source: Completed by author)

7． Regarding the accessibility issues on Tianhe Nanyi Road, it is necessary to strengthen the design of street accessibility facilities and signage, reflecting care for special groups such as the elderly, children, and people with disabilities, and demonstrating the diverse cultural sentiment of the street. Non-motorized vehicle parking should be properly regulated, and the distance between the blind road and the non-motorized vehicle parking should be carefully considered during the renovation design to avoid being occupied. Where accessibility facilities are lacking, such as at the entrance to TeeMall, accessible ramps should be installed. Visual impairment guidance facilities should be reasonably installed on Tianhe Nanyi Road.

8． Regarding bicycle-related issues, first, the width of the bicycle lanes can be widened by

compressing the width of the car lanes and releasing street space. Secondly, special materials can be used to distinguish the bicycle lanes from the motor vehicle lanes, and eye-catching bicycle signs can be installed. Finally, to address bicycle parking issues, bicycle parking facilities should be properly designed based on the needs of the population and the service radius of bicycle parking points. The management of bicycle parking should be strengthened to create a good cycling environment.

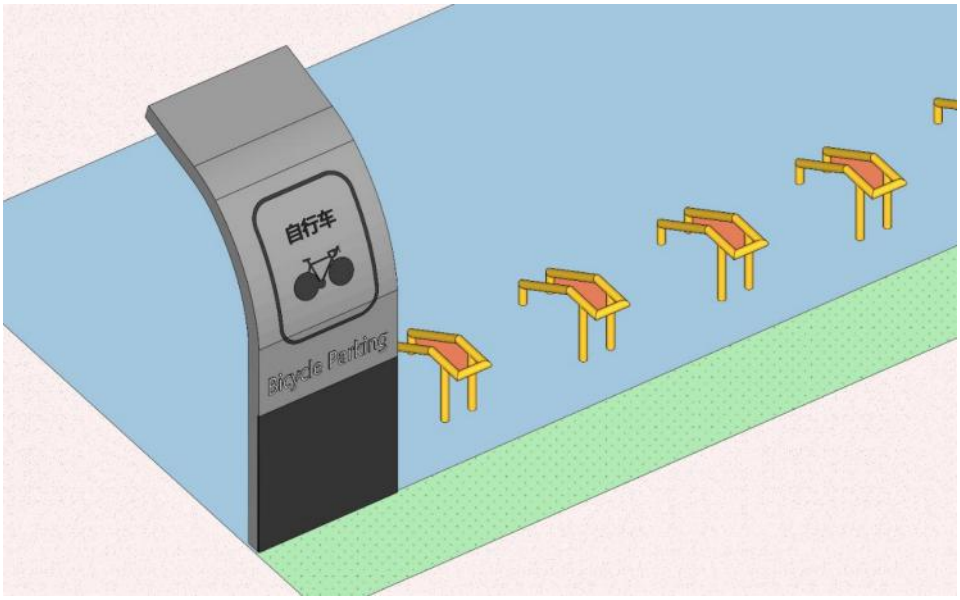


Fig. 6-11 Signage for bicycle parking areas（Source: Completed by author）

The transformed street space of Tianhe Nanyi road in the context of complete streets. Divide Tianhe Nanyi road into three sections, namely the TeeMall section, the Parc Central section and the Zhengjia Plaza section for renovation design.

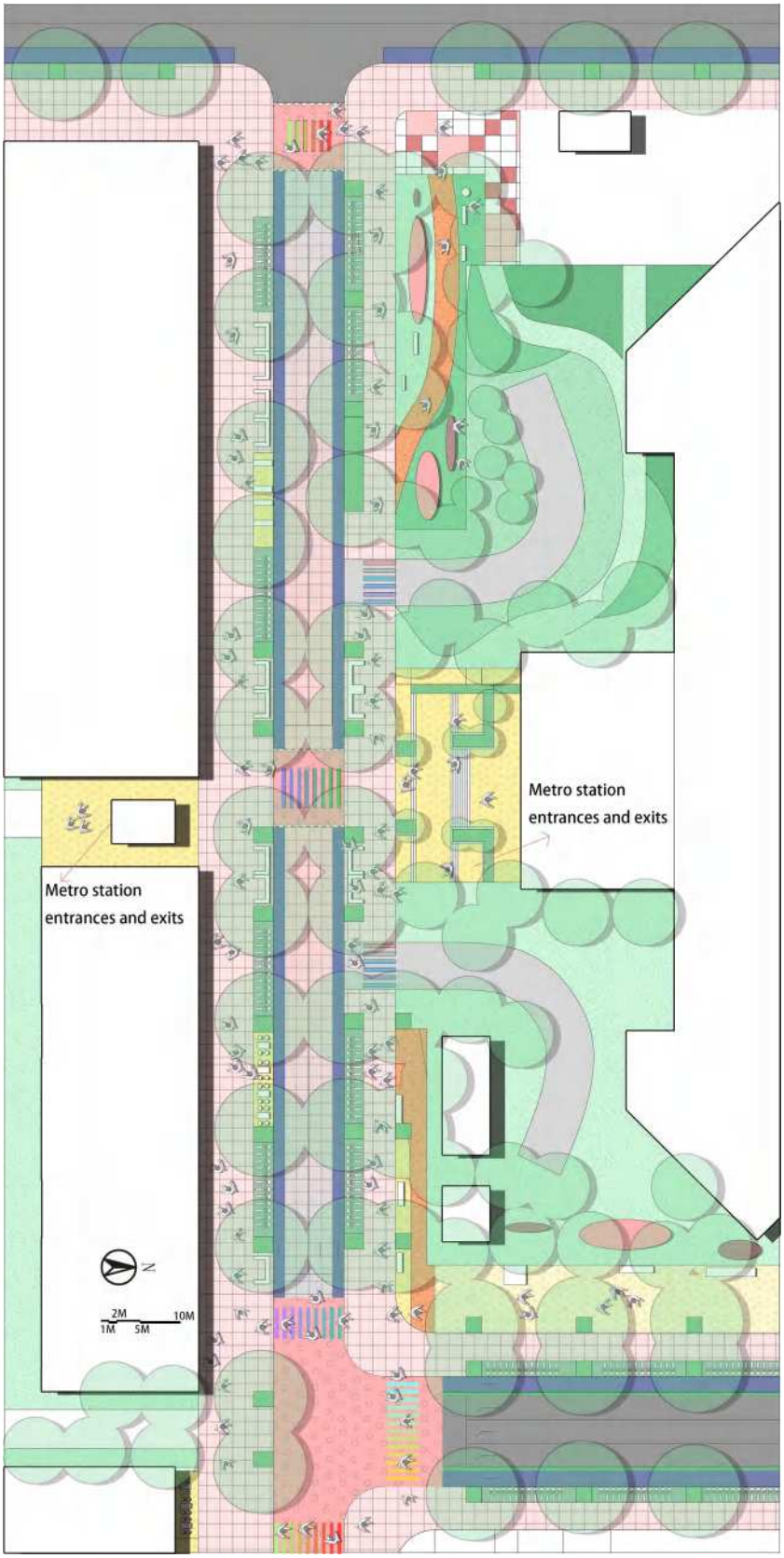
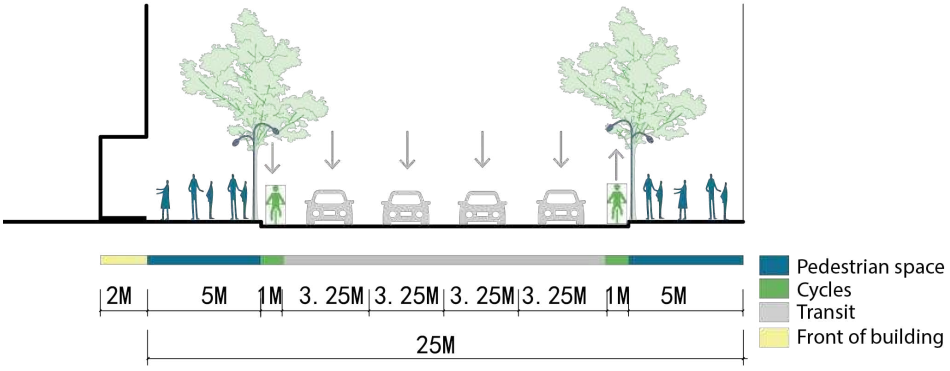


Fig. 6-12 Tianhe Nanyi Road optimization plan(TeeMall part)（Source: Completed by author）

Fig. 6-13 Perspective view of Tianhe Nanyi Road.(TeeMall part)(Completed by author)



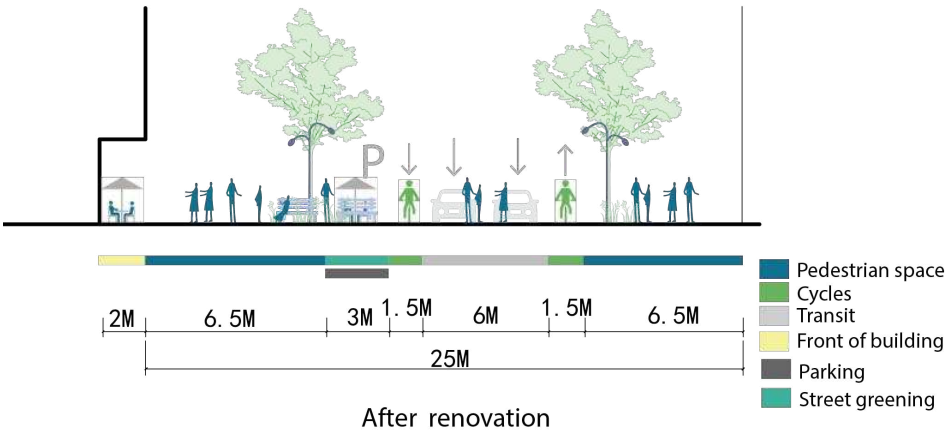


Fig. 6-14 Section of Tianhe Nanyi Road before and after renovation(TeeMall part)（Source: Completed by author）

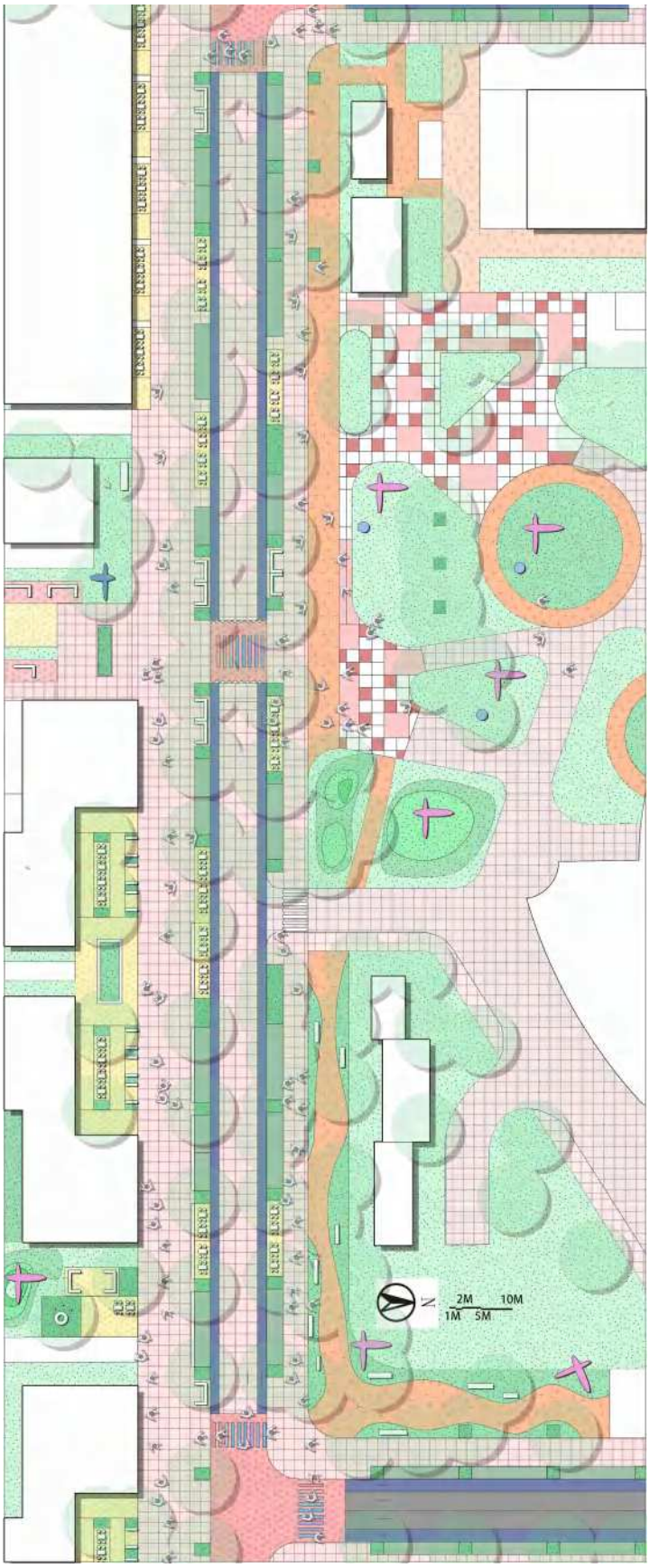


Fig. 6-15 Tianhe Nanyi Road optimization plan(Parc Central part)(Source: Completed by author)

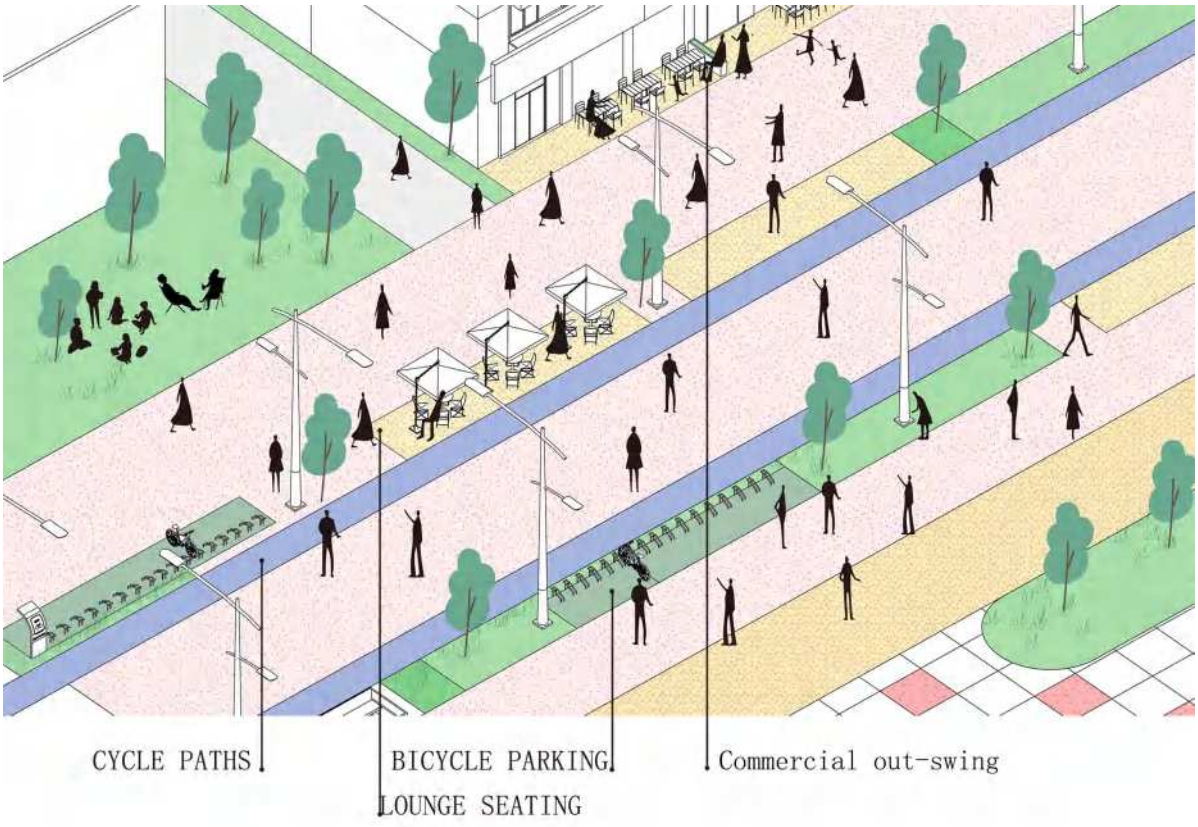


Fig. 6-16 Axonometric view of Tianhe Nanyi Road.(Parc Central part) (Source: Completed by author)

