

**Does government favor high end housing development around a
representative TOD project – first phase of NO.2 metro line instead of
improving transit accesses for residents nearby?**

**An exploration of transit equity, institutional issues and TOD
in Shenzhen, China**

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Abstract

Facing the constraints on land use, energy resource and environment, Shenzhen has employed Transit-Oriented Development (TOD) for over a decade, with an expectation to transform its development pattern, including establishing efficient urban morphology with low cost, enhancing economic benefits of land use, preventing unreasonable urban sprawl, and encouraging public transit use. One particular pattern of TOD in Shenzhen is to bring up surrounding land development by urban rail transit. However, a representative TOD project – the first phase of Shenzhen NO.2 metro line which is one of the earliest TOD project in Shenzhen is underperforming owing to current lower ridership in several representative TOD stations than expected. But comparatively, residents in the nearby densely populated neighborhoods don't have easy accesses to rail transit like NO.2 metro line. The objective of the thesis is to explore why government planned a speculative TOD rail transit line through a reclamation zone and whether the government favors high end housing development around the project while not improving transit accesses to the densely populated neighborhoods nearby.

Relevant planning documents of the project and the study area are reviewed to summarize the key guidelines and expectations for TOD of the study area. Moreover, based on Shenzhen TOD Guide and Standard, built environment of several TOD represented stations are evaluated quantitatively. Social demographics data are collected and analyzed by descriptive statistics, in order to define and assess transit equity in the research. Interviews of a government official from transportation department and a practitioner who led the projects are conducted so as to further understand the initial purpose of the TOD project, institutional and transit equity issues of the study area. Conclusions are drawn as what expectations of the TOD project are, what factors that result in high end housing development are, considerations for transit equity in study region, and what lessons the relevant agencies should learn with regard to the issues.

Key Words: Transit Oriented Development; Transit Equity; Institutional Issues; Integrated Transportation and Land Use Planning

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Chapter 1 INTRODUCTION

Rapid urban growth and sprawl which favored automobile-oriented development in past decades has created serious issues related to transportation congestions in some Chinese metropolitan cities. Traffic jam frequently constricts ring roads, main boulevards and streets, and transportation hubs. In Shenzhen, a metropolitan city in southern China, the registered vehicle amount reached over 1.9 million in the end of 2012 (Shenzhen Statistical Yearbook - 2013). A national report by Amap – an authoritative GPS electronic map server company published in 2014 indicates that Shenzhen is now the fifth most congested city in China, with a number of permanent residents more than 10 million (Statistics Bureau of Shenzhen Municipality). The current transportation conditions result from rapid urbanization of Shenzhen, with which the motorized trips nearly doubled in the last decade and the private car ownership reached 1.8 million in 2013, 17.8% more than that in 2012 (Ministry of Public Security Traffic Management Science Research Institute). The rapid increase of private automobile ownership deteriorates the road traffic and environment, makes the bus transit less attractive, and prevents efficient use of available land.

Among Chinese metropolises with relatively mature public transit system, Shenzhen is a particular one due to its location immediately north of Hong Kong. Owing to China's Open Door Policy and economic liberalization around 1980, Shenzhen became the first and one of the most successful Special Economic Zones in China. Shenzhen, which was a small county with population of only 300,000 in 1970s, became a key linkage between the world and mainland China after 1980. Since then, a lot of international entities have invested more than \$30 billion to build factories and create joint ventures. Shenzhen has got a name for one of the fastest growing cities all around the world. As of 2004, residents of Shenzhen reached 8.62 million residents within an area of 1,949 km² (Statistics Bureau of Shenzhen Municipality, 2004). If floating people were added, the total people amount could reach more than 10 million. U.S. "Forbes "magazine defined city as fifth in population density in the world rankings, with a number of 17,150 people/km² (Yangcheng Evening News, 2010). In the meantime, the model share of private car went up from 25% in 2001 to 38% in 2005 (Peng, 2011).

In order to deal with fast urbanization, Shenzhen started urban rail transit comprehensive planning early. The city initiated the first phase of urban rail transit construction in 1999 and operated the first two metro lines in 2004. After Shenzhen Urban Rail Transit Plan 2005 – 2010 was made in 2003, three more metro lines of the second phase were finished in the middle of year 2011, increasing operation distance from 64 to 177 kilometers (Shenzhen Economic and Social Development Statistics Report, 2010). From then on, the proportion of urban rail transit ridership compared with public transit ridership raised from 6% to 26% after the second phase was finished (Shenzhen Comprehensive Transportation Plan of the Twelfth Five-Year Plan of China, 2012). Shenzhen now ranks the fourth in urban transit system according to the ridership per year (2012 Annual Report of China Urban Mass Transit). By 2030, the city will have a totaling of 424-km metro system (Shenzhen Metro).

Among the advanced planning strategies to transform itself from a little county to a big city within 30 years that Shenzhen adopted, Transit-Oriented Development is a very important development pattern, which has been applied for over a decade in Shenzhen. In the second phase of the metro construction (2011 to 2030), Shenzhen government aims at shaping built environment around stations by integrated land use and transportation (Peng, 2011).

Compared with applying TOD to enhance public transit use and tax revenue so as to promote economic development and smart growth in many American cities, the expectation of TOD in Shenzhen is to transform its development pattern, including establishing efficient urban form with low cost, enhancing business value of land use, preventing unreasonable urban sprawl, and encouraging public transit use (Tian, et al., 2011). According to Shenzhen's TOD Planning and Design Guide with quantitative standards of development scope, traffic location, floor area ratio, building density, proportions of different land uses, and population density, TOD is further divided into Regional City-Oriented TOD, District City-Oriented TOD, Community-Oriented TOD and Special TOD.

This research focuses on a region which is divided as District City-Oriented TOD, with one third distance of metro line NO.2 that was operated in the end of 2010, from Window of the World Station to Chiwan Station. The region was developed through redevelopment on the western side and reclaimed land on the east coast since 2000, with a goal to form a new

industry cluster district and employment center. The first phase of NO.2 metro line shown on the map was planned as a particular TOD pattern in Shenzhen -- to prioritize urban rail transit network to developed regions and another one is to bring up surrounding land development through urban rail transit (Urban Planning Land and Resources Commission of Shenzhen Municipality). However, a lot of Shenzhen residents complain about the TOD project in Shenzhen, which was planned through a reclamation zone that was all vacant land in 2011.



Figure 1.1 First Phase of NO.2 Metro Line, Whole NO.2 Metro Line and Study Region
(Source: Shenzhen Urban Transportation Research Center)

After four years' operation, the project brought up primarily high end housing development around the stations. The project was even described as a subway leading to a “depopulated zone” (Shenzhen News, 2012). Wang et al. (2011) from Shenzhen Metro analyzed the route design of this project from the perspective of ridership demand, saying that the sectional passenger flow of the project compared with the whole NO.2 metro line is imbalanced. The following graphs show sectional passenger flow of which the obvious disequilibrium appears in the stations within the reclamation area. Tan and Zong (2013) summarized the existing factors that affect the ridership of the project – the main development brought

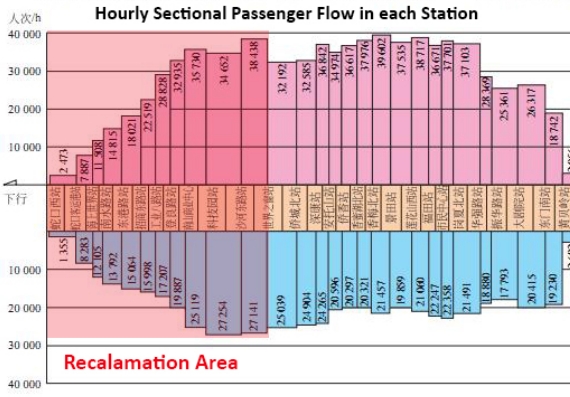


Figure 1.2 Sectional Flow of NO.2 Metro Line

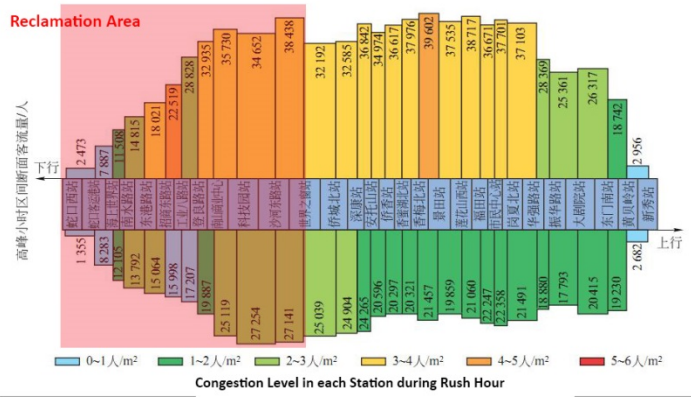


Figure 1.3 Congestion Level (People/ Square meter)

(Source: Shenzhen Metro)

by the project is top grade residential lots while offices and commercial development is fewer. Residents living in the area don't have high demand for public transit. Although there are densely populated neighborhoods to the west of the reclamation zone, the walking distance is too long from the neighborhoods to the station. Bus transfer services around the stations of the project are also under provided (Zong, 2013). Hence, the road traffic of the densely populated communities is so bad that it usually takes residents twice as much time to reach accesses to fluent road or rail transit, while the residents in the reclamation zone who can afford to live in the high end housing area don't usually travel by transit. In the meantime, according to Transport Commission of Shenzhen Municipality, the densely populated neighborhoods are usually most congested area among the whole district, as the following map shows.

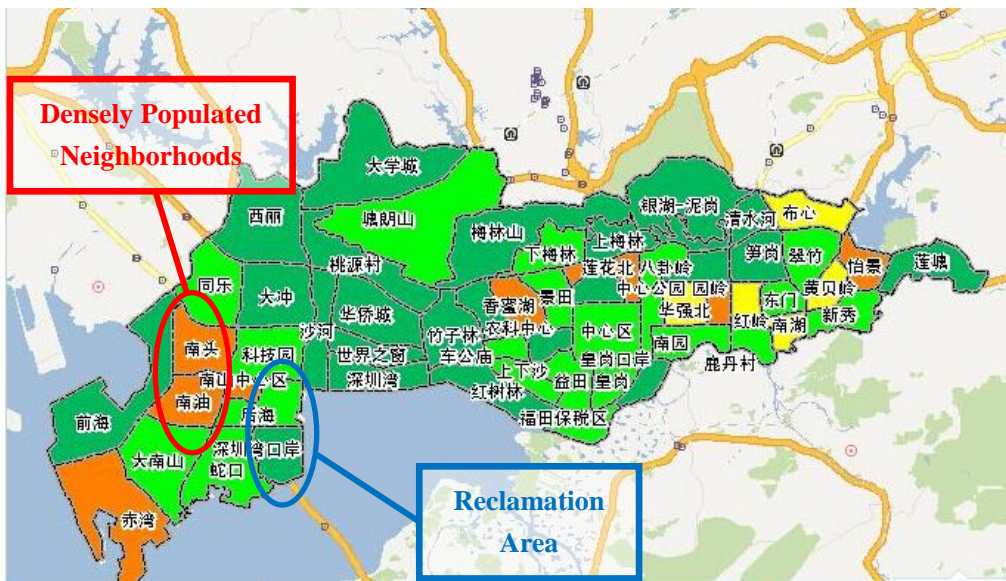


Figure 1.4 Road Congestion Level of Study Region (Orange: Congested; Green: Fluent)

(Source: Transportation Commission of Shenzhen Municipality)

Aiming at the transit equity issue, the thesis tries to explore why government planned a speculative TOD rail transit line through a reclamation zone and whether the government favors high end housing development around the project while not improving transit accesses to the densely populated neighborhoods nearby. Moreover, due to political and institutional problems, policy-making process for transit improvement becomes more complicated (Gakenheimer, 1999). So another objective is to understand how relevant government agencies work together to enact transit policies that responds to purposes of TOD and transit equity.

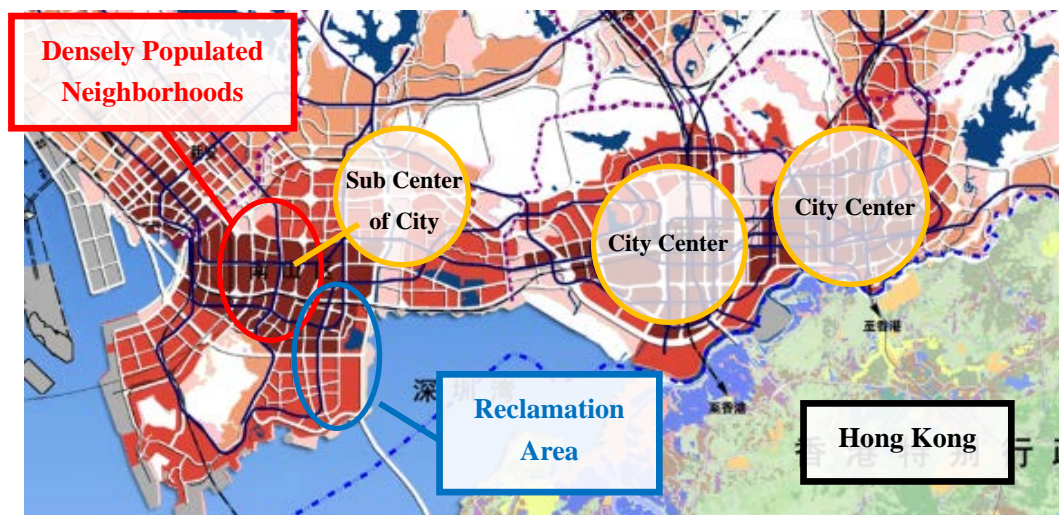


Figure 1.5 Population Density in Study Region and Main Locations in Shenzhen

(Source: Transportation Commission of Shenzhen Municipality)

Focusing on the surrounding areas of the project, the research starts with reviewing relevant planning documents of the project and the study area, for a purpose of summarizing the primary guidelines and expectation for TOD of the study area.

Moreover, based on Shenzhen TOD Guide and Standard, built environment around some representative TOD stations in study region are evaluated, as a main source for defining and assessing “transit equity” of the two communities mentioned above. Additionally, social demographics of the two communities are analyzed. Interviews of a government official from both transportation department, and a practitioner who participated in the projects were conducted so as to further understand the initial purpose of the TOD project, institutional cooperation and transit equity of the study area. The conclusions are drawn as what

expectations of the TOD project are, what factors that result in high end housing development are, considerations for transit equity in study region, and what lessons the relevant agencies should learn with regard to the issues. A previous vice mayor of Shenzhen once highlighted that, “We should enhance public investment as efficient as possible, make urban rail transit attract more people and ease the burden of road system” (Peng 2011), the thesis is expected to inspire Transit-Oriented Development in Shenzhen, or in other Chinese cities.

Chapter 2 LITERATURE REVIEW

In this research, the underperforming TOD project – first phase of NO.2 metro line planned on the reclamation area, the congested road traffic and lack of urban rail transit accesses in the densely populated neighborhoods and the little demand for public transit of residents in the high end housing area brought up by the TOD project constitute a representative issue of transit equity. The following parts cover literatures about transportation equity, TOD, and institutional issues behind.

2.1 Transportation Equity

The uncontrolled rise in urbanization, motorization, exclusionary planning and disproportionate investment in transportation infrastructure has resulted in a socio-economic imbalance and inequity (Li, et al., 2007). In American practices, the Civil Rights Act of 1964 was a main catalyst to bring up significance of transit service equity. Title VI of the Act indicated that all federal agencies must distribute federal resources equitably in such a way as to maintain quality of services so that resources are provided in the fairest and least discriminatory manner possible (Colopy, 1994). The following paragraphs summarize literatures focusing on primary aspects regarding transportation equity.

2.1.1 Definition of Transit Equity

2.1.1.1 Definitions from Western Literature

Definition and measurement of equity is crucial to analysis results (Litman, 2002). Litman (2014) further refined his definition of transportation equity which had widely been acknowledged by other scholars and practitioners, as follows:

1. Horizontal Equity

Horizontal equity is about equal distribution in ability and need between individuals and groups. According to this definition, individuals and groups in equal level should receive equal shares of resources, and be treated the same in other ways, which means that public policies should avoid favoring one individual or group over others, and that consumers should be able to get from fees and taxes they pay unless a subsidy can be justified.

2. Vertical Equity

Vertical equity cares about the distribution between individuals and groups by income or social class, which different groups differ in abilities and needs. For this definition, policies are equitable if they favor socially and economically disadvantaged groups by compensating for inequities. This definition is applied to support affordable modes, discounts and special services for economically and socially disadvantaged groups, and prevent disadvantaged groups from excessive external costs, such as pollution, accident risk, financial costs and so on.

Litman (2014) also gave out primary indicators to define equity. For horizontal equity, indicators relevant to this thesis are:

- Policies and regulations are equally distributed to all users.
- Quality of service is comparable for different groups and locations.
- Modes can receive public support according to what they expect.

For vertical equity, they are:

- Investments in transportation services favor lower income areas and groups.
- Affordable housing is an available component in accessible and multi-modal transit locations.
- Transportation services offer with easy access to medical services, schools, commercial uses, employment opportunities and other fundamental uses.

