Intermodal Transit Hub:
Improving the Transfer Environment at the Li Shui Bridge Transportation Node in Beijing

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Preface

I am not from Beijing or a similar big city. To me, the most terrible experience in Beijing is “fighting” in subway stations or trying to find a bus stop for transfer. However, I guess if I knew how to drive, the most terrible experience would be the severe traffic congestion happening everyday. I started to think about how architects can do to help.

All traffic issues come from many broader issues or planning failures, but can be remedied by the development and usage of public transportation. Then I narrowed down to consider the architectural failures in existing public transportation systems, which can be largely imprvoed to provide commuters a better experience. If taking the subway or bus is not a nightmare anymore, more and more people will choose public transit over private cars because subway can assure that you are on time, while driving in Beijing’s peak hours will never do.

These observations and thoughts drove me to select Beijing as my thesis location and to explore how to improve the transfer environment at key locations, to facilitate commuter’s transfer, lesson their pain, and potentially, encourage the use of public transportation.

Acknowledgements

I would like to thank Professor Brian McLaren and Gundula Proksch for their guidance, continued enthusiasm and support throughout the quarter. I would also like to thank Professor Sharon E. Sutton for her guidance of choosing and refine the topic of my thesis, teaching me about rigorous scholarship. Also I would like to thank my boss and friend Colin Bott, my friends Weilan Zhang, Sheng Zhao, Wei Zheng, Ling Liu, Yucheng Zhang for discussions and providing me great ideas and suggestions. Finally, this thesis would not have been possible without the love of my parents Xiaonong and Hongwei, the care and support of my boyfriend Xiaochen Zhang.

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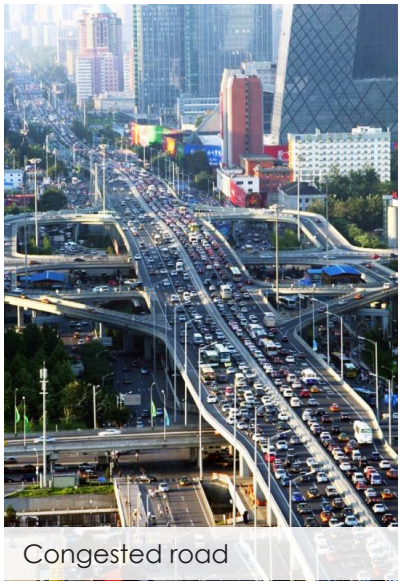
Figure 1.1 Location and districts map of Beijing

Chapter 1: Introduction

Problem Statement

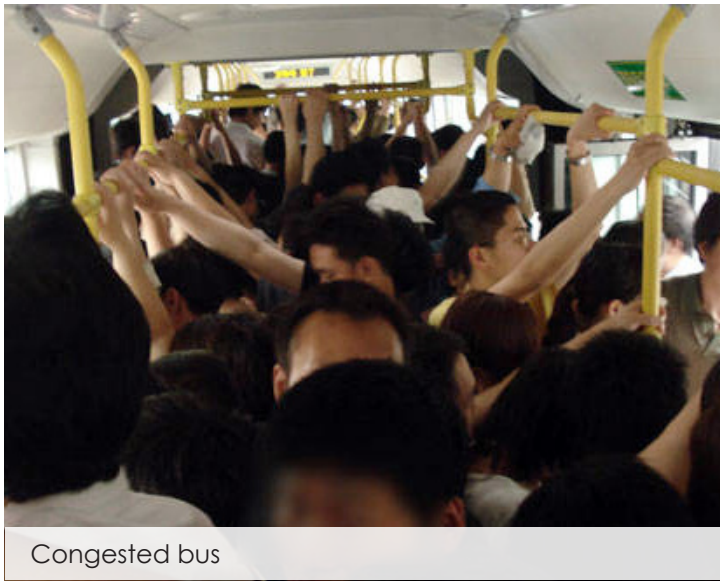
Beijing has become the most important transportation hub in China and in the East Asian region(Figure 1.1). Railways, roads, and motorways pass through the city on six ring roads, nine expressways and city express routes, eleven China National Highways, fifteen subway lines, and several railway routes. In addition, an international airport serves the city (Figure 1.4 and 1.5). Over the last ten years, more and more people could afford cars and road congestion has become a severe problem. The city has the longest commutes of any city in China with residents spending an average of one hour going to and from work(Figure 1.2).

To reduce traffic jams, the city has been working hard on largely develping its public transportation system to accomodate its large population[1](Figure 1.3). In the meantime, transportation planners have proposed multiple means to encourage use of public transit, including efforts to integrate multiple transportation modes in key locations. However, this concept is underdeveloped, resulting in inconveniences for commuters in using public transit in current transoportation nodes. For instance, transfer between



Congested road

Congested subway station



Congested bus

Figure 1.2 Congestion problem in Beijing's traffic system

different modes of transit are not seamless and smooth enough, while insufficient park and ride facilities are provided at stations for commuters who drive there. Also, transfer experience is undesirable both spatially and psychologically because the high-density commuters have to suffer in crowds while transfering. Transit stations, especially those at key locations, are usually pure "transfer machines" with limited amenities and other experiences. Finally, the urban design of these stations does little to mitigate the high level of vehicular traffic they attract, creating an unpleasant situation for pedestrians. Thus, public transit facilities do not help to reduce the use of cars under current conditions.

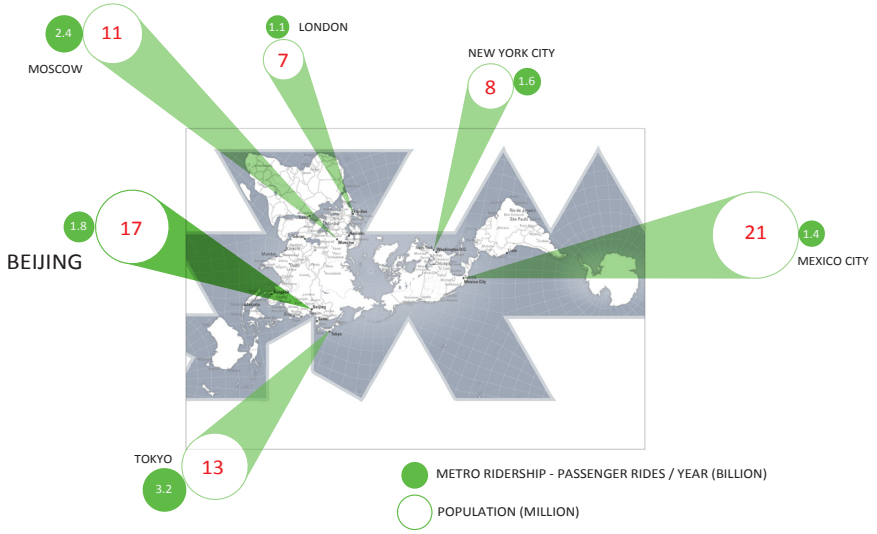


Figure 1.3 World cities comparison: Population v.s. Metro annual ridership

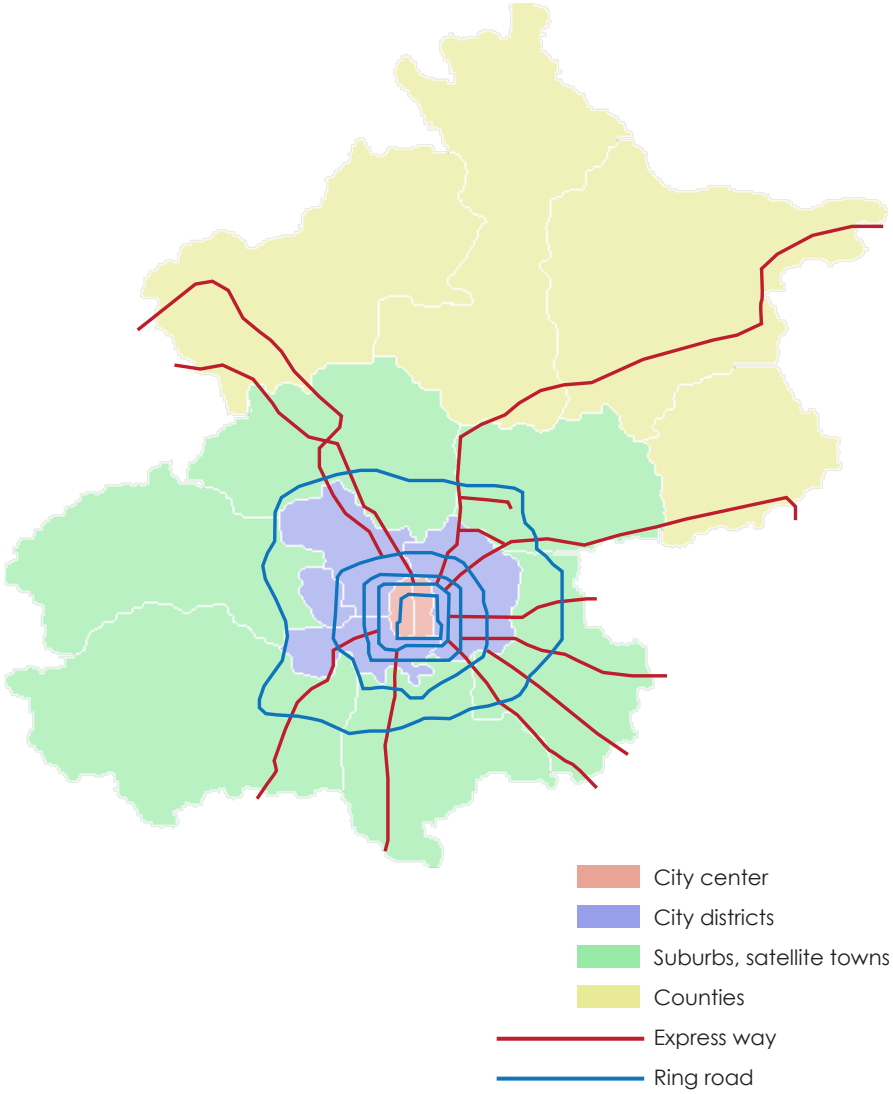


Figure 1.4 Road system map of Beijing

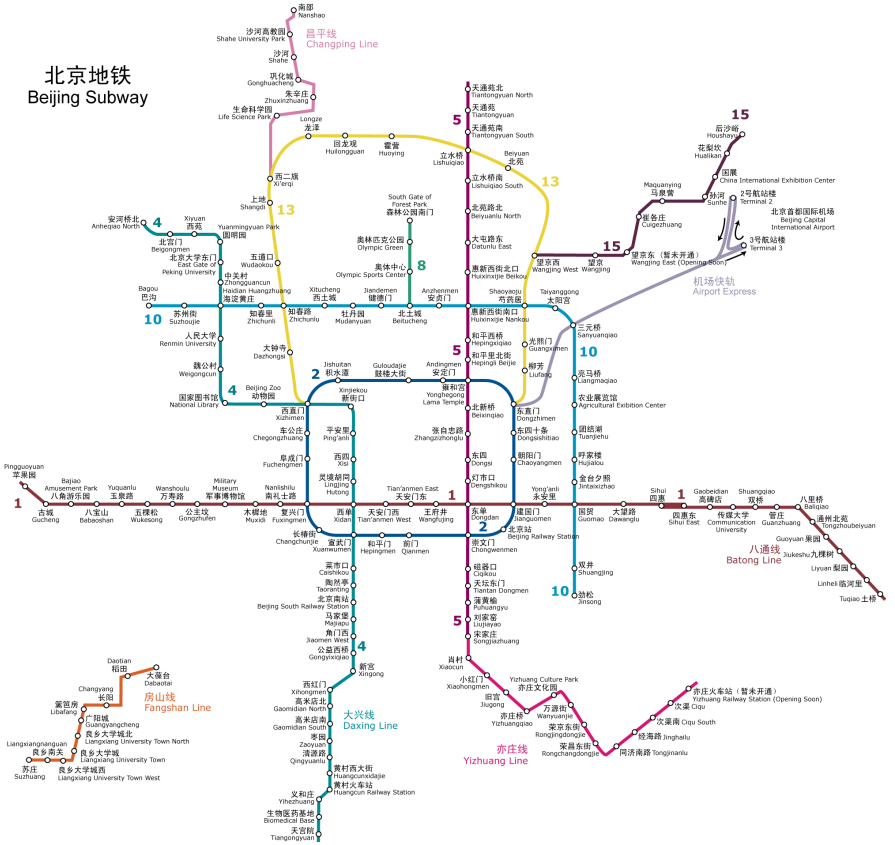


Figure 1.5 Subway system map of Beijing

Project Rationale

This thesis begins with the premise that commuters will be encouraged to use public transit if a more convenient, pleasant transfer experience is available(Figure 1.6). It will seek to investigate how to achieve the following goals(Figure 1.7):

A) A "hub" that integrates distributed arrivals (via walking, bicycling, or driving) and large-group arrivals (via subway, buses), along with clear and carefully planned transfer circulation among different means of transit to allow faster transfer.

B) A station that provides disirable spatial quality and affiliated amenities that could help divide users' flow, release stresses of the commuters, and bring services and amenities to the neighborhood.

C) An interesting public place that weaves into the urban context boosting activities at a pedestrian level, and engages the community and neighborhood with green space and cultural values.

An intermodal transit facility, as a relatively mature building type, has a great potential to help shape Beijing's integrated transit environment at key locations, and thus to help encourage public transit usage in general. On the one hand, integrating multiple

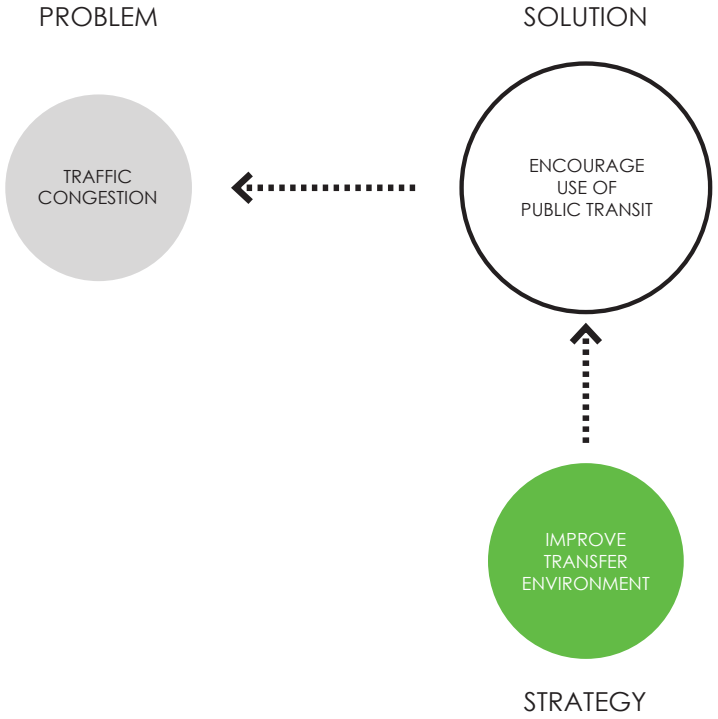


Figure 1.6 Project rationale

PROBLEMS

I HAVE TO **WALK SUCH A LONG WAY TO TRANSFER** TO ANOTHER LINE OR OTHER TRANSIT MEANS, NOT TO MENSION THAT **THERE AREN'T ENOUGH P&R SPACES** TO EASY MY TRAVEL...

IT'S LIKE **EVERYDAY WARS** TO FIGHT WITH SO MANY PEOPLE TO GET ON THE BUS/SUBWAY...

THE TRANSPORTATION NODE IS **A MESS, BORING AND UNPLEASENT**. I WON'T BE THERE EXCEPT WHEN I HAVE TO...

VISION

I CAN **TRANSFER BETWEEN DIFFERENT MODES OF TRANSIT MEANS EASILY, SMOOTHLY AND FAST**.THERE ARE **PLENTY OF P&R, BICYCLE PARKING** SPACES INTE-GRATED IN...

THE EXPERIENCE IN THE STATION **I**SN'T A NIGHTMARE ANYLONGER. THE FLOW IS DIVIDED TO **"FAST' AND "SLOW" LANES** BASED ON USERS' ACTUAL NEEDS.

THE NODE IS **A REAL PLACE**, WHICH ISN'T ONLY ABOUT TRANSPORATION, BUT A PLACE **WE ARE PROUD OF**. IT'S **INTERESTING**, IT **WORTH A JOURNEY**...

Figure 1.7 Problems and vision of transportation "nodes"

transit means together within a walkable distance, ideally "under one roof", could improve the convenience of making a transfer. Unconnected bus stops, taxi stops, subway entrances, and parking facilities that currently exist around significant locations have the potential to be architecturally integrated. Clearer circulation and signs could be incorporated into the new structure to help commuters transfer more quickly and conveniently.

On the other hand, a large-scale intermodal transit hub could help to improve vitality in a cityscape such as in Beijing, which unlike most American cities, has multiple centers which contain large amount populations. A sub-center would be a good candidate for a new intermodal transit hub for two reasons. There is a high number of daily commuters who would potentially use the facility. This high concentration of people would support the services and amenities currently lacking in many outlying neighborhoods, thus improving the quality of life. It would also reduce the need for traveling to the city center. Second, since sub-centers are on the edge between the city center and distant suburban areas, they are also perfect locations for introducing new "park and ride" facilities. Thus this thesis will explore how an intermodal transit hub in a sub-center in Beijing would be beneficial for building a healthier network of transit-oriented sub-centers at the city scale.

Thesis Overview

This thesis will explore the feasibility of applying foreign experience of intermodal transit facilities to Beijing's particular urban condition. The literature review and precedent analysis are organized based on three inquiries(Figure 1.8):

How can an intermodal transit hub:

A) facilitate smooth and seamless transfer between different modes of travel and encourage use of public transit? (efficient transfer)

B) add services and amenities that will facilitate commuting and add uses that are lacking in the neighborhood? (comfortable experience)

C) help shape a healthier community node through a high quality, sustainable, pedestrian friendly, safe and lively civic place? (interesting place)

The selected neighborhood for the design project is called Tian Tong Yuan, which is one of the largest residential neighborhoods in Asia, and is regarded as one of Beijing's major sub-centers because of its size and density(Figure 1.9). Tian Tong Yuan has severe traffic jams daily during peak hours on its main north-south pathway, An Si/Li Tang Road. Although two subway lines and over thirty bus lines are

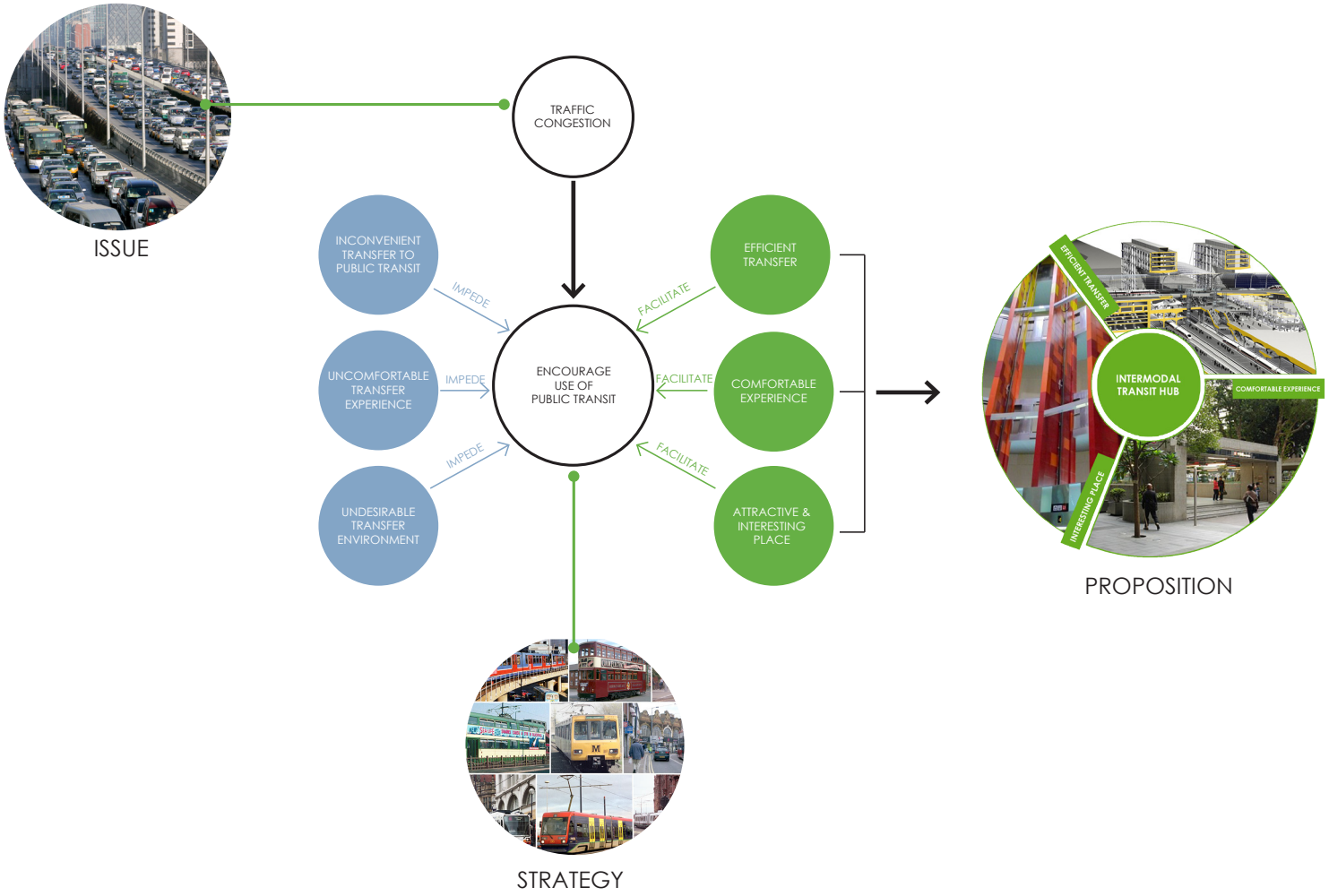


Figure 1.8 Thesis Framework and goals

Figure 1.9 Aerial photo of Tian Tong Yuan neighborhood and An Si / Li Tang Road

connected to the neighborhood, the majority of the commuters choose to drive because of the inconvenience of taking public transit. The use of private cars causes traffic congestion and, even worse, contributes to an unhealthy community environment.

Li Shui Bridge Station, located on the southern edge of Tian Tong Yuan neighborhood, is selected as the site for a new intermodal transit hub. This station is along An Si/Li Tang Road, acting as the gateway from Tian Tong Yuan to the city center, and is strategically located at the intersection of two subway lines. Linking existing and new transit means together into a unified whole to achieve a seamless, convenient transfer experience will be a real challenge for this design. Not only will the thesis need to propose specific site responses, it will also need to translate foreign approaches to the Chinese condition. The ultimate goal of this thesis is to provide a model for transit-oriented sub-centers in Beijing through research, analysis and design.