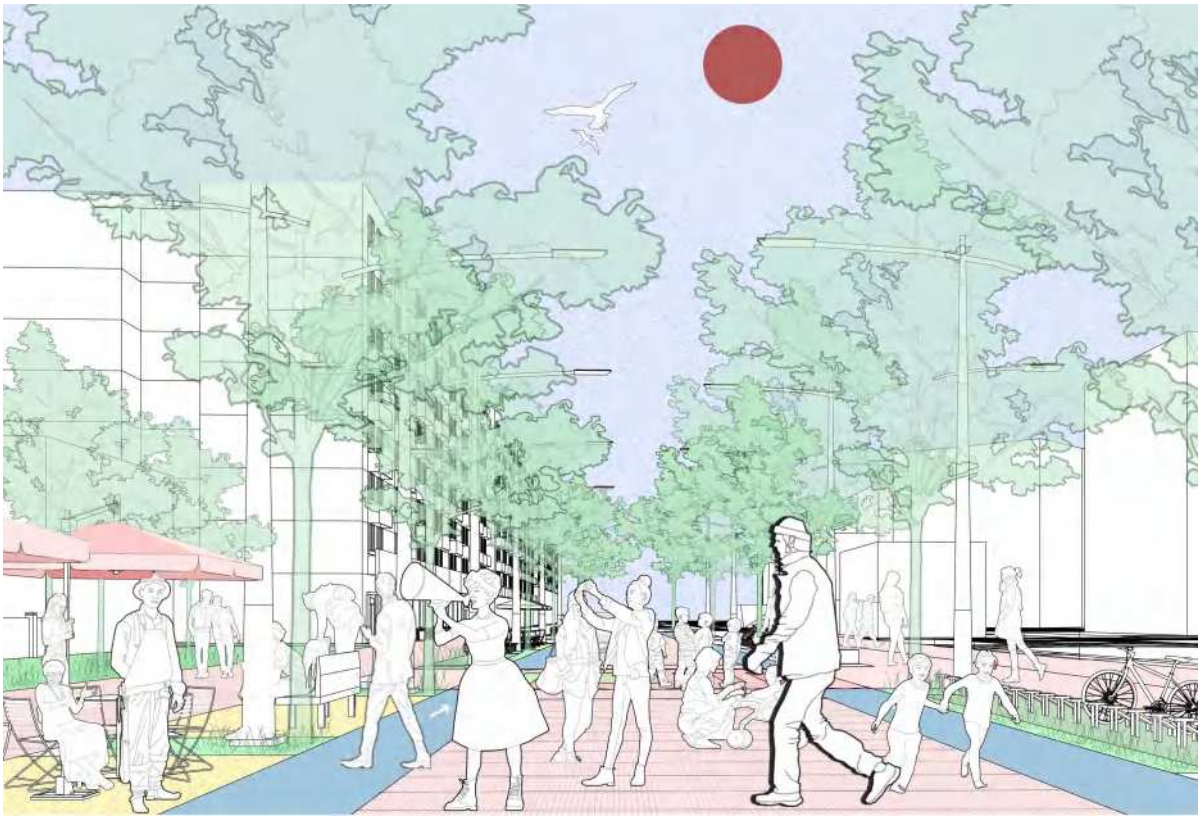


Fig. 6-17 Perspective view of Tianhe Nanyi Road(Parc Central part).(Completed by author)

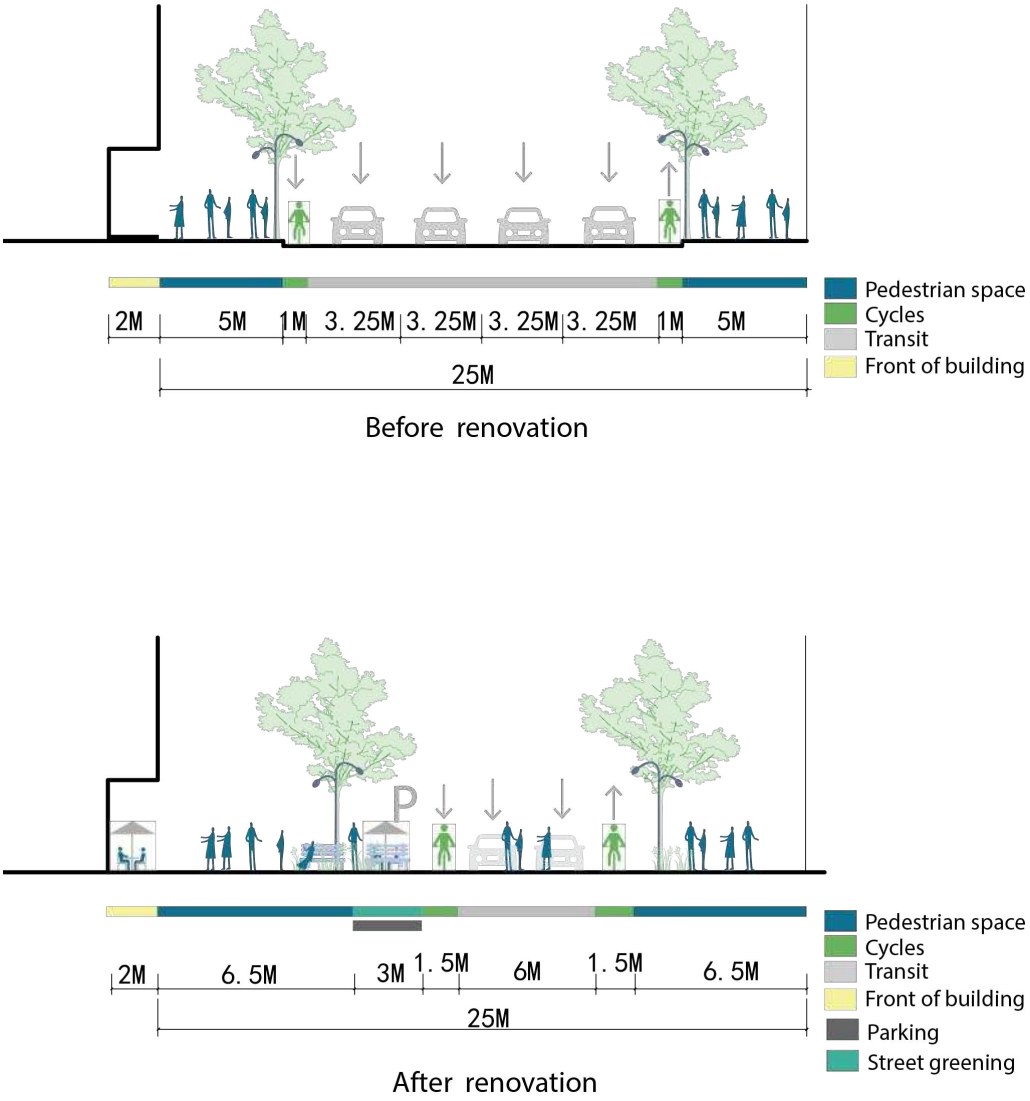


Fig. 6-18 Section of Tianhe Nanyi Road before and after renovation(Parc Central part)（Source: Completed by author）

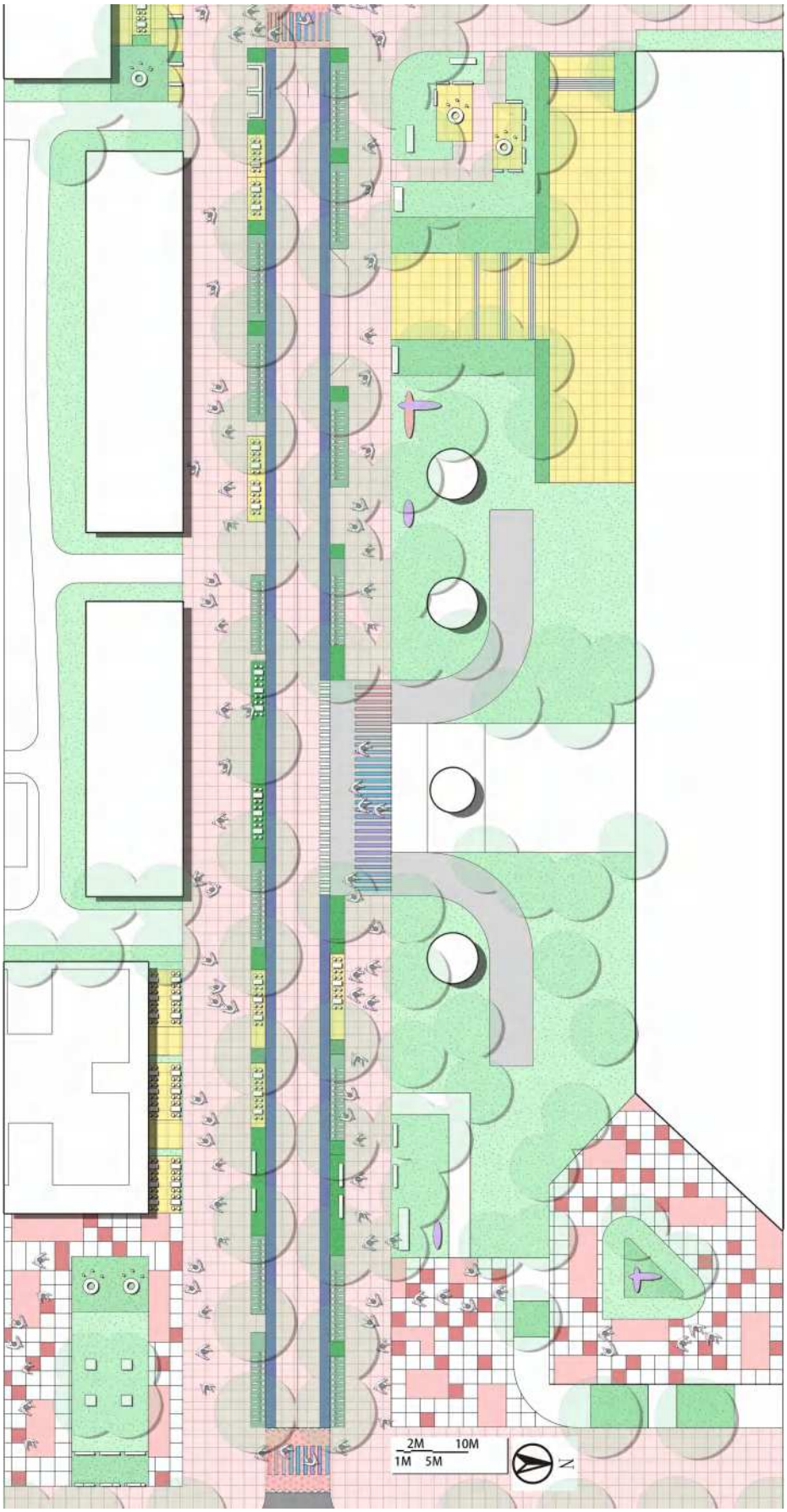


Fig. 6-19 Tianhe Nanyi Road optimization plan(Zhengjia Plaza part)（Source: Completed by author）

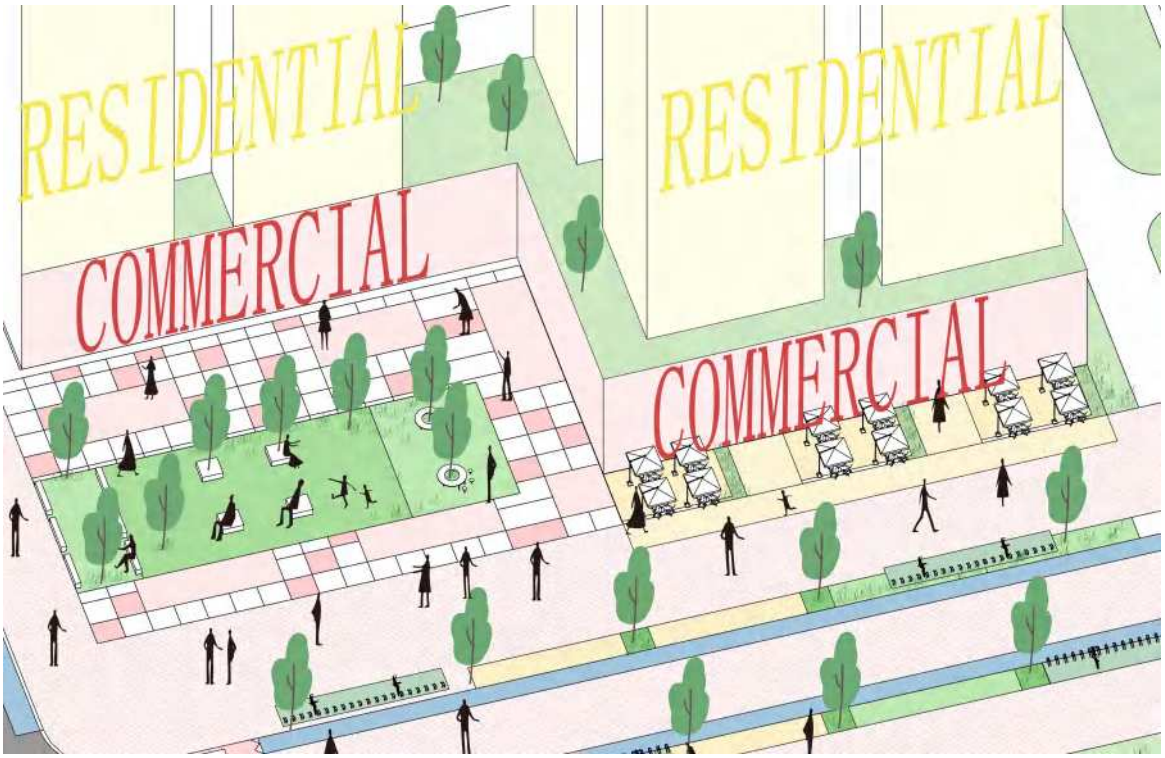


Fig. 6-20 Axonometric view of Tianhe Nanyi Road.(Zhengjia Plaza part)(Source: Completed by author)

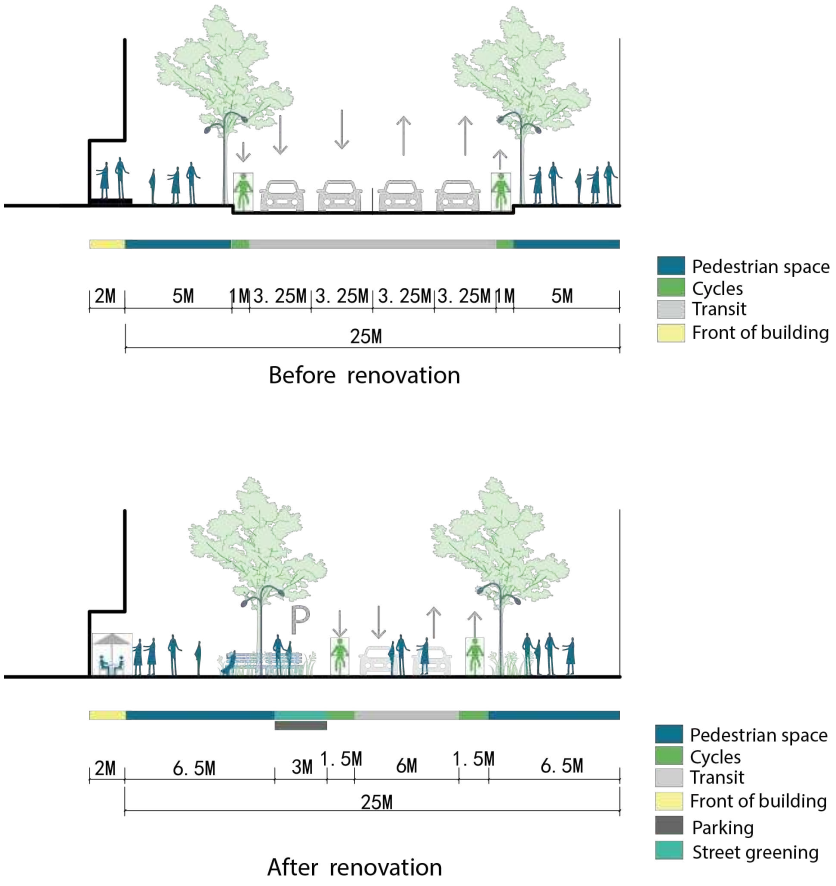


Fig. 6-21 Section of Tianhe Nanyi Road before and after renovation(Zhengjia Plaza part) (Source: Completed by author)

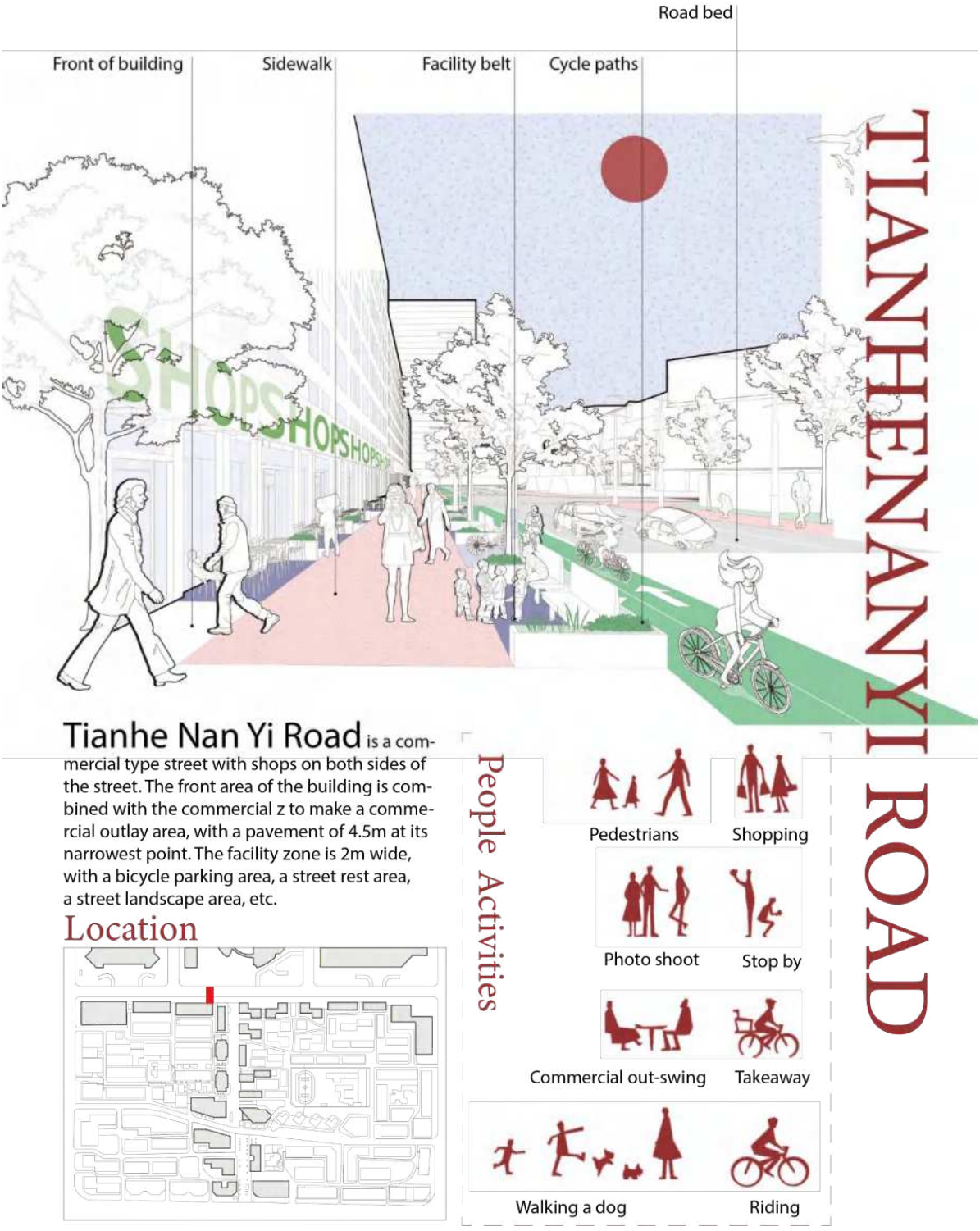


Fig. 6-22 Perspective view of Tianhe Nanyi Road (Source: Completed by author)

6.2.2 Urban Public Commercial Pedestrian Street Renovation and Enhancement -Tianhe Nan Pedestrian Stree

The goal of the street transformation of Tianhe Nan Pedestrian Street is to become a public commercial pedestrian street in an urban city. The street originally served as a road within a

residential neighbourhood and was private in nature. However, as the city has grown, it has evolved into a commercial street open to the public. However, the original road form could not meet the demands of the new positioning of Tiannan Pedestrian Street, and given its special geographical location on the new central axis of Guangzhou, the transformation into a public urban commercial pedestrian street was explored in the context of a complete street.