In this research, the observed equity issue can be considered as a combination of both horizontal and vertical equity issue. Most residents in the densely populated areas earn less than residents living in high end housing area, while they have similar ability and need for public transit. But it's obviously that the two groups of residents get imbalanced accesses to urban rail transit although the densely populated neighborhoods have already been well developed with high population while the other high end housing area was all vacant land when the metro line was finished in 2010. A major purpose of transit is to cater to the transportation needs of disadvantaged people (Tavares, 2010), which can be considered as most residents in the densely populated neighborhoods. Even though not all of them represent low income people, they do have high demand for public transit, especially rail transit due to

congested road traffic in their neighborhoods.

2.1.1.2 Definitions based on China's Context

Most literatures of Chinese scholars agree with the definition of horizontal and vertical equity. In China, equity deserves much discussion in the context of accessibility and environmental pollution for different social groups (Zhang et al., 2005; Connors et al., 2005). Equity is defined at the level of accessibility distributed through the whole urban area. Lu and Zhang (2008) defined three categories of transportation equity – 1. Equal distribution of public transportation; 2. Equal rights and responsibility to use public transportation; 3. Public transportation as a tool to enhance social equity, which are mostly similar to Litman's definition. Zheng and Ma (2009) defined transportation inequity as 1. Horizontal inequity resulted in by motorization 2. Disadvantaged groups, including physically disable people and low income people 3. Environmental justice issues, pollutants generated by transportation development result in harm for residents in the future. Yang, Shi and Lu (2005) defined a new term of equity: regional equity and intergeneration equity. It is about differences of economic development conditions, the marginal utility of transportation investment in regions with lower economic development level will be higher.

Basically, the definition of transportation equity based on China's context is similar to the general definition of Western literatures, which mainly focus on spatial distribution of transportation investment, individuals who need public transit and environmental justice. The observed issue in this research mostly covers the first two categories of equity.

2.1.2 Impact of Transit Equity

Litman (2014) summarized main types of impacts. The primary ones related to this research are:

- Mobility and accessibility
- Amount of travel modes available in an area (walking, cycling, car-pool, rental vehicles, public transportation, taxi)
- Roadway quality like traffic speeds, safety, physical condition

- Quality of public transportation service, including frequency, speed, reliability, and comfort.
- Land use accessibility, like density, mixability, connectivity
- Access to education, employment, and other economic opportunities.
- Impacts on business, property values, and broader economic development in an area

These points can be applied to China's context as well and are ideal guide for evaluation of transit equity in the case of this research.

2.1.3 Transportation Equity Issues

2.1.3.1 Summary from Western Literature

Litman (2014) published that planning biases which cause transportation inequity issues tend to be both horizontally and vertically inequitable. Some practical examples give evidence on that lower income neighborhoods receive less than a fair share of transport investments and services (Bullard and Johnson 1997). Ahmed (2008) claimed that policy makers in emerging economies prefer policies with outcomes advance economic development and modernization, while largely don't pay attention to social, economic, and environmental impacts on communities.

2.1.3.2 Summary of Chinese Examples

In addition to Ahmed's (2008) argument, a Chinese scholar Li (2011) further explained the reason for the phenomenon which is similar to the observed issue. He said supply and demand constitute a significant standard for government to make decisions. Transportation policies in China usually have purposes outside the considerations for demand, such as enhancing urban development efficiency, improve investment, and optimize the transportation network in the long run. In the case of this research, the urban rail transit wasn't aimed for demand of residents in the densely populated neighborhoods, but for the GDP increase brought by real estate development, i.e. the "future" high end housing development on the reclamation area. This could be a "double-win" transaction between the

city government and the developers who knew the land development would generate considerable profit. The distorted transportation policy and transportation inequity appear consequently. Liu (2007) explained inequitable transportation investment in another way. He mentioned that even though decision makers of Chinese government need to balance equity and efficiency, they are inclined to be more concerned about efficiency, development and GDP increase, owing to the fact that China is now a rapidly developing country. The argument of these literatures could be a support to explain the observed issues of this research.

2.1.4 Measurement of Transportation Equity

The measurement of transportation equity is an important step to evaluate transportation equity. The ultimate destination of transportation is accessibility (Litman, 2014), which is a key element among the methods.

2.1.4.1 Measurement Methods

The report *Measuring Accessibility as Experienced by Different Socially Disadvantaged Groups* (TSG 2005) evaluates the quality of accessibility by people with various needs and abilities. It assesses local accessibility like access to local bus stops and regional accessibility like access to employment opportunities) for some socially disadvantaged groups. Measures of accessibility usually concentrate on distance from households to transit stops (Handy and Niemeier, 1997). Each of these measures is typically computed using GIS to determine the length of time a particular journey would take with each mode (O'Sullivan et al., 2000). Equity occupies a significant portion in these measures, as accessibility can be pretty different among groups (Kawabata, 2009).

Welch and Mishra (2013) proposed an approach to measure transit equity by integrating both accessibility and mobility measures with overall transit quality measures – transit connectivity to assess the distribution of transit service in a region. In their context, distribution of transit service coverage to household and employment locations is transit equity. Connectivity defines the level of coordination of transit routes, coverage, schedule, speed, capacity, and urban form characteristics, and is an influential element of transit service

quality. A Gini index is contained together with geographic visualization approach to estimate transit equity.

2.1.4.2 Useful Data for Measurement

According to Welch and Mishra (2013), the data they used to calculate a Gini coefficient showing transit equity level incorporates:

1. Average vehicle capacity of a transit line; 2. Frequency of transit service; 3. Daily hours of operation of each line; 5. Speed of each line; 6. Distance in each line from one node to another; 7. Population and population density; 9. Employment rate; 10. Average income level of surrounding neighborhoods

Most listed data is easier to get based on China's context.

2.1.5 Policy Recommendation to Achieve Transportation Equity Objectives

Litman (2014) said in order to reflect equity objectives, decision makers should pay more attention to accessibility rather than mobility. Moreover, planning and investment practices should be reformed toward equity objectives instead of favoring sprawl ("Smart Growth Reforms", VTPI 2005). Public transit policies can aid in removing barriers relative to transportation service availability and accessibility, cost of transportation, spatial mismatch, and economic opportunities (Tavares, 2010).

2.2 Transit Oriented Development

2.2.1 TOD in Shenzhen

In Shenzhen, TOD has become a key strategy for urban and transportation sustainable development in order to deal with the constraints on land use, energy resource and environment (Zhang, et al., 2011). Compared with applying TOD to enhance public transit use and tax revenue so as to promote economic development and smart growth in many American cities, the expectation of TOD in Shenzhen is to transform its development pattern, including establishing efficient urban form with low cost, enhancing business value of land uses, preventing unreasonable urban sprawl, and encouraging public transit use (Tian, et al.,

2011). The first phase of NO.2 metro line is a representative project within this definition. In order to achieve the goal, TOD should run through the whole process of urban and transportation planning, design and construction, with a systematic technical guidance system (Shao, et al., 2011).

2.2.2 Difficulties of TOD in Shenzhen

2.2.2.1 Existing Problems

Shenzhen Urban Transportation Research Center (2012) reported some existing problems of TOD. Firstly, at the macro level, as the first special economic zone, urbanization of Shenzhen is speeding up, residential area is spreading fast. The average travel distance of citizens is gradually increasing in recent years. Moreover, at the meso level, a systematic TOD technical mechanism hasn't been established. So the planning and design of TOD is still not very scientific, clear, and reasonable. Last but not least, at the micro level, the land uses along TOD lines are limited by previous zoning resolution, which isn't flexible enough. Land use development around stations is not satisfying, such as lower FAR and less accessibility than expected, which appeared around some stations of first phase of NO.2 metro line.

2.2.2.2 Institutional Issues behind TOD

Government officials from Urban Planning Land and Resource Commission of Shenzhen Municipality claimed that the first phase of NO.2 metro line is a speculative TOD project, which is different from providing existing developed areas with urban rail transit to relieve high traffic volume (Southern Metropolitan News, 2012). Some practitioners vaguely said that the project is due to "political factors" rather than real transportation planning objectives. Technicians from Transportation Commission of Shenzhen Municipality disclosed that there was little cooperation between Urban Planning Land and Resource Commission of Shenzhen Municipality (Planning Department) and Transportation Commission of Shenzhen Municipality (Transportation Department) when the decision of the first phase of NO.2 metro line was made.

There are many similar institutional issues behind TOD. Zong, et al., (2011) identified relevant difficulties in current urban rail transit practice based on the practice of urban rail transit planning and design in Shenzhen, as follows:

(1) The government is lack of coordination and management and had difficulties in leading the planning and design management of urban rail transit. To be specific, the coordination between urban development and transportation system requires lots of work, but the staff and material resources for urban rail transit construction remained nearly similar. The research results of the feasibility of urban rail transit planning and construction are mainly approved based on review of national expert level while the results of project planning and design are submitted to local government to check. It's hard to find specific and detailed technical problems just based on one or two times expert review. Even though the problems are found, they will remain unsolved due to limited time and hard coordination.

(2) There is lacking of a unified mechanism to coordinate the work of rail transit planning and construction among different agencies. Relevant governmental agencies don't have clear responsibilities regarding rail transit planning and construction.

(3) It's lacking of a technical mechanism to coordinate and manage the rail transit development among different processes of urban planning. For example, because there are different business owners of rail transit & land development, road traffic infrastructure, municipal facilities, and investors, rail transit has been finished while the development of surrounding areas falls behind, the same as traffic feeder service, which directly affect the efficiency and interest of rail transit.

2.3 Summary of Common Policy Recommendation for Urban Public Transit Development in China

1. Insufficient funding and complex political and institutional issues guide transportation policy toward current direction. Policies may turn to more equitable directions if more capital is available in developing countries.

2. Transportation planning as a professional field, lacks integration with other public policy field, especially land use planning. A more integrated transportation and land use planning development pattern would not only mitigate unequal distribution of transit services,

but also keep distances to a reasonable extent which is possible by non-motorized transportation means.

3. Collaboration among agencies in different fields of urban planning is a complex issue in developing countries in which there is complicated bureaucracy. Bureaucrats often operate on their own desires without proper supervision systems. However, growing urban centers will benefit from more comprehensive planning approaches that care about social, economic, and ecological impacts with regard to integrated transportation and land use planning.

Chapter 3 METHODOLOGY AND DATA

The primary key word of the thesis is transit equity, and then institutional issue on TOD. The steps for the research are as follows:

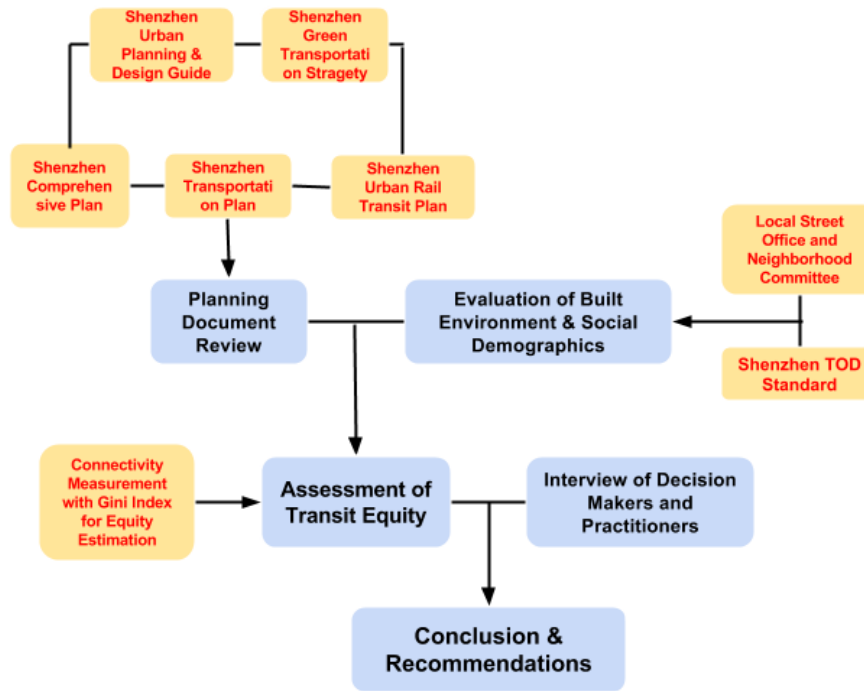


Figure 3.1 Flow Chart of Methodology

3.1 Planning Document Review

Focusing on the surrounding areas of the project, the research starts with reviewing relevant official planning documents of the project and the study region. Shenzhen Comprehensive Plan (2010 – 2020) includes overall plan for the reclamation area and Shenzhen Transportation Comprehensive Plan (2008) specifies transportation planning in the whole district. In the meantime, Shenzhen Urban Rail Transit Plan (2011 – 2016) contains more detailed goals, objectives, guidelines and plans for each metro line. Shenzhen Urban Planning and Design Guide (2009) covers the basic guidelines and expectation for Transit Oriented Development and integrated land use and transportation planning. The purpose of reviewing the planning documents is to systematically learn about the planning history of the study region, the objective of planning the speculative NO.2 metro line through the reclamation area, and idea of this representative TOD strategy. Based on this, the primary

guidelines and expectation for TOD of the study region are summarized.

3.2 Evaluation of Built Environment and Social Demographics

In order to define and assess transit equity issue of the two communities in the study region, the first step is to evaluate the built environment and social demographics. Shenzhen TOD Guide and Standard isn't a single file but a refined version of Shenzhen Urban Planning and Design Guide (2009), Shenzhen Green Transportation Development Strategy (2012). It contains qualitative and quantitative standard for different all types of TOD in Shenzhen. The research would quantify certain built environment factors about Walk, Cycle, Connect, Compact, Transit, Mix, Densify, and Shift which are from categories of TOD Standard by Institute of Transportation Development and Policy (ITDP) and also similar to Shenzhen TOD Guide and Standard's classification. Additionally, the online interactive map service from Transport Commission of Shenzhen Municipality provides with supportive resources to evaluate mobility during a day. Regarding social demographics in the two communities, data is available from local street office and neighborhood committee. Descriptive statistics is used to discover the differences of residents in the two communities. The data contains number of residents, population density, average income, average housing price, proportion of rental housing in each neighborhood, ratio of private car ownership, and proportion of travels by public transit. All data are on neighborhood level.

3.3 Assessment of Transit Equity

Based on the evaluation of built environment and social demographics, the research defines and assesses transit equity in this case, according to appropriate definitions from Western and Chinese literatures. In this thesis, the definition and assessment of transit equity are conducted with regard to transit accessibility and connectivity of which data is easier to get from built environment and neighborhood level demographic evaluation.

The approach to measure transit equity of this study refers to a seamlessly combination of both mobility and accessibility measures with overall transit connectivity measures by

Welch and Mishra (2013). This method contains the following steps.

3.3.1 Transit Connectivity

The research will start with building the first model of connectivity, which was first developed by Mishra et al. (2012). Data of each public transit line in study region including frequency of a line, speed of the transit mode, distance of a transit line l from node n to destination, capacity of vehicle, and activity density of the underlying land use served by a transit node would be utilized to calculate an inbound and outbound connecting power, which can be defined as:

$$P_{l,n}^o = \alpha \left(C_l \times \frac{60}{F_l} \times H_l \right) \times \beta V_l \times \gamma D_{l,n}^o \times \vartheta A_{l,n} \times \varphi T_{l,n} \quad (1)$$

$$P_{l,n}^i = \alpha \left(C_l \times \frac{60}{F_l} \times H_l \right) \times \beta V_l \times \gamma D_{l,n}^i \times \vartheta A_{l,n} \times \varphi T_{l,n} \quad (2)$$

Explanations of the notations used here are:

Notation	Explanation
$P_{l,n}$	inbound/outbound connecting power of line l
C_l	average vehicle capacity of line l
F_l	frequency of line l
H_l	daily hours of line l
V_l	average speed of line l
$D_{l,n}$	inbound/outbound distance of line l from node n to destination
$A_{l,n}$	activity density of line l, at node n
$T_{l,n}$	transfer scaled index of node n in a line l
α	scaling factor coefficient for capacity of line l
β	scaling factor coefficient for speed of line l
γ	scaling factor coefficient for distance of line l
λ	eigenvalue

Table 3.1 Notations of Connecting Power Calculation (Source: Welch and Mishra)

In these two equations, $A_{l,n}$ -- activity density is not directly available, and requires further calculation. The following equation shows how to get it.

$$A_{l,n} = \frac{H_{l,n}^z + E_{l,n}^z}{\Theta_{l,n}^z} \quad (3)$$

where $H_{l,n}^z$ is the amount of household in zone z which includes line l and node n; $E_{l,n}^z$ is employment for zone which includes line l and node n; and $\Theta_{l,n}^z$ is area of z containing line l and node.