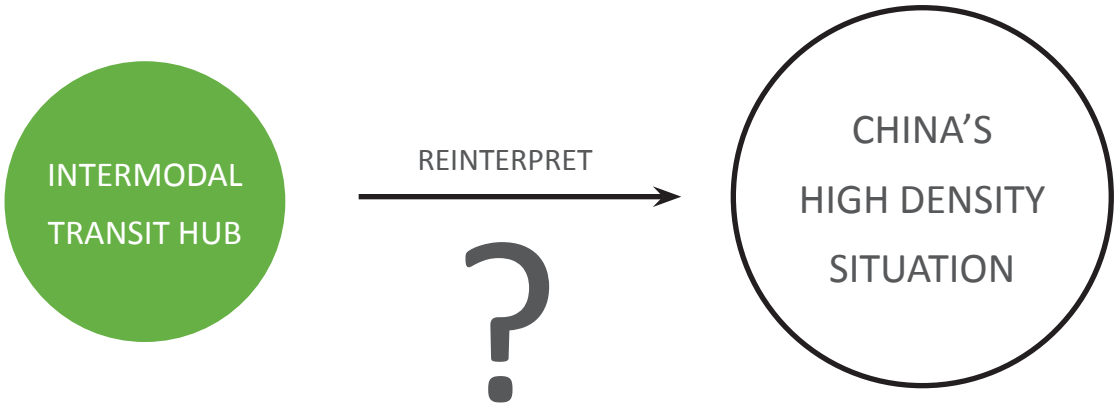


Figure 1.10 Diagram of thesis direction

Chapter 2: Theoretical Framework

Figure 2.1 Diagram of thesis goals

The Literature Review and precedent Analysis in this chapter are organized and integrated together based on three subjects as follows(Figure 2.1):

1. Efficient transfer

2. Comfortable experience

3. Interesting place

Efficient Transfer

Multiple transportation systems can be interrelated in intermodal passenger transport[2]. Many transportation modes can be seen as intermodal; for example, urban public transit systems such as bus lines, rail lines or subways are often linked with local airports, or extensive parking facilities and airport shuttles are available at most airports. Therefore, the main goal of intermodal passenger transportation is to promote public transit and to reduce the reliance on automobile, thus, release public traffic burden and air pollution(Figure 2.2-2.3).

A strategically located intermodal transit hub including many modes of transportation together can increase passengers' destination alternatives. Facilities are required at the transit hub to secure intermodal transit operation smooth and easy access. Additional facilities, services and amenities such as ticket booths, comfortable waiting rooms, food services should also be integrated in an intermodal transit hub. In order to encourage automobile users to make as much of their journey by public transport as possible, automobile parking facilities are often included at intermodal transit

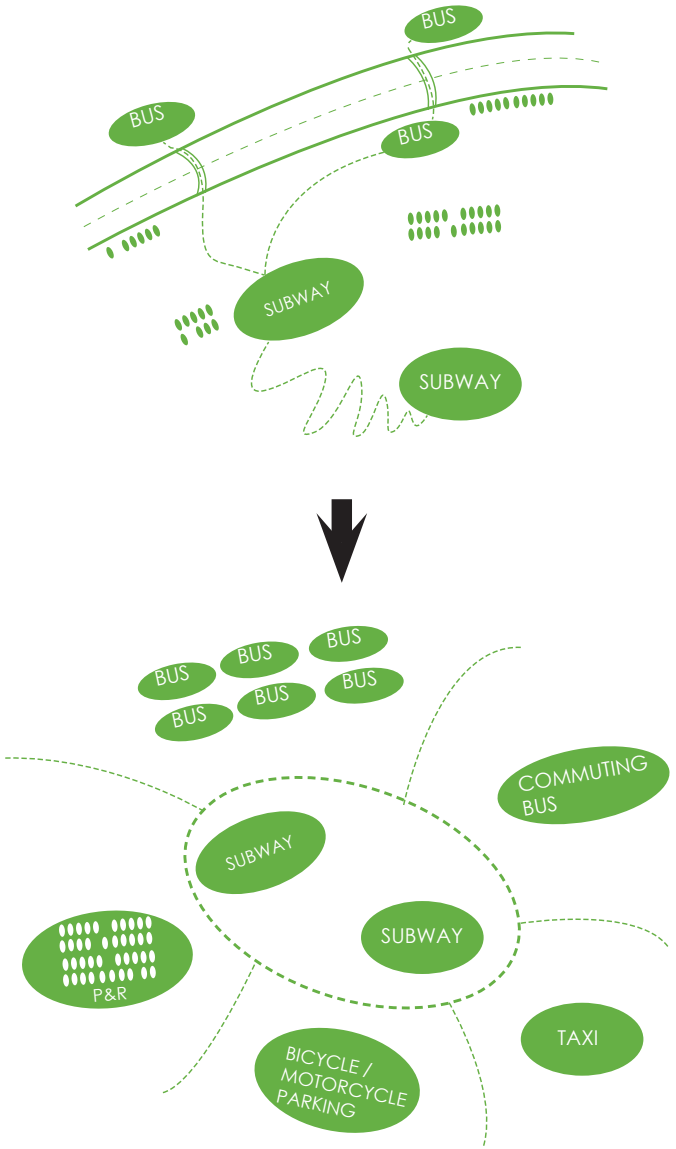


Figure 2.2 Concept of intermodal transit facility

hubs. Depending on the scale and requirements, some intermodal transit hubs are supported by larger transit-oriented development including retail, residential, offices, hotels and entertainment venues. Transit hub in such kind not only improves the mobility for the region, but also can help shape a lively community.

Another factor that determines a successful transit hub is good architectural wayfinding design. Providing clear clues for commuters and users to have sense of orientation, without overkilling them by signs everywhere, is important to improve the quality of their experience. The integration of clear articulation, reasonable composition of interior and exterior space, multilayer circulation system, and the communication system are the essences to deliver the efficient way finding system.

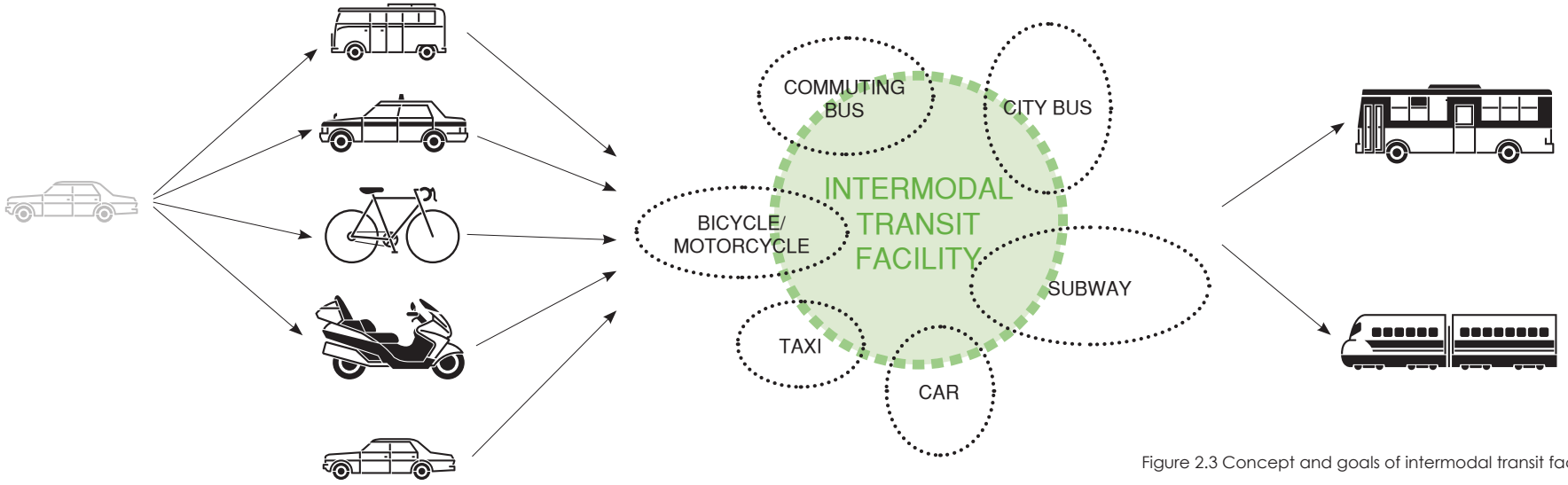


Figure 2.3 Concept and goals of intermodal transit facility

Precedent 1: Houston Northern Intermodal Facility

Houston, Texas, EE&K Architects

The Houston northern Intermodal Facility by EE & K Architects, is designed as a central hub to receive and distribute multiple transportation with radial pattern in the urban area. This new transit system provides Houston's new rail and bus services, which will help to encourage the public commuter and reduce private automobile uses. The central grand hall plays a role of central indoor plaza to cover the vertical circulation linking the bus routes, rail lines with the other public and serving spaces. In order to attract new growth and activities, and thriving urban development, the transportation center interlocks with the adjacent redeveloped industrial area, promoting a vibrant, mixed-use and walkable community built around the station. The transitional landscape intends to invite recreational, commercial and cultural activities into this complicated infrastructure, and potentially, develop the terminal as a multifunctional public venue, from there, the transit-dynamic routes also repurpose the surrounding neighborhood with restaurants and shops with new residences above, a hotel, cultural attractions, as well as acres of parks and open space[3]. (See Figure 2.4 to 2.10)

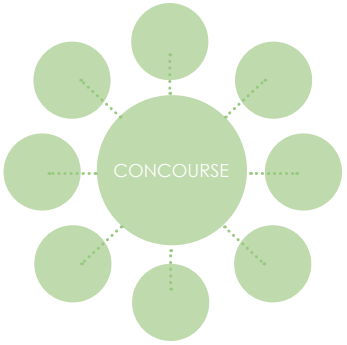


Figure 2.4 Houston Northern Intermodal Facility - Spatial relationship diagram

Figure 2.5 Houston Northern Intermodal Facility - Ground floor plan

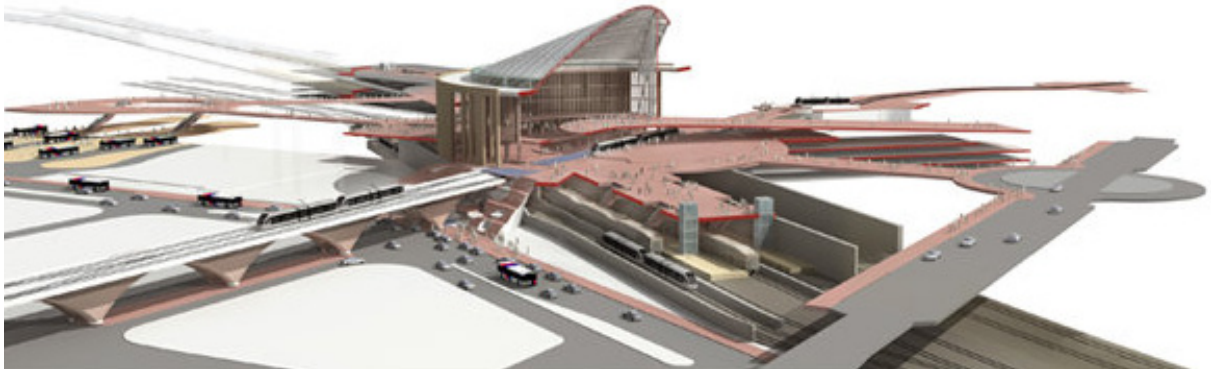


Figure 2.6 Houston Northern Intermodal Facility- Sectional perspective

Figure 2.7 Houston Northern Intermodal Facility- Section

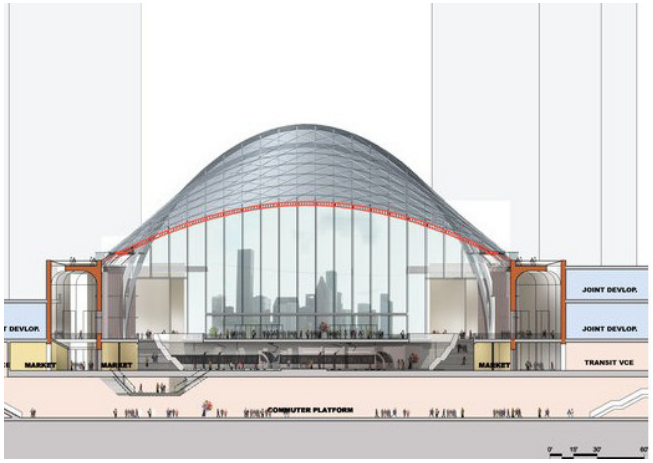


Figure 2.8 Houston Northern Intermodal Facility- Cross section

Figure 2.9 Houston Northern Intermodal Facility- Interior view

Figure 2.10 Houston Northern Intermodal Facility- Exterior view

Precedent 2: Transbay transit terminal

San Francisco, California, Pelli Clarke Pelli Architects

Figure 2.11 Transbay Transit Terminal - Spatial relationship diagram

The new transit terminal in San Francisco integrated nine systems into a unified infrastructure. Modes of transportation are organized vertically via seris of atrium along the long section. Among adjacent skyscrapers in the central downtown area, the roof acts as an urban green threshold to engage with public activities during different times of day and of the year. Several lightwells on the central axis bring light and natural ventilation on to the central plan. The terminal activates 1.3 mile extension of the Caltrain rail line, and receives and distributes the bus and rail services on high level above ground. At the same time, the transparent façade system creates an intimate relationship between lively neighborhood with 2,600 new homes and encourages pedestrian flow and commercial opportunities[4 5]. (See Figure 2.11 to 2.16).

Figure 2.12 Transbay Transit Terminal - Birdeye view

Figure 2.13 Transbay Transit Terminal - Cross section view

Figure 2.14 Transbay Transit Terminal - Bus deck level at elevators

Figure 2.15 Transbay Transit Terminal - Train station platform

Figure 2.16 Transbay Transit Terminal - Birds eye view at night

Precedent 3: Gateway Multimodal Transportation Center

St Louis, Missouri

This transportation center in downtown St. Louis, Missouri is a multifunctional hub not only connects St. Louis with other cities but also distributes bus service within urban zones. Opened in 2008, the center is operating several services 24 hours every day, including Metrolink, Metrobus, regional bus, Greyhound cross-country bus, and taxis. The building expresses its functional performance and multi- dynamic circulation throughout the organization of material scheme and structural composition. For instance, the combination of stainless steel and the multicolor glazing panels in the footbridge zone created a medieval Cathedral-like mosaic window, providing different color shadows during different times of days and years, and thus reflecting and interacting with the pedestrian circulation and passengers' movement[6]. (See Figure 2.17 to 2.21)

Figure 2.17 Gateway Multimodal Transportation Center - Exterior view 1

Figure 2.18 Gateway Multimodal Transportation Center - Exterior view 2

Figure 2.19 Gateway Multimodal Transportation Center - Entry canopy

Figure 2.20 Gateway Multimodal Transportation Center - Tinted glass, inside the walkway

Figure 2.21 Gateway Multimodal Transportation Center - view of waiting area

Comfortable Experience

The importance of the non-travel section in modern tranportation buildings such as airports, transit stations has been rising. Originally planned as an infrastructural building, the distance from check-in to gate, or between different transfer options was kept as short as possible. The modern stations or airports make the passenger pass by as many shops as possible. Especially in large scale airport or rail stations, shops and recreational services can not only help passengers kill time with convenient shopping and entertainment experience, but also become features that attract frequent users as destinations. (Figure 2.22)

As for urban stations and transit hubs, because of their superior locations and large flow of users, the potential for expanding stations with shops and amenities is huge. Furthermore, multiple options of experience can also divide commuters with different needs and time allowance into separate flows. Dividing the flow of travelers is even more crucial for a high-density situation like in China. Extended openning hours and days of shops to accomodate

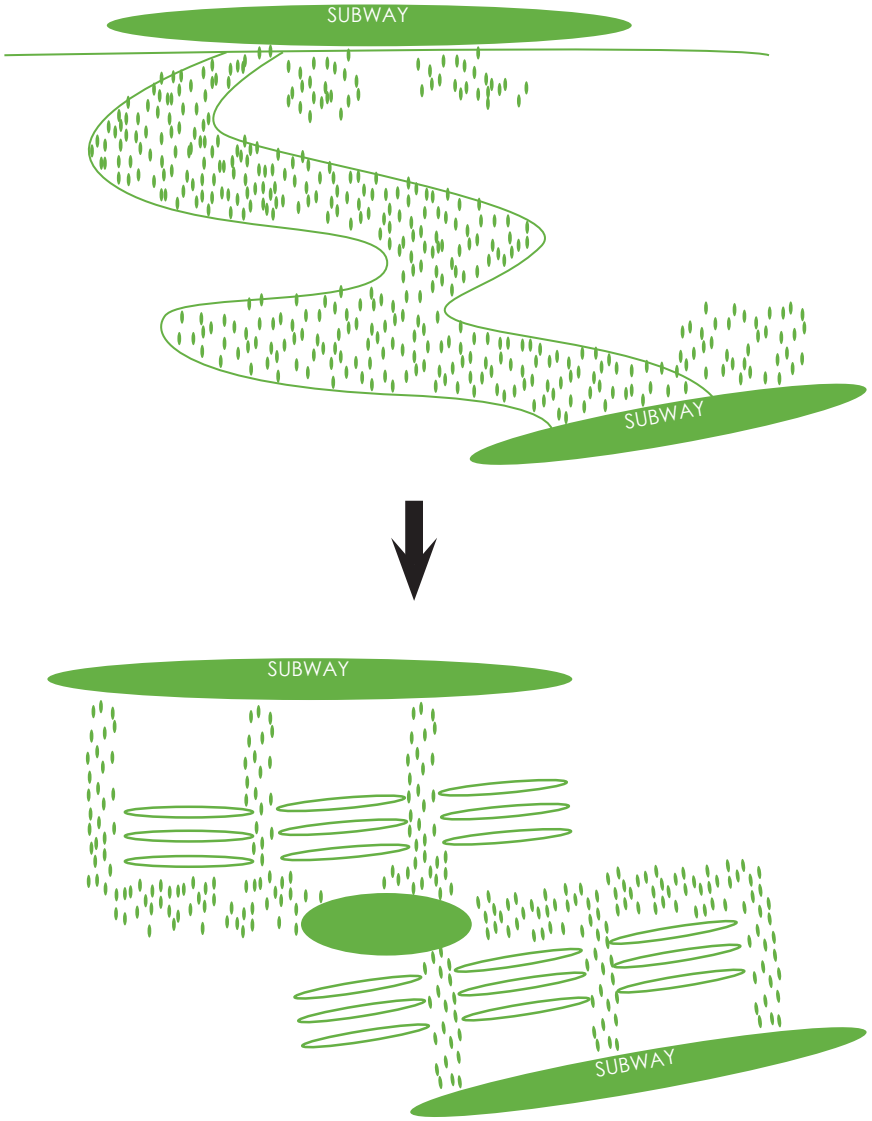


Figure 2.22 Diagram of dividing flow with other experience along transfer

transit schedules not only keep both the business and the station lively, but also secure commuters' convenience and security, especially during night time.

Shops and recreational services should be added into the stations or transit hubs. With easy shops and fast food restaurants, cafes merged into the key station area and along main transfer path, commuters can largely benefit from the convenience with time saved. Expanding the station with more mall-like shops and recreational services, and potetially linking to other shopping centers, will eventually make a transportation center more of a desitination for a neighborhood.

Considerate amenities can bring commuters and users even more disirable experience. For instance, the new Terminal 2 of Munich Airport Center (MAC) has, in addition to luxury shops and gourmet catering, a miniature of Herzog & de Meuron's famous Allianz Arena Stadium, where business passengers have access to interactive touchscreens to get the latest news on economics, politics, finance and sport.

Introducing recreational services to a transportation center can be customized, based on the different cutural character of the neighborhood it is serving. Further connections with the larger urban context should also be considered since transit makes transportation nodes more accessable within the larger network.

Precedent 4: Berlin Central Station

Berlin, Germany, Meinhard von Gerkan

Berlin Central Station is an urban infrastructure to integrate the subway services, commercial programs and other transportation services within one internal space. The glazing dome roof spans across the five stories below not only articulates the lightweight the mega structure, but also creates visual connection with the urban context from exterior. The level 1 and level -2 are two subway lines and platforms positioned perpendicularly with each other. The level -1, level 0 and level 1 are sandwiched between these two subway lines, in order to create a public zone for shopping and entertainment programs. The retail shops on these three levels are designated as different sizes for different purposes, facing each other and have been linked by the corridor circulations and footbridges. The triple-height atrium spaces provide vertical circulations from the platform to the shopping zones directly, together with the horizontal circulations on each level; the mixed-use complex creates a dynamic and public experience[7] [8]. (Figure 2.23- 2.29)

Figure 2.23 Berlin Central Station- Interior view 1

Figure 2.24 Berlin Central Station- Interior view 2

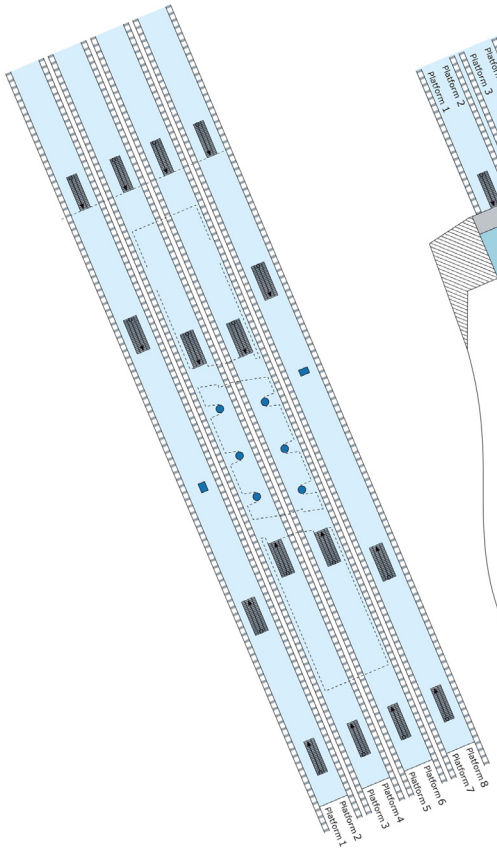


Figure 2.25 Berlin Central Station- Plan Level -2

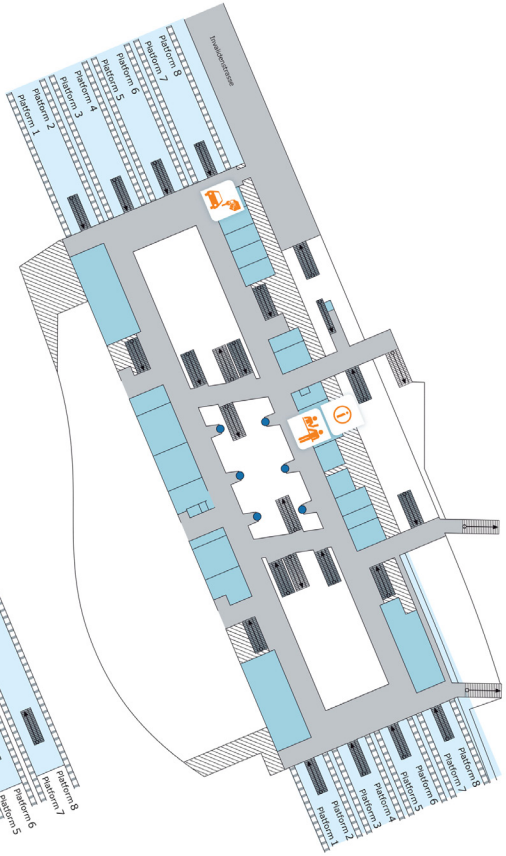


Figure 2.26 Berlin Central Station- Plan Level -1

Figure 2.27 Berlin Central Station- Plan Level 1

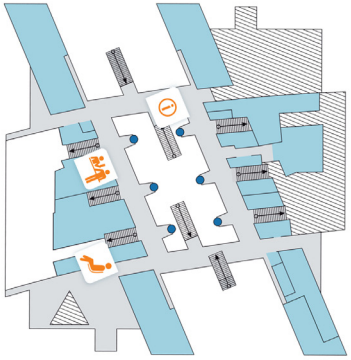


Figure 2.28 Berlin Central Station- Plan Level 2

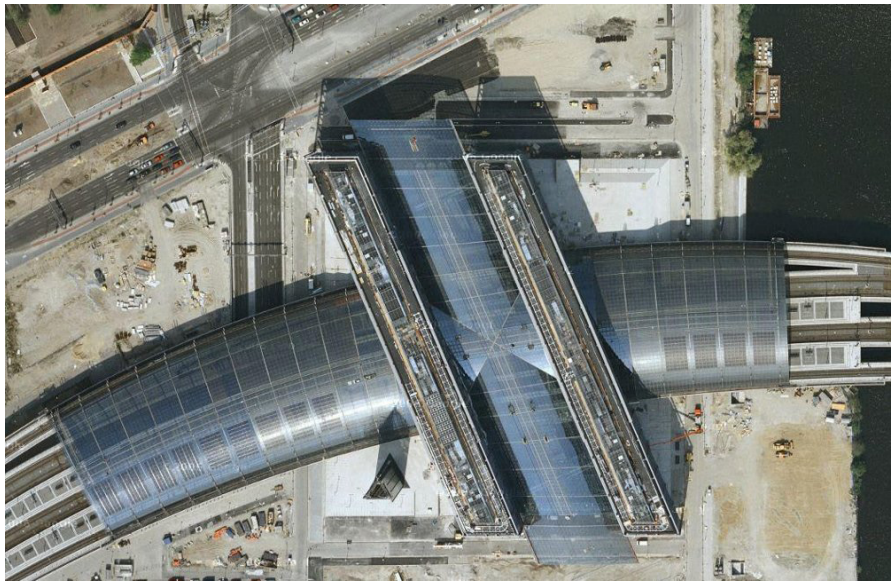


Figure 2.29 Berlin Central Station- Aerial roof plan

Interesting Place

A healthier community should be a walkable community, not relying on automobiles. Transit helps bring vitality and accessiblity to a community originally with problems of traffic congestions, air pollution, and so forth. In order to achieve the purpose of encouraging use of public transit, besides providing enough other uses to activate the space, the station's environment needs to be well designed to be attractive. Moreover, as a public place with high-density of flow, a transit hub is also responsible for contributing to the environment quality and life of the larger neighborhood. Instead of being a pure transportation machine, a transit hub should be a lively civic desitination, which a neighborhood is proud of. The following are ways to consider this subject:

A)Pedestrian friendly and multi-modal arrivals

As a urban public insfrustucture, the transit hub should be pedestrian friendly to allow easy access on foot or bicycle. Moreover, because

of the linkage between mutiple transportation modes, the transit hub should provide approriate entry experience for multi-modal arrivals. Landscaping, and pedestrian-scaled lighting are both good ways to show a welcoming gesture to the community and the users.