Fig. 6-23 Before and after street renovation of Tianhe Nan Pedestrian Street(Source: Completed by author)

Challenges and current situation：

Tianhe Nan Pedestrian Street was originally intended as an internal community road in the enclosed Six Luck district, but with the development of urban construction and the spillover of surrounding businesses, it has gradually evolved into an open commercial street in an open community. The original road form could not meet the demand for the new positioning of Tianhe Nan Pedestrian Street, combined with its special geographical location - on the new central axis of Guangzhou. In the context of the Complete Streets concept, Tianhe Nan Pedestrian Street has been transformed into an urban public commercial pedestrian street by enhancing the quality of its street space and refining the design of its street facilities.The existing slow-moving spatial problems of Tianhe Nan Pedestrian Street are as follows:

1． There is a height difference between the street and the shops, which is fractured and affects accessibility.

2．The pedestrian space on Tianhe Nan Pedestrian Street is too wide and not well designed, resulting in poor utilisation and comfort of the pedestrian area.

3． The southern section of Tianhe Nan Pedestrian Street has mixed pedestrian and non-pedestrian traffic, which affects pedestrian safety and greatly reduces the cycling experience.

4．Insufficient space and lack of guidance for bicycle parking, resulting in haphazard parking and obstructing the normal passage of pedestrians.

Optimization strategies:

There are a total of 6 points to address the above problems on the Tianhe Nan Pedestrian Street.

1．Balance the height difference between the shops and the street on Tianhe Nan Pedestrian Street. Improve the accessibility of Tianhe Nan Pedestrian Street.

2．Extend the commercial space; the existing street space on Tianhe Nan Pedestrian Street is too wide and undesigned, resulting in poor use of street space and greatly affecting the experience of street amenity. By extending the commercial space and incorporating shade and amenity facilities, the vitality of the street can be enhanced.

3． Provide additional leisure facilities. From the site analysis chapter, it is clear that pedestrians require a large amount of resting design on Tianhe Nan Pedestrian Street. By providing additional resting facilities combined with shade and streetscape greenery, pedestrians will be able to stay on the street for longer periods of time.

4． The streetscape of Tianhe Nan Pedestrian Street is a combination of commercial outbuildings and amenities to create a pleasant street space experience for pedestrians.

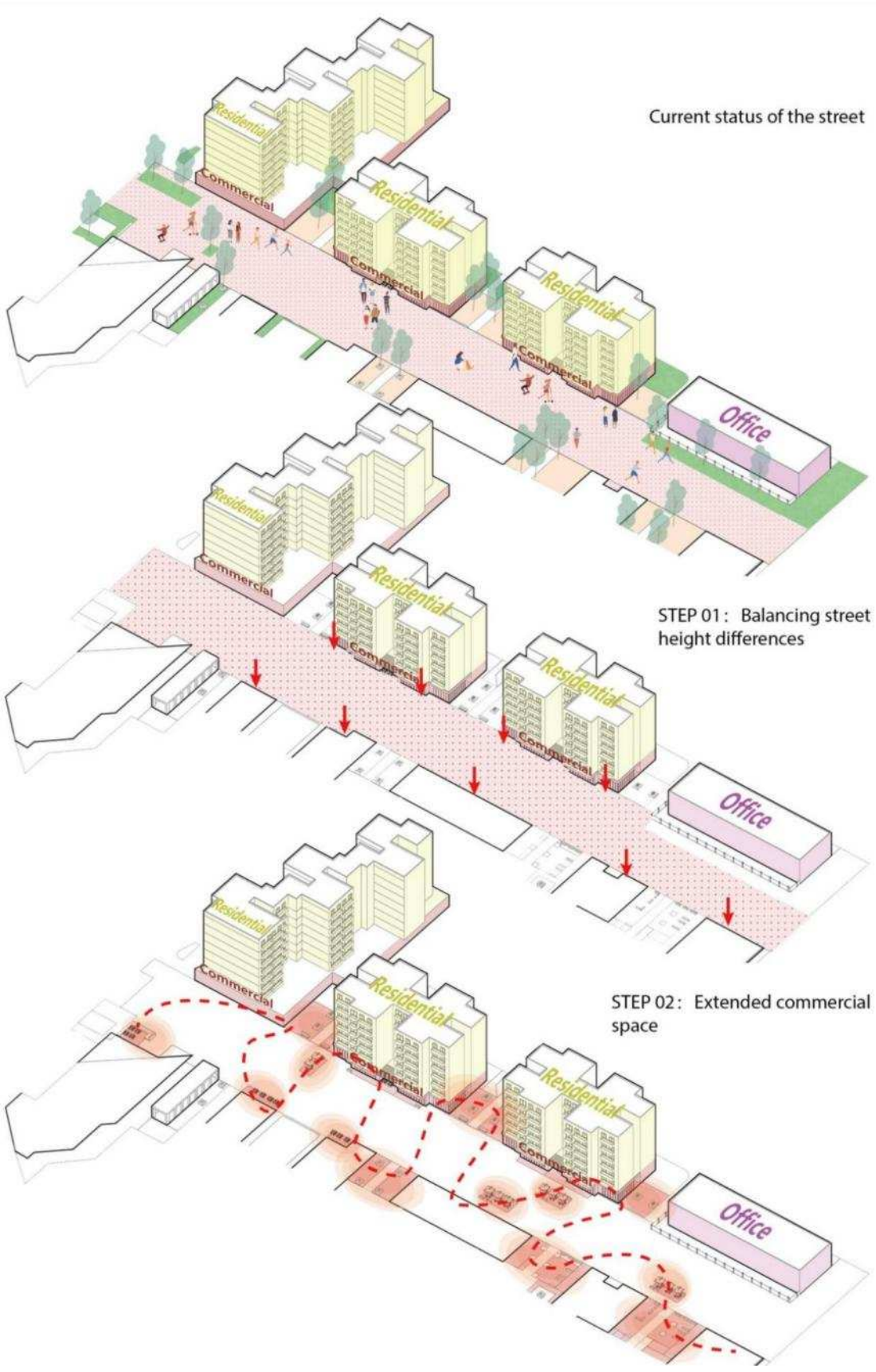


Fig. 6-24 Strategies for the transformation of the streets along the south side of the Tianhe Nan Pedestrian Street.（Source: Completed by author）

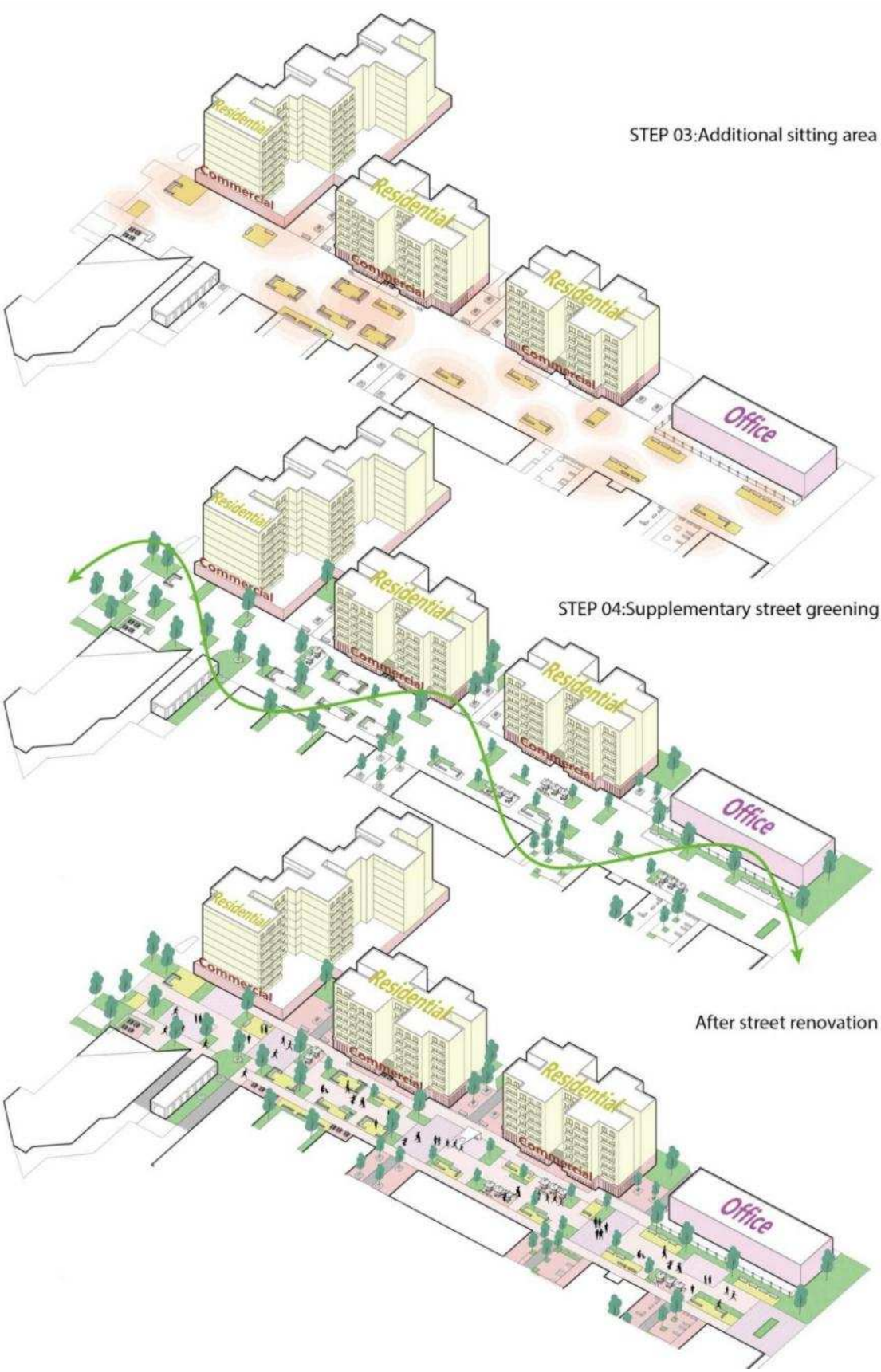


Fig. 6-25 Strategies for the transformation of the streets along the south side of the Tianhe Nan Pedestrian Street.（Source: Completed by author）

5． To address the problem of mixed pedestrian and non-pedestrian traffic on the southern section of Tianhe Nan Pedestrian Street, improve the walking and cycling experience by providing a purely pedestrian area and a shared area for cycling and walking.

6． To address the lack of space and guidance for bicycle parking on Tianhe Nan Pedestrian Street. The solution is to provide bicycle parking in accordance with the needs of the population and the service radius of the bicycle parking points. The installation of prominent signs and markings will increase identification. The solution is to provide bicycle parking in accordance with the needs of the population and the radius of service.

The street space of Tianhe Nan Pedestrian street is transformed in the context of a complete street. The Tianhe Nan Pedestrian street is divided into two sections, the northern and southern sections, to be transformed and designed

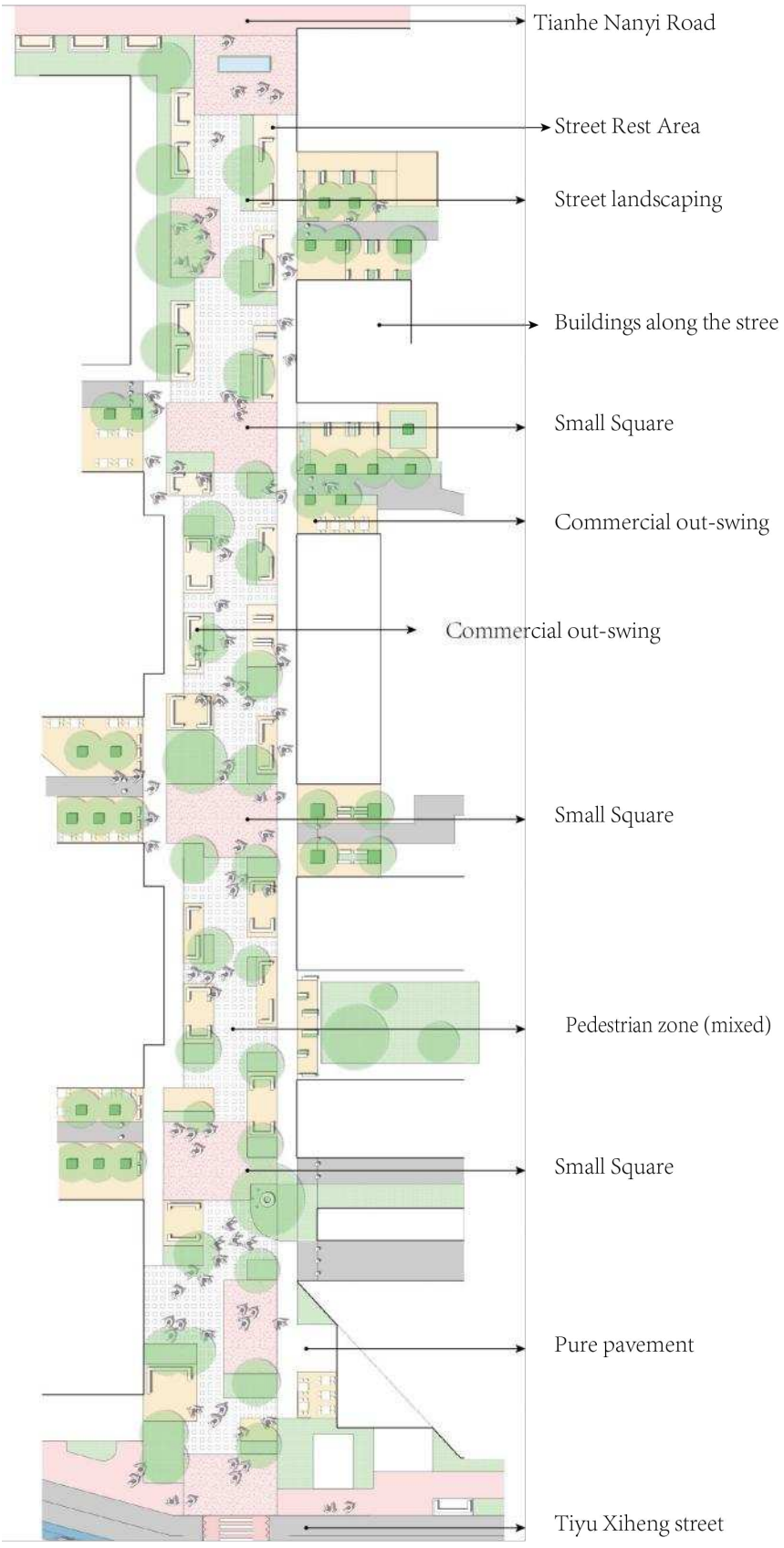
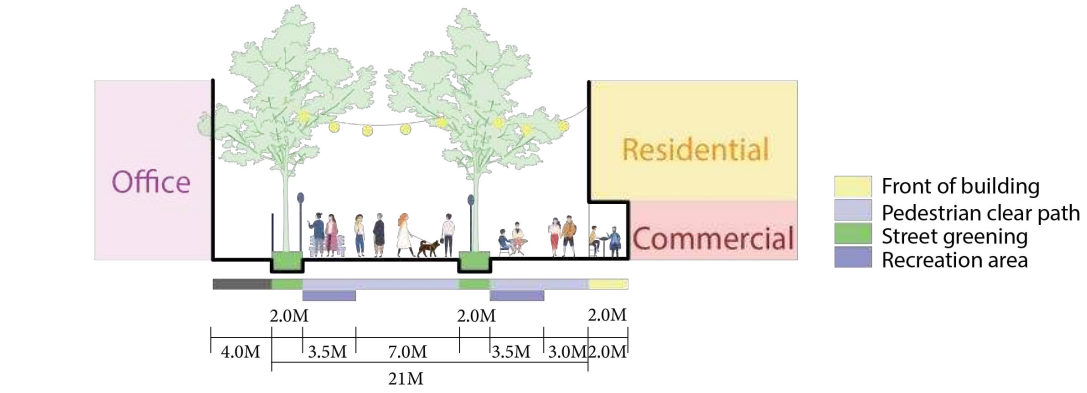