Then, after the inbound and outbound connecting power of a transit line, and the activity density index are achieved, another index called transfer scaled index is needed. The node scores are adjusted by the number of transit lines on the node so as to scale for the least number of transfers required to reach the highest number and quality of destinations. The transfer scaled index is defined as:

$$T_{l,n} = \frac{\sum P_{l,n}^f}{\Theta_{l,n}^z} \quad (4)$$

Explanations of the notations used here are:

Notation	Explanation
$T_{l,n}$	transfer scaled index of node n in a line l
$\Theta_{l,n}$	number of lines l at node n
$\sum P_{l,n}^z$	sum of connecting power

Table 3.2 Notations of Transfer Scaled Index (Source: Welch and Mishra)

3.3.2 Transit Catchment and Accessibility

The second model is about transit catchment and accessibility. The following equation represents the connectivity calculation for a station within the half-mile catchment area.

$$\rho_{z1,n} = a \times \exp^{-bt_{h1,n}} \quad (5)$$

Explanations of the notations used here are:

Notation	Explanation
$\rho_{z1,n}$	connectivity index
$t_{h1,n}$	walk time from housing unit h1 to transit node n
a, b	parameters of pro-rated connectivity

Table 3.3 Notations of Transit Connectivity Index (Source: Welch and Mishra)

The parameters for a and b are from Kimet al. (2005) which are estimated based on empirical data. A final connectivity index is

$$\theta_{zu} = (|S_{\omega}| - 1)^{-1} \sum P_{l,n}^f(\rho_{n1,n}) \quad (6)$$

Explanations of the notations used here are:

Notation	Explanation
θ_{zu}	connectivity index for a zone
S_{ω}	set of stops in transfer center ω

Table 3.4 Notations of Final Connectivity Index (Source: Welch and Mishra)

The next step is to calculate the inequity index. The most common measure for this inequity is the Gini index, which has traditionally been used to calculate the distribution of wealth among population within a region. GINI index here is a value from 0 to 1 with an equation of

$$G_{\alpha} = 1 - \sum_{k=1}^n (X_k - X_{k-1})(Y_k - Y_{k-1}) \quad (7)$$

Notation	Explanation
G_{α}	Gini index value for a population or sample
X_k	cumulative proportion of final connectivity index with attribute k (for k = 0, . . ., n)
Y_k	the cumulative proportion of attribute k

Table 3.5 Notations of GINI Index (Source: Welch and Mishra)

A cumulative calculation shown above is how to get GINI Index. A notice here is that transit nodes that are outside the catchment area which is defined as a half mile in this research have a Y value of 0.

3.4 Interview of Decision Makers and Practitioners

After locating and realizing the issues, interview of two representatives who know the project well will be conducted. First one is a project manager from Shenzhen urban planning & design institute who led the TOD project initiated by planning department. The second one is a government official from transportation department in Shenzhen, which may hold different objectives on the project but got few opportunities to work or coordinate with planning department for the project.

The interview is to further understand the initial purpose of the TOD project, their opinions toward the transit equity issue in this research, and institutional issues behind.

3.5 Data Used in the Research

There are three parts of data:

1. Data about background and introduction of the observed issue is from Shenzhen Comprehensive Plan (2010 – 2020), Shenzhen Transportation Comprehensive Plan (2008), Shenzhen Urban Rail Transit Plan (2011 – 2016), Shenzhen Urban Planning and Design Guide (2009), and Shenzhen Green Transportation Development Strategy (2012).

2. For data collection of the built environment and social demographics, the guide is from Shenzhen TOD Guide and Standard. The built environment data will be collected based on the standards and scoring system derived from ITDP's TOD Standards, which will focus on Walkability, Connectivity, Mixability, Density, Compactness and Transfer.

The social demographics data average income, average housing price, average rent, rental rate, private car ownership proportion and ratio of travel by public transit.

3. Data for assessment of transit equity includes population density, employment, and households' number in each block group of study region. Moreover, frequency of a line, speed of the transit mode, distance of a transit line l from node n to destination, capacity of vehicle, and activity density of the underlying land use served by a transit node are also collected.

Chapter 4 RESULTS AND ANALYSIS

The following parts cover all relevant findings and results from planning document review, evaluation of built environment & social demographic, definition and assessment of transit equity, interview of decision makers and practitioners and supporting evidence. Corresponding analyses are also included to further explain the findings and results.

4.1 Planning Document Review

4.1.1 Shenzhen Comprehensive Plan (2010 – 2020)

The plan defined goals of the city during the ten years as: an early bird of China's Special Economic Zone; a representative international metropolis of China; and a part of world-class metropolitan area based on cooperation with Hong Kong. Some features of Shenzhen were repeated in this plan, including: a cooperative city with Hong Kong in financial industry and international trade under the policy of "one country, two systems" -- a characteristic city featured with innovative industry, advanced comprehensive service industry and culture industry; and an important transportation hub a border port of China.

The TOD project in this study was approved in July, 2007 and was initially operated in December, 2010, which is nearly the beginning of period in Shenzhen Comprehensive Plan.

1. Development Phase and Objective

The plan defines years from 2011 to 2015 as an important urban transformation period, which encourages the reclamation area to focus on financial industry development, owing to the fact that the land was reclaimed for more cooperative development with nearby Hong Kong. Moreover, comprehensive service industry is also a concentration in addition to financial industry development.

2. Cooperative Development with Hong Kong

The role of Shenzhen as the first Special Economic Zone is to realize free trade, free capital movement, cultivation of capital market in common. The plan intends to further promote cooperation between the two cities, which can not only enhance the status of Hong Kong as an international financial center in China, but also help Shenzhen become a regional financial center. Moreover, cooperation in innovative industry like information technology, high education, and research are also highlighted in the plan. Another definition for the

reclamation area is an open regional innovation system that leads flow of capital, information and people.

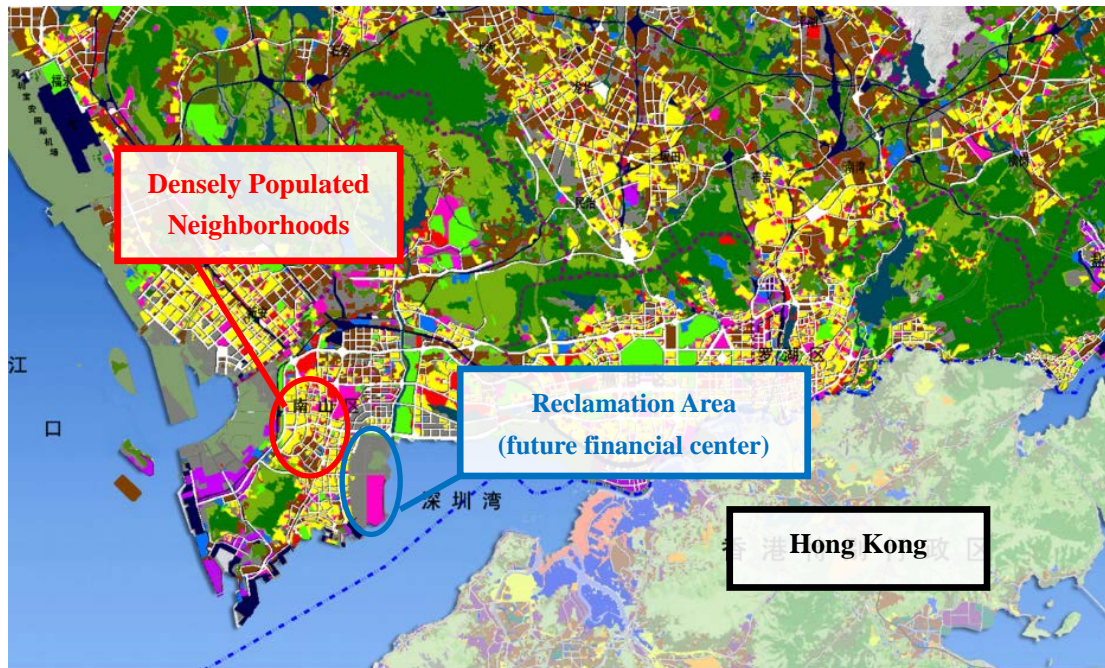


Figure 4.1 Location of Study Regions in the Plan

(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

3. Public Transit Development

The plan emphasizes more investment to public transportation, including traffic facilities and public transportation subsidies, due to potential more demand in the future.

4.1.2 Shenzhen Transportation Comprehensive Plan (2005 – 2015)

Relevant part in this document is Facilitating Urban Rail Transit Development. Integrated land use and transportation planning is specifically described in this part.

Around 2005 prior to approval of the project in this research, development was still a main goal for the city. Basic principles mentioned in this plan are a “double win” pattern which linked urban rail transit to surrounding land use development. Another combination is public and private partnership based on government’s leading role. This plan underlines the role of market for urban rail transit investment, which would relieve the financial pressure of urban rail transit by land use development profit.

The plan also talks about enhancing connection among different transportation modes. To be specific, the connection with Shenzhen Bay Port which is a popular port between

Shenzhen and Hong Kong, and the connection with bus stops leading to the densely populated neighborhoods.

4.1.3 Shenzhen Urban Rail Transit Comprehensive Plan (2011 – 2016)

This file is a very detailed one that incorporate not only summaries of urban rail transit phase I development from 2005 to 2010, but also specific plans for urban rail transit development in Shenzhen from 2011. The following paragraphs are about the TOD project – phase I of NO.2 metro line, including initial idea for the project, the TOD concept practiced in this project, land use planning of the reclamation area, transit equity issues generated by short-term operation of NO.2 metro line and corresponding remedies.

1. First Phase of NO.2 Metro Line

The project was initiated by Urban Planning Land and Resources Commission of Shenzhen Municipality (planning department) in 2004. The plan of the project was finished in October, 2006 and approved in June 2007. The length is 9.44 miles and total investment is over 1 billion dollars, of which 45% was from municipal government, and 55% from enterprise loans. The purpose of first phase of NO.2 metro line is to connect the city sub-center with the two main city centers and form a fast rail transit corridor, and also for mixed use development around the rail line to balance employment and residence.



Figure 4.2 Phase I (Red) and Phase II (Green) of NO.2 Metro Line
(Source: Shenzhen Urban Transportation Research Center)

NO.2 metro line incorporates red first phase and green second phase with a total length 15.72 miles and 22 stations. The red first phase responds to public transportation demand from south waterfront neighborhoods to the node with second phase. However, this claim isn't absolutely true because there is nearly no transportation demand along the corridor in

the reclamation area as the red ellipse on the map shows, which includes four representative stations on reclamation land. The second phase is to connect city center to the sub-center of city. In the meantime, the whole NO.2 metro line is a solution to link the relatively isolated peninsula – Shekou Port to main urban area.



Figure 4.3 Relatively Isolated Peninsula — Shekou Port (Source: China Transportation News)

Construction and operation of the project was under supervision of Shenzhen Metro Co., Ltd (SZMC), which is a state-owned enterprise to operate as authorized by Shenzhen Municipal government. SZMC undertakes the task of urban rail transit investment, construction, operation and value-capture. Besides first phase of NO.2 metro line, NO.1 metro line is also a part of phase I urban rail transit development in Shenzhen. After five years' operation of phase I, ridership increased continuously from 57,660,000 (2005) to 138,230,000 per year (2009), with decreasing operation cost and increasing benefit (Shenzhen Statistics Year Book 2012). Phase I also contributed to remarkable economic growth in Shenzhen, which probably can express major urban development goals during that period (2005 – 2011) and account for why government favors residential real estate industry development around the project.

2. TOD Concept in this Project

In this plan, it provides with general language of integrated land use and urban rail transit planning. For example, the plan says Phase I of NO.2 metro line was to encourage mixed use development. Through building some commercial and public uses, the project would not only provide convenient transit for nearby surrounding “new residents”, but also enhance community vitality. The rationale for TOD concept practiced here is that the project

would also offer some employment opportunities around the rail line, enhance job-housing balance, and then reduce automobile travel naturally. However, what happened today is apparently not well represented by the paper work. High end housing constitutes over 60% land development around four representative stops on the reclamation land.

Moreover, the plan also emphasized that urban rail transit development with TOD concept should be primarily focused on areas which are already well built and developed with huge transportation demand. This is because it meets residents' needs to travel conveniently. But one point mentioned in the plan may result in why government chose the reclamation area rather than densely populated neighborhoods as TOD stations – TOD project should also focus on existing transportation corridor, owing to the fact that in this way more physical space for urban rail transit development is available, which can reduce construction difficulty & investment.

Additionally, there is a saying in the plan claiming “keep on goals of achieving social welfare based on profitable business.” This could also be an excuse about high end housing development that can make lots of profit for both the government and real estate developers.

3. Three Levels of TOD Planning for the Project

As mentioned earlier in Literature Review Part, TOD is divided into three levels under situations of Shenzhen. For this project, this was a choice to develop special district with specific development purpose, i.e. cooperative development with Hong Kong. The idea for reclamation area was for a main purpose of bringing up surrounding land development rather than meeting transportation demand. The plan justifies the project well because this responds to the contemporaneous city master plan. When this plan was posted online in 2011 which is near the time it was approved, some residents voiced their opinions about first phase of NO.2 metro line as a speculative project. An interesting manifestation in the plan is that it covers existing operational conditions of all the four metro lines before 2011, except NO.2 metro line. This is probably due to the definition of this project which government also took as a speculative project. Government considered this is also a way to bring future residential and commercial development on the reclamation area to concentrate on metro stations, which can realize integrated land use and transportation development and compact spatial fabric. After all, at macro level, the idea of TOD should definitely be chosen to support city

comprehensive plan and future development pattern transformation.

When it came to meso-level, main issues are route design and station selection. The reclamation area has a very significant location feature – it's near Shenzhen Bay port which is now a very popular land border port between Shenzhen and Hong Kong, with 100,000 people crossing the border everyday (Transport Commission of Shenzhen Municipality). So another justification is that this project can coordinate urban rail transit development with other transportation modes and develop comprehensive multi-modal transportation pattern for the region.



Figure 4.4 Shenzhen Bay Port and Shenzhen Bay Bridge to Hong Kong
(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

With increasing travel through Shenzhen Bay Port and Shenzhen Bay Bridge, the government believed that an equally important task together with first phase of NO.2 metro line is to improve cross-border travel and transport of Shenzhen Bay port, which provides with physical conveniences for transportation of resources, people and information. This is an inevitable step for next thirty years of Shenzhen, which is a development phase to stabilize position of this metropolis in China and promote Shenzhen's competitiveness around the world. And making full use of adjacent location to Hong Kong and cooperation with Hong Kong is a crucial method to fulfill the goals.

Micro-level of TOD planning is a more detailed one, which focuses on station area

zoning, land use planning and design. A general design guideline is to develop residential, commercial and office uses inside 650 feet radius around metro stations, and less development with a highlight of public spaces between 650 and 1,650 feet radius around stations. Residential land uses should be around 50% of the surrounding uses.

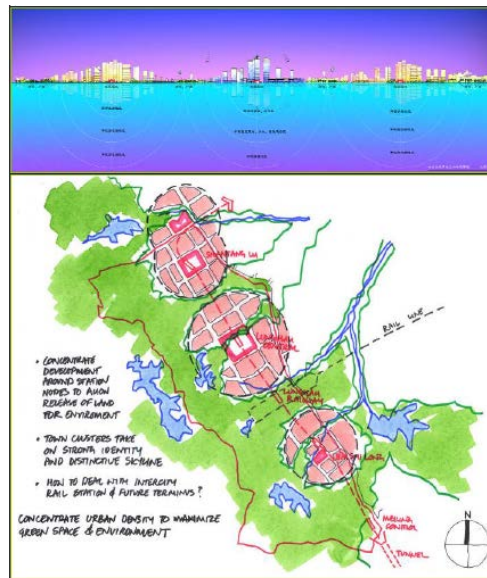


Figure 4.5 Integrated Land Use and Transportation Development Pattern
 (Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

4. Land Use Planning of Reclamation Area in Broader Regional Context

Due to the plan’s emphasis on integrated land use and transportation planning, it also shows particular urban design proposal of the reclamation area in broader regional context, which is called Shenzhen Bay Regional Design.

According to Shenzhen Comprehensive Plan (2010 – 2020), Shenzhen Bay Region is a prioritized part along Shenzhen’s waterfront, because it is primarily due to Shekou Port – the peninsula that makes Shenzhen a distinctive waterfront city. The reclamation area together with the whole regional waterfront, can serve as a role to demonstrate modern waterfront life in an international metropolis. Once again, the region is mainly served for further cooperation with Hong Kong. If Shenzhen Bay port could become more popular in the future, not only the region but the whole district would be largely affected by new industries. The plan expects the region to be a more attractive sub-center of the city with advanced comprehensive service industry, financial industry, innovative industry and cultural industry.



Figure 4.6 Important Nodes of Shenzhen Bay Region (Source: Shenzhen Urban Design Center)

Two parts of reclaimed land from above map constitute both a horizontal and vertical waterfront space for exchange and interaction. The plan also brands the reclamation area of this research (yellow) as Shenzhen Bay Center with commercial, office, cultural facilities development. Proposed land uses have some key words – comprehensiveness, flexibility, and high density. The plan says mixed-use buildings other than residential ones would be built to manifest the concept of TOD and community vitality. Around 2 square miles would be applied to commercial development with offices, entertainment, hotel, business apartment with multiple services.



Figure 4.7 Site Plan of Shenzhen Bay Region

(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

5. Land Use Planning of Reclamation Area in this Research

The reclamation land is one core part of the Shenzhen Bay Region, which would

function as a platform for new economic development and innovative industry, and a measure to enhance business competitiveness of Shenzhen. This is a unique waterfront development in China based on its location to Hong Kong, beautiful landscape and future multi-functioned land uses. The anchor tenant for this project would be transnational corporations, corporate headquarters, and research centers. Corresponding facilities, services and public spaces would be provided for the community.