B) Interesting features

Public art, special features reflecting its urban and cutural context would be another way of make a transit hub more attractive and interesting. Application of artwork created by local artists, and providing spaces for special events unique to the community, can make the commuters and residents feel more connected and welcomed.

C)Sustainable and green space

Green and urban infrastructure are not exclusive if sustainable design can be carefully carried out, especially when the main purpose of a transit hub is to encourage public transit ridership. Environmental responsibility should be as important in the first stage of design. Moreover, finding a way to integrate the urban scape with natural landscape, thus providing open green space for the community, would be even more beneficial.

"Subways need not be boring or dreary! On the contrary, many operators of metros, subways or underground railways want to attract passengers with good station design. This often means extra effort and cost for the metro operators, but it seems to pay off when a metro is more than just a means of transport but something the residents can be proud of."

Instead of old pictures of messy, dark subway staions full of advertising posters, metro stations throughout the world are presenting more and more interestingly designed stations, together with artworks that best reflect the local culture. They believe that sophisticated architecture can help provide a delightful experience for daily commuters. Distinctive color schemes and works of art helps the orientation of passengers. For instance,several metro subway stations have been turned into museums full of works of art or interesting archeological exhibits, such as the ones in Athens(Figure 2.). Some of the stations feature extrodinarily modern architecture or interior design[9](See Figure 2.20-36).

Figure 2.30 Metro Stations-Syntagma station, Athens

Figure 2.31 Metro Stations-Akropoli station, Athens

Figure 2.32 Metro Stations- Bilbao station, Spain

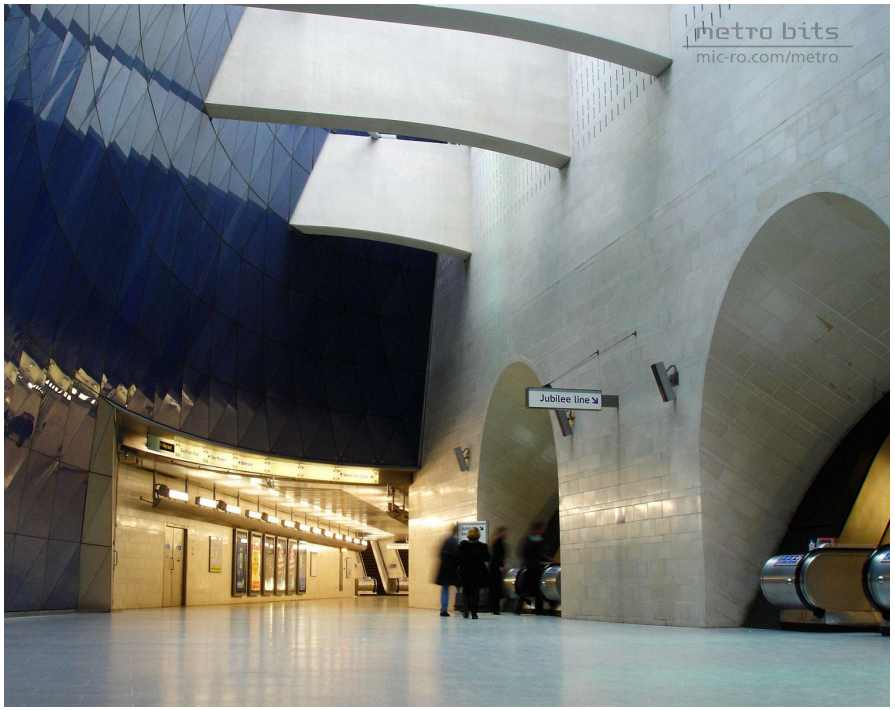


Figure 2.33 Metro Stations- Southwark station, London

Figure 2.34 Metro Stations- Wilhelminaplein station, Rotterdam

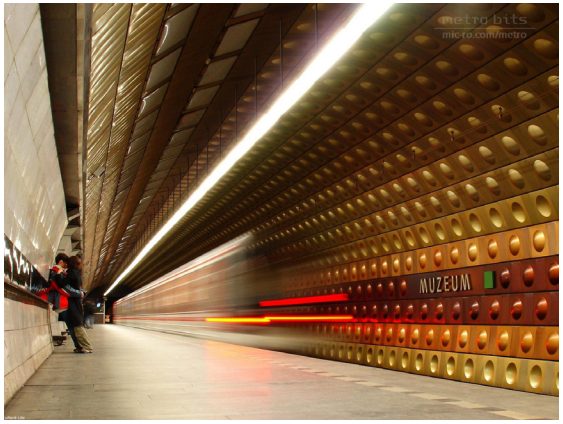


Figure 2.35 Metro Stations- Flora station, Prague

Figure 2.36 Metro Stations- Drassanes station, Barcelona

Precedent 6: Tempe Transportation Center

Tempe, Arizona, Otak and Architekton

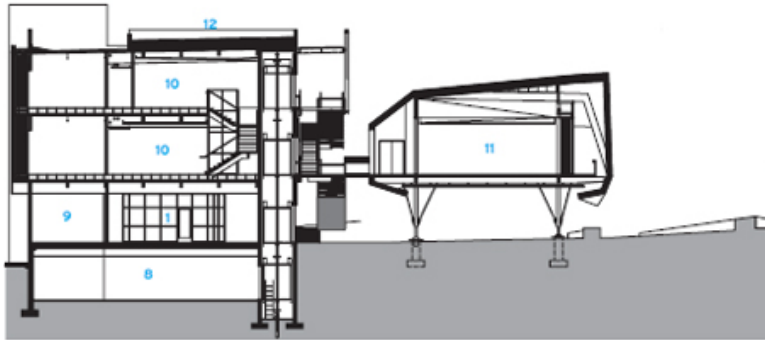


Figure 2.37 Tempe Transportation Center-Section

The transportation center provides multifunctional services including rail, bus riders, cyclists and pedestrians, and incorporates with adjacent office building. More importantly, it mitigates the extreme climate conditions and reduces the energy use during summer time, and becomes one of the fisrt transportation building integrating well with green technology in the U.S.. For instance, the deep shade together with low-E glazing creates a thermal break to deal with solar exposure. As a result, the building consumes about 50 percent less energy than a comparable building. The green desert roof and under floor air distribution system also help to create a sustainable indoor environment[10] [11]. (See Figure 2.37 to 2.43).

Figure 2.38 Tempe Transportation Center-Exterior view

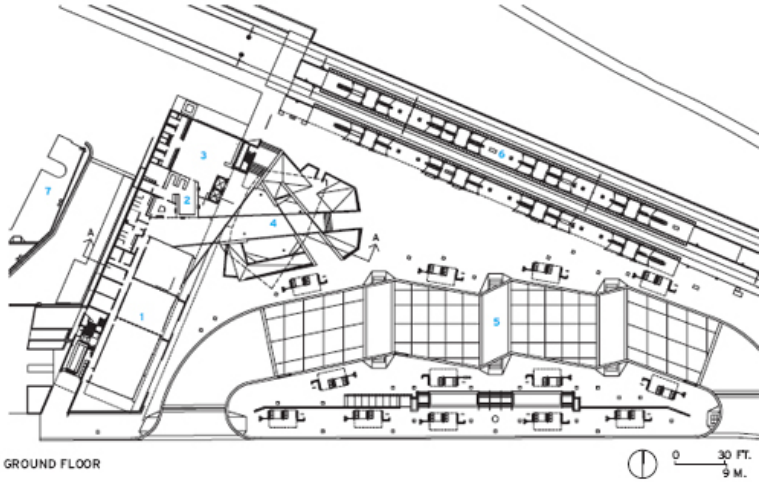


Figure 2.39 Tempe Transportation Center-
Ground floor plan

Figure 2.40 Tempe Transportation Center-
Exterior view at night

Figure 2.41 Tempe Transportation Center-
Entrance view

Figure 2.42 Tempe Transportation Center-
Bird eye view

Figure 2.43 Tempe Transportation Center-
Transit plaza

Findings

In order to improve the transfer environment through the introduction of a new intermodal transit hub, it is important to provide an efficient and seamless intermodal transfer for passengers. Clear circulation and way finding for different modes of transportation are crucial to reach this goal. Besides the primary function of facilitating multimodal transfer, it is important for the new hub to include convenient shopping and other amenities along commuters' transfer. Moreover, in order to help build a vitalized the neighborhood, transit stations need to be expanded with more shopping and recreational functions, potentially linked to other shopping centers nearby. Finally, a transit hub does not have to be a messy and dull transportation machine, it can be well designed with a high aesthetic value. It can provide a more interesting atmosphere to attract more commuters and be seen as a destination. A study of building uses should be drawn from the specific site to explore what functions are lacking or are needed in the neighborhood. It is a good opportunity to include the needed uses to facilitate residents' daily life. The new design should be drawn at the scale of urban design and architectural design, providing not only easier transfer options, but also a pedestrian-friendly urban place for the neighborhood.

Chapter 3: Methodology

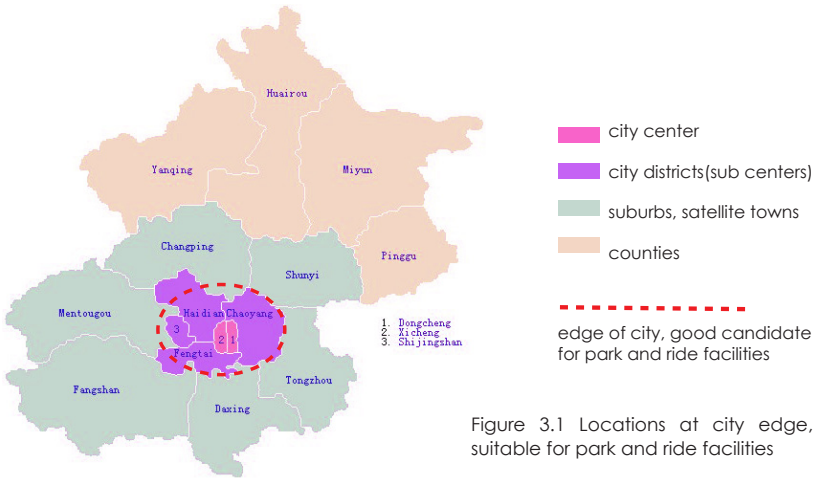


Figure 3.1 Locations at city edge, suitable for park and ride facilities

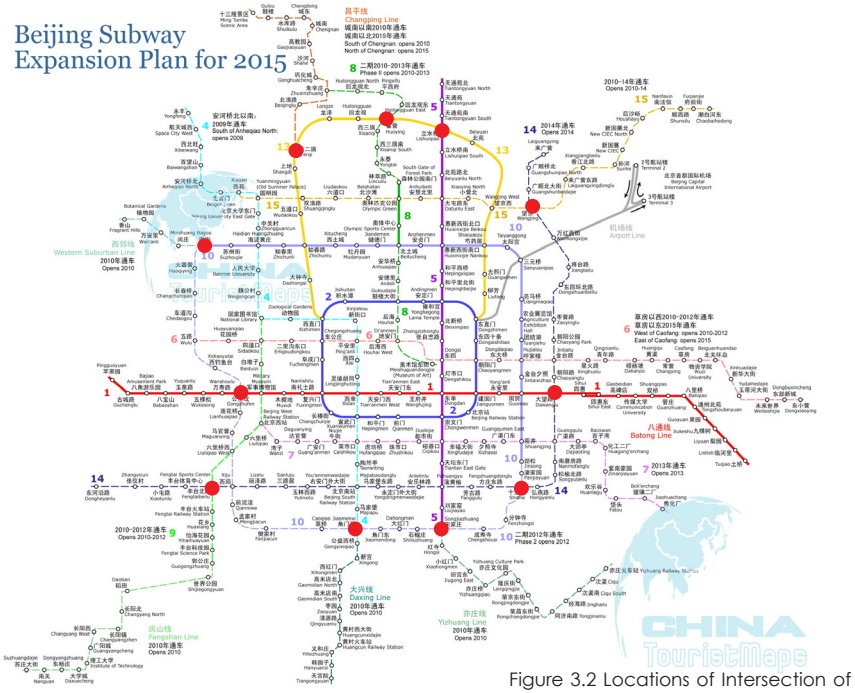


Figure 3.2 Locations of Intersection of two subway lines at city edge on 2015 subway planning map

In this chapter a site for the new intermodal transit hub is selected and analyzed at different scales. The problem of transfer experience is also discussed. The chapter ends with preliminary design goals.

Site Selection

Criteria

A) The site should be on edge of the city so that park and ride facilities can be included in the new hub to reduce car usage in main city areas(Figure 3.1);

B) The site should currently act as an importatant transfer node, which normally is at an intersection of two subway lines(Figure 3.2).

C) The surrounding site should contain large flow of more than 2 other modes of transit such as bus, taxi, commuting bus, bicycle, and pedestrian.

D) The site and current station should have unsatisfying existing conditions.

Selected Site

The selected site is called Li Shui Bridge station, which is at the intersection of subway line 5 and subway line 13. Line 5 is the most important link on north-south direction of Beijing. The current station, together with two other close stations, serve large amount of daily commuters from Asia's biggest residential neighborhood, Tian Tong Yuan.(Figure 3.4)

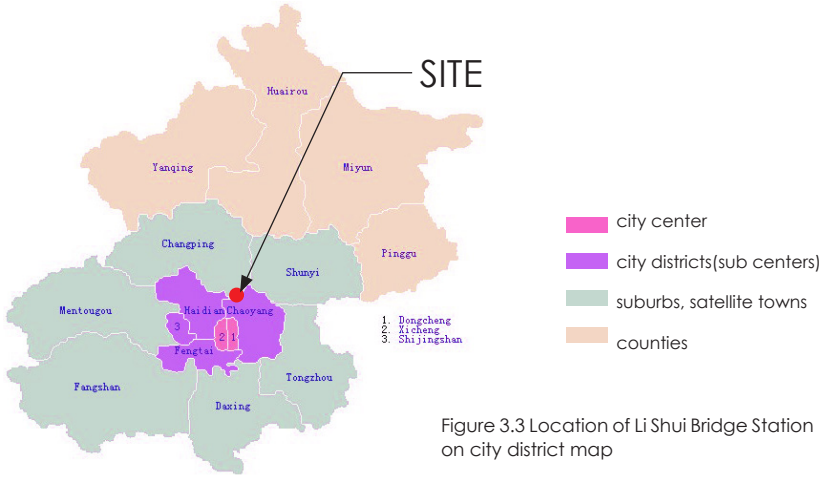


Figure 3.3 Location of Li Shui Bridge Station on city district map

The Neighbourhood: Tian Tong Yuan

Introduction

Tian Tong Yuan is situated in northern Beijing, on the edge of the Chao Yang District and Chang Ping District (Figure 3.3). It is between the 5th and 6th Ring Road, at the intersection of two subway lines(Figure 3.5). The 2008 Olympic Park is to the southwest of the neighbourhood. Its southern boundary is formed by the Qing River. Tian Tong Yuan is the largest residential neighbourhood in Asia with over 400,000 residents occupying 1,978 acres of land(Figure3.6). The neighbourhood is surrounded by other less developed residential neighbourhoods to the north, east, and west. A mega neighbourhood, it is subdivided into East, West, North, Central, and

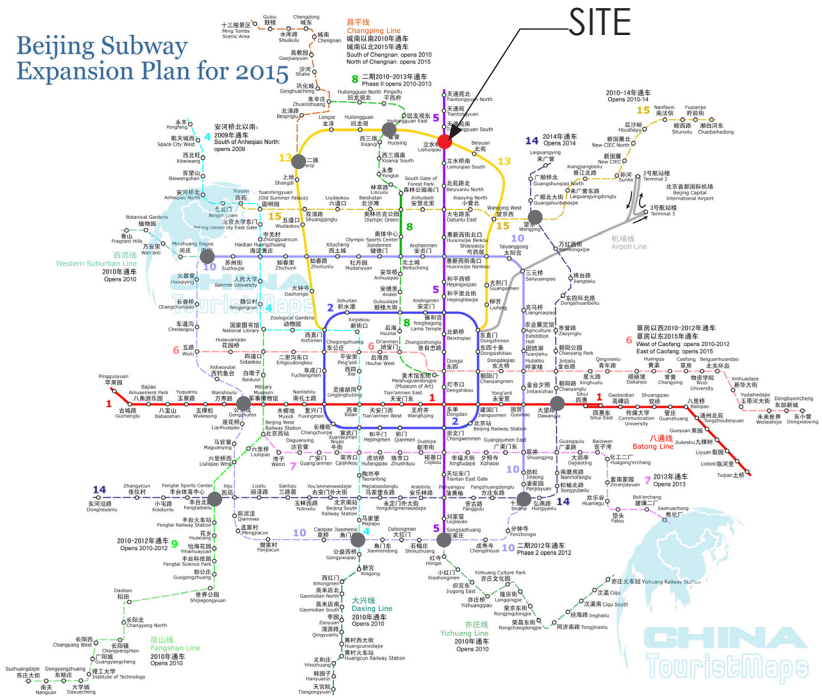


Figure 3.4 Location of Li Shui Bridge Station on 2015 subway map

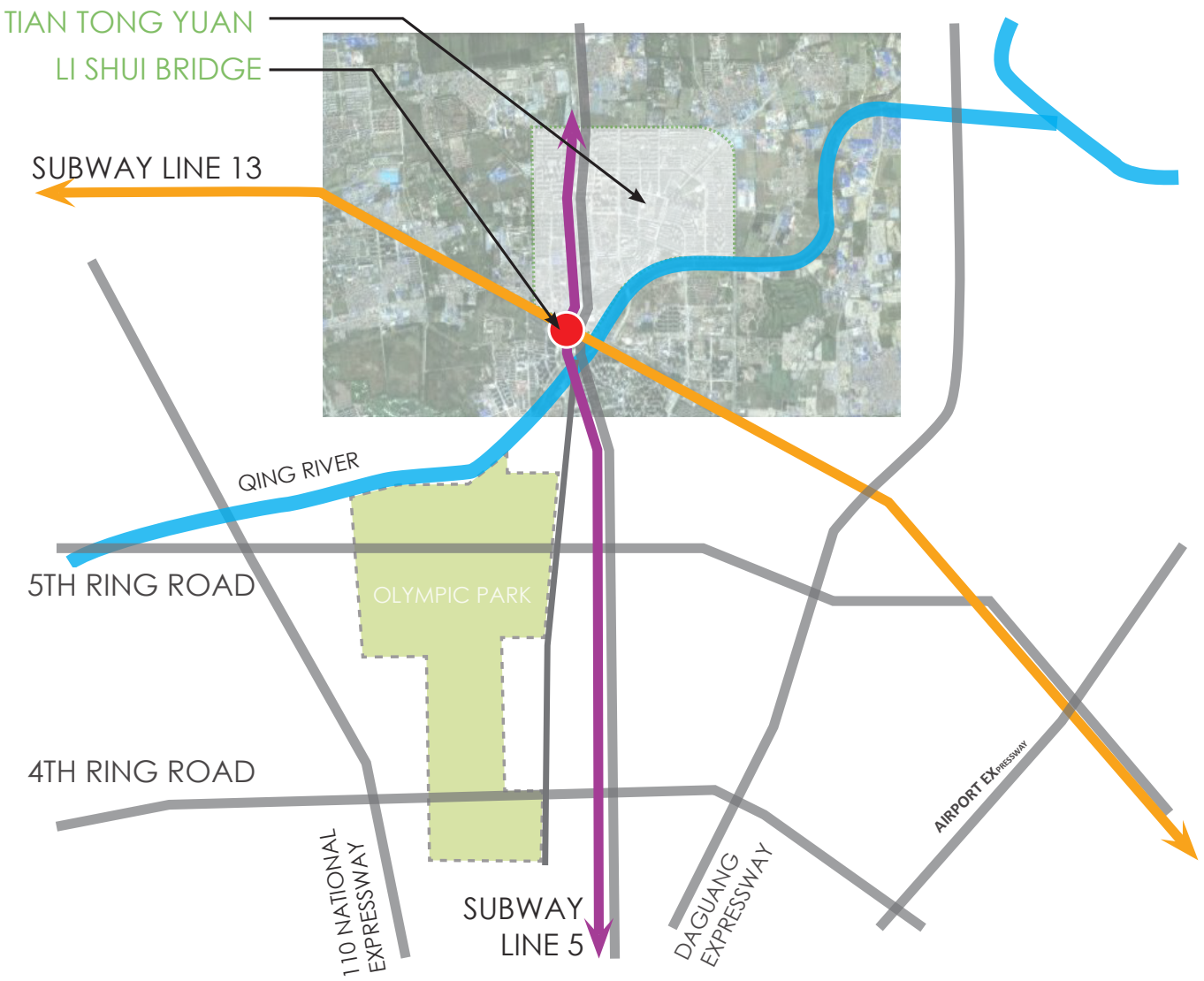


Figure 3.5 Site urban context

Figure 3.6 Comparison between Tian Tong Yuan Neighborhood and Seattle at same scale

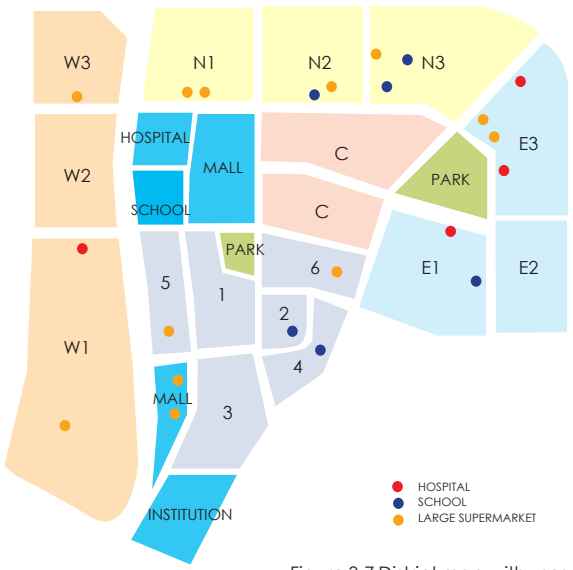


Figure 3.7 District map with uses of Tian Tong Yuan

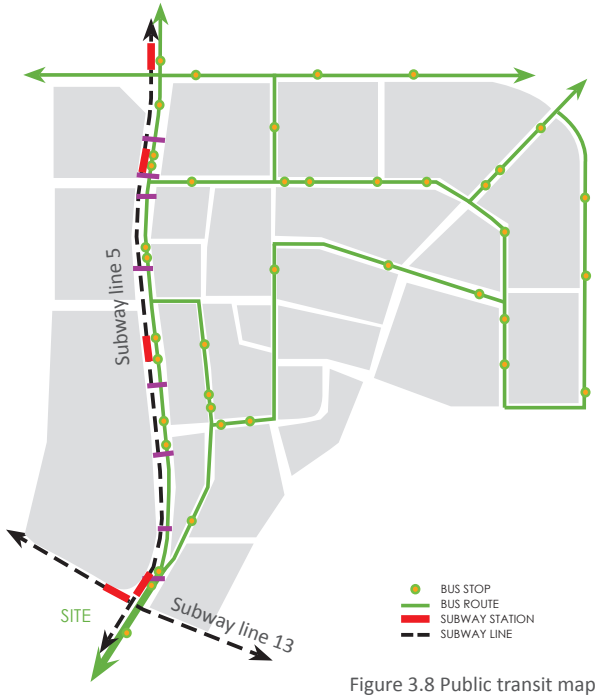


Figure 3.8 Public transit map of Tian Tong Yuan

Old Districts, which are further subdivided into sections. (Figure 3.7) Currently uses in the neighborhood is limited and insufficient to the users' amount. Main daily activities have to be taken outside the neighborhood. In latest development, there were a few malls and schools introduced into the neighborhood. But clearly more retail shops are still needed to fulfill the residents' everyday need.