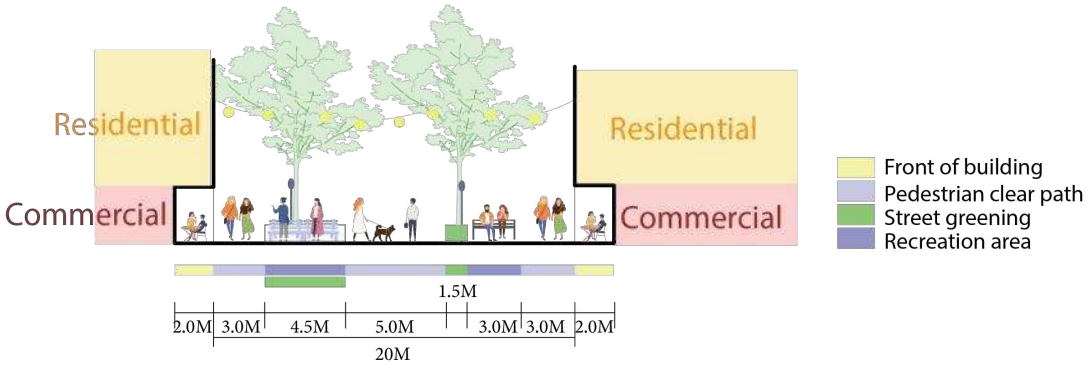
Fig. 6-26 Renovated plan and section of Tianhe Nan Pedestrian street(northern section)(Source: Completed by author)

Fig. 6-27 Perspective view of Tianhe Nan Pedestrian Street(northern section).(Completed by author)

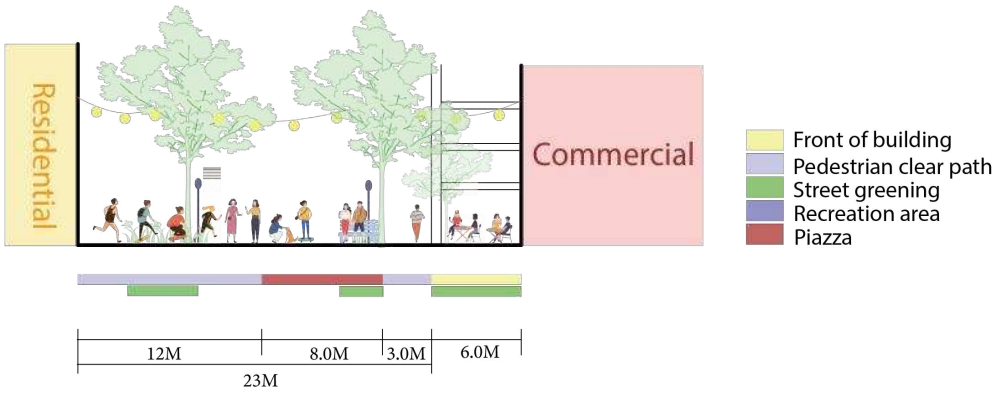
Fig. 6-28 Perspective view of Tianhe Nan Pedestrian Street(northern section).(Completed by author)



A-A Section plan



B-B Section plan



C-C Section plan

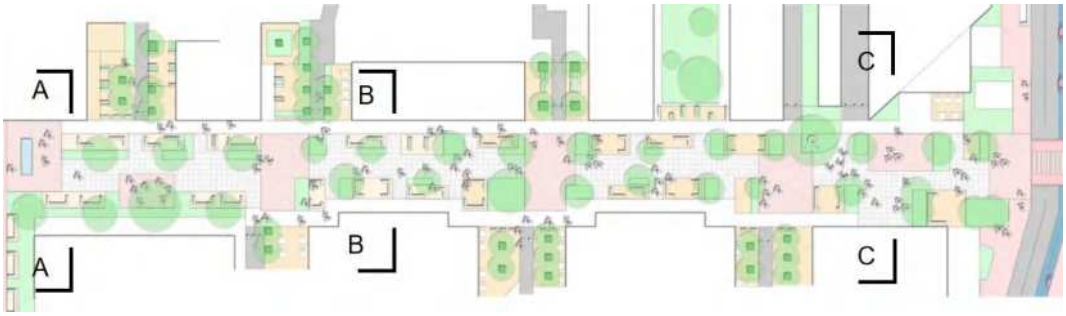


Fig. 6-29 Street profile of the renovated pedestrian street south of the Tianhe Nan Pedestrian Street(northern section).(Completed by author)

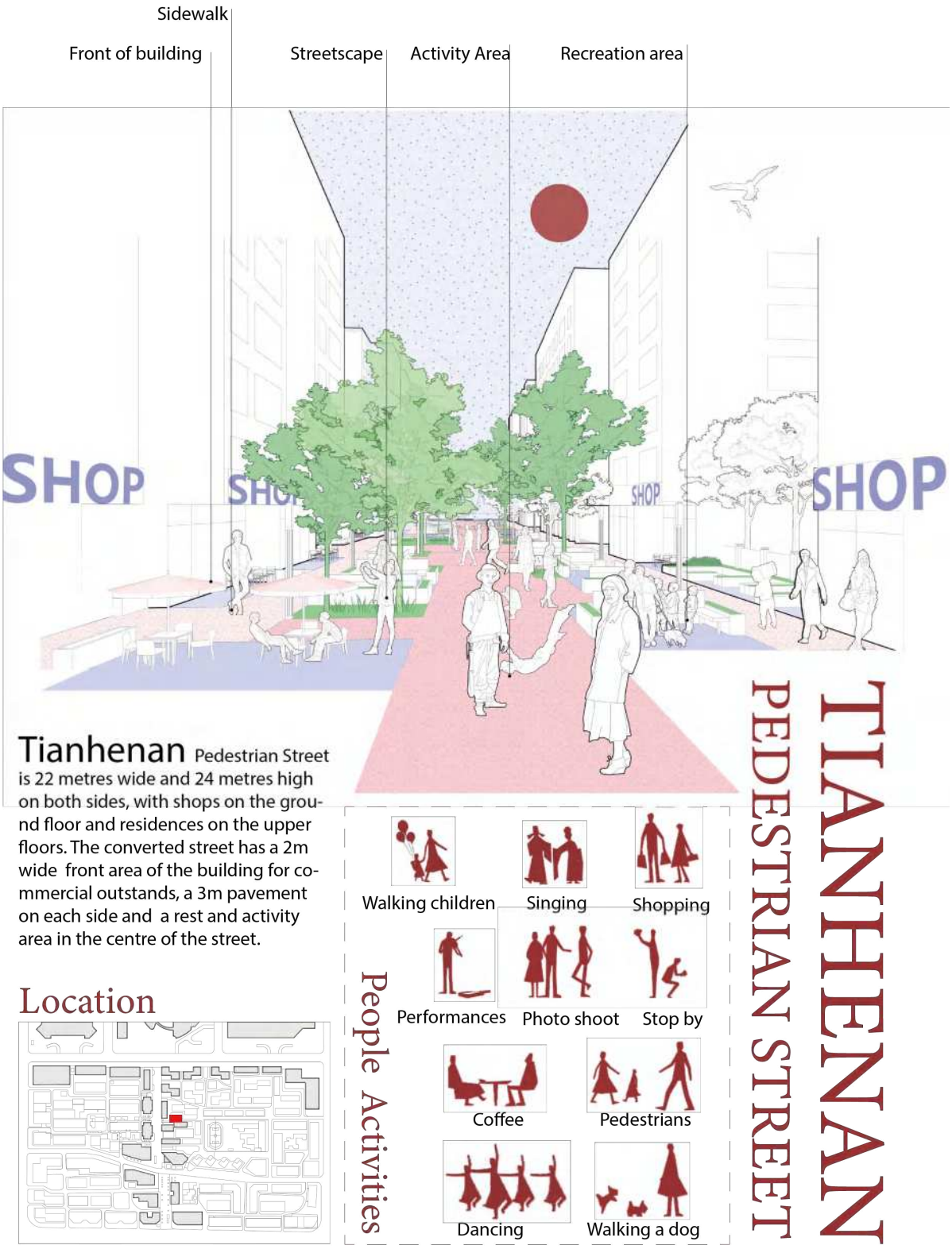


Fig. 6-30 Pedestrian view, crowd activity and location on the south side of the Tianhe Nan Pedestrian Street(northern section).(Completed by author)

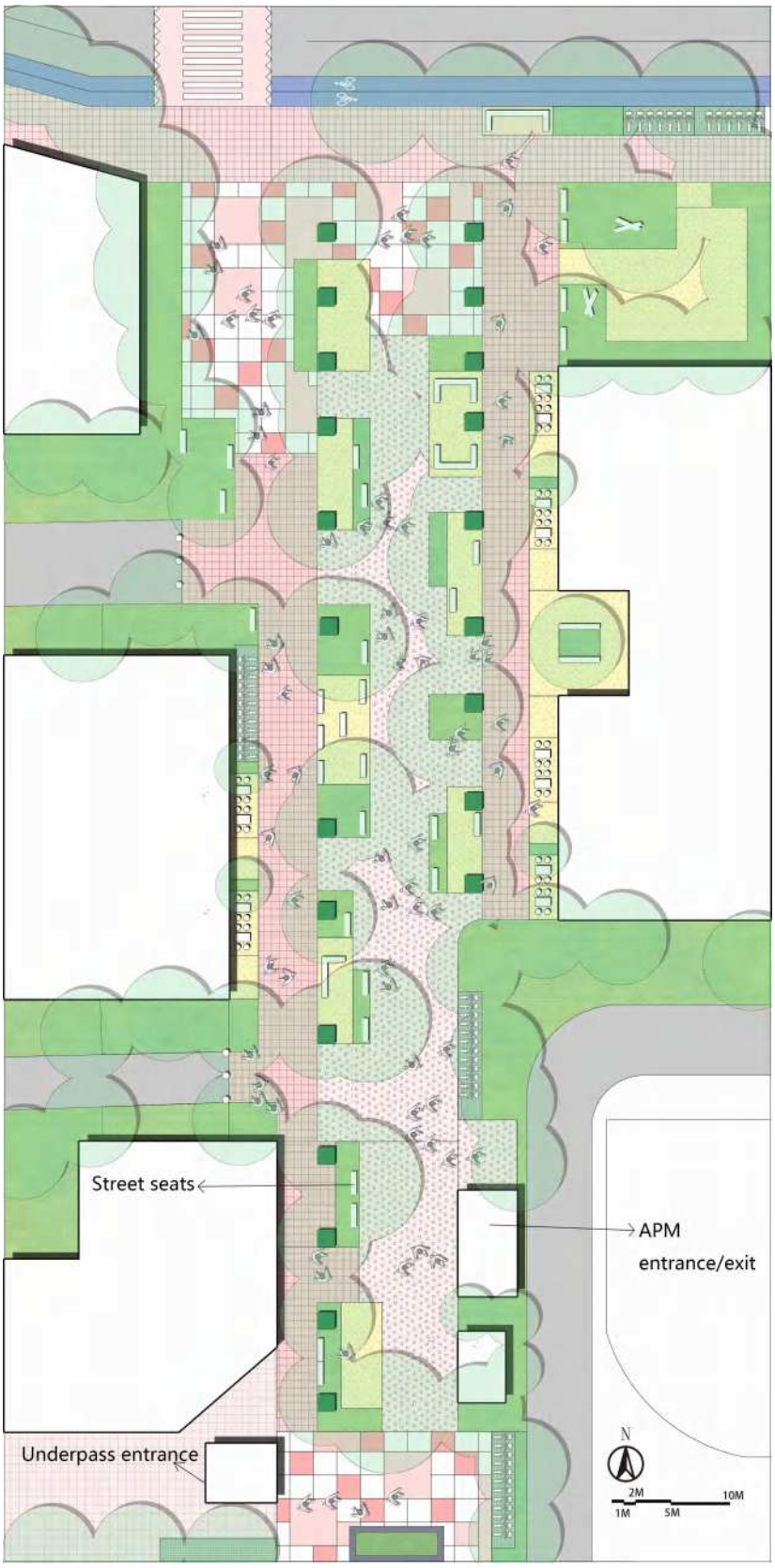


Fig. 6-31 Renovated plan and section of Tianhe Nan Pedestrian street(south section)(Completed by author)

Fig. 6-32 Perspective view of Tianhe Nan Pedestrian Street.(south section)(Completed by author)

Fig. 6-33 Perspective view of Tianhe Nan Pedestrian Street(south section).(Completed by author)

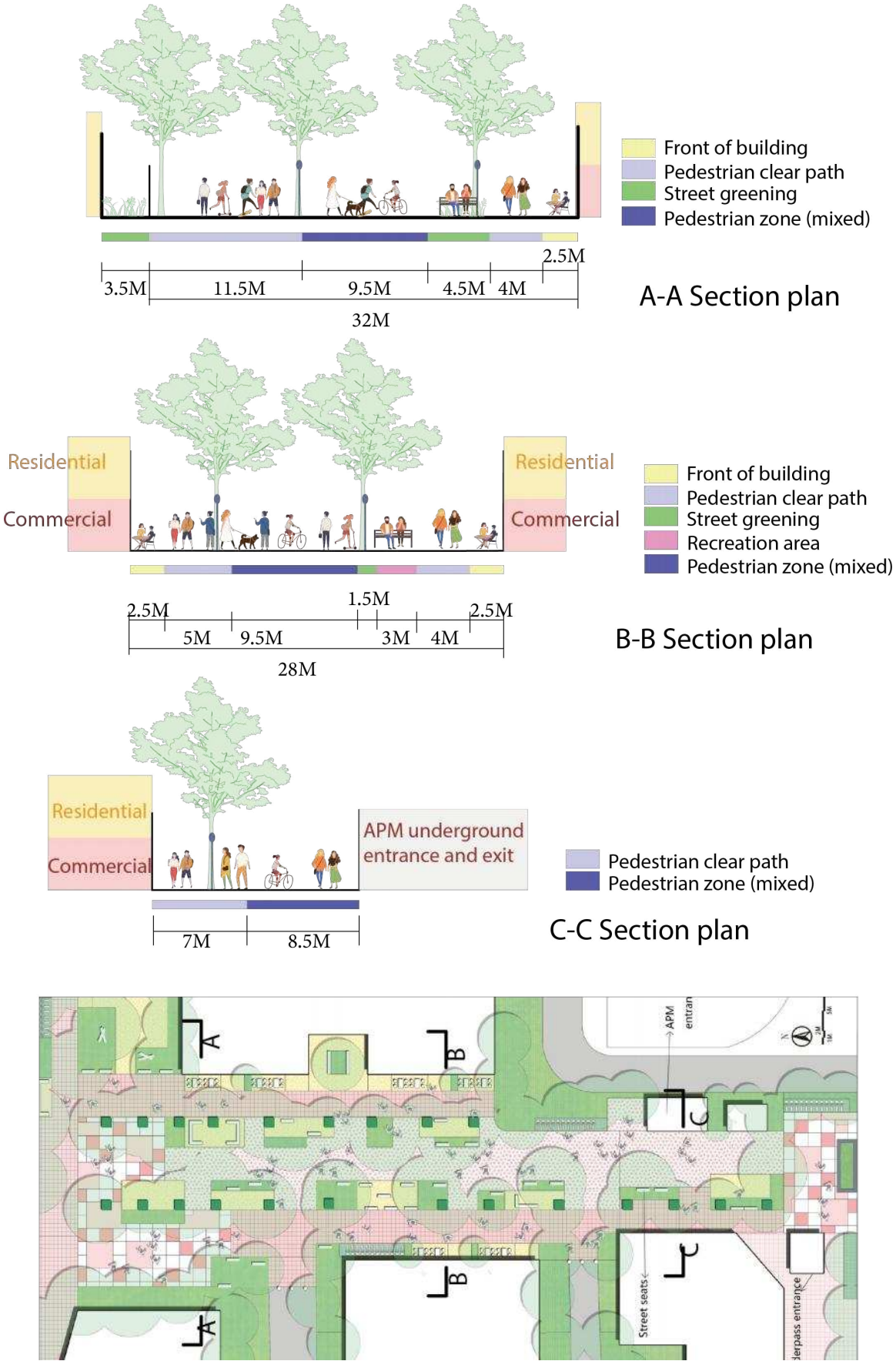


Fig. 6-34 Street profile of the renovated pedestrian street south of the Tianhe Nan Pedestrian Street(south section).(Completed by author)

6.3 Optimisation of street car space in the context of complete streets

6.3.1 Street safety and comfort enhancement - street section optimisation

Challenges and current situation

Tianhe Nanyi Road has a red line of 25 metres, with a four-lane road of 15 metres and a 5-metre wide pavement on both sides. The main problem with the existing lane space on Tianhe Nanyi Road is that the width of the lane is large, which compresses the space for slow traffic and the quality of the lane space is not high.

Optimization strategies

1．Compressing the width of lanes and the number of carriageways on the basis of meeting traffic demand. The four lanes of Tianhe Nanyi Road have been reduced to two lanes and the width of each road has been reduced from 3.25 metres to 3 metres. Freeing up street space for additional walking and cycling space, making it a safer and more comfortable. environment for walking and cycling.