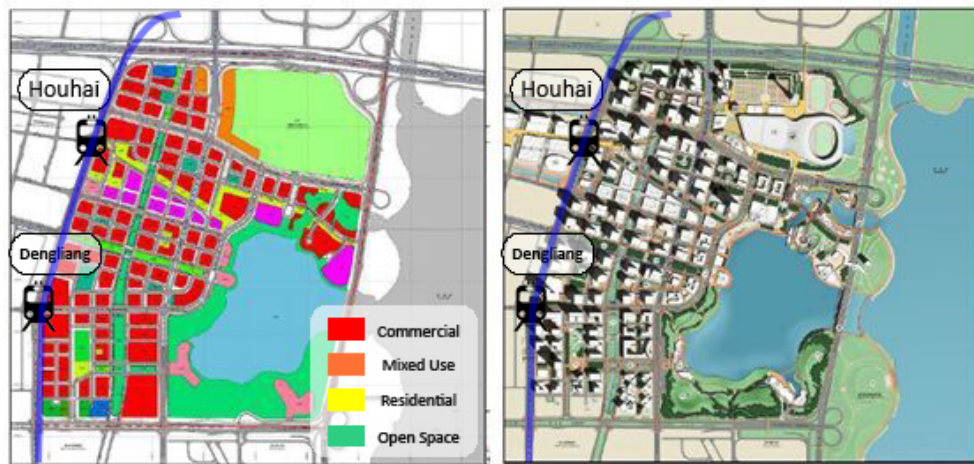


Figure 4.8 Land Uses and Site Plan for the Reclamation Area

(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

The planned land uses contain offices of 427 acres, other commercial uses of 111 acres, cultural buildings of 74 acres, and business apartments of 178 acres. The land use planning also points out the development pattern should highlight public transportation and other transportation modes except automobile travel. Houhai station shown on *figure 4.8* will be a transportation hub for the region, attracting urban rail transit, sightseeing bus and pedestrian. Nevertheless, the five years' development has not made Houhai station an attractive transportation and a regional center.

6. Transit Equity Considerations

The plan nearly doesn't mention the transportation demand in the nearby densely populated neighborhoods at all while it repeats the idea of developing the reclamation area by the TOD project. It has a general sentence – in order to meet public transportation demand from nearby neighborhoods, NO.10 metro line which is a project in Phase III of urban rail transit development would have better be designed through the densely populated neighborhoods and intersect with NO.2 metro line for transfer.

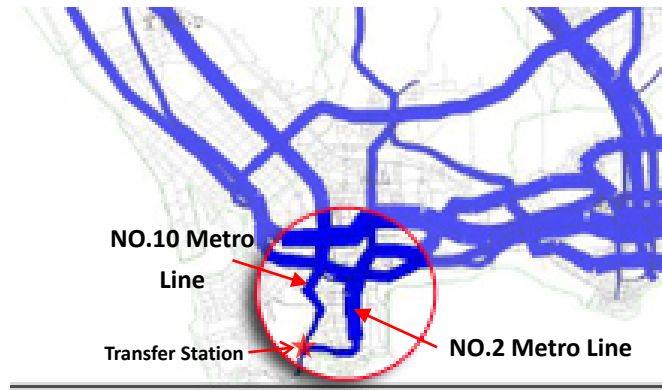


Figure 4.9 Future Urban Rail Transit Demand Estimation in 2030 (thickness as ridership)
 (Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

The above map shows the estimation of future urban rail transit demand with thicker NO.2 metro line and later NO.10 metro line that will serve the densely populated neighborhoods probably around 2030. The map can clearly tell the intent of the municipal government regarding the TOD project in this region – decision makers prioritize the Shenzhen Bay reclamation area as special development district. With TOD, the government believes that new residents and businesses would come there so that demand would go up. Hence, priority was given to the reclamation area development rather than densely populated neighborhoods. But government may also understand the negative externality when they made the decision, which are a lot of complaints about very congested road traffic and poor accessibility to subway stations from the densely populated neighborhoods today. Thus, NO.10 metro line was planned to in response to transit equity. This could be a reason for why government prioritized the reclaimed new land instead of the dense neighborhoods.

This plan illustrates details of NO.10 metro line, which is a linkage from Shekou Port to western districts of Shenzhen. The route in the densely populated neighborhoods is just a small part of this line.

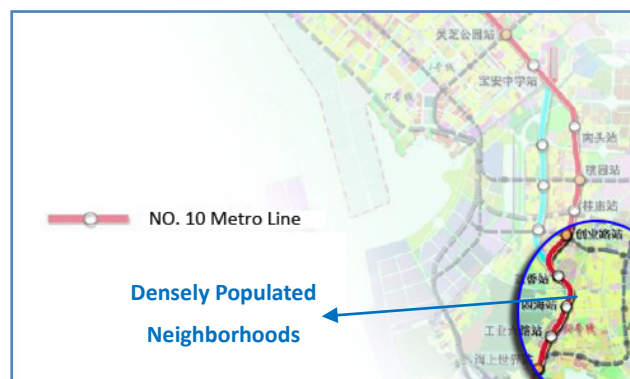


Figure 4.10 Route Design of NO.10 Metro Line

(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

The route design of NO.10 metro line in the densely populated neighborhoods is for existing transportation demand because the neighborhoods are all very well developed over the past several decades. But the interesting thing is that No.10 metro line is also under the concept of TOD with macro, meso and micro level planning as mentioned earlier. Now that the surrounding land uses could be further developed around NO.10 metro line and realize TOD, why did government choose the route design of first phase of NO.2 metro line rather than the route design of NO.10 metro line in the densely populated neighborhoods as the accesses to Shekou Port? There is no answer in the plan, but it mentioned difficulties for NO.10 metro line – dense buildings, narrow road, huge environment impact on nearby residents. This could partially account for why route design of NO.2 metro line was adopted.



Figure 4.11 Integrated Land Use and Transportation Planning of NO.10 Metro Line

(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

Additionally, the plan identified major difficulties for urban rail transit construction, which would change land use types, topography, landscape, underground water flow, existing vegetation; and create noises, worsen water and air quality, generate solid waste. Consequently, construction on the reclamation area would help avoid some of the bad impacts; this is also a factor that affects decision makers' choice.

7. Challenges of Urban Rail Transit Development

There are some challenges and difficulties summarized in the plan which are relevant. Motorized travel increased 2,550,000 people annually in 2007 compared with 2005; the

demand for travel was rising much higher than population growth. This is because Shenzhen is not a regular city with normal development tempo. It is hard to predict future development of the city. Several master plans in the past were not doing well at population and employment projection, resulting in deviation in urban rail transit planning because travel behavior and demand is hard to estimate. The existing high end housing development and low ridership of first phase of NO.2 metro line are a representative example of the difficulty.

Secondly, environmental impact assessment (EIA) is immature in evaluating urban rail transit construction. Since 2003 when EIA legislation was passed, city agencies began to work on EIA of road traffic, rail road, and urban rail transit construction. However, specific standards and methods applied in EIA of different agencies are various. Most agencies did EIA according to their experiences of projects they finished with few reference to the uniform EIA guidelines. To put it in a nutshell, departments that conducted EIA do not employ a mature method currently. There is a lacking of an appropriate and widely acknowledged EIA system, which resulted in undesirable outcomes generated by urban rail transit construction.

Last but not least, public involvement is also a difficult practice when it comes to urban rail transit development in Shenzhen. Even though relevant languages in EIA legislation claim organizations that are responsible for potential negative impact should hold public hearings and discussions, and solicit professional views from experts, public involvement is hard to realize. This is because stakeholders are easy to identify but ways haven't been well discovered, which results from institutional issues in local background.



*Figure 4.12 Existing (2015) and Future (2030) Urban Rail Transit Network near Study Region
(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)*

The chapter about challenges provides with clear reflection of years' urban rail transit operation from 2005 to 2010. This plan shares detailed information of concept, idea and proposals on paper, which is a basis for comparison with existing conditions in the latter part. It also shines some lights on the purpose of designing part of NO.2 metro line on the reclamation area instead of the nearby densely populated neighborhoods which will be covered by NO.10 metro line in the future.

4.1.4 Shenzhen Urban Planning and Design Guide (2009)

This document updated in 2009 contains standards and guidelines for physical planning in Shenzhen, including meso-level and micro level of TOD. The following parts list some items from the guide which are differently represented in existing built environment.

Level of Density	Density Zone	Basic FAR	Highest FAR
1	Zone 1 and Zone 2	3.2	6.0
2	Zone 3	2.8	5.0
3	Zone 4	2.2	4.0
4	Zone 5	1.5	2.5

Table 4.1 Floor Area Ratio Guide of Residential Uses

Level of Density	Density Zone	Basic FAR	Highest FAR
1	Zone 1	5.4	15.0
2	Zone 2	4.2	10.0
3	Zone 3	3.2	8.0
4	Zone 4	2.4	5.5
5	Zone 5	1.8	4.2

Table 4.2 Floor Area Ratio Guide of Commercial Uses

(Source: Shenzhen Urban Planning and Design Guide)

These two tables are floor area ratio guide of residential and commercial uses around subway stations under TOD. Even though zoning flexibility exists, built environment today of reclamation area has clear differences compared with the guide. This is probably due to the fact that development rights don't go together with zoning in Shenzhen.

4.1.5 Shenzhen Green Transportation Development Strategy (2012)

The report reiterates that Houhai station on the reclamation area is a representative

practice of TOD. In recent years, an increasing trend is that transportation becomes more focused on city centers while transport within each cluster increased much less. According to the file, transportation among different clusters in the city rose up by 13%. TOD around metro lines isn't performing very well. Considerations are insufficient in supplying supporting transportation facilities around subway stations. An incongruous phenomenon is that "more TOD, more congestion". The document explains these issues by saying that the mechanism for cooperation between transportation and land development department remains to be promoted. Few collaboration between these two kinds of agencies result in approved project proposals which in fact have shortages in techniques. When it comes to construction, urban rail transit development may not be able to coordinate well with land development in construction phases because of land supply and financing.

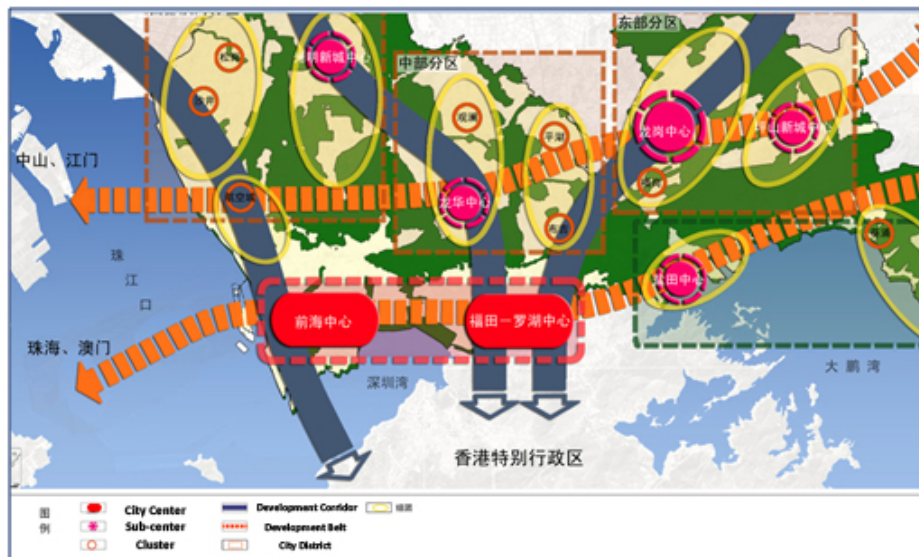


Figure 4.13 Clusters, Corridors and Centers in Shenzhen

(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

All in all, review of planning documents gives useful information regarding history of both the study region and the first phase of NO.2 metro line, the objective and expectation of the project, the idea of TOD practiced in this project, and the transit equity considerations generated by the project. Another significant thing is that the documents can tell some of the reasons and excuses for the research question. The following sections are about more exploration of the real factors behind.

4.2 Evaluation of Built Environment and Social Demographics

This part is to evaluate existing built environment around the main TOD stations on the

reclamation area quantitatively and qualitatively, according to Shenzhen TOD Guide and Standard. The evaluation is in order to discover existing conditions that are different from the planning paper work, based on data and photos collected from site visit. Moreover, data of social demographics in the two communities is analyzed to compare two groups of residents. The findings are in order to further define and assess transit equity in the next part.

4.2.1 Evaluation of Built Environment

According to Shenzhen TOD Guide and Standard, built environment can be quantitatively evaluated by categories of Walk, Cycle, Connect, Compact, Transit, Mix, Densify and Shift which have similar meanings as TOD Standard by ITDP. From the planning document review, there are four representative TOD stations of the project on reclaimed land -- Houhai, Dengliang, Haiyue and Wanxia station.



Figure 4.14 Four Representative TOD Stations on the Reclamation Area

The following maps show satellite view and zoning map of these four stations.

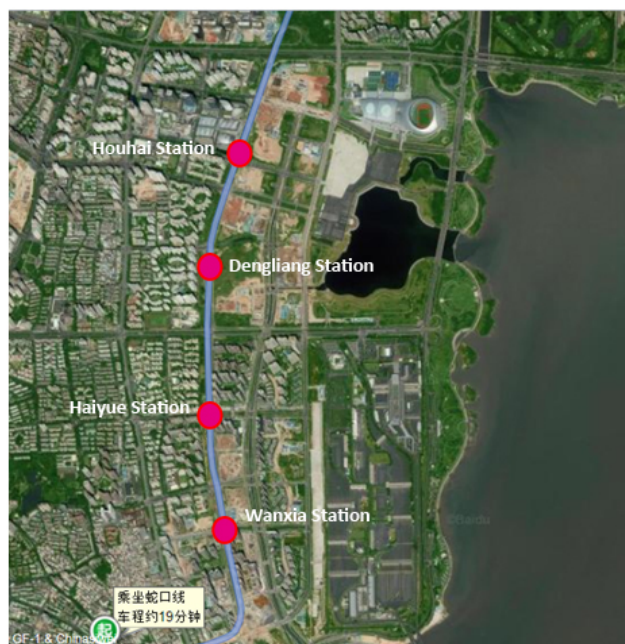


Figure 4.15 Four Representative TOD Stations on Satellite View (2015) (Source: Baidu Map)

It is very clear on the satellite view that the east part to the metro line is nearly all vacant land which is under construction now. For lots on the west part of Haiyue and Wanxia station, they are primarily developed as high end housing, the same as some lots on the east part to the two stations.

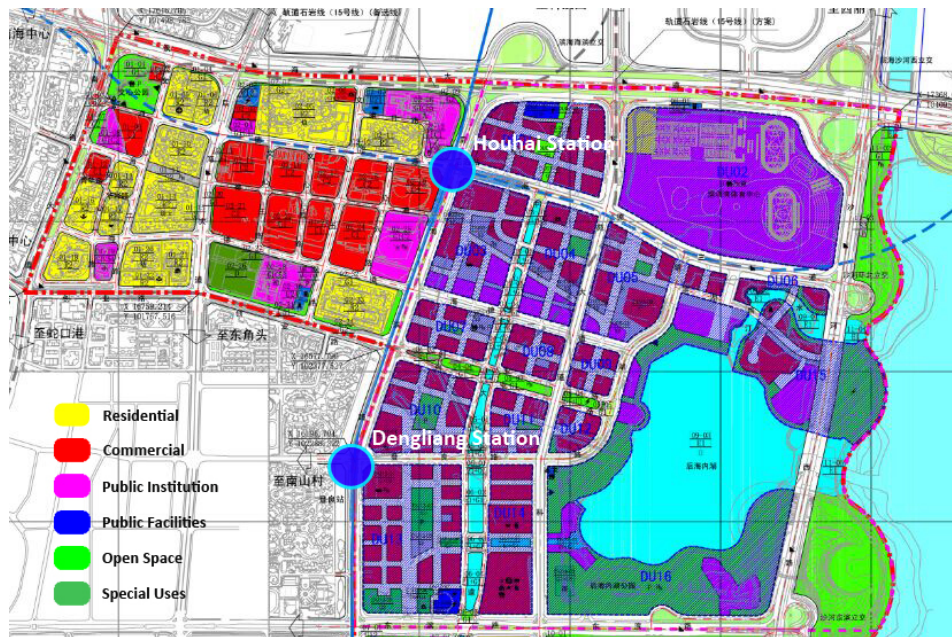


Figure 4.16 Zoning Map (2014) of Land around Houhai and Dengliang Station

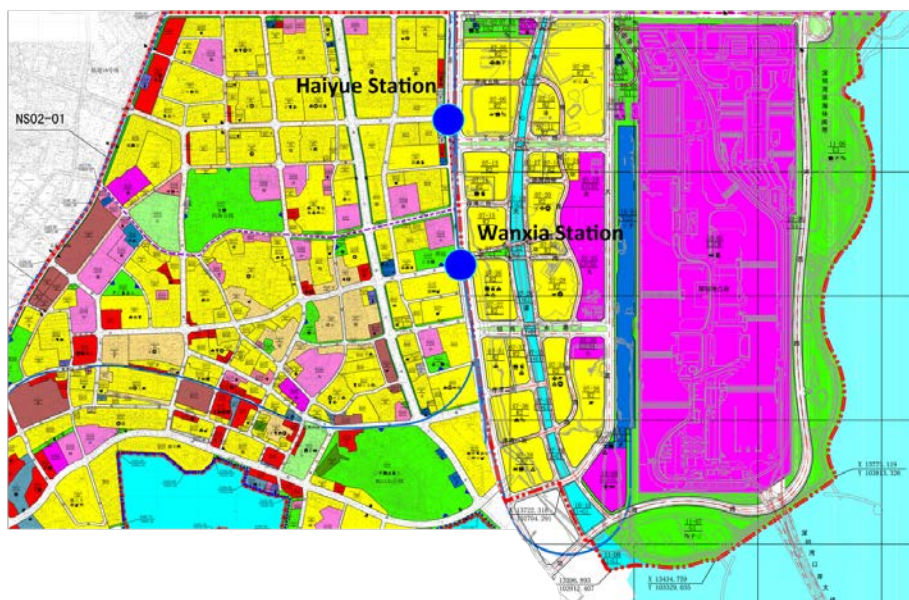


Figure 4.17 Zoning Map (2014) of Land around Haiyue and Wanxia Station

(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

The available zoning map for the study region is posted in 2014, which includes land uses, site area, FAR, supporting facilities, and special remarks. But for most items in FAR, the data is N/A. There are three potential reasons for this:

- If the land uses are open space and water, waste transfer stations, port facilities, and so on, the FAR is not very necessarily to be identified in the open zoning map.
- According to Land Administration Law of China (2004), land uses for governmental agencies and public institutions do not belong to Bid Invitation, Auction and Listing System in urban land transfer of China, they are allocated land uses, which don't have to be given specific FAR.
- The third situation is that the items with remarks of “keeping existing conditions” are mainly developed, FAR won't be needed until redevelopment happens on the site.