The transportation system serving this mega neighbourhood consists of the Li Tang Road, which turns into the An Si Road and connects Tian Tong Yuan to the city centre to the south and to other residential neighbourhoods to the north. Subway Line 5 also runs south into the city centre, terminating just north of the Tian Tong Yuan neighbourhood. It has two stops within the neighbourhood and another on the southern edge of Tian Tong Yuan. A second subway, Subway Line 13, running perpendicular to Line 5, connects to neighborhood on the east and west. The station where these two subway lines intersect is called the Li Shui Bridge Station. Finally, Tian Tong Yuan has 30 bus lines. However, this site analysis will focus on those that serve the Li Shui Bridge Station, which includes 17 lines(Figure 3.8).

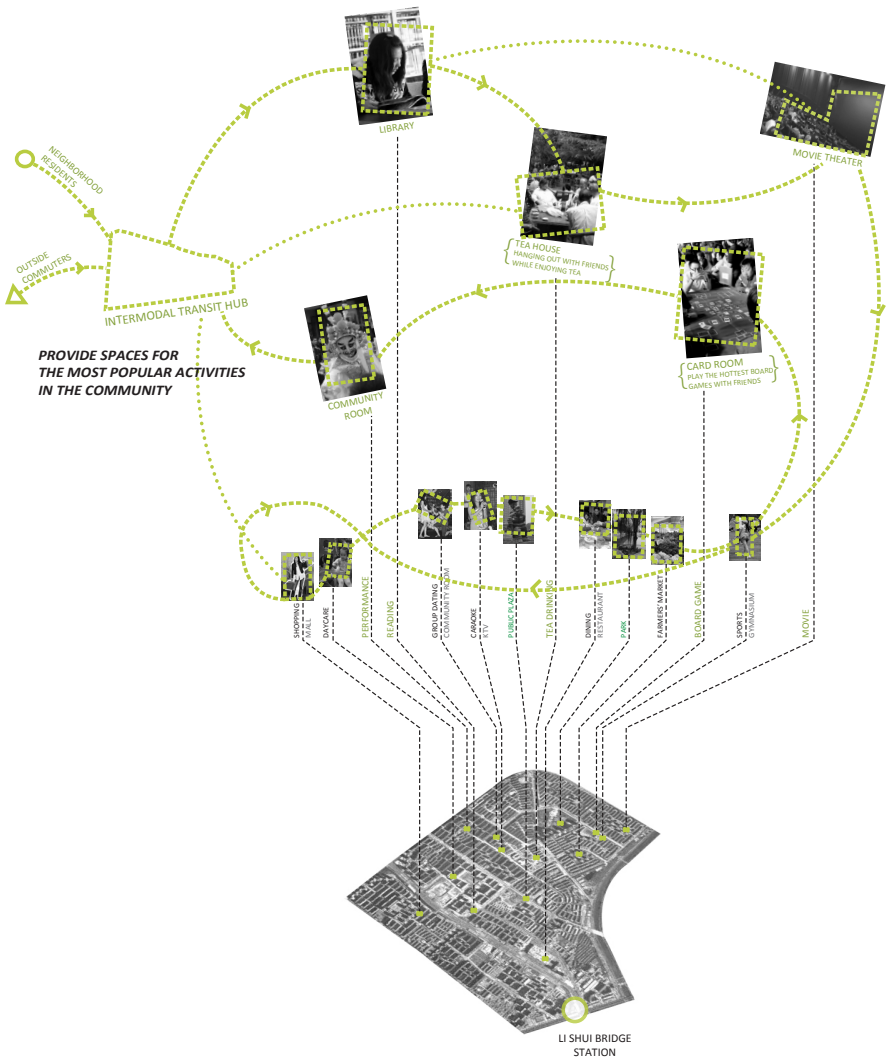
Traffic congestion Problem

Severe traffic jams occur on the Li Tang and An Si Roads, creating daily nightmares for the residents who commute to the city centre for work or school (Figure 3.9). These traffic problems are due to three major planning failures: first, the size of this mega neighbourhood and its lack of a mix of uses. As shown in Figure 3.6, the size of Tian Tong Yuan is huge comparing to Seattle, but it consists entirely of residential and a small amount of retail and other uses. The lack of mixed-use properties means that residents must commute to other neighbourhoods to carry out their daily activities, and then commute back in the evening to their apartments. Travel south to the city centre in the morning and north to the residential neighbourhood in the evening is especially difficult.

Second, the carrying capacity of the Li Tang/An Si Roads is insufficient, given the size of Tian Tong Yuan. Moreover, Li Tang/An Si Roads are serving not only as the main north-south access for the neighbourhood, but also as a gateway through Tian Tong Yuan, from northern suburb to the city centre. To the south, Li Tang is a six-lane road; at a fork in the road in the Old District the eastern leg that serves the neighbourhood continues as six lanes and branches out to another two-lane road (Figure 3.10).

Figure 3.9 Photo of congested Li Tang / An Si Road, looking north, taken at 8:00am. Almost all traffic congested on the side to city center on south.

Figure 3.10 Photo showing traffic merge into bicycle lanes in front of the station's entrance



EXISTING ACTIVITIES & PLACES
+
EXISTING ACTIVITIES WITH NO FORMAL SPACES
+
OPEN SPACE / PARK

Figure 3.11 Analysis of uses and activities in Tian Tong Yuan

Finally, public transit stations are spaced quite far apart so that many commuters must walk long distances to get to the nearest stop. Because of the inconvenience of taking public transit, more and more residents are choosing to drive to work. These vehicles add even more traffic to the already crowded Li Tang/An Si Road. Moreover, a type of illegal taxi and motorcycle largely emerged to fulfil commuters' need of travelling between home and bus stops/ subway stations. These vehicles are regarded as illegal because they are normally privately owned but unlicensed, thus cannot provide security for passengers. More and more illegal vehicles are hanging around on the main roads in Tian Tong Yuan, negatively influencing the community's order, security, and environment.

Analysis of activities

Currently there are several activity gathering spots in Tian Tong Yuan, serving as the most popular destinations in this area(Figure 3.11). Popular activities during spare time of the residents include dining out, karaoke, sports, chess or card game playing, shopping and so forth. Also, according to an online survey about facilities that the residents would like to have in the future, designated card room, tea house, library, gymnasium are currently laking and needed, while more shopping malls, restaurants, karaokes, and farmers' market are welcomed, too.

The Site: Li Shui Bridge Station

Li Shui Bridge Station is on the southern edge of Tian Tong Yuan neighborhood, containing the on-ground Line 5 and the elevated Line 13(Figure 3.12-3.13). The station not only serves large amount flow of commuters from Tian Tong Yuan, together with three other subway stations along Li Tang Road, it also serves users from its south, and acting as an important transfer node in this area.

Analysis of uses and flow

The existing station is bordered by Li Tang Road on east, a residential neighborhood to the northwest, and Lishuiqiao Park on south. Across the fast 6-lane Li Tang Road, there is mixed-use area including residential, commercial and institutional uses. Pedestrian from this side of road use a pedestrian bridge to reach the station. Also, there is an elevated service track linking the two main tracks together on the northwest side of the station.

There are several modes of tranportation around the site including subway, cars, taxis, buses, bicycles, and pedestrian(Figure 3.14). Besides subway Line 5 and Line 13 run perpendicular to each other, the main traffic of cars and taxis happens to the east of the station, on Li Tang Road. Li Tang Road turns into two branches on the north of the station. Bicycle and motorcycle lanes are on both sides of Li

Figure 3.12 Location of Li Shui Bridge Station

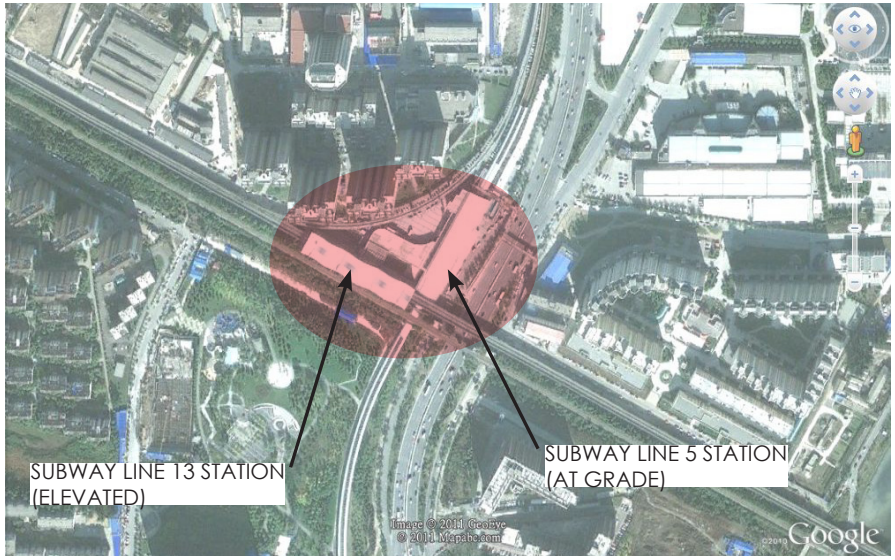


Figure 3.13 Aerial map of the immediate site

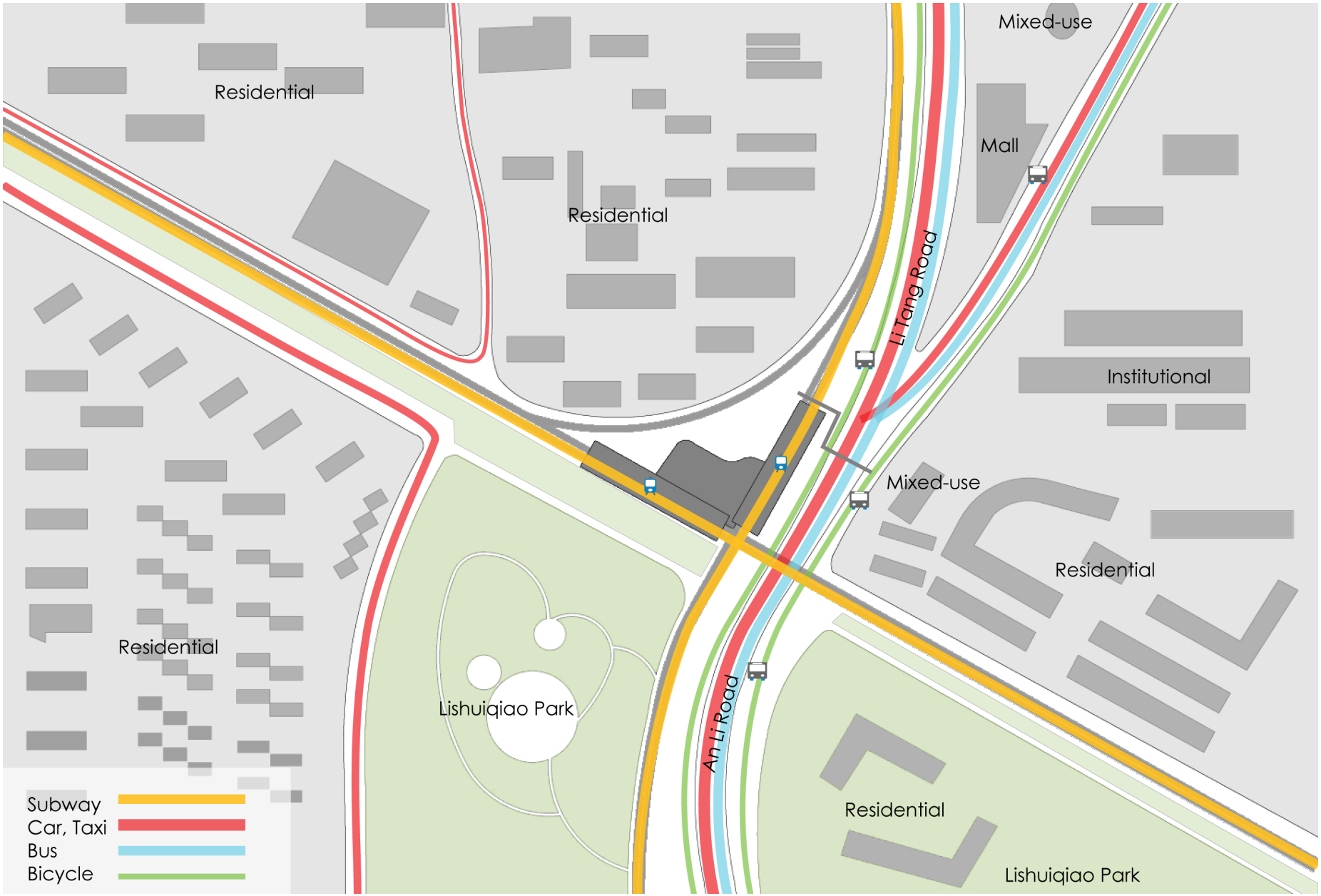


Figure 3.14 Analysis of transportation flows

Tang Road. There are bus stops adjacent to the station, and one more each on its north and south along Li Tang Road.

The existing station present public access for pedestrian on two sides, the northwest neighborhood side and the east road side. Access for users from its south aren't addressed in current condition(Figure 3.15-3.17). Also, since subway Line 5 is on ground, creating a barrier between the neighborhood on the west and Li Tang Road, pedestrian need to use the same pedestrian bridge to go acorss Li Tang Road and track of Line 5.

Due to its strategic location at the intersection of two subway stations and a fork in the main road serving the Tian Tong Yuan neighbourhood, this thesis will focus on improving transfer experience and on creating a vibrant community hub for the

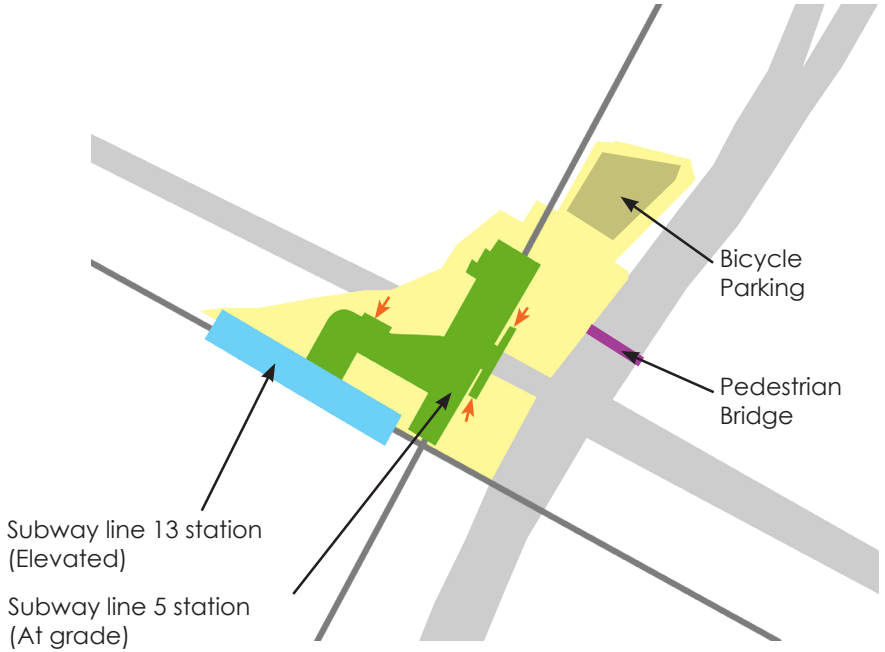


Figure 3.15 Map of Li Shui Bridge Station

Figure 3.16 Photo of Li Shui Bridge Station

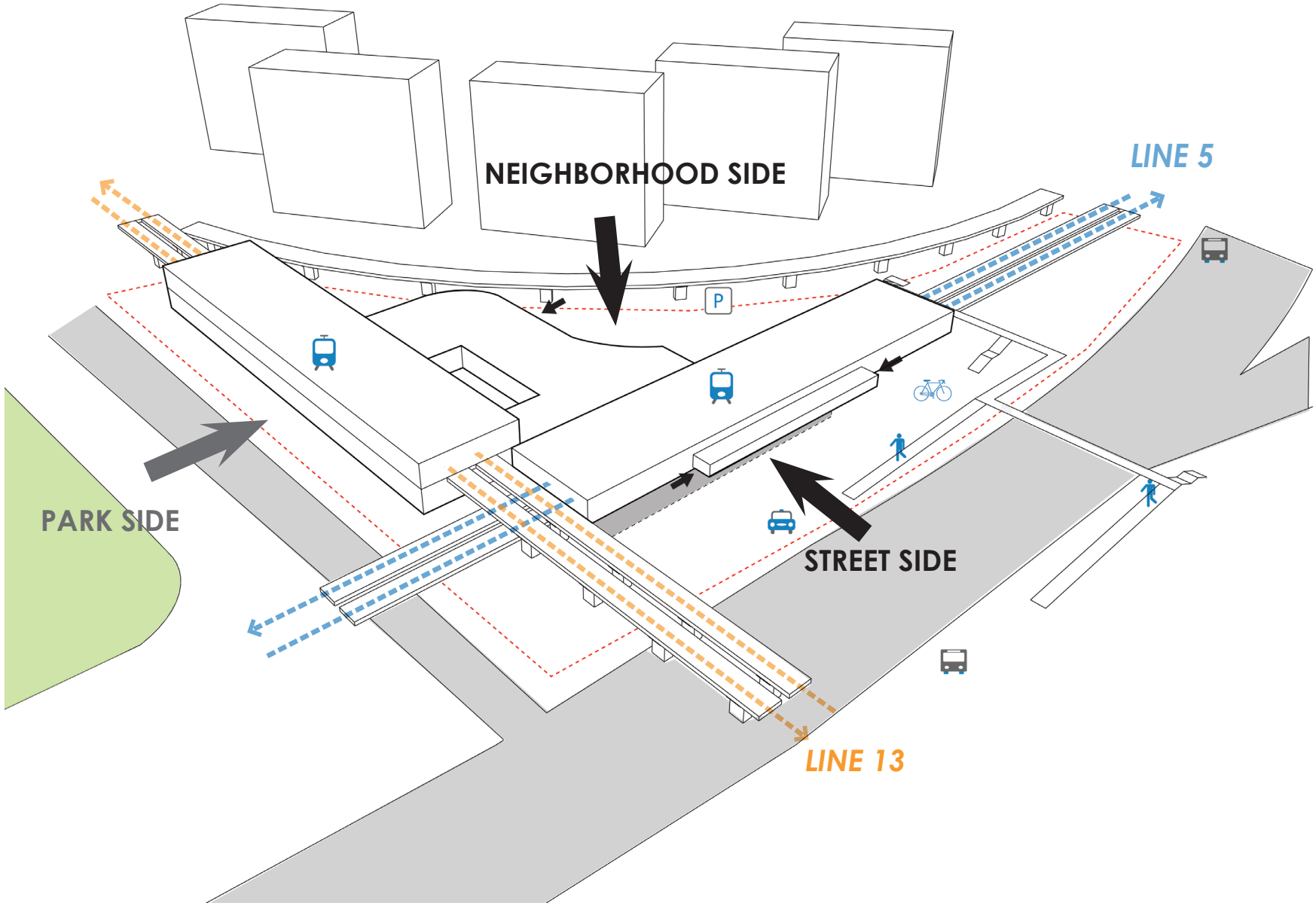


Figure 3.17 Diagram of current condition

neighbourhood at the Li Shui Bridge Station. In addition to the inconvenience of travelling between homes and bus stops or subway stations, another reason that impedes commuters from using public transit is that, the Li Shui Bridge station presents numerous problems.

A) Transfer Problems

The stations for Subway Lines 5 and 13 are in separate buildings that were built at different times. Consequently, the station for Line 5 is at grade while the station for Line 13 is elevated, and they are located some distance apart. Commuters need to use a linking structure to transfer between the two lines. The circulation and signs within this structure are so confusing that commuters can easily miss the right escalator and go out of the exits, from where they need to repurchase tickets unnecessarily to enter again(Figure 3.18).

The elevated Subway Line 13 has a parking lot below, which used to be free and served as a virtual Park and Ride. However, fees began to be charged in 2010, so commuters stopped using it. Lacking free parking around the station, the use of public transit lessened and traffic congestion worsened. Some drivers now park cars randomly in the adjacent area which makes the surrounding neighborhood disordered(Figure 3.19). On the other hand, bus and taxi stops are

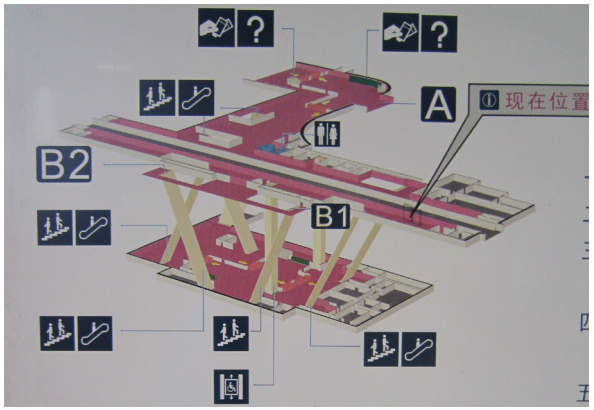


Figure 3.18 Line 5 station map


Figure 3.19 Photo showing radomly parked cars around the station


Figure 3.20 Photo showing crowded entrance with buses, taxis, vendors, and commuters

Figure 3.21 Photo showing the bicycle parking lot

Figure 3.22 Photo showing the pedestrian bridge

Figure 3.23 Photo showing the bus stops nearby

not integrated into the station design, thus the entrance of the station along Li Tang Road is always crowded, full of commuters, commuting buses, taxis, vendors and commuters(Figure 3.20). However, one positive thing about the Li Shui Bridge Station is that it has an area for bicycle parking. When parking was free, it was unsafe to leave bicycles there because of the lack of management and security. Now the for-fee parking lot has a guardian and monitor to secure the area from theft(Figure 3.21).