2．The widening of the pavement on Tianhe Nanyi Road makes it more comfortable. to walk on the one hand, and on the other hand it reduces the space for traffic, thus reducing the speed of motor vehicles and making the street safer. Where pedestrians cross the street, the widening of the pavement reduces the crossing distance and increases the safety and comfort of pedestrians.

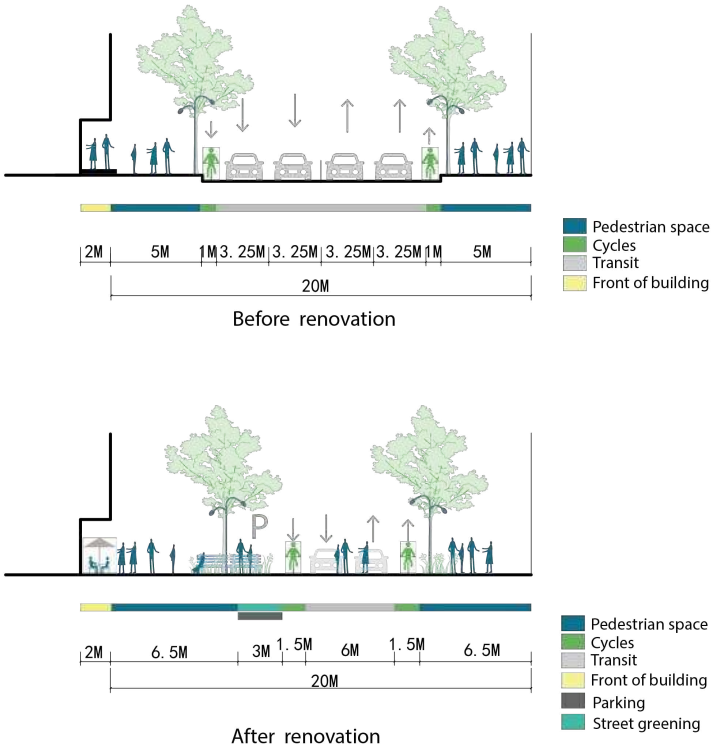


Fig. 6-35 Compressed lane width on Tianhe Nanyi Road to release street space (Source: Completed by author)

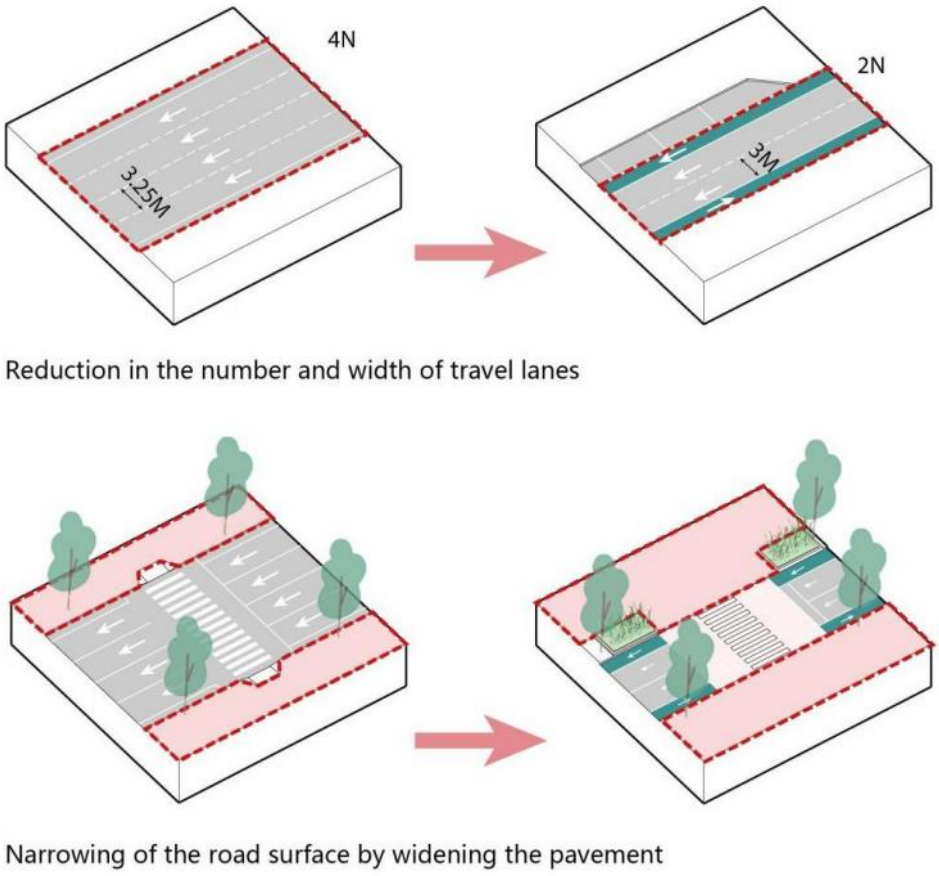


Fig. 6-36 Carriageway Optimisation Strategy (Source: Completed by author)

6.3.2 Street safety enhancement - design of on-street parking facilities

Challenges and current situation

Tianhe Nanyi road is dominated by surface parking and underground parking. On-street parking is mainly concentrated on Tianhe Nanyi Road, near the Liuyun Community, and is mostly illegal parking. Underground parking is mainly provided by the TeeMall, Parc Central, and Zhengjia Plaza shopping malls. This part of the parking facilities is provided by the malls and is not considered in this study, which focuses on on-street parking. Motor vehicles are prohibited from entering Tianhe Nan Pedestrian Street, and there are no parking facilities provided, so this study does not involve the design of on-street parking facilities for the pedestrian street. The existing problems with on-street parking facilities are as follows:

1．According to on-site investigations, there are 59 illegal parking spaces on Tianhe Nanyi Road. The current condition of the street does not match people's needs.

2．Illegal parking on Tianhe Nanyi Road occupies the non-motorized vehicle lanes, making cycling inconvenient.

Optimization strategies:

1． To meet the parking needs, the section of Tianhe Nanyi Road has been adjusted by compressing the width of the motor vehicle lane and releasing some street space for on-street parking. The on-street parking is then designed in a refined manner, combining with the sidewalk to meet the needs of people. There are four main approaches: ①road parking combined with leisure facilities, providing street seats for sitting;②road parking combined with bicycle parking;③road parking combined with commercial outstands, extending the scope of business and driving the vitality of the street;④road parking combined with street landscaping, forming a miniature park, providing shade for pedestrians on the street and serving to reduce energy consumption and absorb and purify rainwater.

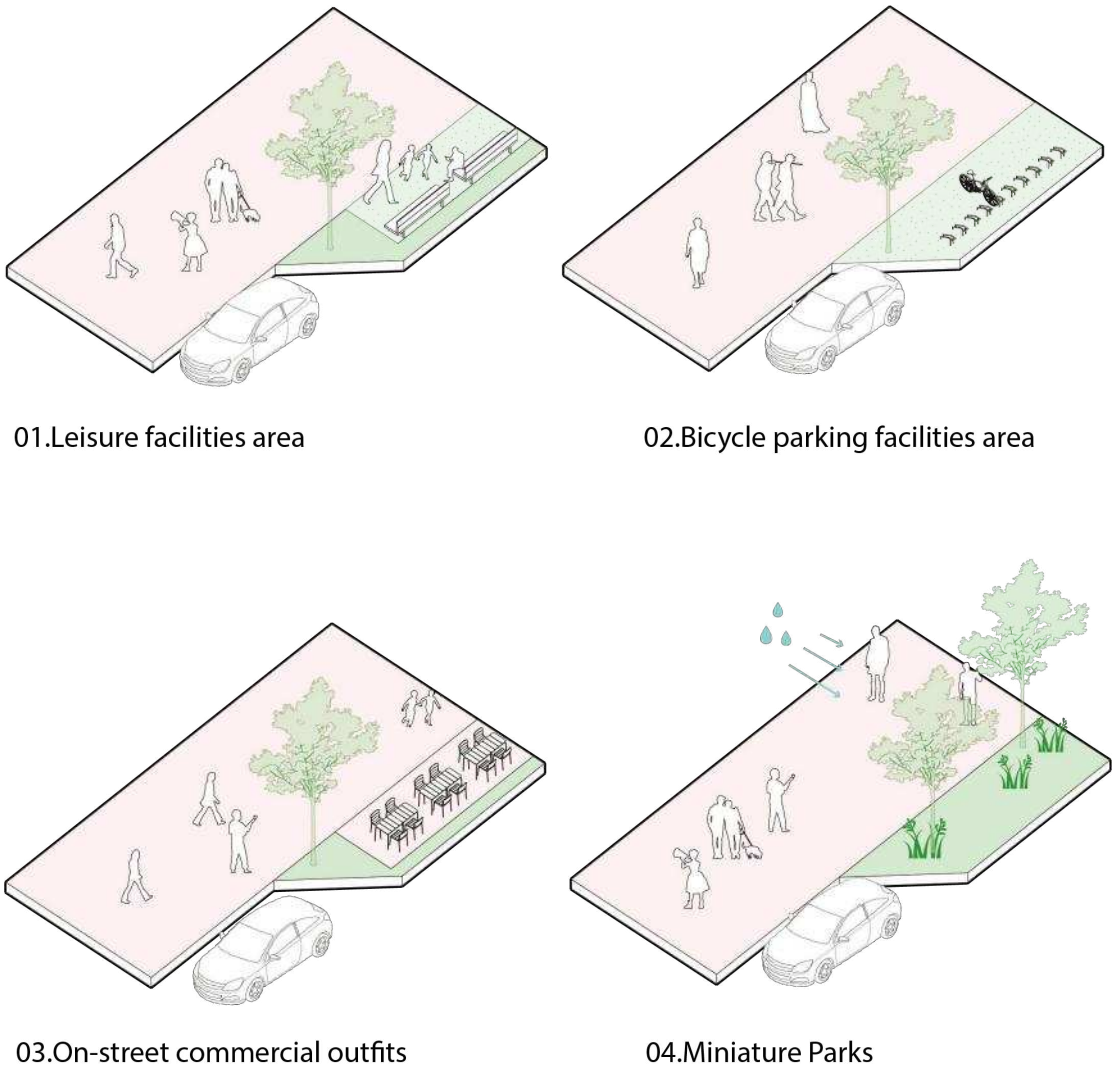


Fig. 6-37 Integrated design of motor vehicle parking spaces and pavement facility zones(Source: Completed by author)

2．Reasonable setting of bicycle lanes, so that bicycle lanes and vehicle lanes can each travel their own path. And strengthen the differentiation and separation between bicycle lanes and vehicle lanes.

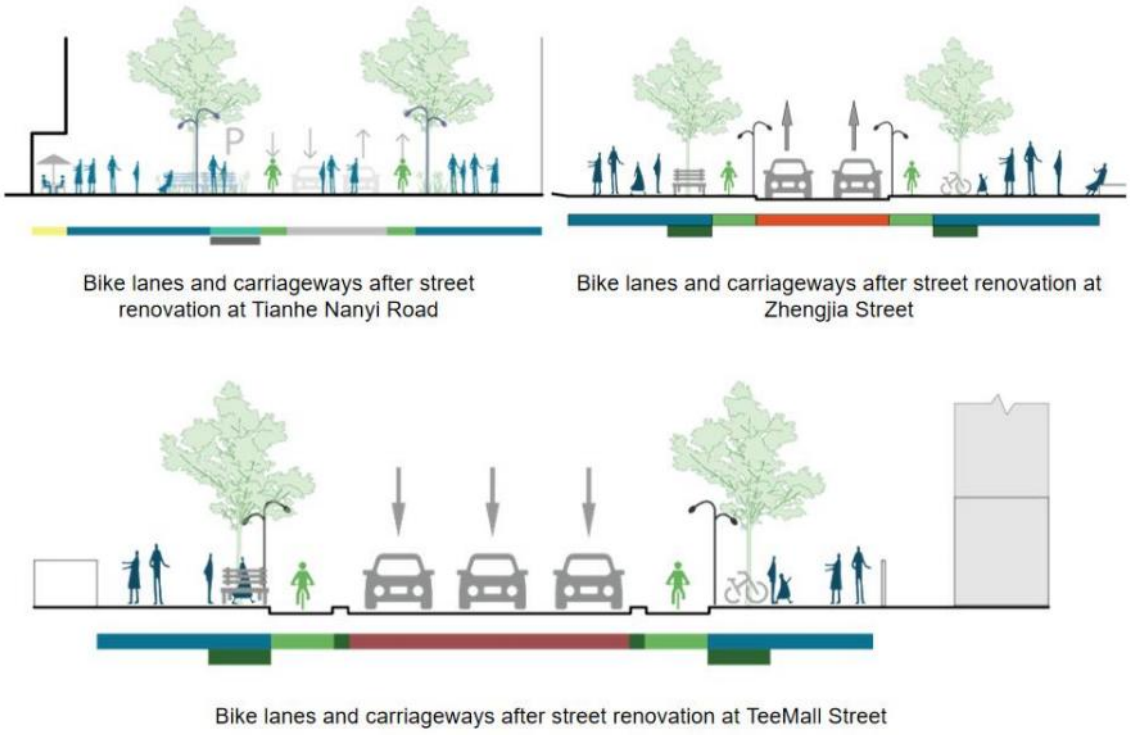


Fig. 6-38 Converted cycle lanes and carriageways (Source: Completed by author)

6.3.3 Street safety enhancement - safe crossing design

Challenges and current situation

One of the goals of a complete street is to create a safe street, and safe crossing design is an important aspect of a safe street. Transforming Tianhe Nanyi Road from a road attribute to a street attribute, turning it into a square and transforming Tianhe Nan Pedestrian Street into a public commercial pedestrian street are the goals of the renovation. The existing crossing problems on Tianhe Nanyi Road and Tianhe Nan Pedestrian Street are as follows:

1． The turning radius at the intersections on Tianhe Nanyi Road is too large, making it difficult for pedestrians to cross.

2． The pedestrian crossing on Tianhe Nanyi Road is mixed with traffic, and inconvenient facilities lead to conflicts between pedestrians and motor vehicles.

3． The conflict between pedestrians and vehicles is prominent at the crossings of Tianhe Nan Pedestrian Street and Tiyu West Road, and there is a lack of traffic guidance facilities.Efforts will be made to optimize the existing crossing design to improve pedestrian safety and convenience.

Optimization strategies:

1．By narrowing the width of the lanes, street space can be freed up for slow traffic, and by raising the intersection to the level of the sidewalk, pedestrians can cross without barriers. The turning radius of the curbs at the intersections of Tianhe Nanyi Road will be reduced, and the distance for pedestrians to cross will be shortened. The intersection will be specially paved to improve the comfort and safety of pedestrian crossings. The narrowing of the intersection will also shorten the distance for pedestrians to cross.

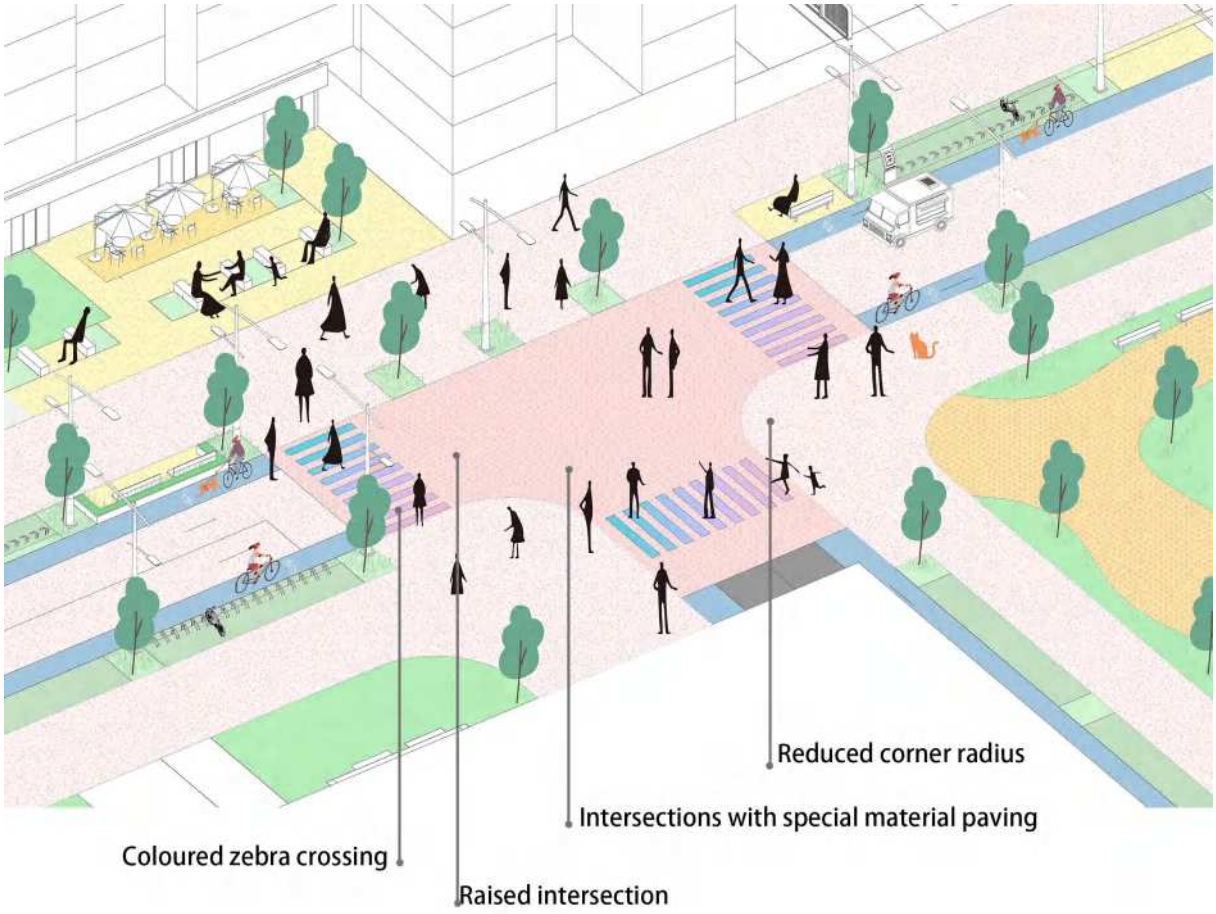


Fig. 6-39 Axonometric view of intersection the street. (Source: Completed by author)

Raised crossings. Raising the intersection to the same elevation as the pavement helps to improve the ease and comfort of pedestrian crossing. It also enables traffic speeds to be reduced and also allows for better visibility between drivers and pedestrians. Keeping pedestrian crossings and pedestrian circulation areas in the same straight line ensures a continuous flow of pedestrian space and avoids detours. The width of the pedestrian crossing should be greater than the pedestrian zone to which it is connected, providing space for people crossing on both sides of the road to meet.