However, some residential and commercial land uses that belong to Bid Invitation, Auction and Listing System and should be given specific FAR are still planned without FAR in the zoning document updated in 2014. As mentioned earlier, the integrated land use planning of Shenzhen Bay Region which contains the reclamation area and urban rail transit planning of first phase of NO.2 metro line was around 2007. Things happened behind the incomplete information and the image from satellite view with much vacancy and high end housing development, may be zoning amendment, unexpected changes in plan and partnership, institutional issues like development rights are not together with zoning.

街坊编号	地块编号	用地代码	Land Use	Site Area (m ²)	FAR	配套设施项目名称	Remarks	土地利用相容性规定 兼容性性质
01	01-01	G1	公共绿地	24739	—	公共厕所、社会停车场(库)(150个停车位)	现状保留	
	01-02	C2	商业性办公用地	2881	—		现状保留	
	01-03	U52	垃圾处理用地	368	—	垃圾转运站、再生资源回收点	现状保留	
	01-04	G1	公共绿地	946	—		现状保留	
	01-05	R2	二类居住用地	14053	—	社区医疗服务站	现状保留	
	01-06	R2	二类居住用地	12389	—	12班幼儿园	现状保留	
	01-07	G2	生产防护绿地	2620	—		现状保留	
	01-08	G1C2	文化设施用地	8138	—		现状保留	
	01-09	C1	商业用地	12393	—		现状保留	
	01-10	R2	二类居住用地	28986	—		现状保留	
	01-11	S2	广场用地	5480	—	自行车停放点	现状保留	
	01-12	C1	商业用地	8338	—		现状保留	
	01-13	R2	二类居住用地	8402	—		现状保留	
	01-14	R2	二类居住用地	34819	—	12班幼儿园、居住区级文化中心	现状保留	
	01-15	G1	公共绿地	755	—		现状保留	
	01-16	R2	二类居住用地	14979	—	社区服务站	现状保留	
	01-17	R2	二类居住用地	10256	—	社区警务室	现状保留	
	01-18	R2	二类居住用地	10569	—		现状保留	
	01-19	G1C54	教育科研用地	7938	—	21班小学	现状保留	
	01-20	R2	二类居住用地	12694	—	8班幼儿园	现状保留	
01-21	R2	二类居住用地	14041	—	社区居委会	现状保留		
01-22	R2	二类居住用地	8925	—	社区服务站	现状保留		
02-01	G2	生产防护绿地	2846	—		现状保留		
02-02	U12	坝场用地	4177	—	变电站	现状保留		
02-03	C2	商业性办公用地	3678	4.40		规划		
02-04	G1C1	行政办公用地	3477	—		规划		
02-05	R2	商业性办公用地	84353	—		8班幼儿园	现状保留	
02-06	C2+G1C23	地广广播电视用地	3024	9.8		广播电视台	依据政府批件	
02-07	U21	公共文体用地	5415	—		公共汽车站	现状保留	
02-08	G1C55	九年一贯制学校用地	29814	—		39班九年一贯制学校	现状保留	

Table 4.3 Many N/A in FAR Part of Zoning Document

(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

The following parts are qualitative and quantitative evaluation of the four TOD stations which are all underground stations. According to Shenzhen TOD Guide and Standard, the quantitative indicators for TOD station area evaluation are: Walkability, Connectivity, Mixability, Density, Compactness, and Transfer.

Indicator	Maximum Score	Definition
Walkability	13	
Walkways	3	Percentage of block frontage with safe, wheelchair-accessible walkways.
Crosswalks	3	Percentage of intersections with safe, wheelchair-accessible crosswalks in all directions
Frontage	6	Percentage of intersections with safe, wheelchair-accessible crosswalks in all directions
Shade and Shelter	1	Percentage of intersections with safe, wheelchair-accessible crosswalks in all directions
Connectivity	15	
Small Blocks	10	Length of longest block (long side).
Prioritized Connectivity	5	Ratio of pedestrian intersections to motor vehicle intersections.
Mixability	15	
Complementary Uses	10	Residential and non-residential uses combined within same or adjacent blocks
Accesses to Food	1	Percentage of buildings that are within 500 meters radius of a source of fresh food.
Affordable Housing	4	Percentage of residential units provided as affordable housing.
Density	25	
Land Use Density	15	Percentage of residential units provided as affordable housing.
Walking Distance to Transit	10	Walk distance (meters) to the nearest transit station.
Compactness	8	
Number of Developed Sites	10	Number of sides of the development adjoining existing built-up sites.
Transit Options	2	Percentage of residential units provided as affordable housing.
Transfer	19	
Cycle Network	2	Percentage of total street segments with safe cycling conditions
Cycle Parking at Transit Stations	1	Secure multi-space cycle parking facilities are provided at all high-capacity transit stations.
Off-Street Parking	10	Percentage of residential units provided as affordable housing.
Driveway Density	2	Percentage of residential units provided as affordable housing.
Roadway Area	8	Percentage of residential units provided as affordable housing.
Total	95	

Table 4.4 Quantitative Indicators for TOD Station Area Evaluation

(Source: Shenzhen TOD Guide and Standard, ITDP TOD Standard)

1. Houhai Station

The station is a representative practice of TOD. It's surrounded by western Houhai commercial center, including theaters, shopping malls, restaurants, bars, and eastern Shenzhen Bay Gymnasium which held a Chinese Universiade in 2011. Shenzhen Metro

claimed that this is one of the most prosperous transportation nodes in the region with most ridership as well. Below picture is the site plan. It's clearly that the land east to the metro line hasn't been well developed and requires more time to make the station a complete TOD hub.



Figure 4.16 Site Plan around Houhai Station (Source: Shenzhen Metro)

Followings pictures taken in 2015 are some existing conditions around Houhai station:



Figure 4.17 Two Major Entries of Houhai Station

Mixed use development is just around the station with walkable dimension. Farther areas are residential buildings.



Figure 4.18 Spatial Fabric around Houhai Station

As above picture show, spatial fabric is pedestrian friendly. Vertical spaces are made full use of and accesses to elevations are easy to find. The following tables summarize scores for each quantitative indicator of station area evaluation:

Indicator	Score	Comments
Walkability	11	
Walkways	3	
Crosswalks	0	
Frontage	7	
Shade and Shelter	1	
Connectivity	9	
Small Blocks	6	
Prioritized Connectivity	3	Ratio of pedestrian intersections to motor vehicle intersections.
Mixability	11	
Complementary Uses	10	
Accesses to Food	1	
Affordable Housing		N/A (data not available)
Density	25	
Land Use Density	15	
Walking Distance to Transit	10	
Compactness	8	
Number of Developed Sites	6	Number of sides of the development adjoining existing built-up sites.
Transit Options	2	
Transfer	19	
Cycle Network	2	
Cycle Parking at Transit Stations	0	
Off-Street Parking	10	
Driveway Density	2	
Roadway Area	5	
Total	91/100	

Table 4.5 Quantitative Area Evaluation of Houhai Station

Hence, the total score for station area wide evaluation of Houhai station is 91/100. Generally, the built environment of Houhai station is able to meet most standards. In the end of 2012 after one year operation, sectional passenger flow of Houhai station had already been 60,489 people per hour, which was very similar to a nearby very successful TOD station – Windows of World station. But the next three stations have different stories.

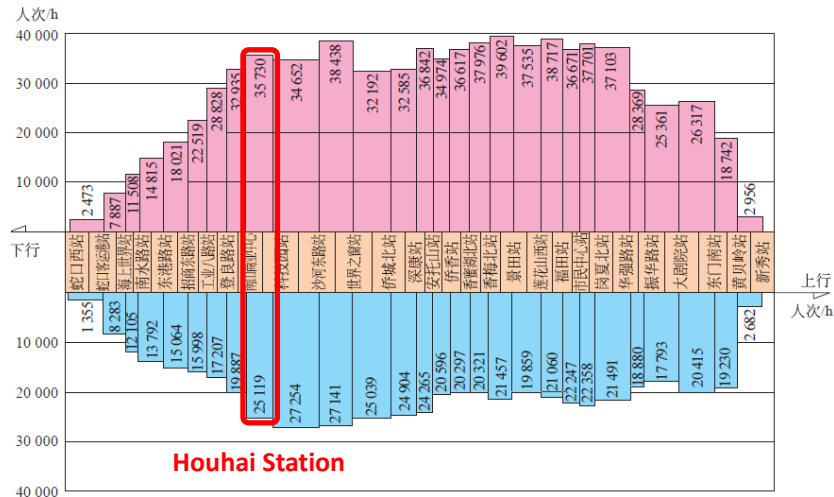


Figure 4.19 Sectional Passenger Flow at each Station of NO.2 Metro Line (2012)
(Source: Shenzhen Metro)

2. Dengliang Station

The station which is an underground one is from south to north. The west land to the station is high end housing and schools. Most parcels east to the station are still vacant reclamation land or under construction now. Again, it's a very interesting phenomenon that the reclamation land on the east side is still nearly vacant after 5 years' operation of NO.2 metro line, which is different from the plans of the planning documents reviewed.

Followings pictures taken in 2015 are some existing conditions around Dengliang station. The view of the left photo is from east to west, which is facing the reclamation area. The right one shows the high end housing development on the west.



Figure 4.20 Photos around Denagliang Station

Dengliang station is 0.5 mile from Houhai station, and was planned to be located in a mixed use development area. But the predominant uses now are residential. Another two photos below show that the commercial uses on the west side high end housing development

area are mostly street front retail oriented at the residents while the existing constructions on the east reclamation area are primarily high end housing projects as well. Some existing conditions are not outcomes of the plans. Although the development on the east reclamation land may take years to complete, the happening high end housing projects and relatively slow progress on the reclamation land could hint difficulties in attracting commercial real estate developers and anchor tenant of expected financial industry.



Figure 4.21 New High End Housing Developments on West Side (Left) and Street Retail on East Side (Right)

The following tables summarize scores for each quantitative indicator of station area evaluation:

Indicator	Score	Comments
Walkability	4	
Walkways	0	
Crosswalks	0	
Frontage	4	
Shade and Shelter	0	
Connectivity	9	
Small Blocks	6	
Prioritized Connectivity	3	
Mixability	5	
Complementary Uses	4	
Accesses to Food	1	
Affordable Housing	0	
Density	17	
Land Use Density	0	
Walking Distance to Transit	10	
Compactness	7	
Number of Developed Sites	6	
Transit Options	1	
Transfer	14	
Cycle Network	2	
Cycle Parking at Transit Stations	0	
Off-Street Parking	5	
Driveway Density	2	
Roadway Area	5	
Total	59/100	

Table 4.6 Quantitative Area Evaluation of Dengliang Station

Hence, the total score for station area wide evaluation of Dengliang station is 59/100. The built environment of Dengliang station is not a qualified TOD station according to standards proposed by Shenzhen TOD Guide and Standard. The development around the

station on both developed west side and ongoing east side is apparently not consistent to the planning document.

3. Haiyue Station

The station which is an underground one is from south to north. It's a featured TOD station because one main access to the station is connected to underground shopping mall, which serves the community. The farther uses are schools and high end housing around, except southeastern part to the station which is still vacant.



Figure 4.22 Site Plan around Haiyue Station (Source: Shenzhen Metro)

The shopping mall occupies 2.7 acres and contains a lot of both underground and street front retail spots. A similar spatial fabric compared with Dengliang station is that high end housing are primarily located on the west side while lower east side is still nearly vacant after 5 years' operation of NO.2 metro line.

Following pictures taken in 2015 are some existing conditions around Dengliang station. The following photos are a main entry to Haiyue station which is located at underground level leading to the mall and near the elevator to ground. Accessibility on and below ground



Figure 4.23 An Underground Entry to Haiyue Station

is good, but the few people appear in the shopping mall, nearby restaurants, and the subway station. This is probably because the existing development around is mainly residential and this area hasn't formed an employment center. The following pictures show that – the mixed use development is focused on a small area wide around the station as the left one shows.

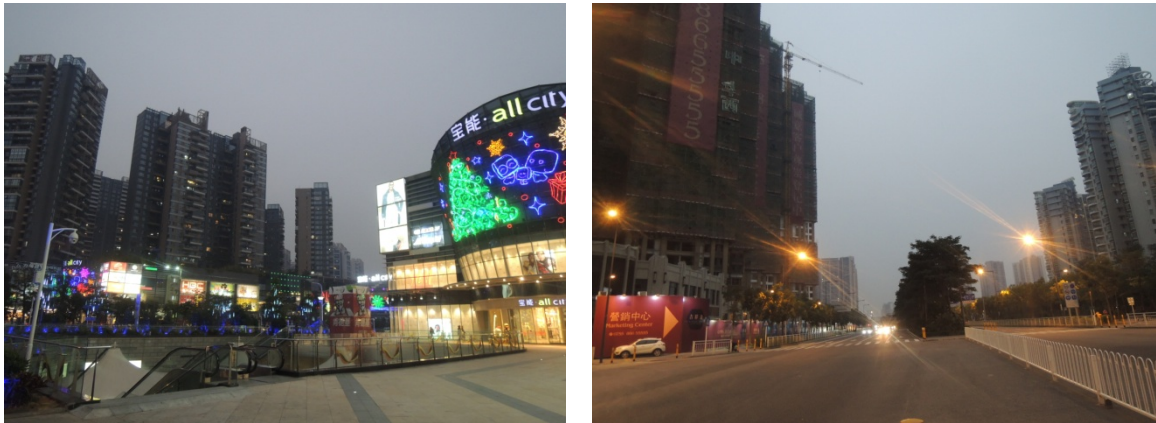


Figure 4.24 Street Level View from South to North (left) and toward South from Haiyue Station (right)

The elevators guide people to the underground shopping center and the main entry shown above. Image on the right is a view on the same point with a reverse direction which is from north to south. High end housing construction suddenly appears on the lot next to the mixed use area. The photos were taken around 6pm on a normal Friday, but not many people and vehicles passed through. The following tables summarize scores for each quantitative indicator of station area evaluation:

Indicator	Score	Comments
Walkability	12	
Walkways	3	
Crosswalks	3	
Frontage	5	
Shade and Shelter	1	
Connectivity	5	
Small Blocks	2	
Prioritized Connectivity	3	
Mixability	11	
Complementary Uses	10	
Accesses to Food	1	
Affordable Housing	0	
Density	15	
Land Use Density	7	
Walking Distance to Transit	8	
Compactness	8	
Number of Developed Sites	6	
Transit Options	2	
Transfer	15	
Cycle Network	2	
Cycle Parking at Transit Stations	1	
Off-Street Parking	5	
Driveway Density	2	
Roadway Area	5	
Total	70/100	

Table 4.7 Quantitative Area Evaluation of Haiyue Station

Hence, the total score for Haiyue station is 70/100. The built environment of Haiyue station can be qualified partially. The design of mixed use development is innovative and characteristic. But the transition to nearby high end housing development is too quick, making service radius of mixed uses programs limited.

4. Wanxia Station

The last stop is Wanxia station, also an underground station from south to north. The station is almost surrounded by high end housing development. There are vacant parcels on the east side but some housing programs already spread out. The site plan made by SZMC



Figure 4.25 Site Plan around Wanxia Station (Source: Shenzhen Metro)

does not sketch any existing buildings on the east side, probably due to the high end housing buildings are mostly under construction and haven't become functional block groups. The spatial fabric is similar to above Dengliang station.

Following pictures taken in 2015 are some existing conditions around Wanxia station. The following photo on the left is an entry with high end housing on the east side of the station. The right one is another entry with ongoing and existing high end housing projects on the west side to the station. Even though the area is walkable, accessibility to mixed uses such as retail, restaurant, and office is poor. The street front retails are all offices for the real estate developers that manage the housings. Moreover, it's hard to reach the schools on the site plan both physically and visually.