B) Experience problems

Commuters must use a pedestrian bridge to cross over Li Tang Road, for example if they want to catch a bus travelling in the opposite direction or to transfer between a bus line and a subway line. The bridge has no overhead weather protection and is filled with unsightly posted advertisements (See Figure 3.22). During peak hours, peddlers and vendors fill up the width of the bridge, making the place dirty and hard to walk through. The peak-hour congestion on the bridge combines with the congestion created below by the fork in the road, resulting in a noisy, polluted, unprotected environment for pedestrians. Moreover, after peak hours at night, security poses a big problem for pedestrians as the bridge has no "eyes" to assure their safety.

Bus stops are currently along the main fast road, without weather protection(Figure 3.23). Besides unpleasant waiting experience, buses also have problems to pull over if the road is congested with traffic. Taxis or those illlegal "taxis" do not have designated drop-off area currently, which also leads to a more disordered site condition(Figure 3.25).

A lack of affiliated commercial and service space in the station not only makes the flow of commuters difficult, but also leads to the current aggregated vendors mixing in the crowds. Commuters transfer experience is dull and crowded, without any other options.

Figure 3.24 Photo showing vendors on the pedestrian bridge

Figure 3.25 Photo showing randomly parked illegal taxi

Design Goals

As the problems described above, the new intermodal transit hub is proposed to acheive the following goals(Figure 3.):

A) Integrating the existing mutiple modes of transportation together as an intermodal transit facility to allow efficient transfer;

B) Introducing shopping and other amenities into the new hub to enrich the commuters' transfer experience, and to vitalize the community.

Programmatically, the new intermodal transit hub will integrate

all existing modes of transportation together into one multi-level, multi-use 24/7 civic place. All modes of transportation will have designated space and are weather protected. Park and Ride for automobies, bicycle storage facilities will also be provided in the new hub to encourage use of public transit. The hub will link every direction through a more public gesture instead of a single pedestrian bridge. Easy shops and fast food restaurants will be provided along commters' transfer. Programs that are currently lacking or very popular in the neighborhood will be introducted into the complex, to enrich the options and experiences for users.

Figure 3.26 Diagram of design goals

Design objectives include, creating visual connections between different facilities to serve faster transfer between different modes; Providing clean and delightful civic place along with services and amenities to attract more users; Centering a plaza with transit happning on it, around a dynamic vertical circulation element; Providing green space and sustainable features in the new civic node.

Program of Spaces

Programs are roughly divided into three main categories: Transit facilities, commercial and community services. Total area is combination of both interior conditioned space and exterior plaza(Figure 3.27).

PROGRAM	Area(SF)	Subtotal(SF)	Total(SF)
Transit Facilities			461,000
Subway station		270,000	
Transit plaza(Exterior)		136,000	
Bus transit center	65,000		
Taxi drop-off	5,000		
Parking		50,000	
Bicycle Storage Facility		5,000	
Commercial			465,000
Shop		270,000	
Restaurant		70,000	
Farmers' market		30,000	
Karaoke		58,000	
Gymnasium		37,000	
Community Service			32,000
Gallery		10,000	
Card room		5,000	
Tea house		5,000	
Common room		12,000	
Unassignable			80,000
Mechanical		60,000	
Vertical circulation		20,000	
			1,038,000

Figure 3.27 Program of spaces

Chapter 4: Design Solution

Concept

The design concept of a climbing green "spiral" is suggested by the two existing subway structures. The at-grade structure of Line 5 and the elevated structure of Line 13 form a perpendicular spatial relationship and "climbing" tendency. A spiral of shops and other amenities is merging into the lower station, together with a large green park at the spiral roof to benefit not only the commuters, but also the surrounding community(Figure 4.1).

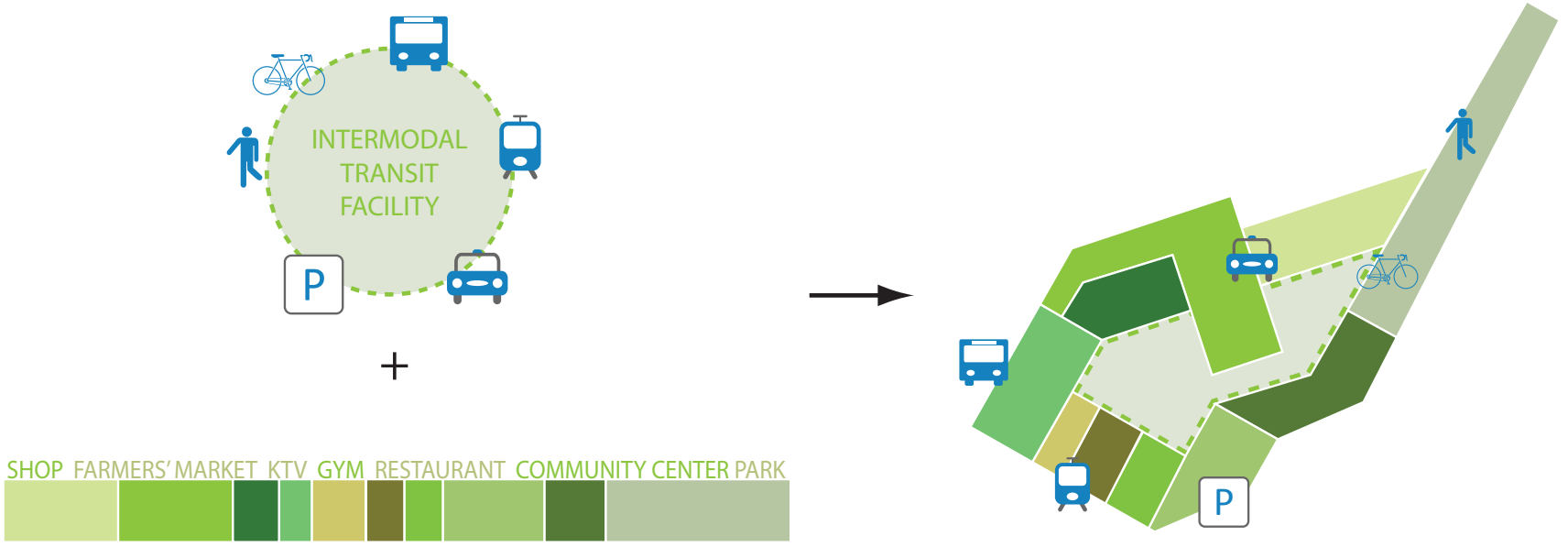


Figure 4.1 Diagram of design concept

Evolution

1. Under current conditions, different modes of transportation are not well integrated, with only two directions of flow are addressed. New access on the southwest park side is proposed in the new design.

2. In this thesis, the assumption of existing structures are only the two subway tracks, one on ground and one elevated, perpendicular to each other.

3. Leave space for platforms of two subway lines along the tracks.

4. An underground transit plaza is proposed in order to bring buses and taxis into the hub. The reason to bring the transit one level down is because the at-grade track of Line 5 blocks the site from the street side. Comparing with a roof-top transit plaza, an underground plaza has less of a structural challenge. The main connection between the underground plaza and upper levels are two double-high spaces. Commuters from the street side also need to go down to this level to reach Line 5 above. Moreover, lots of retail and market space are surrounding the plaza, providing convenience for daily commuters to easiliy purchase breakfast in the morning or grocery after work. Other commercial shops are activated by the large flow of commuters, meanwhile bringing the plaza more vitality.

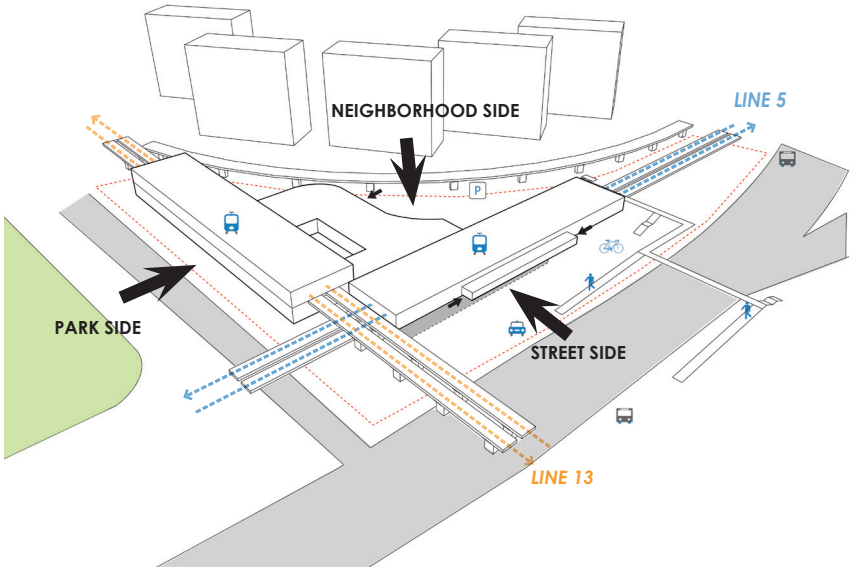


Figure 4.2 Evolution - Current condition

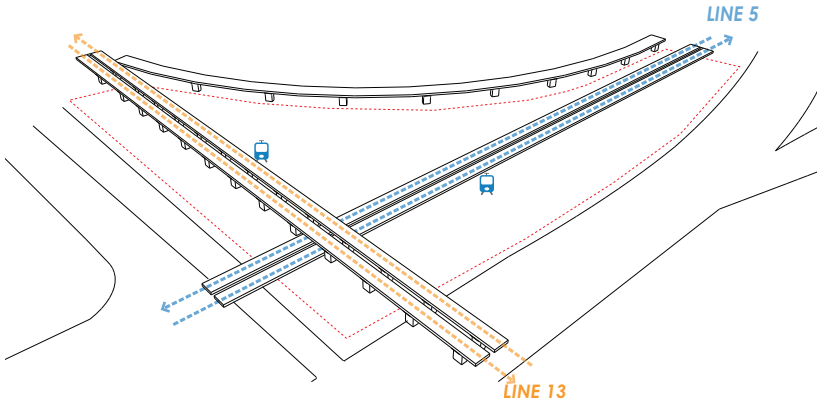


Figure 4.3 Evolution - Existing structure

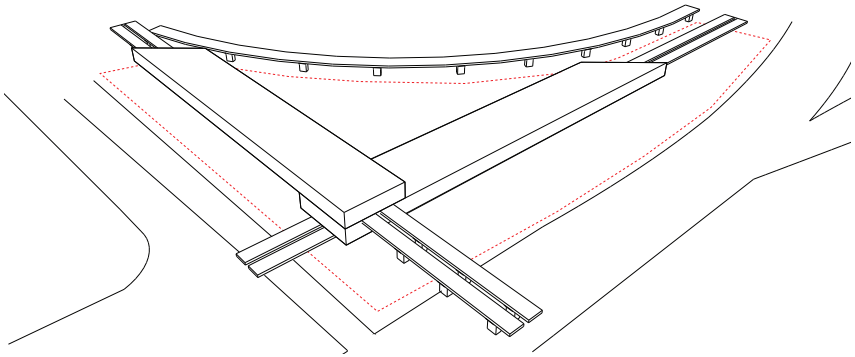


Figure 4.4 Evolution - Platform

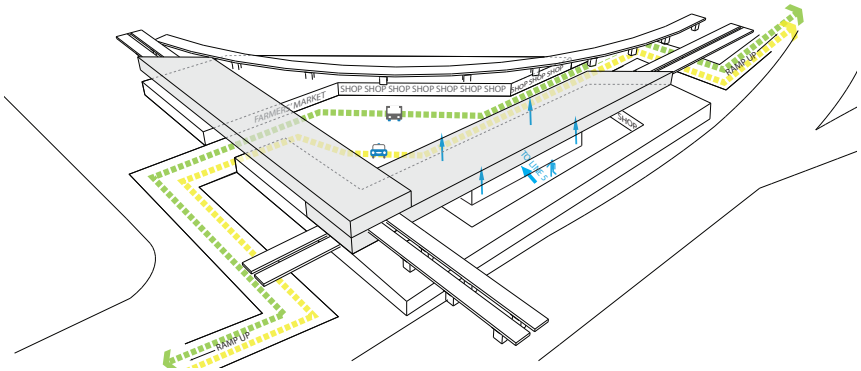


Figure 4.5 Evolution - Underground transit plaza

5. The ground level station in-between the two perpendicular subway lines brings commuters from the neighborhood side and park side into the building. From the concourse, commuters can choose to go up to Line 13, or directly go to one side of Line 5. Commuters need to take escalators down and up, to reach the other side of Line 5. Shops, ticket booth and information office are provided in this level, too. Commuters from the street side can go down to the transit plaza, or use the station down there to reach Line 5 above.

6. The second level of station space provides access to the side of Li Tang Road. Commuters can use escalators to reach this level and use Line 13.

7. The spiral full of shops and other recreational programs merges down to the station levels, with the spiral roof park on top. The park ramp starts from the street side, allowing pedestrians and bicyclists to climb up. Upper program spaces are not simply staggered onto the lower portion. Instead, all programs are intertwined, sharing lots of visual connections.

8. The outcome of the completed spiral complex also creates a roof plaza in the center, allowing outdoor activities and events.

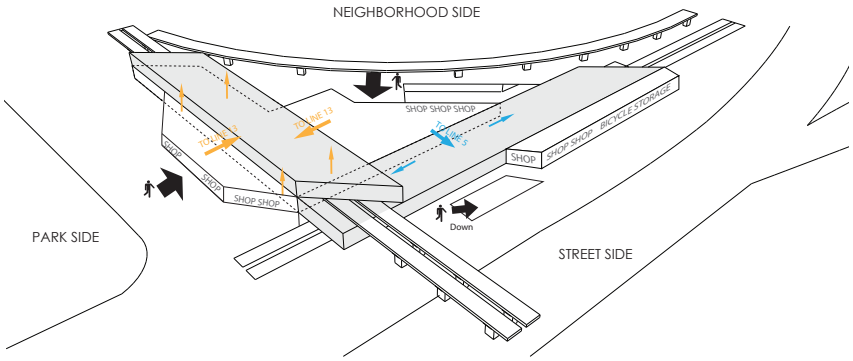


Figure 4.6 Evolution - Ground level

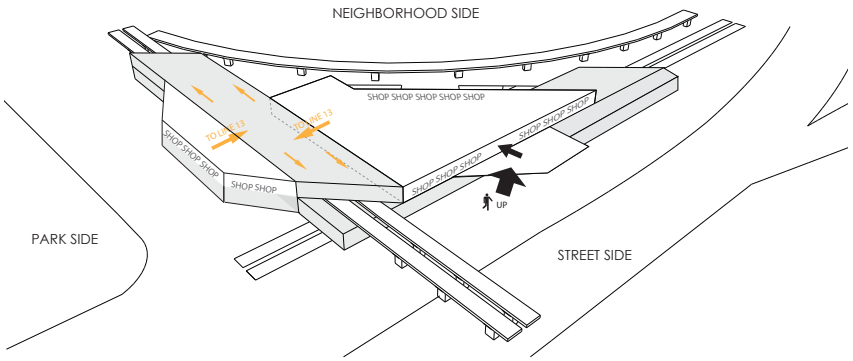


Figure 4.7 Evolution - Second level

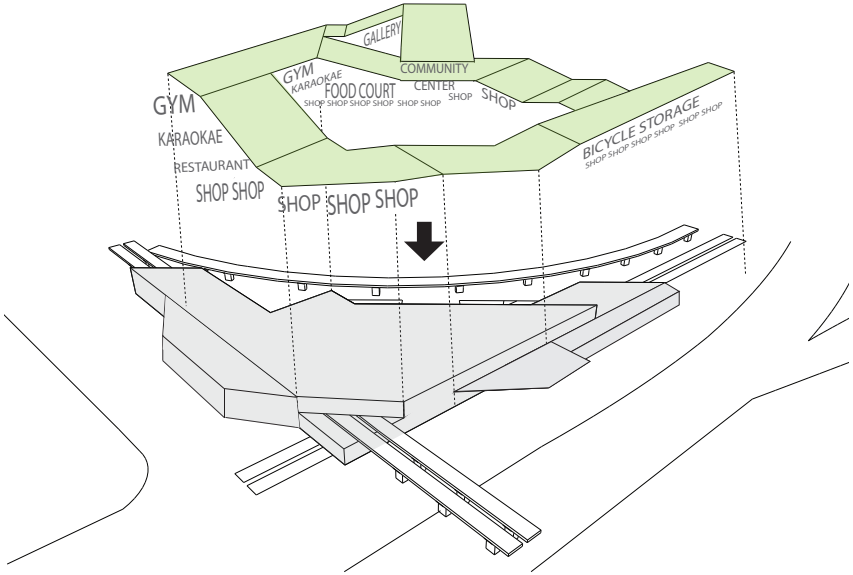


Figure 4.8 Evolution - The spiral

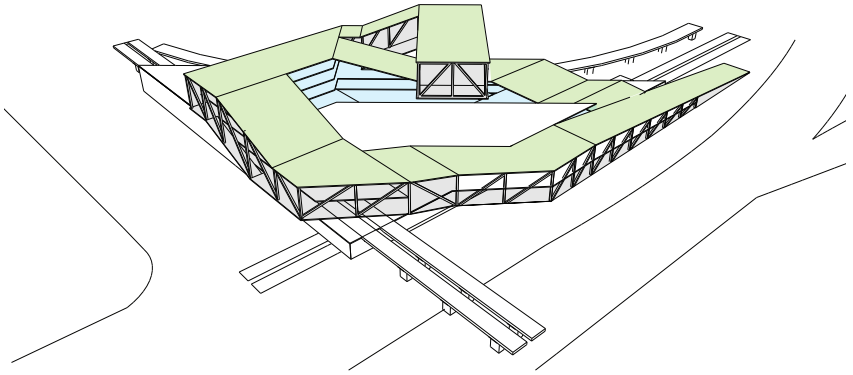
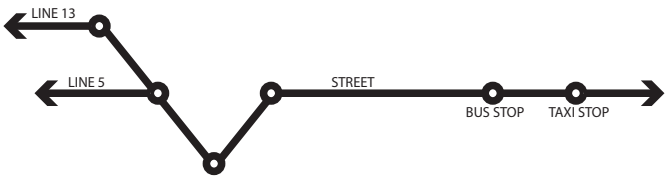
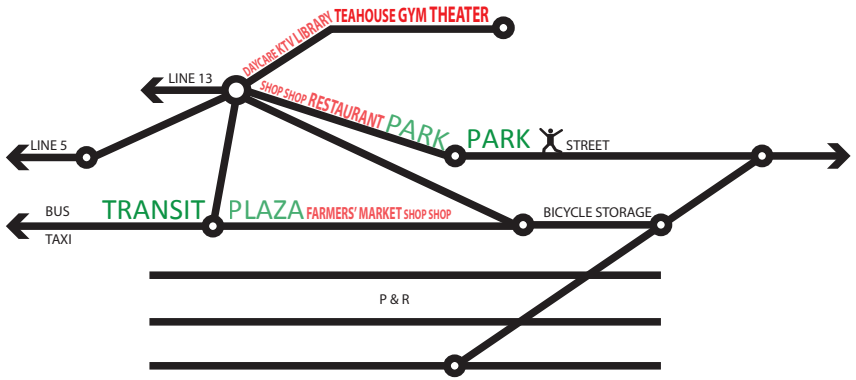


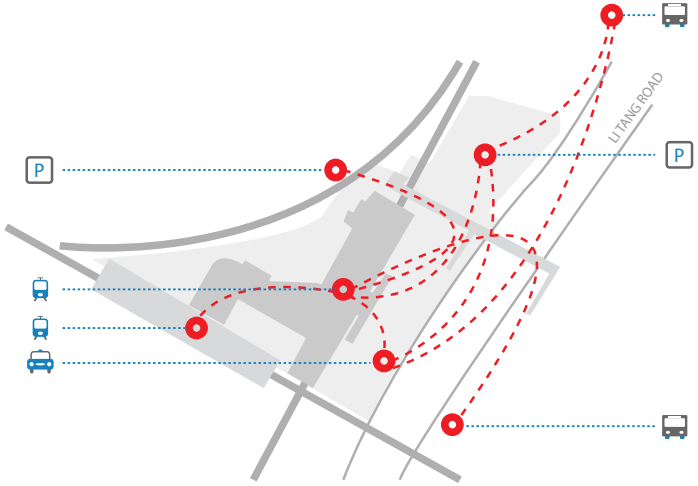
Figure 4.9 Evolution - Outcome

BEFORE

AFTER







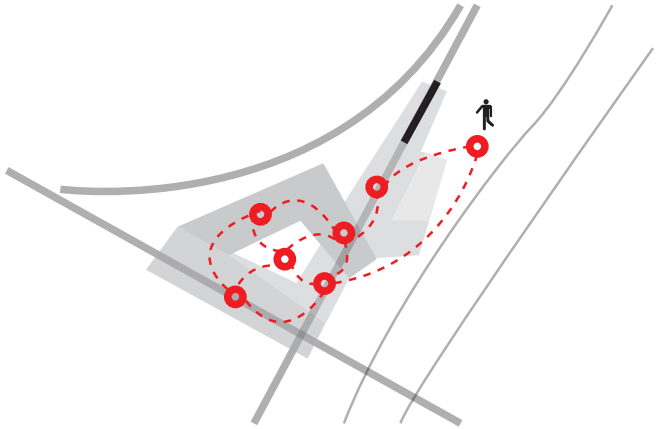


Figure 4.10 Diagram of before-after comparison

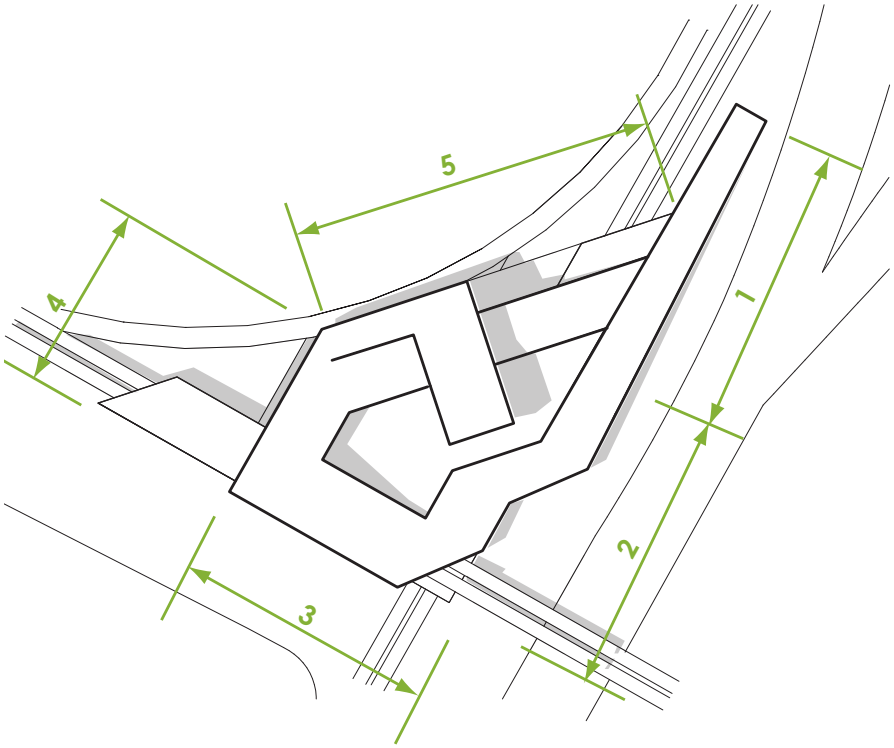


Figure 4.11 Roof plan

Design Outcome

As shown in Figure 4. , instead of disconnected transit modes, the new hub presents an integration of transportation. It also costs less energy to make intermodal transfer. Spatially, the new hub shows a more dynamic network of programs, spaces, and connections, rather than the existing linear paths with limited options of experience.

