19083466

by Yue Wang

Submission date: 08-Sep-2020 09:41AM (UTC+0100)
Submission ID: 133135176
File name: 693653_Yue_Wang_19083466_1064851_1122367823.pdf (20.95M)
Word count: 15980
Character count: 82954

An investigation into job-residence balance in mainland China: the case of Shenzhen

Name: Yue Wang

Student ID: 19083466

Supervisor: Dr Astrid Wood

MSc Spatial Planning, Bartlett School of Planning, UCL

Word Count: 11633

Abstract

With the expansion of cities, the distance between people's employment and residence continues to increase. The increasing demand for work and housing has led to imbalances and traffic congestion, especially in large cities. Understanding the job-living balance and commuting characteristics of Shenzhen can provide necessary information for urban planning, especially space and transportation planning. Based on the job-residence ratio proposed by Cervero, this paper analyses the Shenzhen job-residence balance, combined with Weibo data from ten districts in Shenzhen. Sina Weibo is an essential social network platform in China, and Weibo sign-in data can reflect the urban spatial structure, especially the spatial structure of occupation and residence. With the help of online interviews, ways and times of commuting are used to analyse whether the individual's work and residence are balanced from the perspective. The research found that: 1. The spatial relationship between occupation and residence in Shenzhen is relatively balanced. 2. Job-living balance is not the main reason for the heavy traffic pressure in Shenzhen. The above results show that although Shenzhen has an imbalance between jobs and housing due to high housing prices, the main reason for traffic pressure is the unreasonable allocation of road space and public facilities.

Keywords:

Job and residence balance; Job and residence separation; Cervero jobs-housing ratio; Weibo check-in data; Shenzhen

Acknowledgements

First of all, I would like to thank my supervisor, Dr Astrid Wood. She followed the progress of the paper and gave quick and comprehensive responses. She helped me choose the qualitative method. I am very grateful to her for resolving the jet lag and optimising the online video time over the past five months.

Secondly, I would like to thank everyone who was willing to undertake online interviews. They were very friendly and actively raised some situations that I had overlooked, especially Mrs Fang Hao, who spent an hour and a half patiently answering my questions. Lengthy communication has improved this dissertation, and the help is appreciated.

Finally, thanks to all the websites and libraries that provide online and offline literature review resources, which laid the foundation for this dissertation.

Abbreviation

JRB= Job and residence balance

JRS= Job and residence separation

JRR= Job and residence ratio

List of Contents

List of figures, tables and appendices

An investigation into job-residence balance in mainland China: the case of Shenzhen

1. Introduction

Shenzhen is located in the southern coastal area of China, adjacent to Hong Kong. Shenzhen was the first special economic zone established after Chinese reform and opening up. After 40 years of development, Shenzhen has become a centre for the Chinese economic and technological innovation. According to data from the sixth Chinese census in 2010, the population density of Shenzhen is very high, reaching 5201 people per square kilometre. High density has made Shenzhen the city with the highest housing prices in mainland China (320 cities housing price rankings in 2019, 2020). Momford (1968) organised and elaborated the idea of Garden cities proposed by Howard (1902), and put forward the concept of balance. The separation of work and residence has led to a significant increase in commuting distance and commuting time, which in turn leads to a series of social problems such as traffic congestion and environmental pollution. The key to solving the above issues is to effectively understand the characteristics of job-residential distribution and the commuting characteristics of urban residents. But in previous literature, research has mainly focused on Beijing and Shanghai. This dissertation uses big data and online interviews to study JRB and commuting characteristics to provide references for Shenzhen urban planning.

In research on Shenzhen, Shi (2017) selected three classic employment streets and residential streets to analyse commuting characteristics at the micro level, proving that the job-residential relationship in Shenzhen is balanced at the micro level. Besides this, there are very few studies relating to Shenzhen JRB. Through targeted research, we can gain insight into Shenzhen's unique urban problems. In summary, it is proposed, based on the crowd-sourced geographic data, to use the microblog sign-in data to study the JRB and commuting characteristics of big cities, providing a reference for similar research methods and real-life situation. Gives the rapid development and popularisation of information data in China, large-scale data sources provide an accurate research resource for related urban issues. The online interview part of this dissertation reveals the reality of Shenzhen JRB and commuting characteristics, and provides basic information for urban planning. The practical

significance of this dissertation is to guide the formulation of transportation planning and policies, and to help reflect on the deficiencies of urban planning and land management policies.

This dissertation first uses the Sina Weibo Application Programming Interface, (API) to obtain users' sign-in data, and effectively screens the sign-in data and coordinates conversion. The place of residence and of work is identified through the time interval. By using the two sets of data obtained from the identification, the JRR of each district was calculated (Cervero, 1989, 1991), and the JRB in Shenzhen was analysed. The research results also used two calculations of the average JRB index of Shenzhen to ensure the reliability of the research results and prove the feasibility of the research method. This paper finds that the overall job-residential balance in Shenzhen is relatively fine.