Figure 4.26 View of High End Housing on the East Side (left) and West Side (right) to Wanxia Station



Figure 4.27 Enclosed Vacant Land and Ongoing High End Housing Project

These pictures show the fantastic renderings of future Shenzhen Bay on the wall, which is usually defined as the “Super Advanced Business District”. However, the existing construction gives a sense of “Super Rich Residential District” by very powerful developers. What is happening now around Wanxia station is clearly not quite the same according to the planning document and zoning resolution. The developer formed a unique waterfront luxury residential development once they got development rights transferred from the city. However, zoning doesn’t disclose specific development indicator, and there is no zoning laws in Shenzhen as most Western cities do, which gave developers flexibility to make changes in their development between 2007 and 2012.

Following bad consequences could be that the beautiful landscape corridor won’t be able to play perfect role as public space and would be a part of these private development if it’s surrounded by these high end housing development. The following tables summarize scores for each quantitative indicator of station area evaluation:

Indicator	Score	Comments
Walkability	4	
Walkways	0	
Crosswalks	0	
Frontage	3	
Shade and Shelter	1	
Connectivity	3	
Small Blocks	2	
Prioritized Connectivity	1	
Mixability	0	
Complementary Uses	0	
Accesses to Food	0	
Affordable Housing	0	
Density	12	
Land Use Density	7	
Walking Distance to Transit	5	
Compactness	7	
Number of Developed Sites	6	
Transit Options	1	
Transfer	14	
Cycle Network	2	
Cycle Parking at Transit Stations	0	
Off-Street Parking	5	
Driveway Density	2	
Roadway Area	5	
Total	42/100	

Table 4.8 Quantitative Area Evaluation of Wanxia Station

Hence, the total score for station area wide evaluation of Wanxia station is 42/100. The built environment of Wanxia station is not qualified according to Shenzhen TOD Standard. The development around the station is apparently not consistent to the planning document and zoning. Maybe future development on the vacant land could supplement more uses.

All in all, built environment around the four representative TOD stations on the reclamation area has different aspects and things in common. The station area land use planning of Houhai and Haiyue station applies basic ideas of TOD and possesses their own distinctive urban design and spatial fabric. Comparatively, development around Dengliang and Wanxia station isn't very similar to what the planning documents and zoning resolution says and is not qualified TOD pattern. For all these four TOD stations, reclaimed land on the east to the stations is prevalingly high end housing project with few mixed use development. Some vacant land on the east side remained to be developed so that demand of residence and businesses hasn't been brought up, which is probably a reason that the flow of pedestrian and vehicles isn't high around 6pm on Friday night.

4.2.2 Evaluation of Social Demographics

The evaluation of social demographics in the two communities is in order to lead the research to transit equity issues. The following parts are mainly about demographic features and public transit related information.

Sources of available neighborhood level data is from local street office and neighborhood committee Number of residents living in each neighborhood is extracted from an official website called Sofun which provides with most updated housing sale information. This study assumes that there are three people in one apartment – a common family pattern in China. The following map shows location of the two communities.

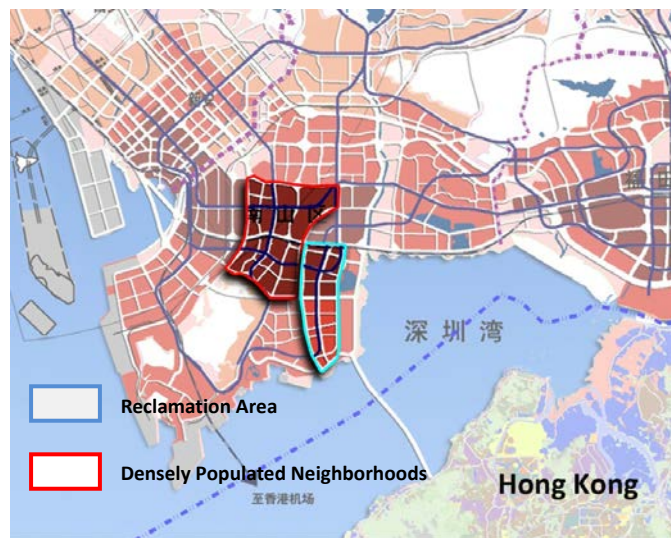


Figure 4.28 Location of Two Communities

(Source: Urban Planning Land and Resources Commission of Shenzhen Municipality)

24 neighborhoods are surveyed in the reclamation area while 13 neighborhoods are from the dense neighborhoods. The following table shows population density.

Community	Land Area (square mile)	Number of Residents	Population Density
Reclamation Area	1.5	14,505	9,670
Densely Populated Neighborhoods	2.53	29,574	11,689

Table 4.9 Overall Information of the Two Communities (Source: Shenzhen Statistics Year Book, 2012)

1. Densely Populated Neighborhoods

The densely populated neighborhoods have more uses like schools, hospitals, community centers, shops, public institutions, offices and factories than another community. Most neighborhoods are formed around early 21st century so that the uses and facilities are relatively complete. Many immigrants settle down here with lower rents and life expense than

the high end housing region. Most of them prefer public transportation because private car ownership costs them more due to the fact that they don't hold local citizenship identification – Hukou. With the increasing automobile ownership and travel, major boulevards from south to north become very congested now. Private cars compete with buses, resulting in much less efficiency of bus system and more complaints of residents who need public transportation. The following table summarizes variables of main neighborhoods in this community:

Neighborhood Name	Metro Station Around	Number of Residents	Average Housing Price	Average Rent	Average Income	Rental Rate	Proportion of Automobile Ownership	Travel by Transit
听涛花园	Dengliang	3384	\$32,385	\$4,417	\$6,000	13%	43%	60%
四海小区	Haiyue	2742	\$28,333	\$3,000	\$7,000	6%	70%	50%
翠竹园小区	Haiyue	1296	\$35,488	\$5,636	\$7,000	13%	70%	50%
学府花园	Houhai	2256	\$30,045	\$4,895	\$4,000	7%	4%	80%
阳光棕榈园	Houhai	3396	\$35,447	\$5,446	\$4,000	14%	50%	80%
Dengliang花园	Dengliang	2088	\$22,594	\$4,454	\$4,000	17%	52%	80%
太子山庄	Dengliang	2922	\$27,205	\$4,164	\$4,000	11%	10%	80%
南粤山庄	Dengliang	1317	\$23,074	\$3,892	\$4,000	12%	23%	80%
惠中名苑	Dengliang	789	\$25,600	\$3,276	\$4,000	17%	35%	80%
西苑花园	Dengliang	7485	\$6,884	\$2,300	\$4,000	1%	28%	80%
山海翠庐	Haiyue	1026	\$37,062	\$6,130	\$4,000	21%	65%	80%
山居岁月花园	Haiyue	873	\$34,839	\$5,888	\$5,000	23%	62%	80%
Average		2,465	\$28,246	\$4,458	\$4,750	13%	43%	73%
Total		29,574						

Table 4.10 Social Demographics Information of Densely Populated Neighborhoods

(Source: Street Office and Community Board)

2. Neighborhoods on the Reclamation Area

These high end housing projects gradually took place after 2008 when the plan of NO.2 metro line was approved. The uses on the reclamation area are primarily residential and the buildings generally have more than 20 floors. The housing price is much higher than regional average level. Due to some loopholes of real estate investment several years ago, a lot of speculative investment happened so that the building occupancy rate is not high (Sofun). Supporting uses and facilities for this community are not as good as the former one. Mixed use development like retail, shopping malls, and offices tends to only serve for the residents living in that area. The following table summarizes variables of in this community:

Neighborhood Name	Metro Station Around	Number of Residents	Average Housing Price	Average Rent	Average Income	Rental Rate	Proportion of Automobile Ownership	Travel by Transit
广博星海华庭	Wanxia	1,569	\$40,000	\$5,326	\$8,000	11%	67%	50%
Wanxia花园	Wanxia	1,050	\$20,818	\$5,787	\$8,000	14%	11%	50%
明海苑	Wanxia	876	\$29,999	\$6,300	\$8,000	7%	47%	50%
港湾花园	Wanxia	645	\$39,543	\$7,000	\$8,000	9%	100%	50%
海莉园	Wanxia	189	\$28,794	\$3,542	\$8,000	72%	100%	50%
半岛花园	Haiyue	3,432	\$16,168	\$2,555	\$8,000	8%	26%	50%
Haiyue花园	Haiyue	3,684	\$40,365	\$7,298	\$8,000	7%	61%	50%
天骄华庭	Haiyue	1,278	\$44,805	\$9,737	\$8,000	14%	79%	50%
蓝月湾畔花园	Haiyue	750	\$37,810	\$6,949	\$8,000	20%	86%	50%
桂园小区	Haiyue	2,835	\$30,430	\$4,024	\$8,000	7%	32%	50%
爱榕园	Haiyue	3,900	\$33,516	\$3,296	\$8,000	5%	22%	50%
蔚蓝海岸花园	Dengliang	2,532	\$43,262	\$6,507	\$7,000	8%	100%	40%
天海花园	Dengliang	1,680	\$34,982	\$5,215	\$7,000	9%	45%	40%
浪琴湾花园	Dengliang	1,728	\$41,812	\$6,650	\$7,000	10%	90%	40%
文德福花园	Dengliang	2,586	\$33,568	\$6,356	\$7,000	6%	12%	40%
西海湾花园	Dengliang	1,746	\$37,484	\$5,496	\$7,000	30%	69%	40%
观海台花园	Houhai	2,787	\$51,166	\$6,633	\$7,000	9%	68%	40%
海珠城	Houhai	1,368	\$24,944	\$4,447	\$7,000	34%	7%	40%
锦隆花园	Houhai	624	\$28,155	\$5,664	\$7,000	74%	70%	40%
海阔天空雅居	Keyuan	2,055	\$49,706	\$7,548	\$7,000	9%	59%	40%
阳光带海滨城	Keyuan	2,748	\$51,367	\$9,131	\$7,000	10%	78%	40%
恒力听涛花园	Keyuan	1,773	\$58,241	\$6,691	\$7,000	13%	68%	40%
浅水湾花园	Keyuan	936	\$53,694	\$17,387	\$7,000	22%	100%	40%
海怡东方花园	Keyuan	2,238	\$54,800	\$6,349	\$7,000	13%	100%	40%
Average		1,875	\$38,541	\$6,495	\$7,458	17%	62%	45%
Total		45,009						

Table 4.11 Social Demographics Information of Neighborhoods on the Reclamation Area
(Source: Street Office and Community Board)

3. Comparison

When average housing price, average rent, average income, rental rate, proportion of automobile ownership, and ratio of travel by public transportation are combined to get a mean value for each community, the following table is got.

	Average Housing Price	Average Rent	Average Income	Rental Rate	Proportion of Automobile Ownership	Travel by Transit
Reclamation Area	\$38,541	\$6,495	\$7,458	17%	62%	45%
Densely Populated Zone	\$28,246	\$4,458	\$4,750	13%	43%	73%

Table 4.12 Comparison of Two Communities
(Source: Street Office and Community Board)

It's very clear that reclamation area is more expensive than the densely populated neighborhoods. People who live in the reclamation have less demand for public transit. Residents in the dense neighborhoods can only use buses on congested road, as the walking distance is too far for them to reach NO.2 metro line, or NO.1 metro line.

The following two maps show the road traffic congestion level in this region. The data is from Transport Commission of Shenzhen Municipality, showing an index which means time spent on actual travel compared with time spent on expedite road of same distance. Both on a weekday and a weekend, road traffic of the densely populated neighborhoods is more congested than that of the reclamation area. This is because the dense neighborhoods are already mature with frequent economic activities, business travels, commuting residents and bus transit while parts of land on the reclamation area are still under construction or vacant. Even though there are many existing high end housing buildings, number of residents is not high because of immature complementary uses development, relatively lower occupancy rate,

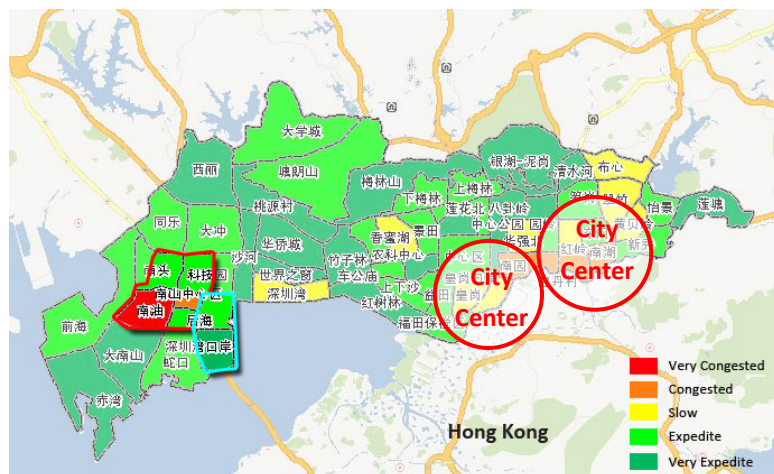


Figure 4.29 Road Congestion Level on Weekdays

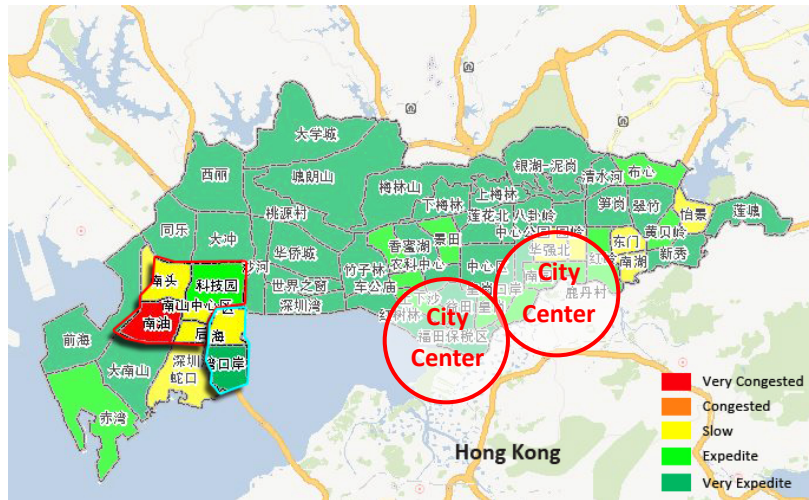


Figure 4.30 Road Congestion Level on Weekends

(Source: Transportation Commission of Shenzhen Municipality)

fewer businesses and economic activities, and less demand for public transportation. Although Shenzhen Urban Planning and Land Resource Commission gave an excuse in 2012 saying that the TOD requires long time to make effects on the reclamation area, public transportation investment should also been given serious consideration to the nearby densely populated neighborhoods. After four years' operation of NO.2 metro line, road transportation congestion and public transportation facilities are visibly not distributed evenly. The following part is to quantitatively measure transit equity in this region, in order to achieve evidence and questions for interviews with decision makers and practitioners.

4.3 Definition and Assessment of Transit Equity

4.3.1 Definition of Transit Equity in the Case

Based on above evaluation of built environment and social demographics, data and information of transit routes, schedules, frequency, capacity, demographics, and spatial fabric are available. Transit connectivity, catchment and accessibility are key factors that affect residents' travel and choice in this study. Hence, these three factors are indicators of transit equity in this research. As mentioned earlier, the methodology of this research is based on Welch and Mishra's (2013) transit connectivity measurement.