As shown in Figure 4. and 4. , from unfolding sections of the spiral, spaces and movements are dymically integrated into a whole, under a unified ramped roof park. The park with pedestrian-friendly access, merges into the surrounding landscape and cityscape.

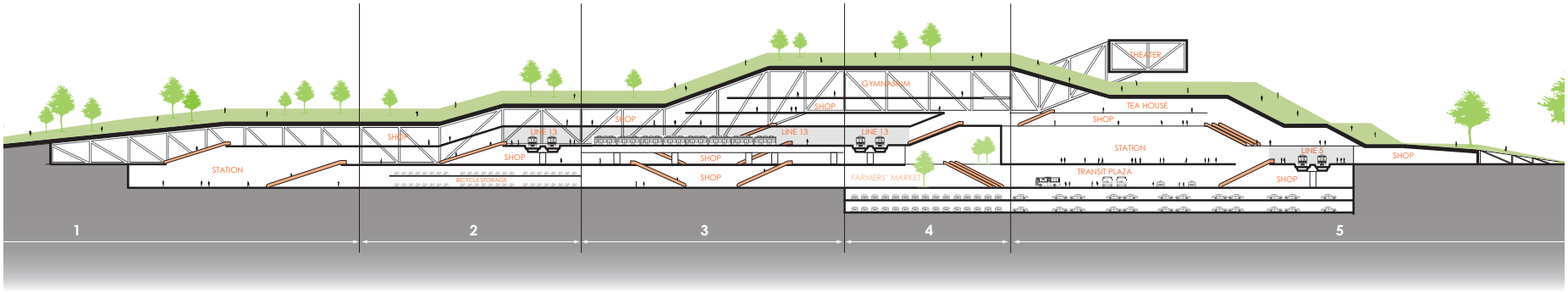
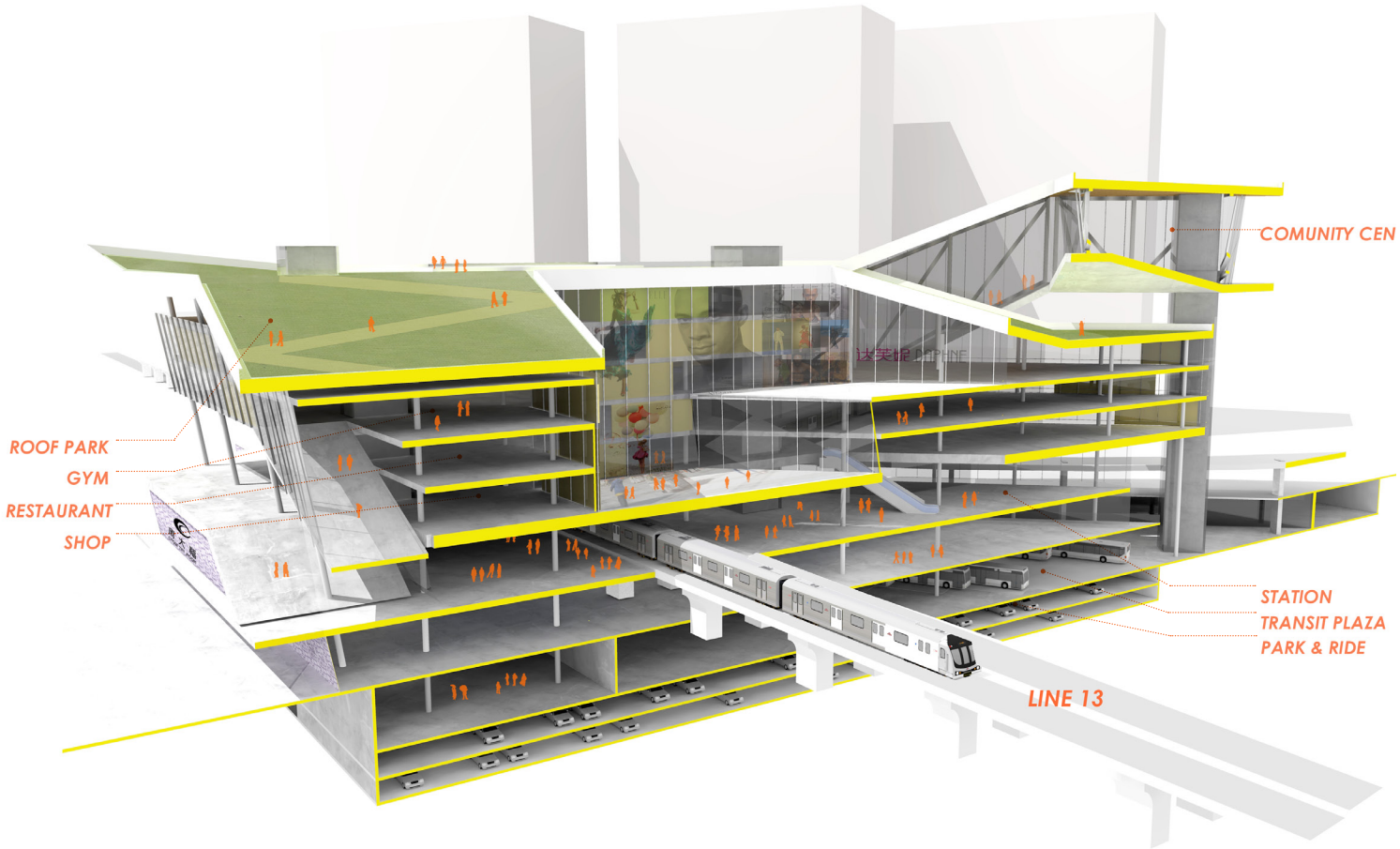


Figure 4.12 Unfold section



As shown in Figure 4. , a ramped circulation wraps around the main functional spaces, connecting different kinds of activities together into a spiral complex. Meanwhile, a roof plaza is enclosed by the spiral, potentially acting as a civic gathering place that can host events. In this view, visual connection between the lower transit area and upper mall is mainly created through a triple-high atrium, allowing easy circulation up or down.

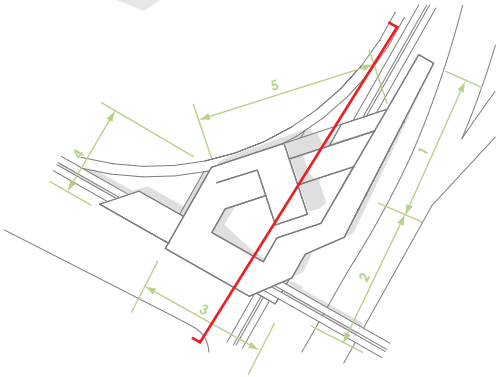
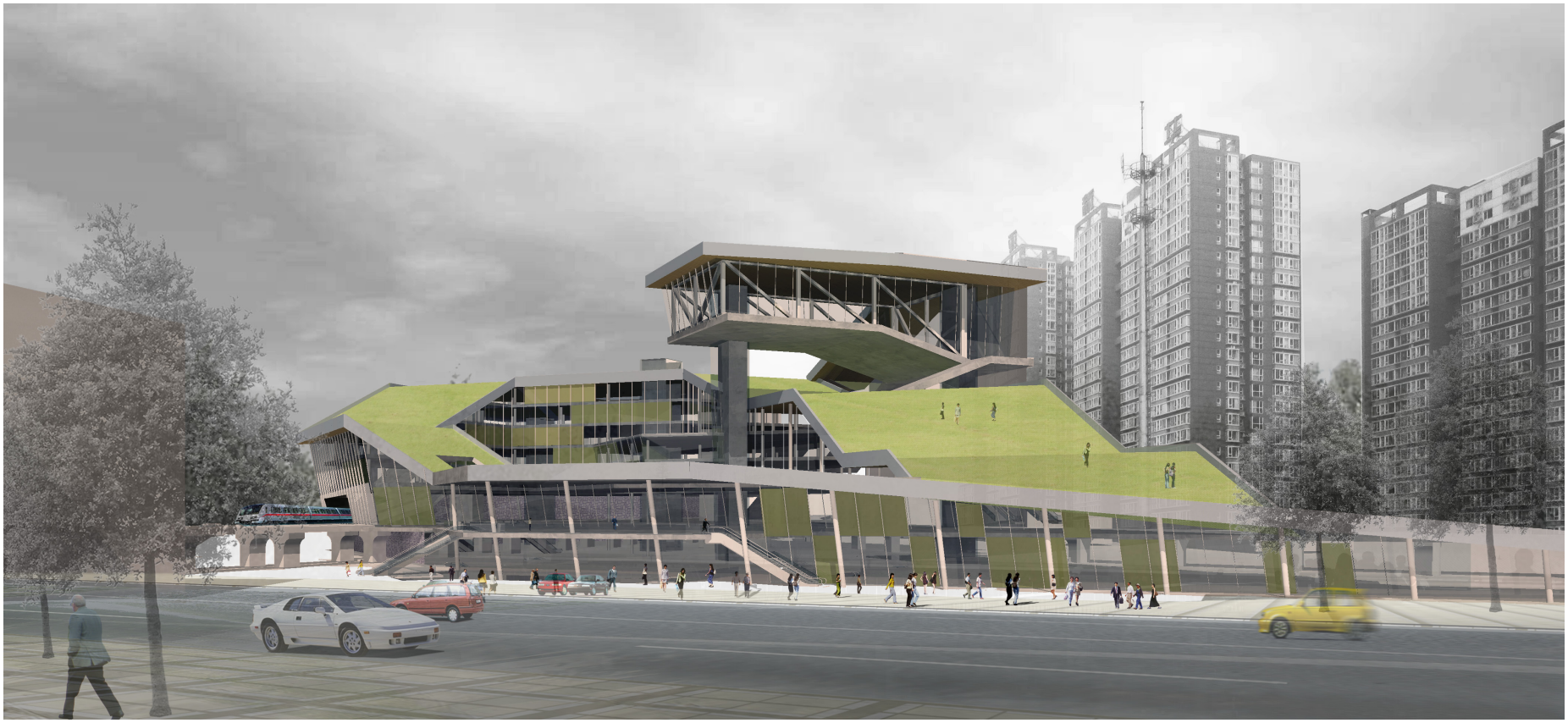


Figure 4.13 Sectional perspective 1



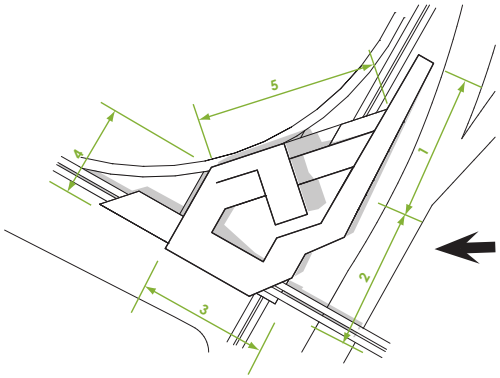


Figure 4.14 Exterior view-street side

From the side of Li Tang Road, the new intermodal transit hub presents a welcoming gesture for pedestrians with large ramped roof park. With the vertical high-rise residential buildings as a background, the horizontally expanded hub acts as a giant hand , connecting and distrubuting flows of transportation and commuters. The towering community center overlooks the adjacent neighborhood, becoming a new focal point for the neighborhood.

Figure 4.15 Exterior view-park side

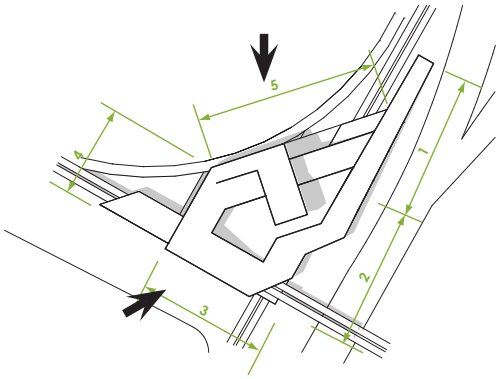


Figure 4.16 Exterior view-neighborhood side

View from the park side presents a transparant, mall-like entrance. Several terraces allow indoor-outdoor interaction at different levels, creating visual connection with the Lishuiqiao Pak. The roof park also has several voids to connect back to the interior spaces.

View from the neighborhood side features the climbing spiral with a community gallery inside. The building's dynamic gesture also tackles the relationship with the elevated subway service track.

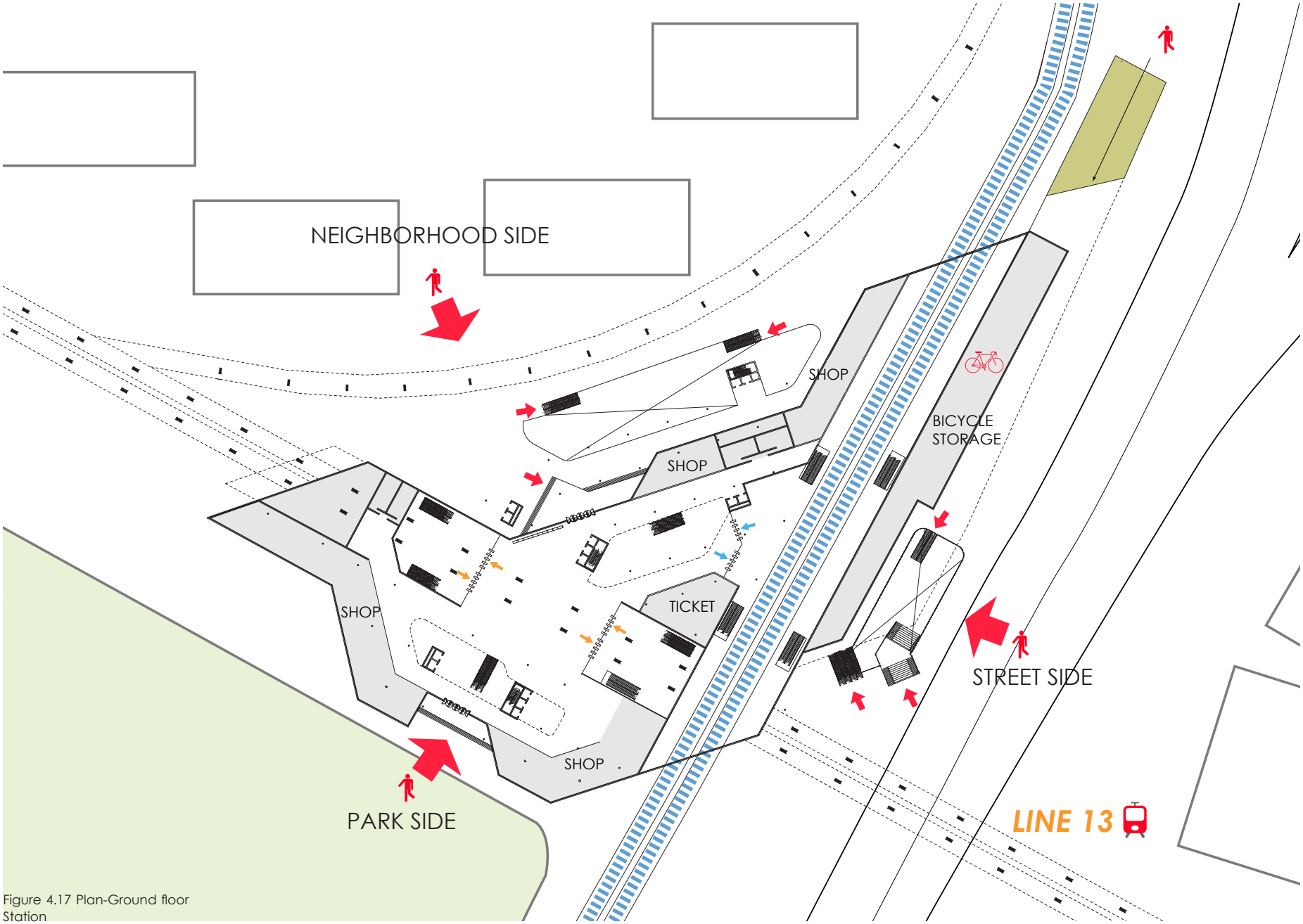
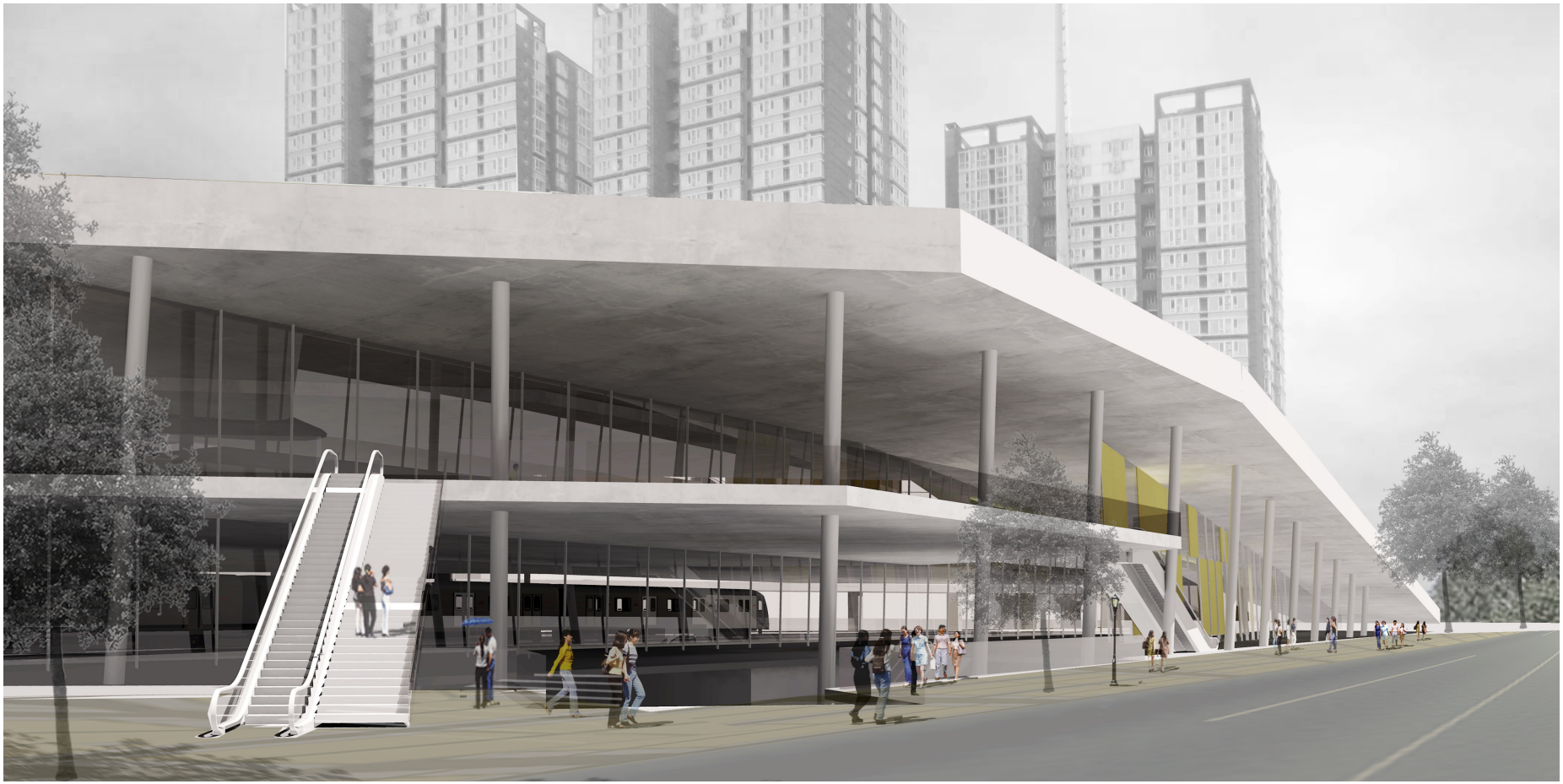


Figure 4.17 Plan-Ground floor
Station



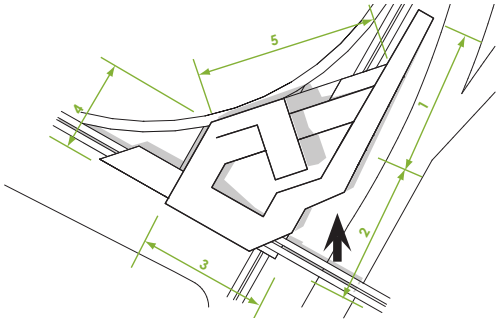


Figure 4.18 Entrance view on street side
To station above / To transit plaza

Entering from the side of Li Tang Road is tricky because of the blocking of Line 5. The solution is to bring pedestrians up to the second level of station, or down to the transit plaza via a sunken plaza. Signage will further provide clear direction for way-finding. Along the street, a pedestrian-friendly sidewalk and transparent retail spaces add more public atomosphere to the entrance.

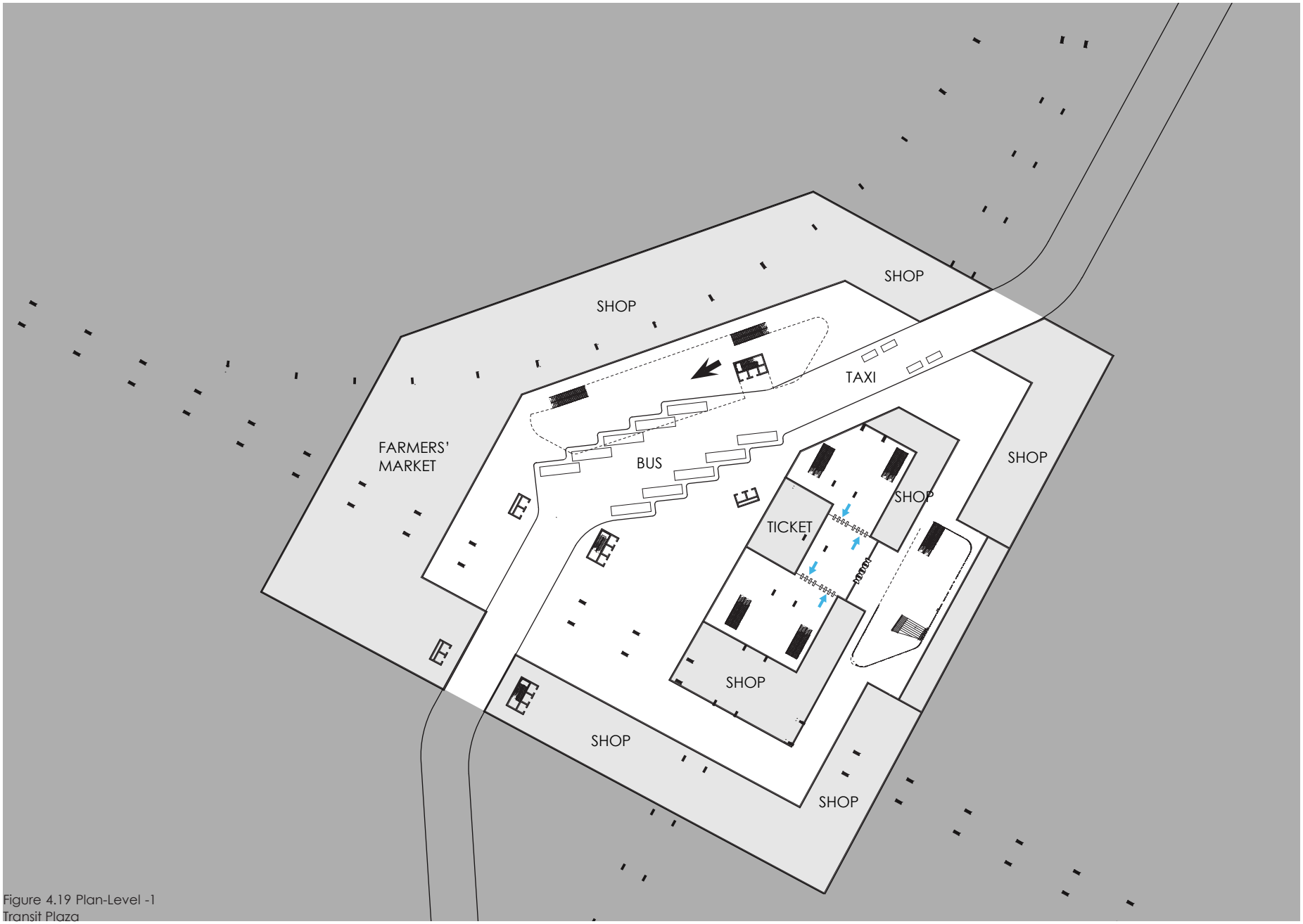


Figure 4.19 Plan-Level -1
Transit Plaza

Figure 4.20 View of transit plaza

Bringing commuters down to the sunken transit plaza is due to the restriction of Line 5. However, bringing light and activities will still make a lively public space for commuters. Daily commuters can conveniently purchase breakfast before a ride on the bus. Lots of commercial spaces provided here remedies the existing problems of disordered vendors.