The second survey method initially planned was the questionnaire survey commonly used in job-resident relationship analysis. However, the author encountered obstacles in practice. For example, people in commuting conditions are not willing to fill out the questionnaire at the risk of being late. Given the global spread of the coronavirus, staying in public for a long time increased health risks. To make up for the wide range but insufficient depth of quantitative data, the author chose interviews as the method of collecting qualitative data. When collecting data on Weibo, the author found that Weibo can initiate a public vote on a single choice. After screening the participants, the author finally selected six participants for online interviews. Online interviews can efficiently and comprehensively present urban occupation, housing and commuting issues through the eyes of residents. This flexible form of conversation avoids the problems of time-consuming and limited traditional questionnaires. As Shenzhen is the city with the highest proportion of young people in China, it is reasonable and meaningful to use Weibo sign-in data and interviews.

This dissertation is divided into five main parts: introduction, literature review, main body, discussion and conclusion. The main body of the thesis includes the two research methods used and the findings obtained. This dissertation is divided into six main chapters; the main content of each chapter is as follows:

The first chapter briefly summarises essential information and the organisational structure of this dissertation.

The second chapter is the literature review. This chapter introduces the research background of the thesis and clarifies the research goals and significance of the idea. Secondly, the literature review covers Chinese and international research on the spatial relationship between occupation and residence. Finally, it describes the gap in this type of research and the research question of this dissertation.

The third chapter concerns the selection of research methods. This chapter first introduces the basic situation of Shenzhen and proves the feasibility of using Weibo data and interviews for research. Chapter 3 explains the process of obtaining and processing microblog sign-in data. On the whole, Weibo data is used to identify and analyse employment and residence. It helps obtain spatial distribution characteristics and balance indicators. The second part of Chapter 4 uses online interviews to verify the attributes of Shenzhen JRS and commuting characteristics. The end of the chapter lists the results obtained through these two research methods.

Chapter 5 analyses the results in Chapter 4, and then validates the analysis results by combining literature reviews.

Chapter 6 summarises the main work and conclusions of this dissertation. It points out the deficiencies of the paper and its potential impact on future policies.

2. The concept, theoretical foundation and related literature review of JRB

2.1 Job and residence balance

Job and living balance, also known as job-living spatial balance, is an ideal state in urban development., When the number of residents matches the number of jobs in a metropolitan area, the commuting time and distance are short, and long commutes are rarely generated. Most residents can commute by foot or bicycle, with low travel costs and short travel time. This state helps relieve traffic pressure,

saves energy, reduces pollution, and contributes to sustainable development. Planning policies that lead to spatial changes need to consider structural changes and historical conventions at multi-scalar levels. The factors from multi-scalar levels are interrelated and interdependent. Therefore, it is necessary to expand the scope of business to multi-scalar levels and involve the environmental, economic and social forces affected by the policies of different sectors in order to better understand spatial changes.

The earliest use of the concept of job-residence balance in planning was proposed by Ebenezer Howard in 1902. In the 19th century, the population and slums of London increased substantially, and traffic problems gradually emerged. Howard believed that when the urban area exceeds a specific size, it should develop new nearby cities rather than expanding. New cities need equipping with complete service facilities to ensure a balanced distribution of employment and housing. This ideal of work within walking distance of the house is the germ of the concept of JRB. One of the essential purposes of examining the workplace and residence separation is that it can improve urban traffic problems. Mitchell et al. (1954) analysed the impacts of land use and the built environment on transportation behaviour in their work. Subsequently, many researchers began to pay attention to the factors affecting the choice of different commuting methods (Cervero et al., 1996; Boarnet et al., 2001).

After the 20th century, as the industrial revolution began to spread throughtout the world, the issues that cities have struggled with in the process of urbanisation have become increasingly severe. As a pioneer in urban construction, Finnish architect Eliel Saarinen (1943) put forward the theory of organic decentralisation. He argued that, viewing the city as an organism, the urban population and jobs should be allocated to places away from the centre to ensure reasonable development. One of the principles of organic evacuation is to ensure that the traffic demand between the individual daily life and work is low, and to avoid mechanised transportation. Furthermore, American scholar Mumford (1968) deepened the Howard's concept of JRB in Howard's thought. Through measures such as limiting the area or residential density of the city, the balance of urban and rural purposes, and the internal functioning of the city can be achieved. Cervero (1989) defined the JRB as the number of employees in a particular area being equal to the number of jobs, and the labour force in this area being able to work nearby. Giuliano (1991) further refined the concept, and believed that JRB should be manifested in a specific area with different housing types matching various jobs, achieving the perfect

complementation of the characteristics of residence and employment. Kange-Rae et al. (2006) defined an employment-housing imbalance as a situation wherein employees in a given type of work cannot afford to live nearby or residents of a given type cannot find a suitable job nearby. The JRB mechanism can reduce the need for commuting, alleviate traffic congestion and air pollution, and also help low- and middle-income families to reduce expenditures (Levine, 1998). The higher the degree of mixing of different types of economic activity or different types of land use, the more conducive to the balance of employment and housing (Knaap et al., 2005).