Reducing the turning radius and reusing the space at the corners to safely accommodate large

numbers of pedestrians. Adjusting the turning radius of the intersection in the project to 5 metres increases the turning space. Reduced pedestrian crossing distances and improved crossing safety.

Narrowing of the junction. Increasing the kerb expansion strip and pedestrian space and shortening the pedestrian crossing distance will protect pedestrians waiting to cross the street. Ensure visibility at crossings and avoid parking at crossings. Use these extension spaces for landscaping and street furniture.

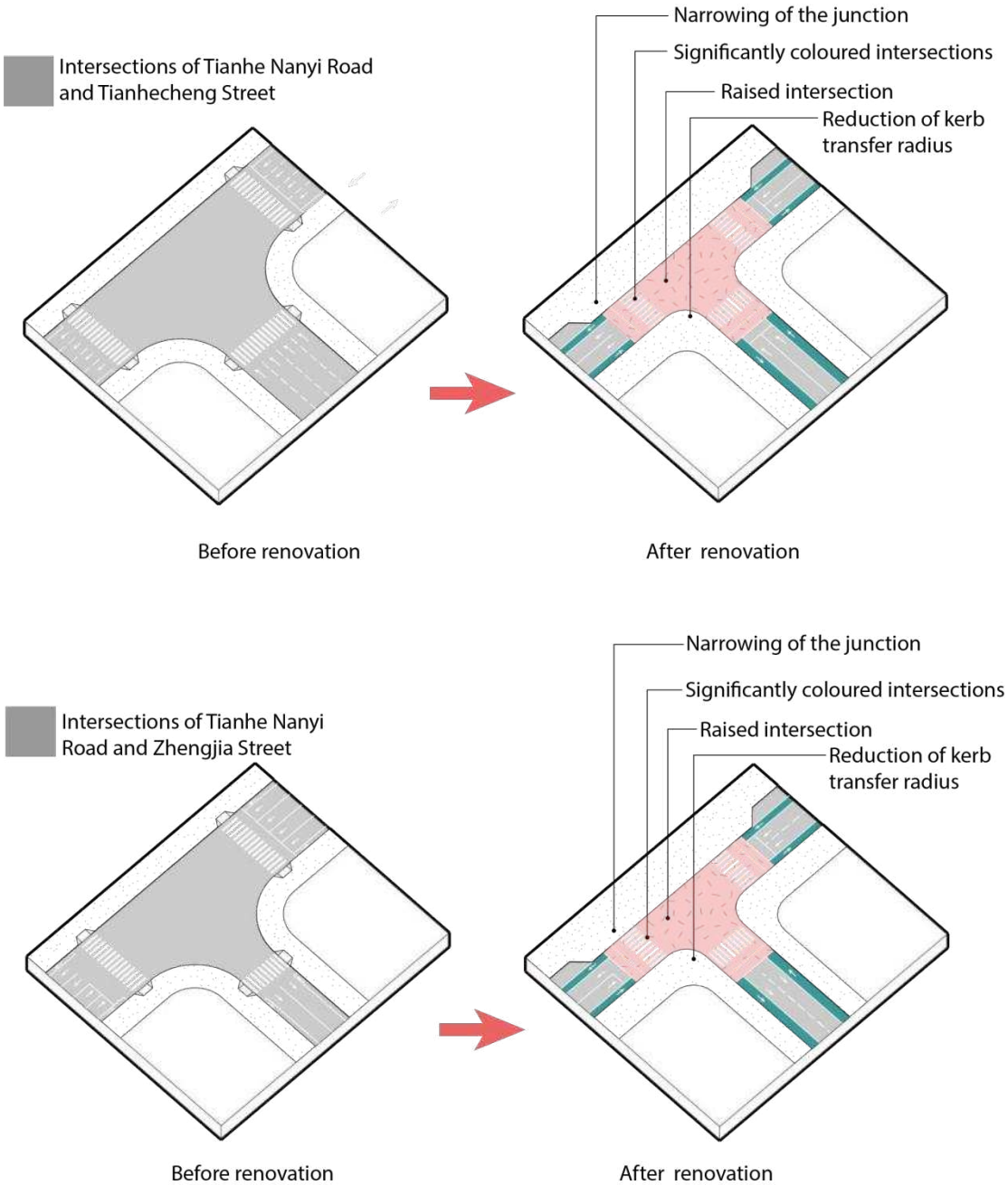


Fig. 6-40 Street intersection design(before and after) (Source: Completed by author)

2．Sorting out the bike lanes and motorways on the south side of the Tianhe Nanyi Road to bring order to street traffic.Reasonable compression of lane width and intersection narrowing design can shorten the distance for pedestrians to cross, and improve pedestrian safety. Pedestrian crossings will be raised to the level of the sidewalk and specially colored or paved to ensure barrier-free pedestrian crossings, as well as improve the comfort and safety of pedestrian crossings.

3．Reasonable regulation of the bike lane and motor vehicle lane on Tiyu Xiheng Street to promote orderly traffic flow. Pedestrian crossings will be raised and specially colored or paved to ensure barrier-free pedestrian crossings, and improve the comfort and safety of pedestrian crossings. The color or pavement will be extended from the north end to the south section of Tianhe Nan Pedestrian Street to maintain the unity and continuity of the street visually, thus improving pedestrian safety while crossing.

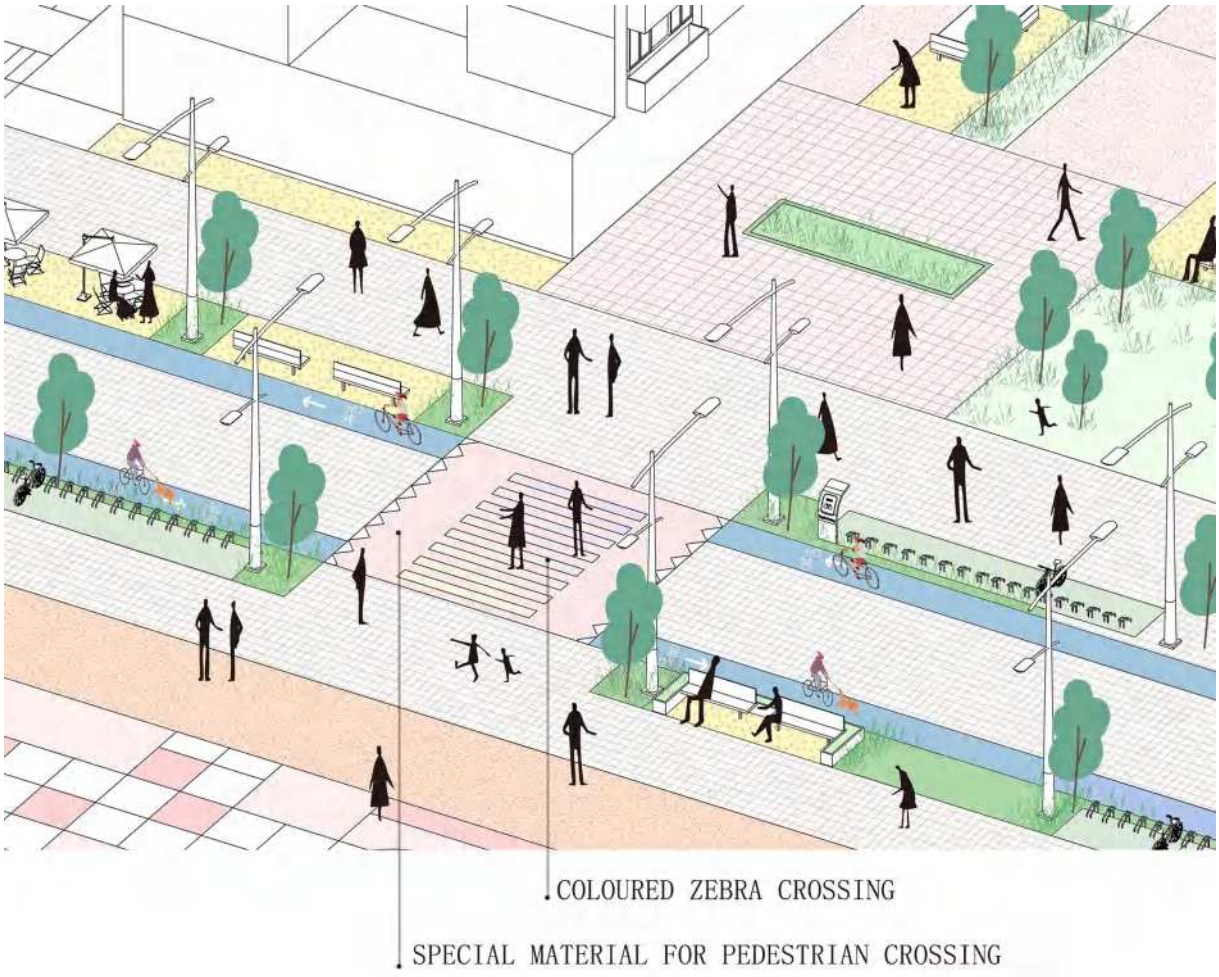


Fig. 6-41 Axonometric view of pedestrians crossing the street. (Source: Completed by author)

Pedestrian crossings are kept in a straight line with the pedestrian zone to ensure a continuous flow of pedestrian space and to avoid detours. Pedestrian crossings should be wider than the pedestrian zone to which they are connected, providing space for people to cross on both sides of the road. In addition, the following three points should be noted in the design of pedestrian crossing transformations:

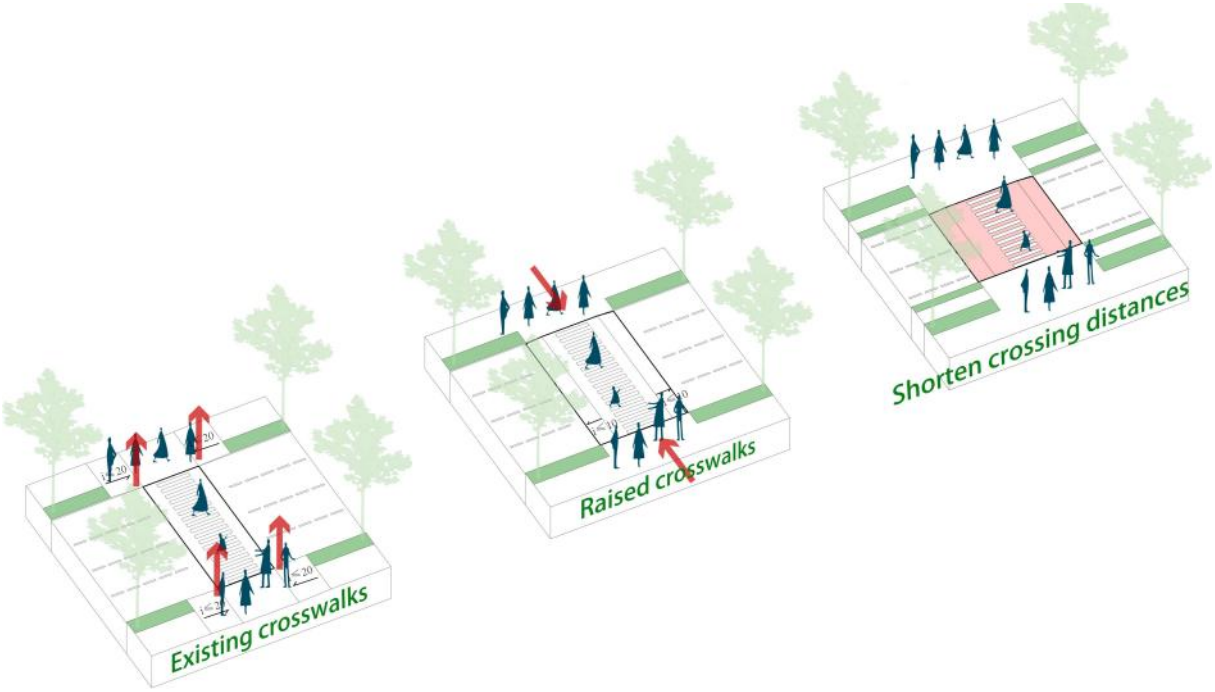


Fig. 6-42 Pedestrian crossing (Source: Completed by author)

1. Spacing. Reasonably control the spacing of crossing facilities to enable pedestrians to cross the street in close proximity. In an urban environment, horizontal pedestrian crossings should be provided at 80-100 metre intervals, while avoiding crossings that are more than 200 metres long at intervals that could cause safety problems.

2. Signing. Pedestrian crossings must be marked, either by paving or by materials for decoration. Eye-catching reminders and zebra crossings are preferable to parallel or dashed pavement markings as they are more visible to oncoming traffic, making it easier for drivers to slow down, increasing the safety index of the road and providing a safe environment for pedestrians crossing the street.

3. Visibility and lighting. Provide adequate waiting space for pedestrians by adding curb extensions and safety islands, allowing them to clearly observe oncoming traffic and widening the cause for drivers. Limit parking or install curb extension strips so that pedestrians and motorists can see each other clearly, and all pedestrian crossings should provide adequate

lighting. Pedestrian crossings should be at least as wide as the pavement to which they are attached and not less than 3 m wide.

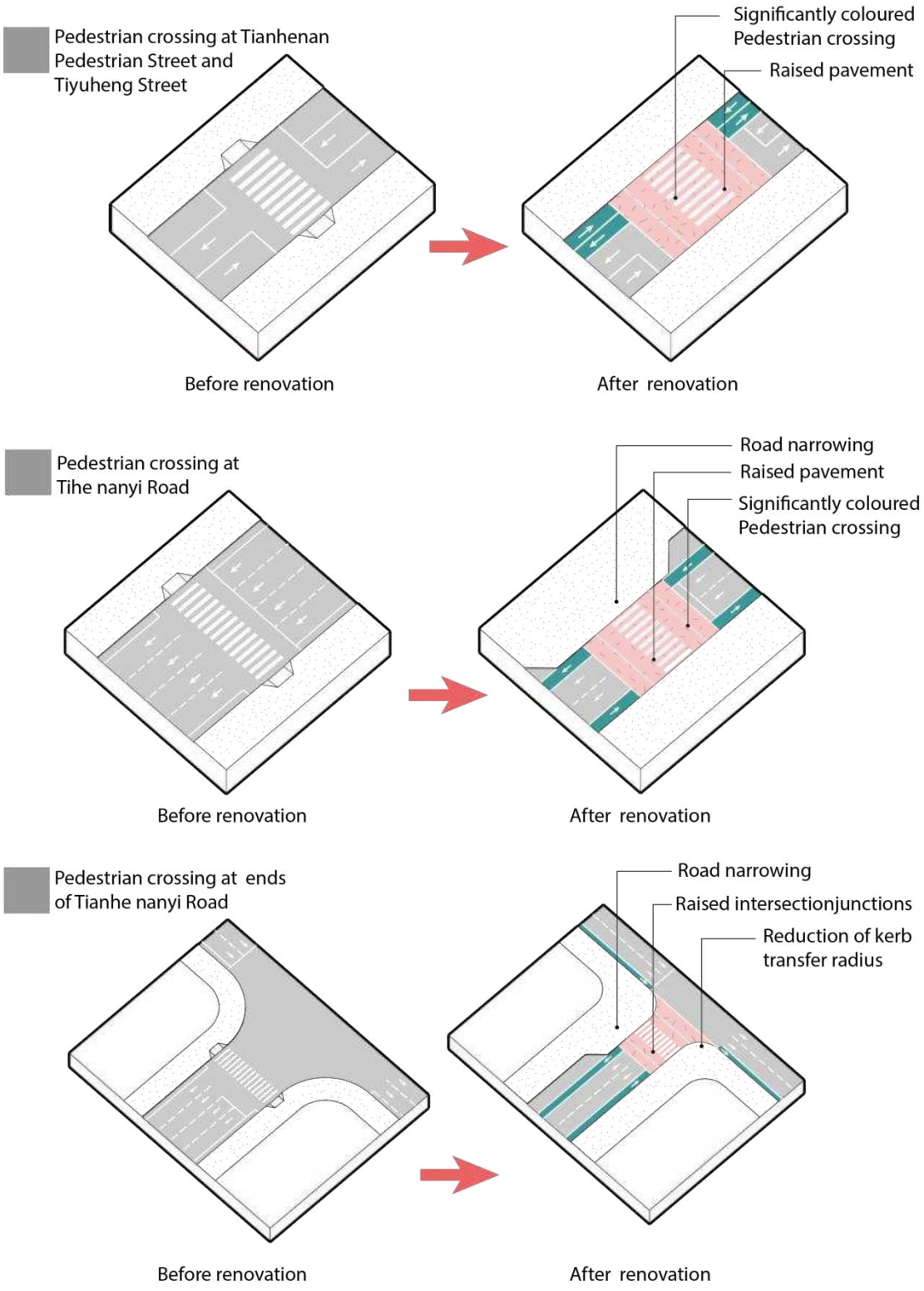


Fig. 6-43 Pedestrian crossing modification(before and after)(Source: Completed by author)

6.4 Design of streetscape greening enhancements in the context of complete streets

Trees, shrubs, grass and other landscape planting play an important role in making streets pleasant, enjoyable, memorable and sustainable. Proper use of streetscapes can help define the character of a street, as well as providing shade for pedestrians on the street and acting to reduce energy consumption and absorb and purify stormwater. In addition to providing environmental benefits, healthy green landscapes also have psychological and social benefits. People are attracted to places that are well maintained with planting, and healthy green landscapes are good for urban life and business development. Sixteen per cent of people in the questionnaire survey felt that the most important issue for improvement in Tien Nam Nam First Road and Tien Nam Pedestrian Street was the low quality of the streetscape. Of the reasons for the poor pedestrian experience on the streets, 11% of respondents felt that the quality of the streetscape needed to be improved the most. One of the four most important elements of the street design is the green ecology, with 79.18% of respondents considering this factor to be very important.