The second level of the station allows access to Line 13 for users from the street side. Commuters getting off from each direction of Line 13 have different options, either exiting right away, or wandering a bit in the adjacent shops. They can also use the grand stairs to go to upper levels on both ends, and enjoy multiple choices of entertainment.

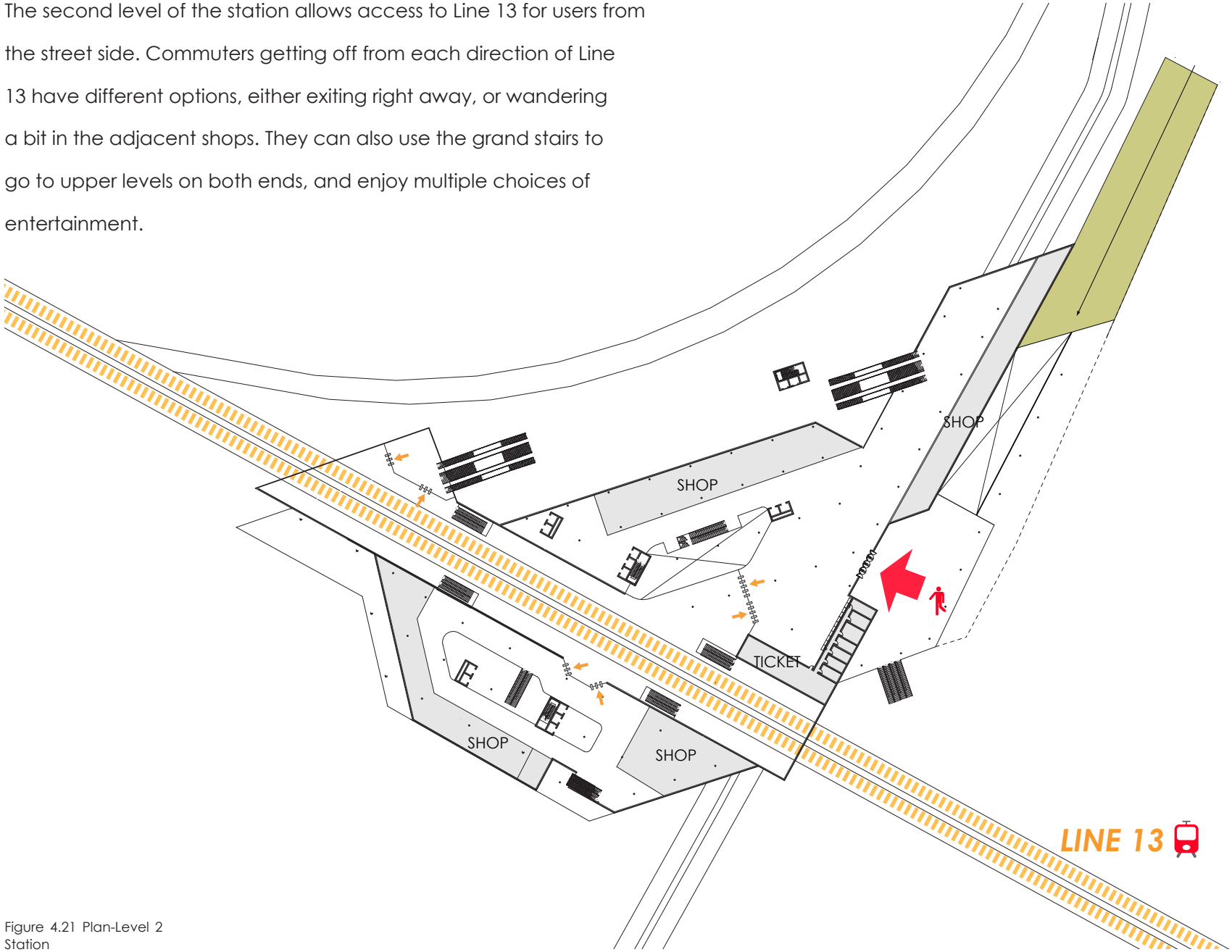


Figure 4.21 Plan-Level 2 Station

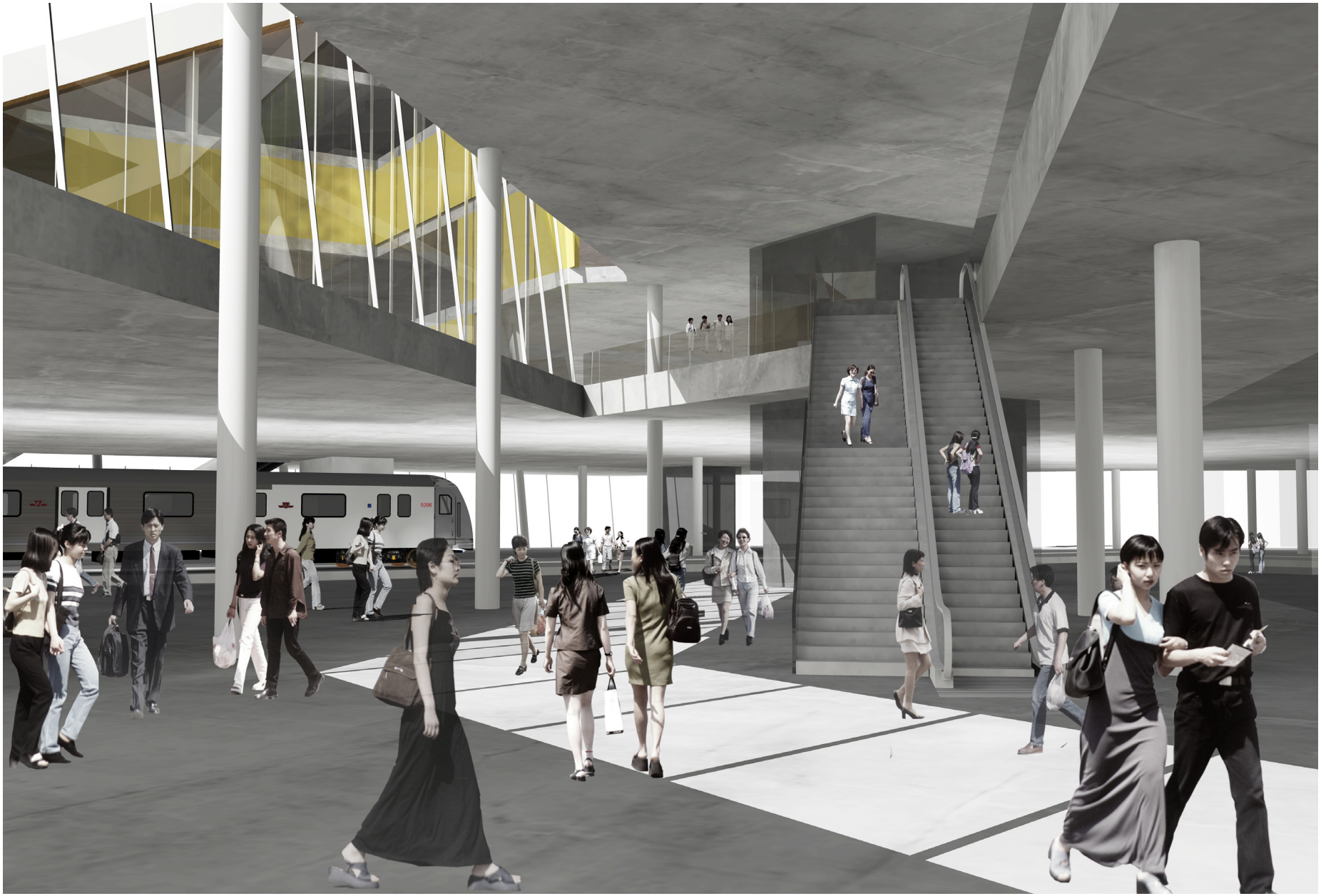


Figure 4.22 Interior view - Subway waiting

From the point where stations transform into a mall, the visual connection is created via an atrium. People can see a variety of signage to choose their destination based on their needs. Daylight comes from south and north sides, providing a stable and consistant lighting level throughout the day.