4.3.2 Calculation of Transit Connectivity

In this research, in order to facilitate the calculation, the neighborhoods are zoned according to areas which are surrounded by avenue and boulevard. Because main transit routes with most number of buses which are the major public transit component go through avenues and boulevards. The following map shows the zones:

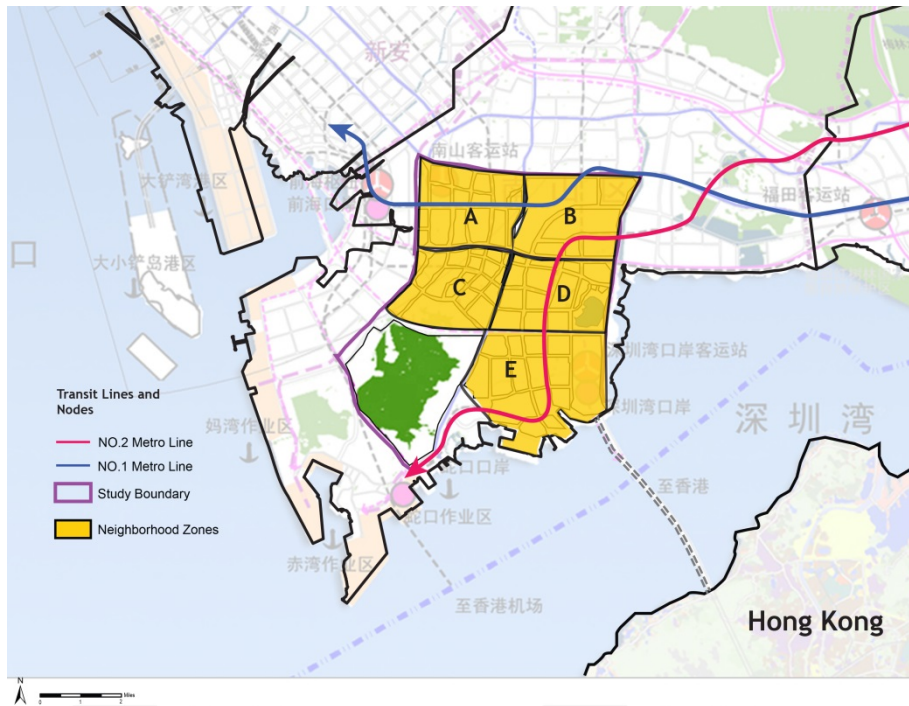


Figure 4.31 Neighborhood Zones for Calculation

(Base Map Source: Urban Planning Land and Resource Commission of Shenzhen Municipality)

For the purpose of calculation, the employment data that is unavailable is assumed as two third of total population number in a zone. This is because Shenzhen household usually contains three people – parents and a child. The assumption is that two people will be in employment status in each household. The summary of each zone is:

Zone	Population	Population Density	Employment
A	17,744	11,689	11,830
B	11,830	11,689	7,886
C	11,252	11,689	7,502
D	15,753	9,670	10,502
E	18,004	9,670	12,002

Table 4.13 Summary of each Zone (Source: Street Office and Community Board)

The next step is to identify nodes in the five zones and corresponding connections in order to get data for inbound and outbound connecting power calculation. The selection of

nodes is based on road intersections where over three transit lines (bus or rail) go through. And after mapping them, nearly all the nodes appear at intersections of avenues and boulevards, which is like follows:

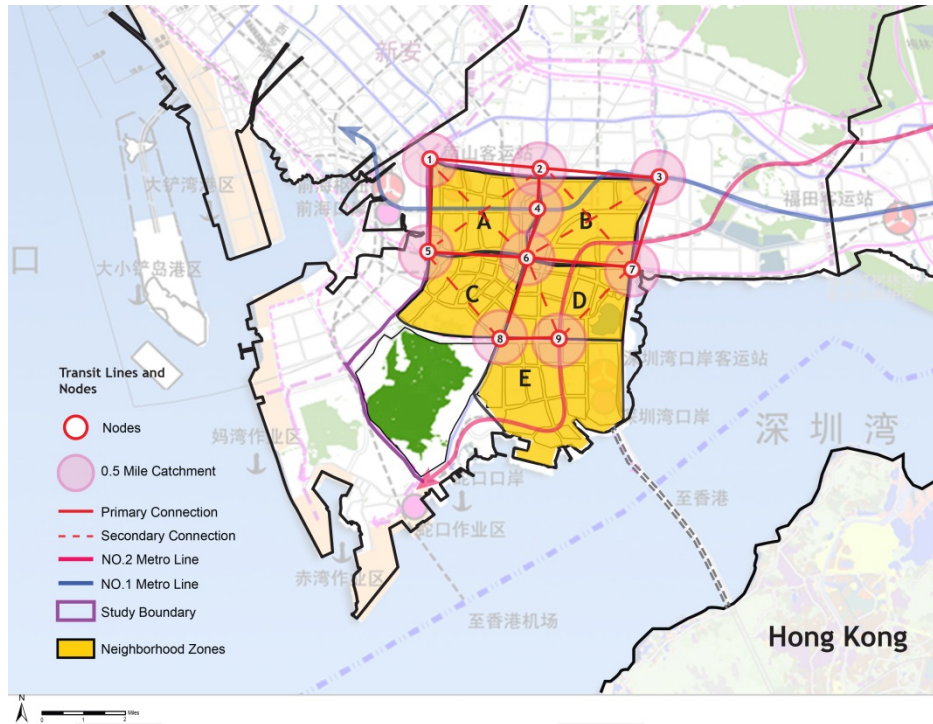


Figure 4.32 Nodes and Connections

(Base Map Source: Urban Planning Land and Resource Commission of Shenzhen Municipality)

For the table of specific data of each line, which includes Mode, Distance, Speed, Frequency, Operations a Day, and Capacity, Distance means the sum of distance from each stop within the catchment area to the node. The summary of the table is on the next page:

NO	Line	Mode	Distance (mile)	Speed (mph)	Frequency (minutes)	Operations a Day	Capacity (number of people)
1	1	Rail	4.07	62	3	175	2502
2	2	Rail	5.2	50	8	131	2400
3	22	Bus	5.4	21	10	102	55
4	42	Bus	6.0	21	15	68	55
5	58	Bus	6.0	21	10	102	55
6	74	Bus	6.0	16	20	51	55
7	78	Bus	7.0	19	30	34	55
8	79	Bus	7.0	20	12	85	55
9	81	Bus	6.0	20	20	51	55
10	122	Bus	9.0	19	60	17	45
11	204	Bus	7.0	17	7	146	45
12	226	Bus	9.0	21	10	102	45
13	301	Bus	7.0	18	10	102	45
14	323	Bus	9.0	18	10	102	45
15	327	Bus	9.0	17	10	102	45
16	395	Bus	7.0	16	7	146	45
17	B688	Bus	9.0	20	15	68	35
18	B689	Bus	6.0	17	15	68	35
19	B702	Bus	7.0	21	20	51	35
20	B796	Bus	8.0	16	30	34	35
21	B813	Bus	9.0	22	15	68	35
22	M200	Bus	7.0	20	10	102	50
23	M241	Bus	8.0	19	15	68	50
24	M364	Bus	8.0	20	18	57	50
25	M370	Bus	9.0	21	14	73	50
26	M375	Bus	8.0	21	10	102	50
27	M413	Bus	9.0	21	60	17	50

Table 4.14 Detailed data for calculation

(Source: Shenzhen Metro, Shenzhen Bus Group Company)

The first step of calculation is to get the inbound and outbound connecting power of a transit line. Then the activity density and transfer scaled index are available. For activity density, the data of employment is based on the assumption mentioned above. The results of connecting power of a transit line, and total connecting power of line n at each node is:

Node	P0 _{l,n}	Pi _{l,n}	Al,n	Tl,n	Pt _{l,n}
1	0.8969	0.897	0.7258	6	0.1486
2	9.9784	9.9784	1.4689	8	2.5896
3	11.5989	11.5989	1.6988	9	1.9789
4	8.8269	8.8269	1.1598	8	2.2989
5	0.1896	0.1896	0.6985	5	0.0498
6	35.5982	35.5982	1.6289	10	3.4896
7	29.8968	29.8968	1.6985	9	7.7258
8	0.0459	0.0459	0.9896	5	0.0187
9	0.4659	0.4659	0.3626	6	0.0786

Table 4.15 Results of Connecting Power

4.3.3 Transit Catchment and Accessibility

Based on the results of connecting power, the results of connectivity index in each zone are:

Zone	$\rho_{n1,n}$	S_{ω}	$\sum P_{l,n}^t$	θ_{zu}
A	30	162	8.5765	7.8549
B	35	162	18.0828	15.2983
C	20	162	3.5581	4.5896
D	50	162	11.3127	11.8900
E	45	162	9.9889	10.0236

Table 4.16 Connectivity Index in each Zone

A higher connectivity index θ_{zu} means higher speed transit lines and easier access to opportunities (areas with high activity density). In this research, Zone B has highest zonal connectivity index number due to the fact that both NO.1 and NO.2 rail transit line go through the zone.

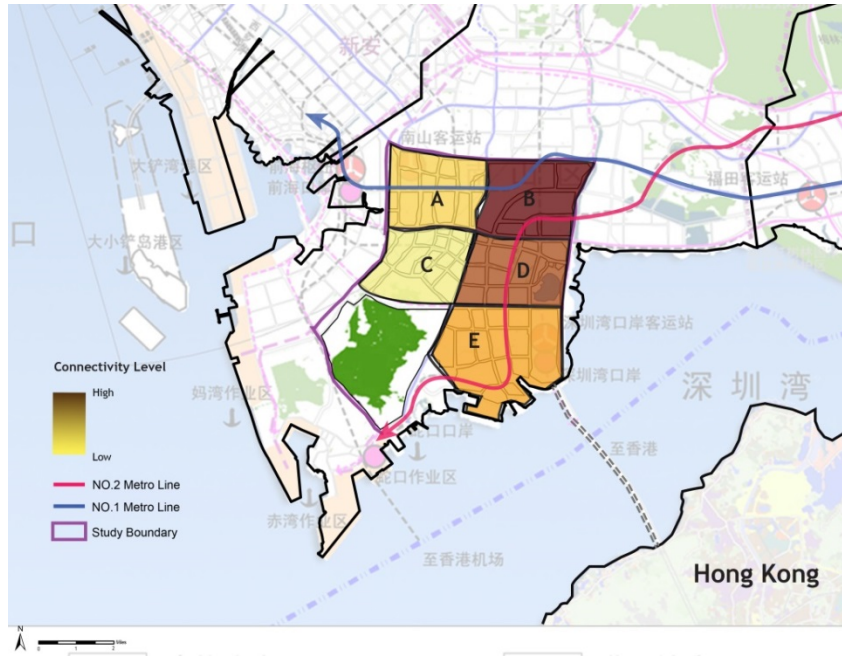


Figure 4.33 Connectivity Level in each Zone

(Base Map Source: Urban Planning Land and Resource Commission of Shenzhen Municipality)

Follow table is a summary of how to get GINI Index after accumulative sum up of final transit connectivity index and its proportion.

Zone	Connectivity Index	Proportion of Connectivity	Proportion of Population	Cumulative Proportion of Connectivity (Yk)	Cumulative Proportion of Population (Xk)	Yk - Yk-1	Xk - Xk-1	(Yk - Yk-1) * (Xk - Xk-1)
C	4.5896	0.092427	0.150868831	0.092427	0.150868831	0.092427	0.150868831	0.013944
A	7.8549	0.158185	0.237914806	0.250612	0.388783637	0.158185	0.237915	0.037635
E	10.0236	0.201859	0.241390129	0.452471	0.630173766	0.201859	0.241390	0.048727
D	11.89	0.239445	0.211216363	0.691917	0.841390129	0.239445	0.211216	0.050575
B	15.2983	0.308083	0.158609871	1.000000	1	0.308083	0.158610	0.048865
Total	50	1						0.199746

Table 4.17 Inequality Index of the Connectivity Distribution

The above table shows inequality index. Combining households' number in every sub-block of each zone, the GINI's concentration ratio is as follows:

Zone	Block Group	Households	Connectivity Index	GINI's Concentration Ratio
A	1	305	0.037635	0.3983
A	2	311	0.037635	0.4058
A	3	325	0.037635	0.4242
A	4	331	0.037635	0.4315
A	5	346	0.037635	0.4516
A	6	423	0.037635	0.5514
A	7	394	0.037635	0.5141
A	8	348	0.037635	0.4537
A	9	386	0.037635	0.5042
A	10	393	0.037635	0.5124
A	11	427	0.037635	0.5572
A	12	321	0.037635	0.4185
A	13	328	0.037635	0.4282
A	14	336	0.037635	0.4390
A	15	481	0.037635	0.6280
A	16	460	0.037635	0.6002
Total				7.7183

Table 4.18 GINI Index of Block Groups in Zone A

Zone	Block Group	Households	Connectivity Index	GINI's Concentration Ratio
B	1	427	0.048865	0.3805
B	2	450	0.048865	0.4011
B	3	751	0.048865	0.6696
B	4	775	0.048865	0.6907
B	5	777	0.048865	0.6927
B	6	762	0.048865	0.6795
Total				3.5141

Table 4.19 GINI Index of Block Groups in Zone B

Zone	Block Group	Households	Connectivity Index	GINI's Concentration Ratio
C	1	202	0.013944	0.3802
C	2	204	0.013944	0.3827
C	3	205	0.013944	0.3852
C	4	202	0.013944	0.3801
C	5	207	0.013944	0.3880
C	6	204	0.013944	0.3824
C	7	209	0.013944	0.3920
C	8	225	0.013944	0.4235
C	9	229	0.013944	0.4294
C	10	273	0.013944	0.5119
C	11	279	0.013944	0.5239
C	12	249	0.013944	0.4685
C	13	290	0.013944	0.5455
C	14	259	0.013944	0.4866
C	15	271	0.013944	0.5089
C	16	243	0.013944	0.4560
C	17	298	0.013944	0.5590
C	18	260	0.013944	0.4888
Total				7.0448

Table 4.20 GINI Index of Block Groups in Zone C

Zone	Block Group	Households	Connectivity Index	GINI's Concentration Ratio
D	1	343	0.050575	0.5299
D	2	292	0.050575	0.4517
D	3	310	0.050575	0.4784
D	4	428	0.050575	0.6607
D	5	392	0.050575	0.6059
D	6	413	0.050575	0.6377
D	7	402	0.050575	0.6214
D	8	443	0.050575	0.6846
D	9	452	0.050575	0.6986
D	10	441	0.050575	0.6813
D	11	436	0.050575	0.6735
D	12	451	0.050575	0.6961
D	13	447	0.050575	0.6910
Total				8.1108

Table 4.21 GINI Index of Block Groups in Zone D

Zone	Block Group	Households	Connectivity Index	GINI's Concentration Ratio
E	1	321	0.048727	0.4204
E	2	333	0.048727	0.4355
E	3	436	0.048727	0.5706
E	4	434	0.048727	0.5685
E	5	451	0.048727	0.5902
E	6	485	0.048727	0.6342
E	7	478	0.048727	0.6260
E	8	499	0.048727	0.6536
E	9	463	0.048727	0.6065
E	10	512	0.048727	0.6704
E	11	531	0.048727	0.6953
E	12	525	0.048727	0.6871
E	13	533	0.048727	0.6973
E	14	515	0.048727	0.6735
Total				7.8556

Table 4.22 GINI Index of Block Groups in Zone E

Calculations were done for each block group in each zone that contains main neighborhoods of the two communities. The final number – GINI Coefficient of Transit Equity is a number that quantitatively describes the transit equity level in each block group according to the definition above.

4.3.4 Results

The following map shows the spatial distribution of transit equity levels. The visualization responds to previous discussion and analysis. The high end housing lots have clearly higher value of the transit equity index and more concentrated spatial trend while some parcels in the dense neighborhoods have low level. Some neighborhoods at the northwest corner of the study region have higher value of the index because they can benefit from the NO.1 metro line. But if people go toward south, they will go in areas with much lower number of transit equity.

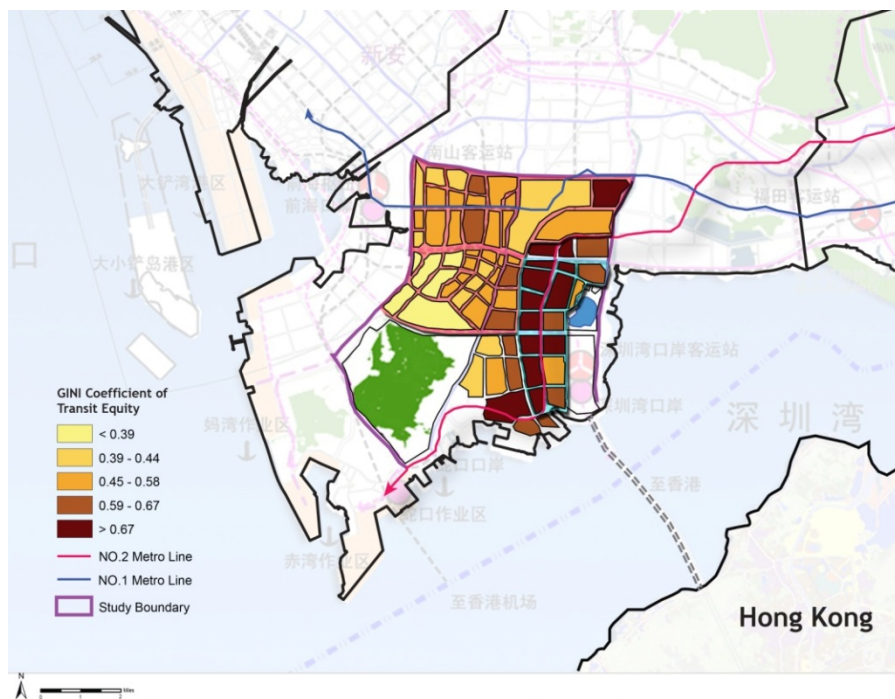


Figure 4.34 Transit Equity Spatial Distribution in Study Region

(Base Map Source: Urban Planning Land and Resource Commission of Shenzhen Municipality)

Consequently, this method illustrates similar story as the findings and analyses in earlier sections, which highlights the unequal urban rail transit distribution and supply. Together with the inconsistent development after five years' operation of the TOD project compared with concordant planning documents, the issues of transit equity were brought to interviews with relevant decision makers and practitioners, in the next portion.

4.4 Interview of Decision Makers and Practitioners

Valuable information came from two interviewees – a city planner (government official) at Transport Commission of Shenzhen Municipality, and director (practitioner and project manager) of Transportation Planning Division at Shenzhen Urban Planning and Design Institute. The city planner is a representative government official who works mainly on transportation issues of the city and has been working there for four years. Some points he mentioned are as follows:

(1) Immature TOD and multi-agency cooperation mechanism

This project – the first phase of NO.2 metro line was planned as a practice of TOD. But at that time, TOD and the three levels of TOD planning hadn't been well localized as an experienced development pattern. Moreover, this project was initiated by Shenzhen's planning department, without much cooperation with transportation department of the city. Some transportation issues haven't been well discovered and analyzed, resulting in some existing conditions which deviate from estimated future development of the reclamation area. He also pointed out that for they have very little collaboration with planning department for most comprehensive urban planning projects that he has experienced in the transportation department. This claim responds to an observation from planning document review, among which the urban planning related files were made by the planning department while the transportation department is the only actor for creating transportation related plans.