Challenges and current situation

1．In the Parc Central section of the Tianhe Nanyi Road, the street trees on the north side of the street are not well distributed and some sections lack street trees.

2．Some of the pocket parks on Tianhe Nanyi Road are under-utilized.

3．The lawn greenery in front of TeeMall, Parc Central and Zhengjia Plaza is of low landscape quality, low hierarchy and ornamental quality and inaccessible.

4．On Tianhe Nan Pedestrian Street, shops along the street bring in a large amount of footfall, but there is little landscaping greenery on the street to provide shade facilities for pedestrians.

Optimization strategies

The design of street landscaping should meet current traffic and landscaping regulations, taking into account the safety of traffic and pedestrians, shading requirements, plant growth habits and the safe sight distance between plants and facilities. At the same time, planting carries the function of urban beautification and ecological protection, and the overall style of planting should be in harmony with the overall appearance of the city, highlighting the characteristics of the road section. According to the needs of different road sections, choose the appropriate tree species and conFig.uration methods.

1．Planting street trees in places where street trees are lacking on Tianhe Nanyi Road I. Street tree pools should be reserved on the outside of the pavement, with the distance from the centre of the trunk to the outside of the kerb of the motorway not less than 0.75m, and the tree cavities are generally square; The spacing of tree pools is determined according to the design of plant greening, in principle not less than 4 metres and not more than 8 metres.

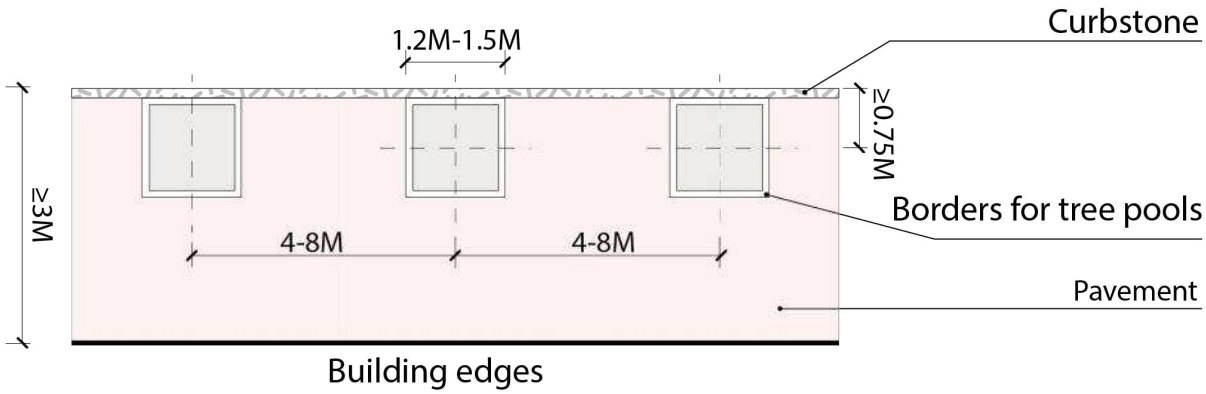


Fig. 6-44 Suggested dimensions for tree pits on Tianhe Nanyi Road.(Source: Completed by author)

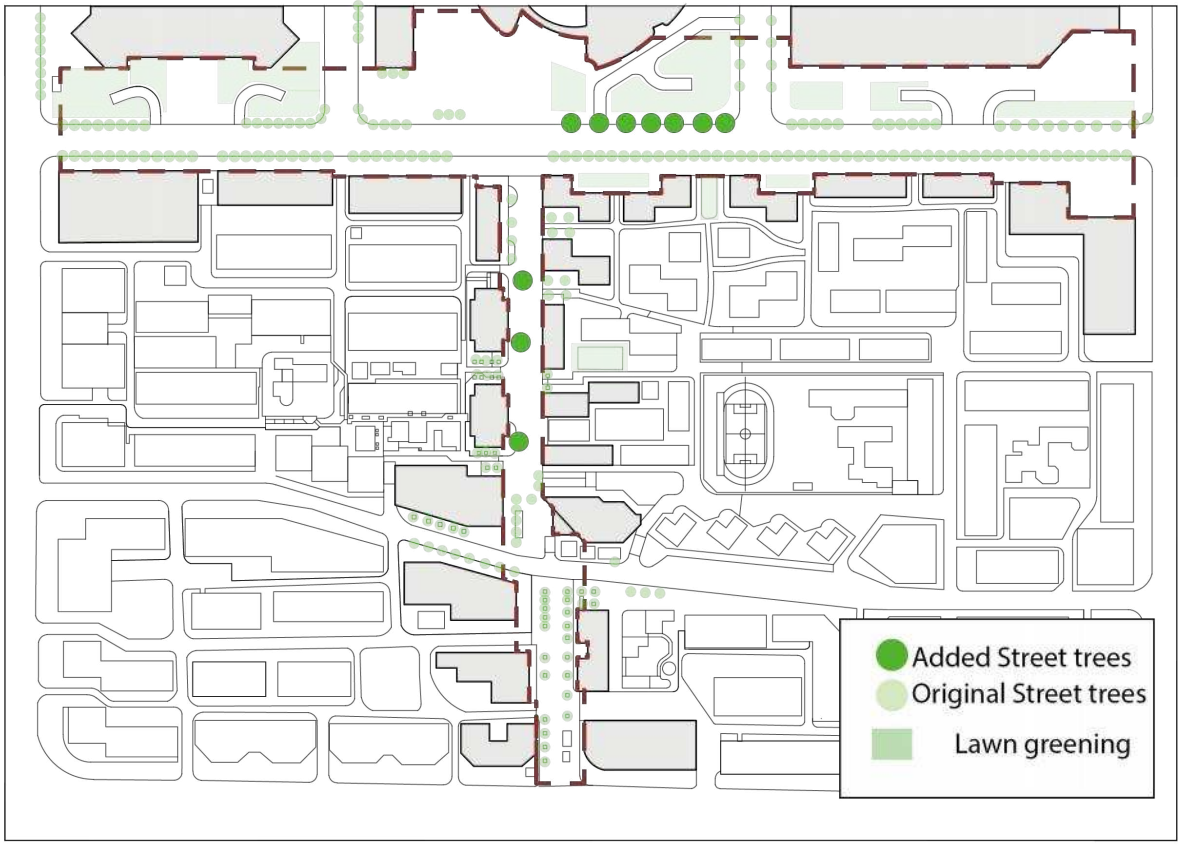


Fig. 6-45 Distribution of trees on the street after street renovation (Source: Completed by author)

2．Enhancing the quality of the pocket park on the south side of the Tianhe Nanyi Road, combining commercial outstands and street amenities to create a comfortable. street

environment for pedestrians and a good business atmosphere.

Fig. 6-46 Transformation of pocket parks on Tianhe Nanyi Road.(Source: Completed by author)

3．Regarding the green belts on the roadside generated by building setbacks on Tianhe Nanyi Road, they can be designed as open green spaces. The existing urban infrastructure can be transformed into a multi-layered landscape structure with a combination of trees, shrubs, ground cover plants, and lawns. The conFig.uration of plants in the roadside belt should follow the principles of landscape art and color coordination, pay attention to the seasonal changes of plants, and create a visually pleasing plant landscape, adding a beautiful scenery to the city. Different types and widths of roadside green belts should have different design styles and techniques to meet the requirements of urban beautification and recreational functions.

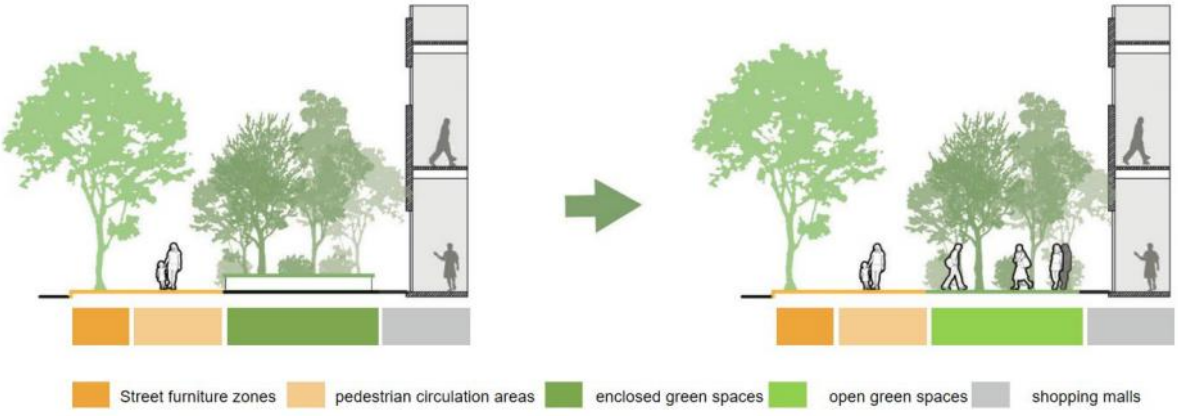


Fig. 6-47 Conversion of enclosed green space into open green space(Source: Completed by author)

Fig. 6-48 Transformed green space near TeeMall (Source: Completed by author)

4．In the Tianhe Nan pedestrian street, various forms of streetscape are set up and combined with street seating and paving to form a characteristic urban landscape, enhancing the street comfort and street vitality of Tianhe Nan street.

6.5 Humanised and refined design of street furniture in the context of complete streets

Carefully designed street furniture makes the pavement more comfortable. and life on the pavement more convenient. Benches provide places to rest, catch up with neighbours or have lunch. Properly distributed litter bins help to keep the streets clean. Appropriately located bike racks and shelters are necessary to encourage cycling, make parking easier and help support cycling as a viable form of transport. In addition to providing amenities, street furniture can also buffer the noise and commotion of vehicles on the street. Street furniture is usually installed in green landscaped/furniture areas, but it can also be installed in street frontages and kerb extensions. Street furniture should not be installed in or protrude into pedestrian areas. The design of street furniture should be simple and compatible with the existing built environment. Street furniture on the Tianhe Nanyi Road and Tianhe Nanyi Walk is mainly divided into street seating, sanitary facilities, street lighting and other facilities

6.5.1 Street comfort enhancement - street seating design

Challenges and current situation

As a commercial street with a high pedestrian flow, and as an internal street of the community, the street seating should meet the needs of the people in Tianhe Nanyi Road and Tianhe Nan Pedestrian Street. According to the preliminary site research and questionnaire survey, the

street sitting problems of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street are as follows:

1． Inadequate distribution of street seating on Tianhe Nanyi Road, which cannot meet the 50M service radius of seating.

2． The number of seats in the northern section of Tianhe Nan Pedestrian Street is low and there are no shading facilities. This results in low usage of the seats during hot weather.

Optimization strategies

Seating is divided into removable and permanent seating. Movable seating allows individuals the flexibility to control the amount of sunlight they receive and for groups to determine their desired seating arrangement. Movable seating is best suited to squares, small parks and outdoor cafes.

1．Seats are set up on Tianhe Nanyi Road based on the needs of the crowd and in conjunction with the service radius of leisure seats. By combining with commercial outdoor placement, street facilities, and street landscape greenery layout, a good rest environment is provided for pedestrians.

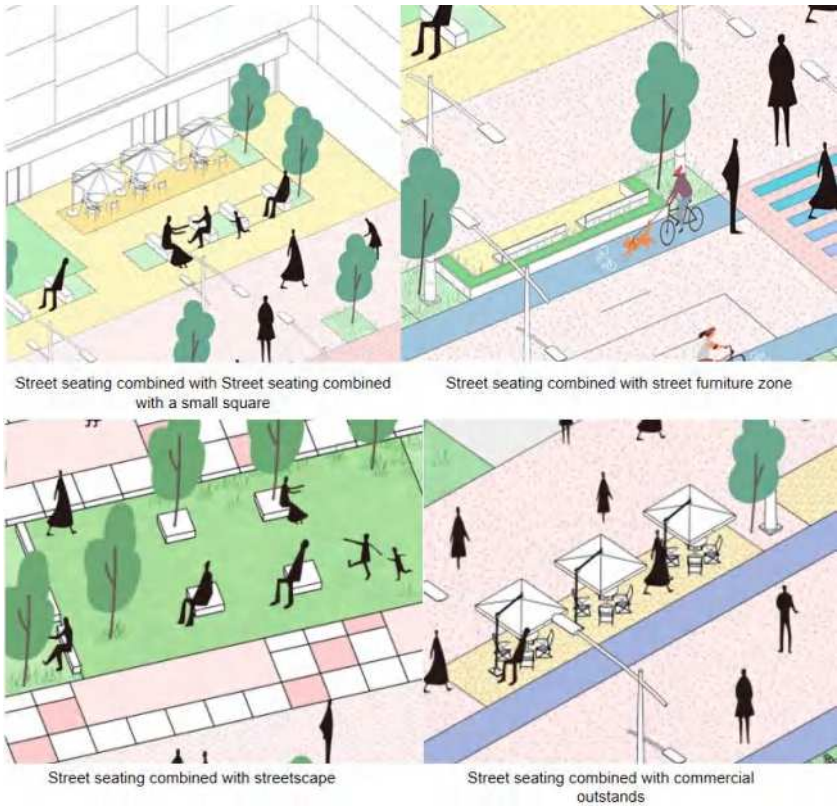


Fig. 6-49 The setting of street seats on Tianhe Nanyi Road. (Source: Completed by author)

2．Seats are set up on Tianhe Nan Pedestrian Street according to the needs of the crowd and

in conjunction with the service radius of leisure seats. Permanent seats can be designed in conjunction with tree pits and arranged in the facilities area of the street, to meet the 50-meter service radius of the street seats.

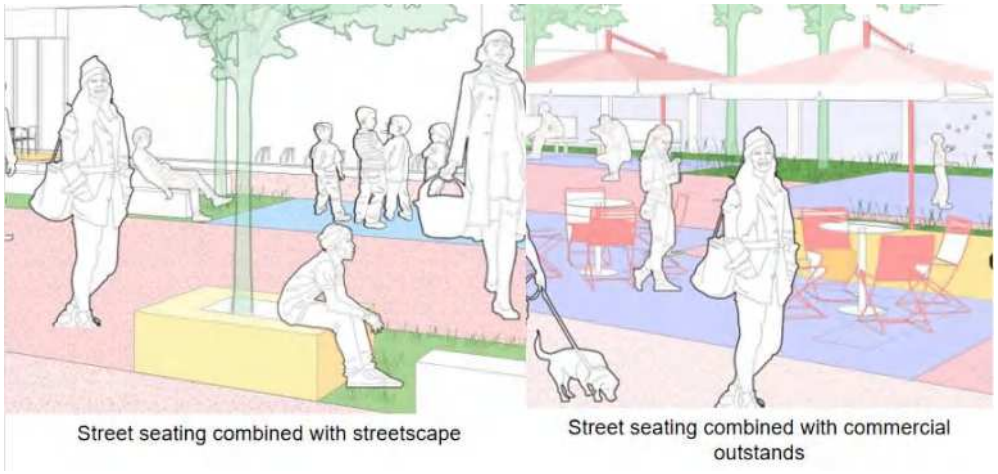


Fig. 6-50 The setting of street seats on Tianhe Nan Pedestrian Street. (Source: Completed by author)

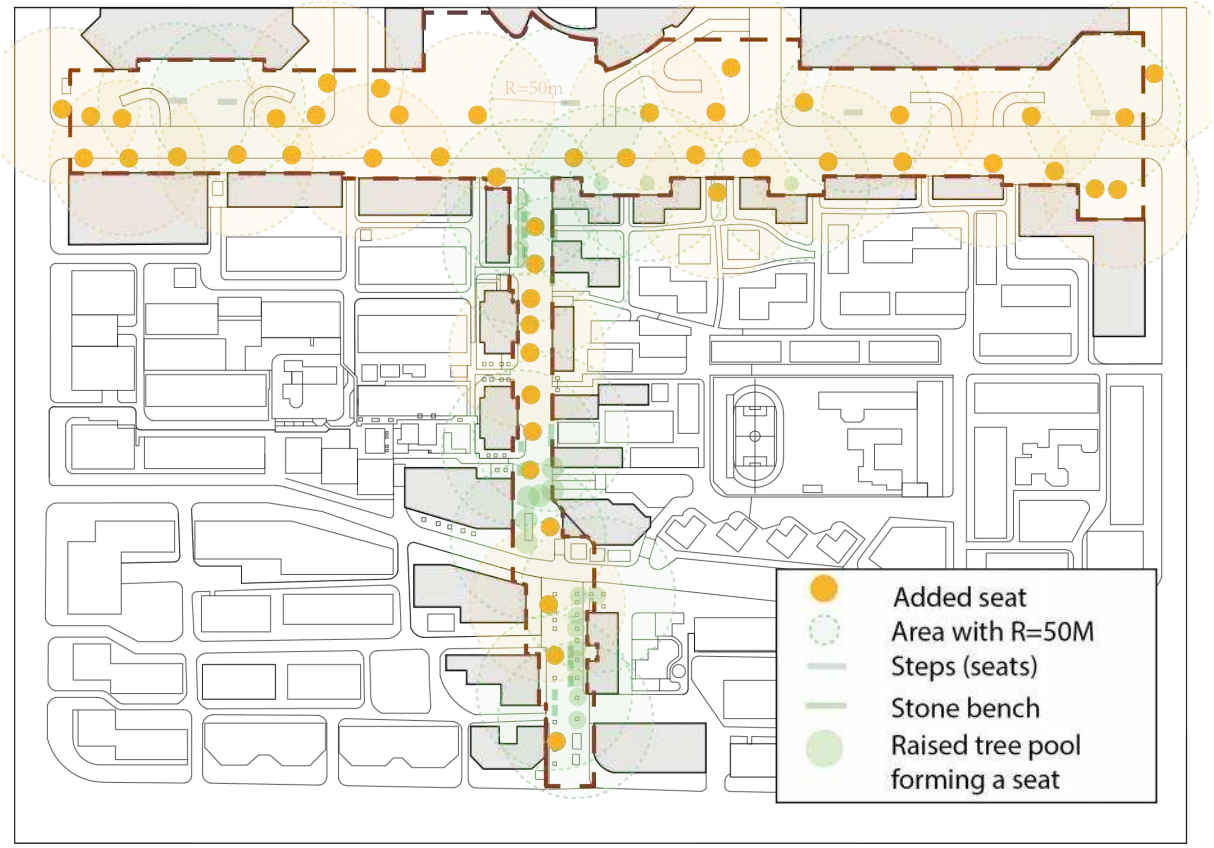


Fig. 6-51 Street seating distribution after street renovation (Source: Completed by author)

Seating should be located in the shaded area under the trees. Seating should be installed to meet the requirements of comfort, durability and ease of maintenance, and in accordance with

the following:

1)Seats facing the pavement should be located at least 1m from the kerb;

2)Seating facing the motorway should be at least 2 metres from the kerb;

3)Seating in public places should not be spaced more than 50 metres apart.