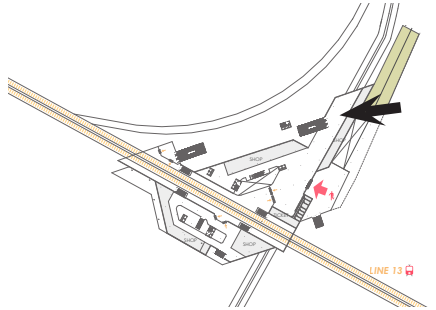


Figure 4.23 Interior view - From station to upper level

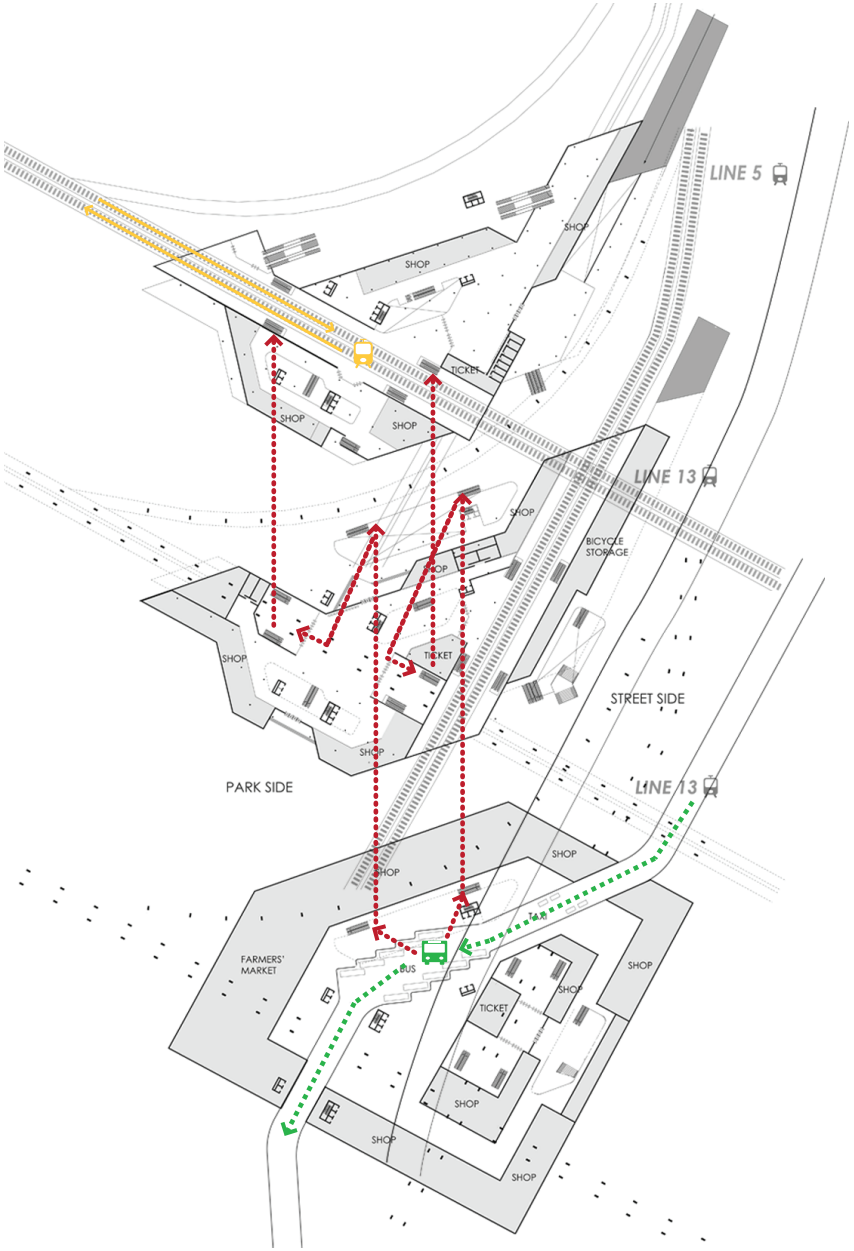


Figure 4.24 Transfer diagram
- From bus to subway line 13

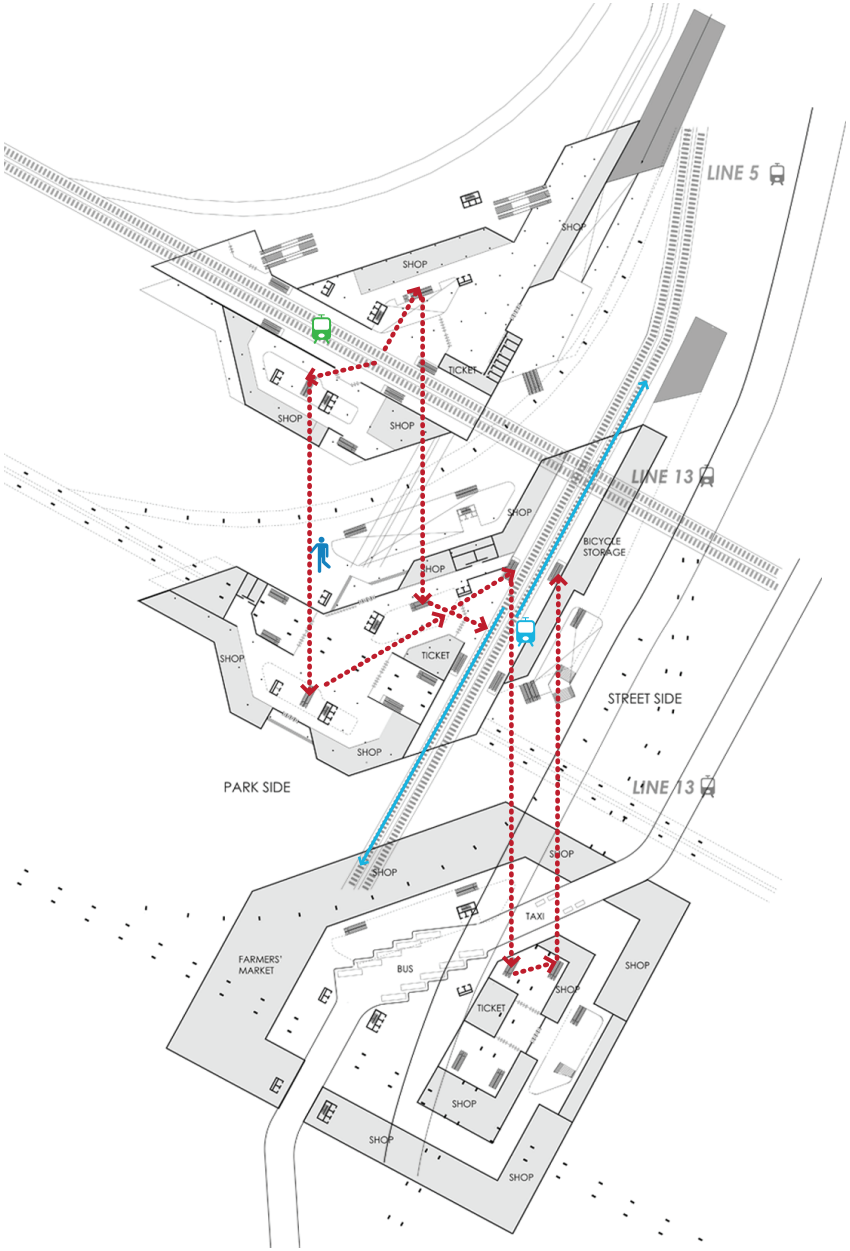


Figure 4.25 Transfer diagram
- From Line 13 to Line 5

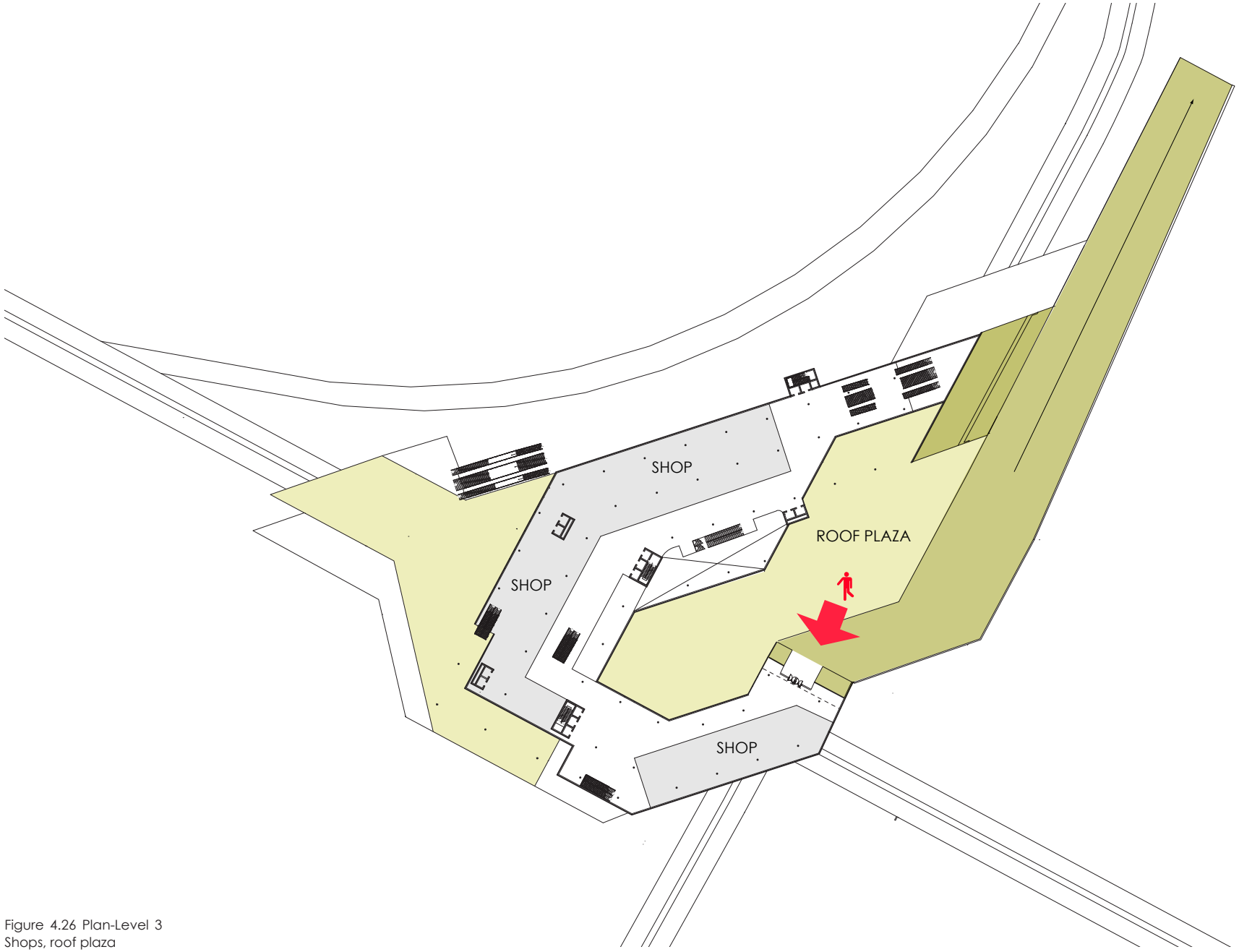


Figure 4.26 Plan-Level 3
Shops, roof plaza

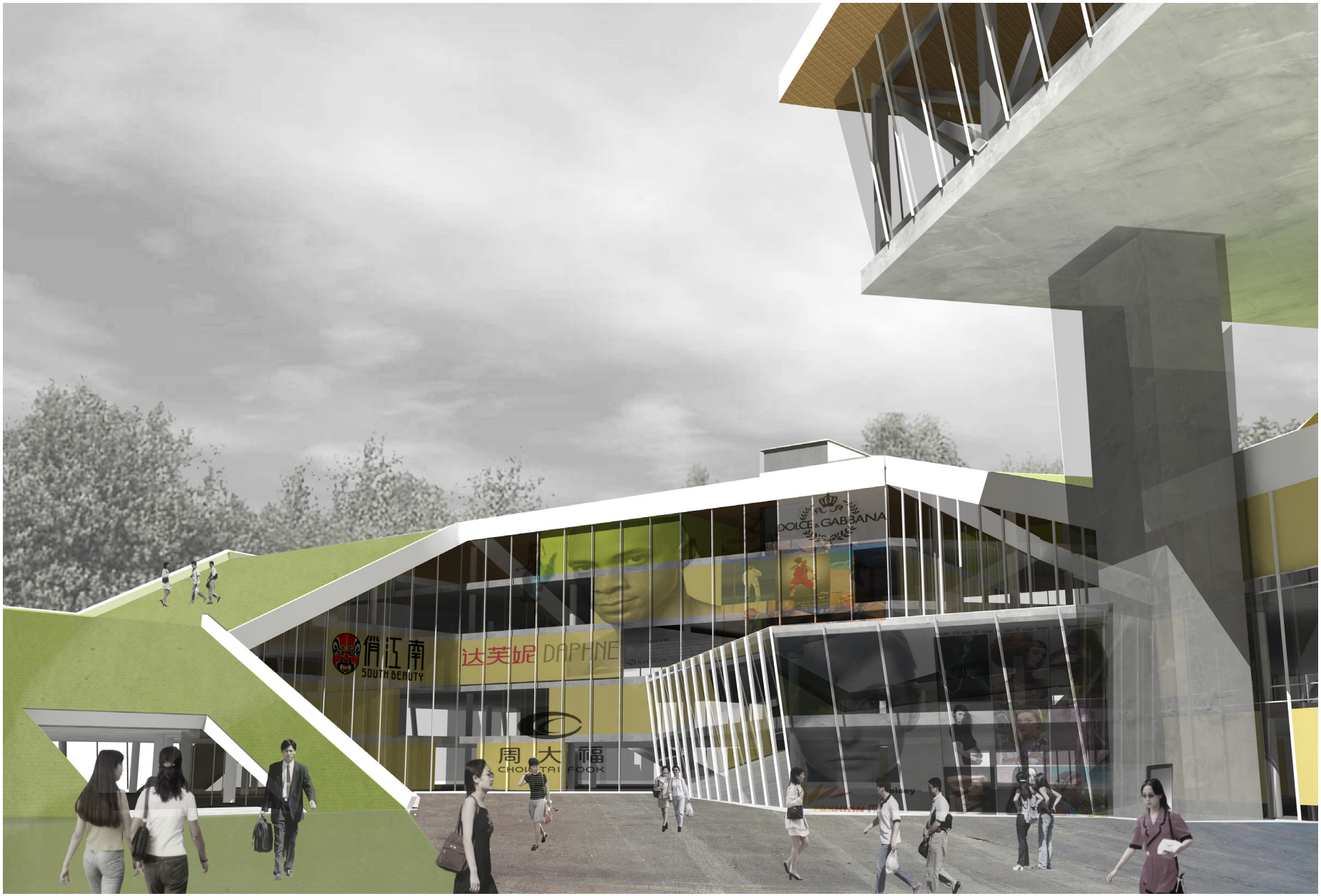


Figure 4.27 Exterior view
- Roof plaza

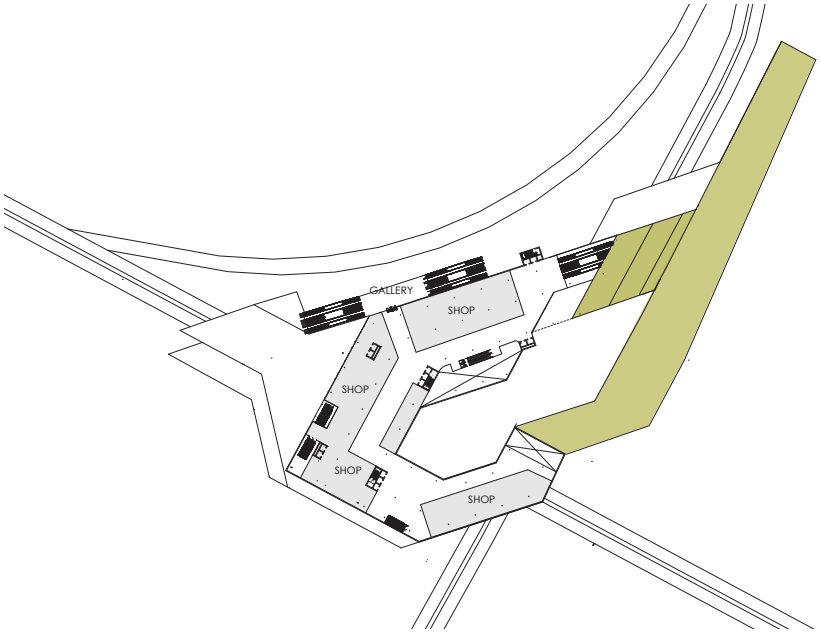


Figure 4.28 Plan-Level 4

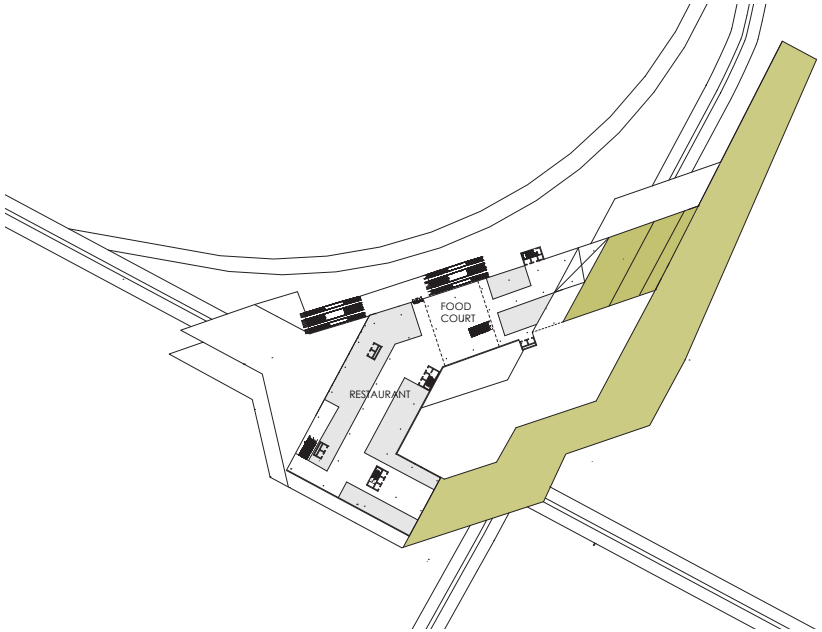


Figure 4.29 Plan-Level 5

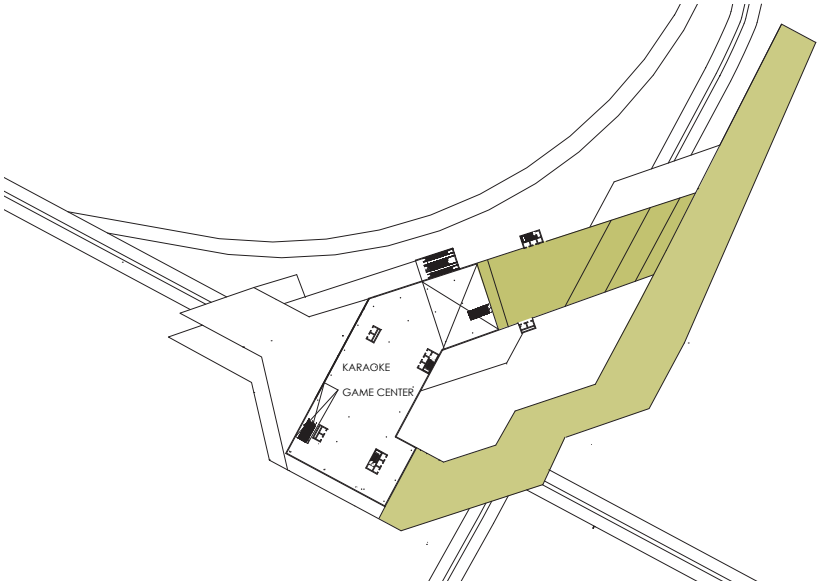


Figure 4.30 Plan-Level 6,7

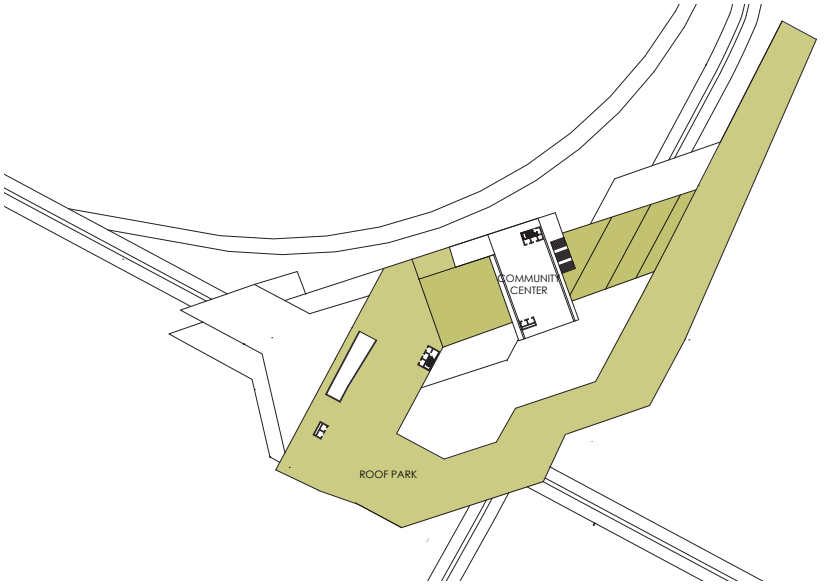
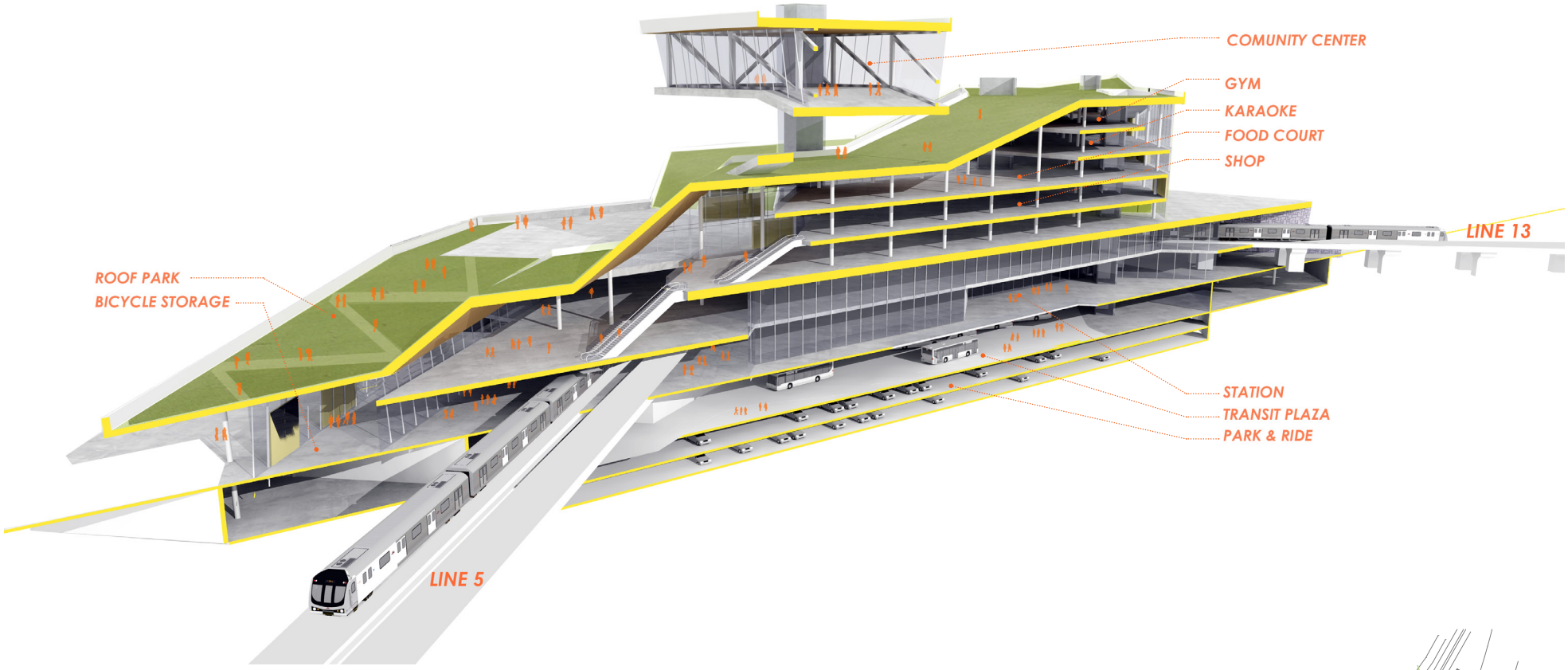


Figure 4.31 Plan-Level 8

The roof park starts to ramp from the street side, and partly stops at this level of the roof plaza. Outdor gathering events, farmers' markets and other special cultural activities can be held here. Indoor-outdoor relationships are strengthened by easy accesses into the building. The roof park continues ramping up from both ends, starting the loop of the green park.

The upper portion of the spiral contains more shops, restaurants and food court, gymnasium, karaoke, and the community center at the top. Vertical cores provide both circulation and structural stability for the irregularly-formed building. The continuous climbing ramp on the northern side houses a community gallery, providing for artwork exhibition while acting as a major circulation that connects all levels together. The roof park is permeable to its below, with voids and circulation cores.



The green spiral park wraps all kinds of programs under one roof as well as creating a sustainable open space for the community. Edges between transportation and amenities are invisible because of several atriums and flexible circulation strategies. Two subway lines, the underground transit plaza and park & ride facilities are comprehensively integrated into the transit hub.

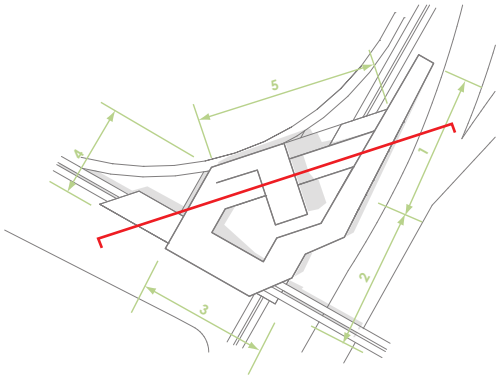


Figure 4.32 Sectional perspective 2

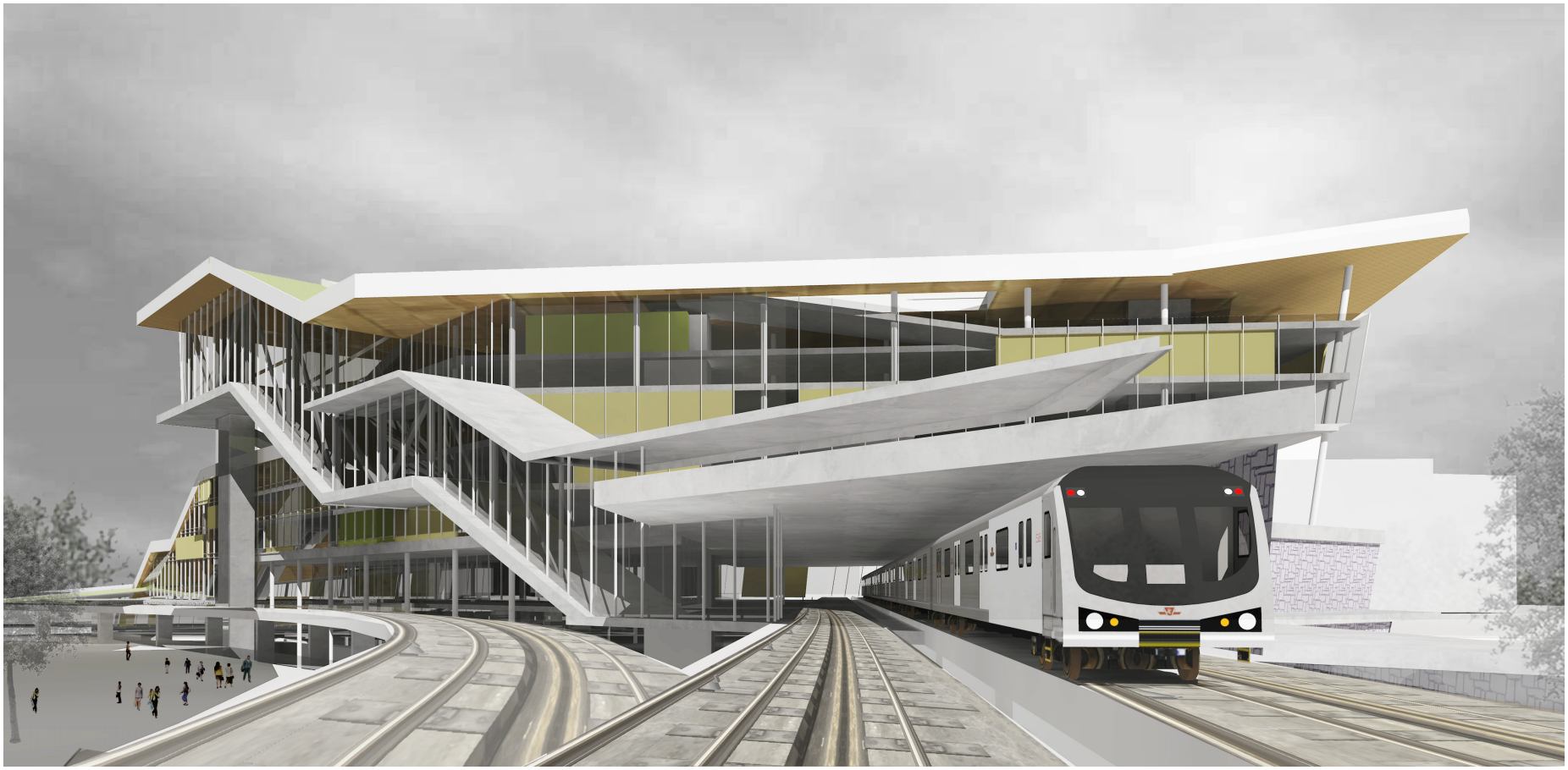
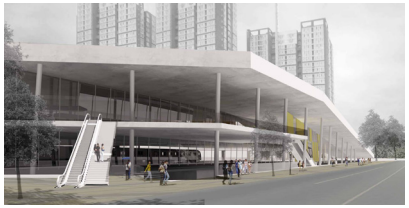
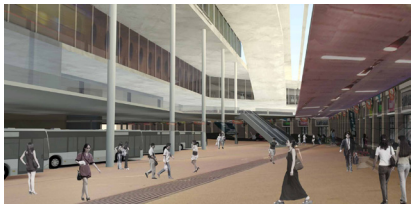


Figure 4.33 Exterior view - Entering on Line 13

Figure 4.34 Final review presentation poster



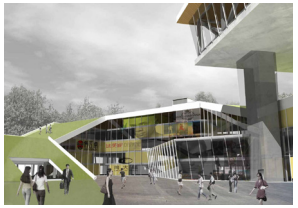
ENTRY FROM STREET SIDE



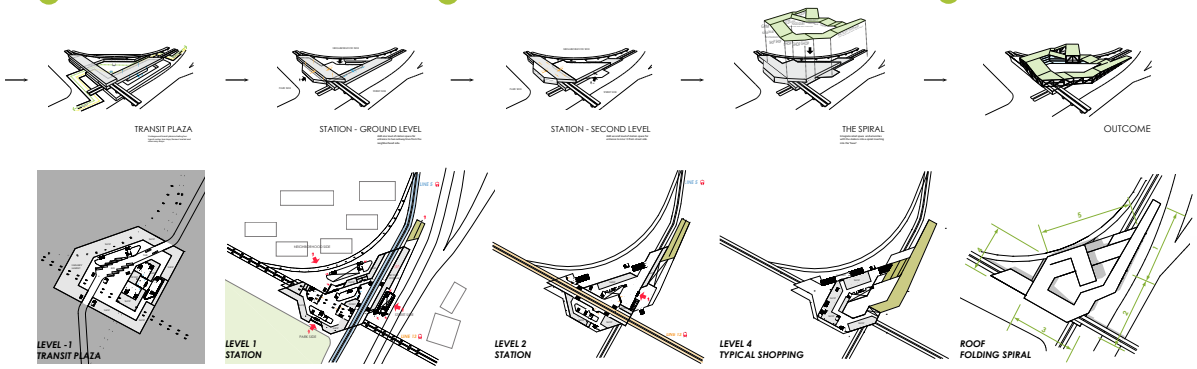
VIEW OF TRANSIT PLAZA

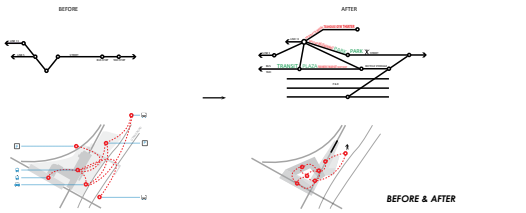
FROM STATION TO UPPER LEVELS

VIEW OF ROOF PLAZA



EXTERIOR VIEW FROM STREET SIDE





BEFORE & AFTER

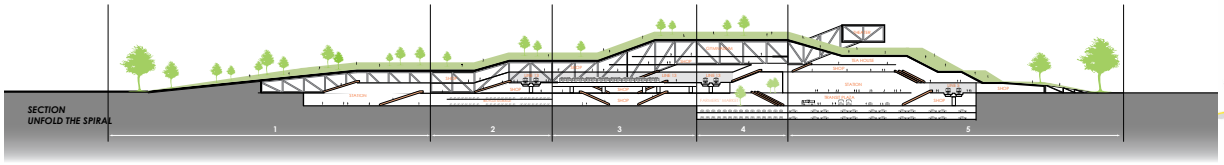
LEVEL -1
TRANSIT PLAZA

LEVEL 1
STATION

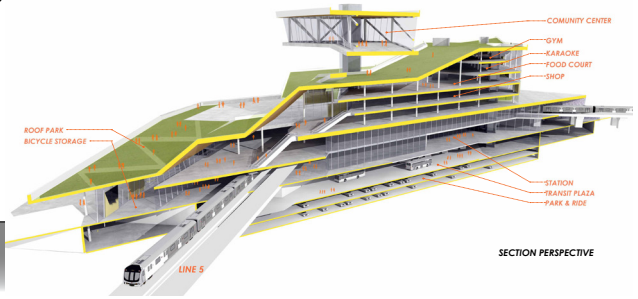
LEVEL 2
STATION

LEVEL 4
TYPICAL SHOPPING

ROOF
FOLDING SPIRAL



SECTION
UNFOLD THE SPIRAL



SECTION PERSPECTIVE

Chapter 5: Conclusion

In this thesis, I began with the concerns about Beijing's traffic congestion problem, and set out to create strategies for improving the transfer environment at transportation nodes to encourage use of public transit. China is a high-density condition, thus improving the commuters' transfer experience means even more to the quality of their life. Exploring how an intermodal transit hub can provide efficient transfer between different transportation modes, comfortable experience during commuters' transfer, as well as a lively civic place for the neighborhood, is the goal of this thesis.

I chose the Li Shui Bridge transportation node as the design site not only because it can represent all the typical problems that influencing commuters' transfer experience, but also it is in Asia's largest residential neighborhood, Tian Tong Yuan. The two existing subway lines, seventeen lines of buses, taxis, bicycles and pedestrians are integrated into a new spiral-pattern transit hub. In addition, the spiral also incorporates other amenites and experiences such as shopping, restaurants, community center, a large ramped roof park, turning into a lively and sustainable public place for not only the commuters, but also the neighborhood.

The design project was well-received by the jury at the final review. They appreciated the overall strategies framework and my design outcome. One of the jury applauded for my tackling of this subject and trying to reinterpret in a high-density situation.

Since it is a very large scale project, there are some issues brought up by the jury, such as the consideration of environmental strategies. In addition, I feel that there are still some parts I didn't solve because of time limit, such as structure system. Other than these, the discussion was suggestive. For example, one of the jury felt that a diagram showing how the building connecting to the adjacent urban context is missing. Also, it would be better to include a clearer analysis of current flow of transportation and pedestrians, since that will make the decisions of entrances' location more convincing.

Overall, the design project as a model for application of intermodal transit hub in Beijing was well-received. In Beijing's Twelth Five-Year Plan for Transportation(2011-2015), five intermodal transit hubs are planned. Although Li Shui Bridge is not one of those since it isn't the most cost efficient choice, hope this thesis will be a good inspiration for the city of Beijing to largely improve its transfer environment in the near future. Hope the development and improvement of public transit system will eventually help solve the traffic congestion problem in Beijing.

Endnotes

1. Wikipedia, "Metro systems by annual passenger rides" http://en.wikipedia.org/wiki/Metro_systems_by_annual_passenger_rides

2. Wikipedia, "Intermodal passenger transport" <http://en.wikipedia.org/wiki/Intermodal_passenger_transport>

3. EE & K Architects website <http://www.eekarchitects.com/portfolio/9-transportation-infrastructure/57-houston-northern-intermodal-facility>

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Edwards, Brian,"The modern station : new approaches to railway architecture / Brian Edwards", London : E. & F.N. Spon, 1997

Figure Sources

All photographs, drawings and diagrams were provided by the author, unless noted otherwise here.

Figure 1.1 Composite Image from online Google Earth

Figure 1.5 http://www.chinatouristmaps.com/transportation/beijing.html

Figure 1.9 Composite Image from Google Earth

Figure 2.5-2.10 http://www.eekarchitects.com/portfolio/9-transportation-infrastructure/57-houston-northern-intermodal-facility

Figure 2.12-2.16 http://transbaycenter.org/

Figure 2.17-2.21 http://www.kai-db.com/showcase/portfolio/gateway-transportation-center

Figure 2.23-2.28 http://www.railteam.co.uk/for-your-journey/in-the-station/berlin-hauptbahnhof/

Figure 2.29 Composite Image from Google Earth

Figure 2.30-2.36 http://mic-ro.com/metro/metroart.html

Figure 2.37-2.43 http://www.archdaily.com/160316/tempe-transportation-center-architekton/

Figure 3.1 http://www.chinatouristmaps.com/transportation/beijing.html

Figure 3.6 Composite Image from Google Earth

Figure 3.31Composite Image from Google Earth