(2) Various performances that different city agencies pursue

Besides public welfare, different city agencies pursue various performances. A huge

proportion of benefits that the city planning department wants are profit and tax revenue by selling land (Shenzhen Government), because ownership of all land in Shenzhen is city government. Comparatively, the transportation department prioritizes higher transportation volume, including public transportation ridership, inter-city rail road ridership and port ridership (Shenzhen Government). Since the planning department was the decision maker of this project, achieving profitable outcome from selling land, and tax revenue was one primary goal. Planning the project on the reclaimed land would cost much lower demolition expense, and the benefit from brand new development on the reclamation area which could attract developers, investors and anchor tenant. Faced with much higher profit which can be brought by new development on the reclamation area, the planning department designed the transit route on the reclaimed land.

(3) Economic growth as a main goal in past several years

The Gross Domestic Product (GDP) is nearly the most important indicator all city agencies desire. The last ten years from now were a period that the city was developing and growing very quickly. Real estate industry is a catalyst for fast GDP growth, since it can bring up over 50 industries with more than 2000 kinds of products, such as architecture, construction, utilities and so on (Shi, 1997). Hence, lots of powerful developers compete for the reclaimed land. In Shenzhen, development rights don't come with zoning and the ownership of all land belongs to the city. When development rights were transferred to developers, it means the city favors their residential oriented real estate development. This is why high rise housing projects appeared around.

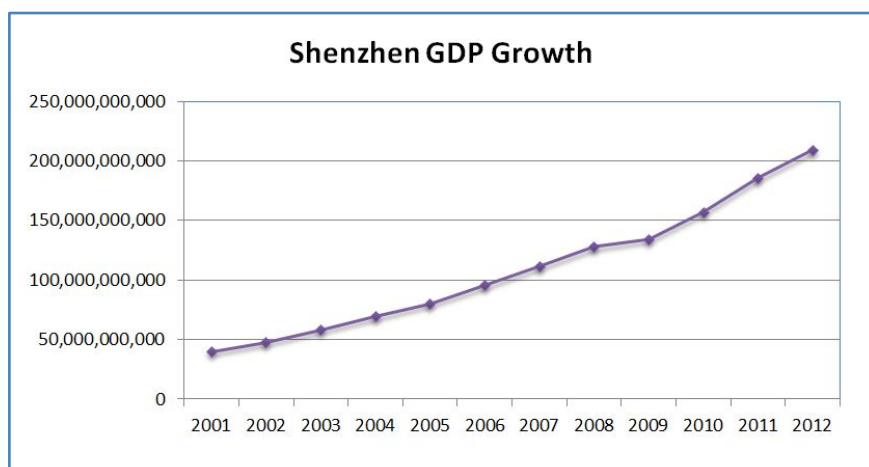


Figure 4.35 Shenzhen GDP Growth from 2001 to 2012

Unit: %

Professions	2008	2009	2010	2011	2012
Total	100.0	100.0	100.0	100.0	100.0
Industry	47.1	43.8	44.2	43.4	41.4
Real Estate	15.7	17.1	15.9	16.9	18.0
Finance	12.5	13.5	13.6	13.6	13.3
Wholesale	9.9	10.4	10.8	10.9	11.7
Information Technology	4.1	4.3	4.3	4.4	5.0
Transportation	3.8	3.8	4.0	3.8	3.6
Public Institution and Social Organization	2.0	2.0	2.0	1.9	1.7
Science	1.4	1.4	1.4	1.6	1.7
Education	1.1	1.2	1.3	1.2	1.3
Social Welfare	0.9	1.0	1.0	0.9	0.9
Entertainment	0.9	0.9	0.9	0.8	0.8
Utilities	0.5	0.5	0.5	0.5	0.5
Labor	0.1	0.1	0.1	0.1	0.1

Figure 4.36 Proportion of Real Estate Industry Growth in GDP growth

(Source: Shenzhen Statistics Year Book, 2012)

The city planner expressed his personal opinion as a government official at transportation department. Even though he basically knows what happened and real cooperation between the two city agencies, he didn't participate in the project. The second interviewee was the project manager who led the project in planning, design, expert review and construction management. Some important points are listed below:

(1) Long time required for investment and development

When they were doing the planning work, first issue is route design for the first phase of NO.2 metro line, and second one is how to do land development around the stations. Regarding the route design, the team preferred a proposal which can not only introduce a rail transit line to the relatively isolated peninsula – Shekou Port, but also practice TOD to realize new development that responds to city's master plan. But what is going on now results from the fact that this kind of TOD requires time. And he claimed that decision makers and planners made this plan for a long run vision which has not been fully accomplished now.

(2) Various complicated factors that affect housing price

The high end housing development was indeed out of his prediction. The initial idea was to develop residential buildings, bring residents and demand for housing, which would

respond to the metro line. The estimation was that the housing price won't be as high as current sale prices. The housing price on the reclamation area has increased 10 times since 2007 (Fang.com). However, the project manager said besides the NO.2 metro line, a number of factors would affect the housing price – demographic change, complex monetary policy, and speculative real estate investment. Below is a chart showing real estate investment in the study region in past several years. Most high rise housing projects were invested those from 2007 to 2009 (Urban Planning Land and Resource Commission of Shenzhen Municipality, 2012), which caused huge speculative real estate bubble. Corresponding policies were made on October 1st, 2010, limiting speculative investment (Shenzhen Government).

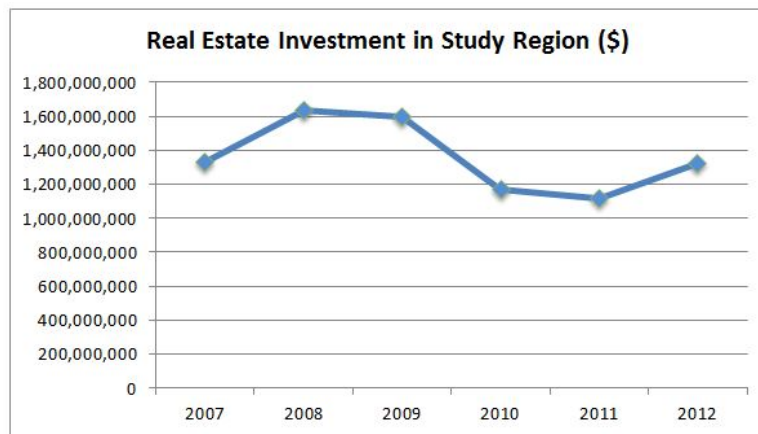


Figure 4.37 Real Estate Investment in Study Region
(Source: Shenzhen Statistics Year Book, 2012; Sofun)

(3) Was there double-win cooperation?

When asked about was there a double-win cooperation between the planning department and developers behind the table, he decisively said NO. He indicated that developers at that time (around 2007) generally hadn't realized the powerful effects on surrounding property value by rail transit. As mentioned earlier, 2007 is just two years after the first phase of NO.1 metro line was operated.

(4). Less public involvement and information sharing in the past

When he was the leader of the team, his role was to create the proposal and participated in expert review. There were not various stakeholders and complicated social network in 2003. The decision was made just by a director of a division at the planning department. But for current urban rail transit planning, much more people were involved, including residents

in surrounding neighborhoods and general public, developers and practitioners. Public involvement and information sharing were not as satisfying as current city planning work now. A case in point is that the planning department didn't share property sale records until 2008 after the TOD project was passed.

The interviews with these two people help discover some helpful points of views, which can be supported by data and information as displayed above. Putting the results and analyses together, including planning document review, evaluation of built environment and social demographics, assessment of transit equity, and the interview, this research provide with conclusions and recommendations for the research question and observed issues.

Chapter 5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The research question is – does government favor high end housing development around a representative TOD project – first phase of NO.2 metro line instead of improving transit access for residents nearby? In order to clearly answer it, the research question is further separated as two questions: 1. Does government favor high end housing development around a representative TOD project – first phase of NO.2 metro line? 2. How does government consider about public transit demand from nearby densely populated neighborhoods when planning the project?

For the first question, conclusions are:

- According to the planning documents, the reclaimed land was prioritized for cooperative development with Hong Kong due to its location. In order to realize master plan, TOD was considered as one important strategy, with detailed three levels planning and design. Residential programs which occupy a big proportion in the plan, are what government favored at that time because of following reasons: 1. demand from more incoming residents; 2. value capture for urban rail transit development from profitable business generated by residential projects; 3. growing real estate industry; 4. beneficial outcomes from selling and developing of city owned land which can achieve good performance for initiator of the project – the planning department; 5. significant incentive for economic growth from real estate industry; 6. time period when the city is fast growing.
- The residential units with ten times higher housing price which is much higher than district's average level are not only affected by urban rail transit development. Data and evidence discussed in the interview part points out that speculative real estate investment in study region was high from 2007 to 2009 after the project was approved due to incomplete policies that limit real estate investment. Speculative investment happened in these years, due to more immigrants and complex monetary policies, resulted in largely increased housing price, forming high end residential housing around the TOD project.
- Compared with residential development, commercial real estate programs haven't constituted planned components on the reclaimed land. This is mainly owing to the fact that development rights don't come with zoning which doesn't have strong legislative support, giving flexibility to developers after they purchased the land and negotiated with

government. So built environment isn't totally consistent with zoning map. Existing limited commercial uses are not able to attract more commercial real estate developers, or anchor tenant for expected financial industry. Another truth is that the reclaimed land is still developing; more time and patience are required to fulfill the plans.

For the second question, conclusions are:

- According to planning documents, the planning department designed the route on the reclaimed land instead of the other community primarily because of construction difficulty & investment. One role of this project is to connect the relatively isolated peninsula – Shekou Port to city centers. Rail transit construction in the dense neighborhoods with dense buildings, narrow road, huge environment impact on surrounding residents are reasons that prevent decision makers from prioritizing transit in those neighborhoods. If the project was planned through the dense neighborhoods, new construction would change land uses, topography, landscape, underground water flow, existing vegetation, create noise, worsen water and air quality, and generate solid waste. Compared with new development on the reclaimed land, the work would be easier. Hence, the government postpones plans for transit demand in the dense neighborhoods, as NO.10 metro line which would come in 2030.

To put it in a nutshell, the research question can't be given a definitely YES or NO. Development plans in the two communities are affected by complicated factors and political considerations. Development or redevelopment in both communities is going as time goes, there is no right or wrong plan.

5.2 Recommendation

Even though the issues studied in this research exist in Shenzhen, the city also owned successful TOD. Since Shenzhen is practicing more idea of TOD and there will be ten more urban rail transit lines in 2030, several recommendations are given:

1. Establish integrated transportation and land use planning mechanism

Integrated land use and transportation planning is what TOD focuses on, which is based

on well cooperation between transportation and land use planning. A better mechanism for teamwork of relevant agencies should be created. The mechanism should cover planning and design, review and evaluation, implementation and enforcement, and other necessary stages. The particular advisor committee with qualified researchers and practitioners can be organized to hold routine meetings and hearings for projects step in both transportation and land use planning fields.

2. Create specialized documents on TOD Guide and Standard in Shenzhen

TOD is a great strategy that Shenzhen will apply more in the future. However, there are few documents, regulations, mechanism, policies regarding localized TOD. Specialized documents regarding TOD standard, three levels of TOD planning and design should be made. The corresponding contents should include land banking, zoning, land use planning, station area wide design, rail transit operation and incentive system.

3. Reflect Transit Oriented Development experiences in Shenzhen

Shenzhen has been applied TOD over a decade, with both very successful and underperforming results. Since the city has planned 16 more urban rail transit line which would all be finished in 2030, there is huge work to refine local TOD. Some necessary aspects to think about contain modes transfer, including connection between port and public transit, transfer among buses and metro. Another perspective is pedestrian friendly land use pattern, which can naturally encourage people to use transit. Most streets built in Shenzhen have wide dimension, so signage, pedestrian facilities should be enhanced to facilitate walking. Moreover, in City-Oriented TOD zones, relevant resolution could be passed to prioritize pedestrians' travel across the streets where automobile need to yield.

Additionally, Shenzhen has been working low carbon city for years, which closely relates to TOD. Policies regarding green building code, environment friendly vehicle standards can be infiltrated into TOD as well.

4. Develop and practice appropriate ways for public involvement

Because more stakeholders are participating in urban development and redevelopment now in Shenzhen, information sharing and public involvement go to a higher level of importance. Online resources sharing could be more diverse and user-friendly; the interactive program showing road congestion level is a good attempt which not only presents the data to city agencies, but also to the general public. Information sharing provides with basis for public involvement. And ways of public involvement can be based on social media and cell phone App (application) announcement, convenient and accessible community meetings. Roles of community planners should be further highlighted and cultivated to build a bridge between decision makers and the general public.

Chapter 6 LIMITATION and FURTHER STUDY

6.1 Limitation

There are following limitations:

- No specialized TOD standard for study region
- No document or data of land transaction
- No ample ridership data
- No employment data in the two communities
- No data of how many residents are actually living in the these two communities now

If these points can be enhanced, more strong conclusions can be made.

6.2 Further Study

It is meaningful to think about how to attract more commercial development in the reclamation area and study from this case to inspire the coming NO.10 metro line

- Interview of representative business owners in high end housing neighborhoods regarding future commercial development
- Interview of residents in the dense neighborhoods about redevelopment that would happen with NO.10 metro line in their neighborhoods
- Study of land use and transportation plan of NO.10 metro line in the dense neighborhoods, and potential impact
- Environment impact assessment processes in Shenzhen
- Current public notification of redevelopment project and community engagement

Bibliography

Ke Peng, *Does Transit-Oriented Development Affect Metro Ridership? – An exploration of association between built environment and travel behavior in Shenzhen, China*. The University of North Carolina at Chapel Hill, 2011.

Institute for Transportation & Development Policy, *TOD Standard*

Ruishan Zheng, Wei Liu, Hong Liu, *From Research to Practice: An Overview of Transit-Oriented Development in China?* China Sustainable Transportation Center

Qun Lin, Jiaye Song, *The System Design of Priority Development for Urban Public Transit*, Shenzhen Urban Transport Planning Center

Qun Lin, Zong Chuanling, *Planning and Design Management of Urban Rail Transit Network in Shenzhen*, Shenzhen Urban Transport Planning Center, 2011

Shao Yuan, Tian Feng, Lu Guo lin, Zhang Xiao Chun, *TOD Planning and Management Practice in Shenzhen*, Shenzhen Urban Transport Planning Center, 2011

Shao Yuan, Tian Feng, Lu Guo lin, Zhang Xiao Chun, *Research of Coordinated Development between Land Use and Transportation based on TOD Pattern – A Case Study of Shenzhen*, Shenzhen Urban Transport Planning Center, 2010

Zhang Xiaochun, Tian Feng, Lu Guolin, Shao Yuan, *Transit – Oriented Development Framework and Planning*, Shenzhen Urban Transport Planning Center, 2011

Wang Jingyuan, Li Zhen, Zhang Jianshi, *TOD Planning and Implementation Strategies of Rail Transit Line 3 in Shenzhen*, College of Civil Engineering, Shenzhen University, 2010

Cai Jun, *Institutional Analysis for the Lag of Urbanization behind the Economic Development*, Dalian University of Technology, 2005

Guicai Li, Xiaofan Luan, Jiawen Yang, Xiongbin Lin, *Transit-Oriented Development and Inter-City Passenger Rail Investment in China Pearl River Delta*, Peking University, Shenzhen Graduate School, 2013

Tamara Tavares, *Sustainable Urban Transport: The Issue of Equity in the Emerging BRIC Countries*, 2010.

Jing Shi, Zhaozhang Wu, Jangwon Jin, *Reform Beijing to a public transit oriented city – from the view of transportation equity*, 2010.

Huapu Li, Shi Ye, *Urban Transportation and Equity: A Case Study of Beijing and Karachi*, 2007.

Todd Litman, *Evaluating Transportation Equity*, 2014.

Timothy Welch, Sabyasachee Mishra, *A measure of equity for public transit connectivity*, 2013.

TaoFeng, Junyi Zhang, *Incorporating Accessibility-based Equity into Stochastic Road Network Design Problem: Sensitive Analyses and Policy Implications*, 2009.

Jing Shi, Lang Yang, *Research on the Regional Equity and Financing Problem of China Railway*, 2006.

Dandan Lu, Shengrui Zhang, *The Research and Analysis of Urban Traffic Equity*, 2008.

Zhongyuan Zheng, Yunsheng Ma, *The Research of Traffic Equality and Urban Rail Transit*, 2009.

Xiaojiang Li, *Thoughts on Urban Transportation Policy*, 2011.

Yuan Lu, Ye Guo, Ying Zeng, *Thoughts on the Practice of Urban Public Transportation Priority Development in China*, 2013.

Lang Yang, Jing Shi, Huapu Lu, *Equity Evaluation of Road Projects Investment*, 2005.

Zhihua Shi, *The Driving Effects on Real Estate to the Correlative Industries*, 2004.