Fig. 6-52 Movable seating and Fixed seating (Source: Montgomery county complete streets)

6.5.2 Street amenity enhancement - sanitation design

Challenges and current situation

Tianhe Nanyi Road and Tianhe Nan Pedestrian Street are commercial streets with high pedestrian flow, and Tianhe Nan Pedestrian Street is an internal community street with a service radius of 30-50 metres. According to the on-site research and questionnaire survey, the following problems exist in the sanitation facilities within the project area:

1． The rubbish bins in the northern section of Tianhe Nan Pedestrian Street are unevenly distributed and exceed the maximum service radius of 50 metres.

2． Some of the sanitation facilities on Tianhe Nanyi Road and Tianhe Nan Pedestrian Street lack timeliness in management and tend to breed odour, which seriously affects the quality of the street.

Optimization strategies

As a freestanding public service facility in the street space, the specific setting of litter bins should pay attention to the following two points: firstly, the interval between the setting of litter bins on the same side should be determined according to the flow of people and the function of the road, combined with the actual demand; secondly, the size of the litter bin opening should be convenient for pedestrians to put in waste, and the height of the bin should be 0.8—1.1m. The following three strategies are used to optimise the sanitation facilities on the First Road of Tianhenan and the Pedestrian Street of Tianhenan from a complete street

perspective:

①The bins on the northern section of Tianhe Nan Pedestrian Street are set up according to a service radius of 50 metres.

Fig. 6-53 Map of sanitation facilities after street renovation(Source: Completed by author)

②Regular maintenance and management should be strengthened, and the facilities should not be less than 95% intact and should function properly. It is recommended to co-locate and integrate with other urban furniture facilities to intensify land use.

③ Encourage the separation of different types of rubbish in conjunction with functions and the expansion of intelligent bins such as smart interconnected, powerful compression and green energy, which will have a positive impact on the landscape appearance and overall quality of the street.

6.5.3 Street Vitality Creation - Street Lighting(Other facilities)

Other facilities: intensive and refined design of facilities. For the traffic facilities and ancillary functional facilities in the streets, the separate forms of setting are not enough to enhance the overall appearance of the street environment. The intensive integration of street facilities design not only unifies the form and style of the facilities, but also saves the occupation of the street space and improves the neatness of the street space. The form of integration of facilities

encourages the use of one pole for multiple uses and the merging of multiple boxes. In addition, street furniture zones can be designed in conjunction with street trees, non-motorized parking and sitting facilities to intensify street space.

Street lighting should not intrude into building boundaries; in streets where street trees shade light severely, horizontal suspension arrangements may be chosen. Sidewalks should provide adequate night lighting; for streets with wide pavements, special pavement post lights should be provided; for streets with narrow pavements, wall lights may be provided in conjunction with buildings or fences along the street.

Fig. 6-54 Street lighting (Source: Completed by author)

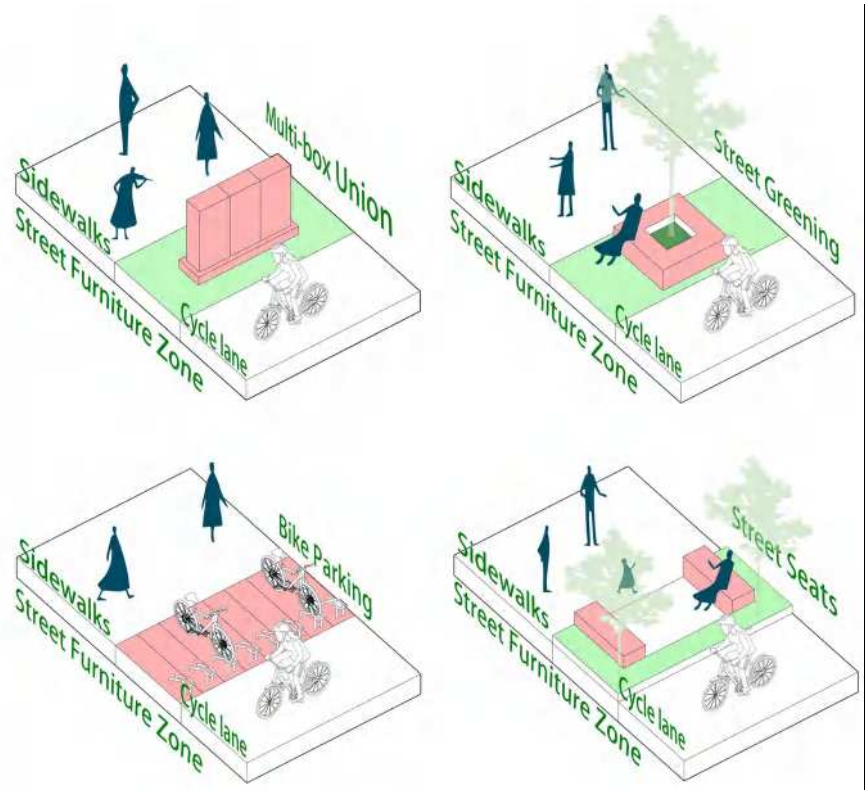


Fig. 6-55 Street furniture belt design(Source: Completed by author)

Conclusion

Conclusion

The aim of this paper is to complete the approach to street space regeneration in a complete streets perspective. Starting with theoretical research, learning from case studies, and finally the generation of design strategies and the application of these strategies to urban design solutions. This is the logic of this paper. The reason for choosing street design as the topic of this paper is that streets belong to an important part of the city where many activities of people take place. Also as a key link between public and private space in the city, it is worth exploring how best to design street space and return it to people. It is worth exploring. For a long time, the design of streets based on the car has caused many problems. This has led to a vicious cycle of 'congestion - road expansion - more cars - more congestion'. Many ideas and practices have also been introduced in China to address this problem. The concept of people-centred streets is gaining traction. The introduction of Complete Streets offers a new perspective on street space with an emphasis on pedestrian priority, it empowers people on the street and improves street safety.

To better understand complete streets, this article selects three case studies: Reseda Boulevard, Broadway Street, and Jiefang Street in Sanya. The article explains the selection criteria for the cases and summarizes specific strategies for street improvement in the context of complete streets from three aspects: improving street safety, enhancing street comfort, and creating street vitality. This provides reference for the street space improvement of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street under the context of complete streets.

The article then proposes specific recommendations for street space improvement in the context of complete streets. Firstly, the article introduces the goal hierarchy, design principles, and evaluation indicators of complete streets. Secondly, based on theoretical research and case analysis, the article proposes specific recommendations for street space improvement. The first recommendation is to improve the pedestrian network and quality of pedestrian spaces to create pedestrian-friendly street spaces. The second recommendation is to optimize the environment for public transportation and motor vehicle travel to optimize vehicle spaces. The third recommendation is to enhance the maintenance and activation of existing green spaces to improve the quality of street landscapes. The fourth recommendation is to pursue refined and human-centered design in street facilities to enhance street comfort and create

street vitality. These street space improvement recommendations have been applied to the street space renovation of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street.

Next, the article analyzes the current status of street space in Tianhe Nanyi Road and Tianhe Nan Pedestrian Street based on the context of complete streets. The analysis is conducted from both a large-scale area perspective and a small-scale street perspective, and is then combined with the evaluation of complete streets and the results of a questionnaire survey. The article summarizes the street space problems of Tianhe Nanyi Road and Tianhe Nan Pedestrian Street and finally presents street space improvement designs under the context of complete streets.

Research innovation

In terms of innovation in research content, this article reviews the latest literature and guidelines on complete streets both domestically and internationally, and puts forward specific recommendations for improving street space in the context of complete streets.

In terms of methodological innovation, this article develops a methodology based on the "goal principle of relevant theoretical research - guiding design recommendations - research under theoretical background - application based on theoretical guidance of design recommendations".

In terms of innovative site analysis methods, a combination of quantitative and qualitative methods are used to analyze the street space in the context of complete streets.

Research deficiencies and prospects

The work of this article is to refine the target strategies and methods for street optimization design based on the review and summary of existing research results. Although some progress has been made, there are still many shortcomings that need to be further deepened and adjusted.

In terms of theoretical research, due to time and energy constraints, the theory is not yet sufficiently in-depth. Moreover, more is learned from secondary research materials on the complete street. Because the complete street originated in the United States, and there is currently little research on complete streets in China, and most of it is from the perspective of road traffic, the theoretical research on complete streets in the Chinese context is still

insufficient, and there is even less research from the perspective of urban design.

Second, the complete street is a transportation policy and design method that involves the planning, design, operation, and maintenance stages of streets. This article mainly explores the design issues of complete streets from the perspective of urban design, and does not involve policy issues and the operation and maintenance stages of complete streets.

Third, because the design of complete streets covers a wide range of disciplines, and this study involves multiple professional fields such as road engineering, traffic engineering, architecture, and landscape design, the lack of certain related disciplinary knowledge in limited time makes it impossible for this article to be comprehensive and complete. Therefore, the design strategies do not fully respond to actual design needs.

Therefore, further research is needed in the future to address these shortcomings. Regarding theoretical research, I will read more primary research materials. When studying and learning the theories that have emerged abroad, I will focus on the application of theories in the Chinese context and theoretical research and applications from the perspective of urban design.Secondly, try to intervene in the planning, design, operation, and maintenance stages of complete streets from multiple perspectives, rather than just limiting it to the design level.Finally, for the multidisciplinary issues involved in complete streets, adopt a research strategy with urban design as the main discipline and other disciplines as supplements, and understand the application of complete streets in the Chinese context from multiple dimensions.

Bibliography

Appendix I:：Research Questionnaire

Complete streets in context Questionnaire for Tianhe Nanyi Road and Tianhe Nan Pedestrian Street

Dear Residents

I am a master's student at the School of Architecture, South China University of Technology, completing my thesis on street transformation from a complete streets perspective, and I would like to distribute a questionnaire to you. This questionnaire is anonymous, not personal, and is intended for academic research. Thank you very much for your understanding and support.

1. Your gender: [Multiple choice] *

○Man ○Woman

2. Your age range: [Single choice]

○Under 18 ○19-59 ○Over 60

3. Your occupation [Single choice]*

○Student ○Office workers ○Merchants ○Retirement ○Others

4. what mode of transport do you use to get here [Single choice]*

○Walking ○Non-motorized vehicles ○Public Transport ○Private Car

5. The purpose of your trip is [Single choice]*

□Access □Sitting and talking □Take a walk

□Shopping □Exercise □Walking a dog

□Walking children □Playing cards and chess □Performing and watching

6. in what areas do you think the streets need to be improved at the moment [Single choice]*

○Poor quality of pedestrian space

○Inconvenient cycling(e.g. discontinuous riding routes, difficulty in parking))

○Single building function and interface along the street

○Poor quality of street landscaping

○Inadequate street rest facilities

○Sloppy management of street facilities(litter bins, street lights, signal boxes, etc.)

○High levels of conflict with motor vehicles(e.g. fast speeds, etc.))

○Inadequate accessibility facilities

7. Do you think the reasons for the poor walking experience are [Single choice] *

○Conflict with motor vehicles

○Lack of leisure facilities

○Mixed walking and cycling

○Illegal parking of bicycles

○Road surface is uneven and non-slip

○Barrier-free facilities are overrun

○Poor quality of streetscape

8. You think the reasons for the poor cycling experience are [Single choice] *

○Car occupancy

○No separate non-motorized lane

○Poorly planned parking spots

○Inadequate facilities(e.g. street lighting, indicator signs, etc.)

○Lack of shading facilities

○Non-motorized lanes are not continuous

9. How important do you think the following elements are to the street [matrix text question] [enter a number from 0 to 100]*

Accessible and safe	_____
Clean and beautiful	_____
Green Ecology	_____
Convenient facilities	_____
Diverse functions	_____
History and Culture	_____
Smart Intelligence	_____

Business Vitality	_____

Appendix II:：Research Questionnaire

Complete streets in context Questionnaire for Tianhe Nanyi Road and Tianhe Nan Pedestrian Street

Dear Residents:

I am a master's student at the School of Architecture, South China University of Technology, completing my thesis on street transformation from a complete streets perspective, and I would like to distribute a questionnaire to you. This questionnaire is anonymous, not personal, and is intended for academic research. Thank you very much for your understanding and support.

1.Carriageway

1.1.The basic condition of the road(including road width, turning radius of kerbs, etc.) is set to a reasonable degree

○Very unreasonable ○Unreasonable ○Fair ○More reasonable ○Very reasonable

1.2.Importance of road related facilities(e.g. barrier railings, road drainage facilities, etc.)

○Very unimportant ○Not very important ○Ordinary ○More important ○Very important

2．Pavement

1.Comfort in the pedestrian access area

○Very uncomfortable. ○Not very comfortable. ○Fairly comfortable. ○More comfortable. ○Very comfortable.

2.Comfortable. cycling

○Very uncomfortable ○Not very comfortable ○Fairly comfortable ○More comfortable ○Very comfortable.

3.Satisfaction with slow moving space paving

○Very dissatisfied ○Not very satisfied ○Fairly satisfied ○More satisfied ○Very satisfied

4.Reasonableness of bus stops and other facilities

○Very unreasonable ○Unreasonable ○Fair ○More reasonable ○ Very reasonable

3．Street furniture

1.Signage legibility

○Very insignificant ○Insignificant ○General ○More pronounced ○Very pronounced

2.Number and location of bins

○Very inadequate ○Not quite adequate ○Fair ○Mostly adequate ○Completely adequate

3.Location and number of bicycle parking points

○Very inadequate ○Not quite adequate ○Fairly adequate ○Mostly adequate ○Completely adequate

4.Number and location of lounge seats

○Very inadequate ○Not quite adequate ○Fairly adequate ○Mostly adequate ○Completely adequate

4．Landscape systems

1.Aesthetics of pavement greenery

○Very unattractive ○Not very attractive ○Fair ○More beautiful ○Very beautiful

2.Aesthetics of the road green belt

○Very unattractive ○Not very attractive ○Fairly beautiful ○Very beautiful ○Very beautiful

3.Aesthetics of other street greenery

○Very unattractive ○Not very attractive ○Fairly beautiful ○Very beautiful ○Very beautiful

5．Building façade

1.Degree of harmony between billboard facilities and the environment

○Very disharmonious ○Not very harmonious ○Fair ○More harmonious ○Very harmonious

2.The importance of the street layout(e.g. crossing safety features, etc.)

○Very unimportant ○Not very important ○Fairly important ○More important ○Very important

硕士学位期间取得的研究成果

一、已发表（包括已接受待发表）的论文，以及已投稿、或已成文打算投稿、或拟成文投稿的论文情况**（只填写与学位论文内容相关的部分）：**

序号	发表或投稿刊物/会议名称	作者（仅注明第几作者）	发表年份	与学位论文哪一部分（章、节）相关	被索引收录情况

注：1.请在“作者”一栏填写本人是第几作者，例：“第一作者”或“导师第一，本人第二”等；
2.若文章未发表或未被接受，请在“发表年份”一栏据实填写“已投稿”，“拟投稿”。
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二、与学位内容相关的其它成果（包括专利、著作、获奖项目等）