2.2 Critical models and theories of JRB

Ideally, the spatial relationship between workplace and residence is determined by the independent choice of residents and enterprises. In reality, the preferences of residents, dependence on historical paths, and the intervention of various policies have made it difficult for the system to achieve balance. The superposition of multiple economic and non-economic forces made the spatial relationship more complicated. Measurement is needed to determine whether it is balanced or not, and to what extent. Measurement includes two aspects: the balance of quantity and the balance of quality. The former refers to whether the number of jobs and the number of residential units in a given geographic area are equal, which is generally referred to as a measurement of balance; the latter refers to the labour that lives and works in a given geographic area. The proportion of the number of participants is called a self-contained measurement. Models and indices can help explore the measurement and optimisation of JRB and urban commuting.

The classic single-centre model assumes that all employment opportunities are concentrated in the city centre, so it focuses on residents' location and commuting behaviour (Alonso, 1964; Muth, 1969; Mills, 1972). However, Hamilton (1982) and other studies on excess commuting found that the actual traffic volume of a city is much higher than that predicted by the single-centre model, indicating that there may be other factors that affect residents' choices and companies' location. Small et al. (1992) further studied the difference between actual commuting and theoretical models (Meng et al., 2009). The most common and most used balance indicator is the job-residence ratio, which is the number of jobs divided by the number of households in a particular area. When the ratio is between 0.8 and 1.2,

the region is considered to be balanced (Cervero, 1996). Since the JRR takes into account single-employee families, Cervero (1996) used an independent index for dual-employee families to modify. But JRR only reflects a nominal balance. Its assumption is quite different from the actual situation. As long as there are a relatively similar number of residence and employment opportunities within a specific area, people will choose to live near their place of employment or work near their place of residence. The measure of self-sufficiency generally adopts the independence index proposed by Thomas, which is the ratio of the number of people living and working in a given area to the number of people working outside. The higher the ratio, the better the self-sufficiency of a community (Thomas, 1969; Cervero, 1996).

Research by Crane (1996) and other scholars considered possible changes in employment location in the future. At such a time, residents would need to weigh the distance between their residence and their current workplace and the gap between their residence and their future workplace. The urban spatial equilibrium model (LRH model) proposed by Lucas and Rossi-Hansberg (2002) further regards the location of enterprises and residents as endogenous, and solves the urban spatial structure in equilibrium. They concluded that agglomeration economy and commuting costs are the two main factors that determine the location and commuting characteristics of industries and residents in cities. Zheng et al. (2009) verified the location motives based on the LRH model by using data on the commuting characteristics of employees in Beijing and the spatial distribution of industries. They found that the locations with higher industrial agglomeration intensity cause longer commuting time, and companies which are willing to pay higher wage for long-distance commuting. Under the above theoretical background, Zheng and Cao (2009) systematically discussed the determining mechanism for this situation. They believed that the factors affecting the relationship between occupation and residence could be summarised on four levels: employment opportunities, housing opportunities, the spatial distribution of urban public service facilities and the commuting cost to families.

Ewing (2004) proposed the employment balance ratio of occupants, and reflected the genuine JRB relationship by calculating the proportion of locally employed persons among the total population living in the area. The measurement of dimensions is susceptible to the selection of the spatial range, and the scale of the geographic range becomes the key. When the size of area measured is different, and the result will be different as well. Generally, the geographic scope is positively correlated with

the degree of balance and self-sufficiency. As for the most appropriate scale, scholars have still not reached a unified answer. Some scholars summarise scale on three different levels: micro, macro and mega (Peng, 1997). Most of the research still focuses on the macro level, that is, the area constituted by a given residence or employment centre and a reasonable commuting radius around it. The reasonable range here is a subjective judgement, and there is no standard number.

2.3 The impacts of JRB

The existing research does not reach a consensus on whether a JRB can improve commuting efficiency. Some scholars affirm the positive effects of JRB in shortening commuting. In contrast, others think that it has little impact or question the feasibility of achieving JRB. Firstly, Robert Cervero was one of the first scholars to pointed out that imbalanced housing is a vital contributor to urban traffic jams and advocated that the government adopt policies to improve it. Servira (1989) believed that unreasonable financial planning leads to insufficient housing. The marketisation of land has made housing prices unaffordable, and unemployment and job-hopping have made job and housing issues more complicated. Increasingly, women choose to work, making the problem more acute, especially for the lower-income groups, who can only afford the housing far from their workplace: this group of people has a long average commute distance. By analysing data from the 24 largest suburban employment centres in the US, Cervero found that the degree of residential employment inequality is positively correlated with the congestion of the surrounding highways, and is inversely correlated with non-motorised commuting.

Later, urban economists represented by Hamilton have expressed doubts about the JRB policy after studying excess commuting. According to the maximisation of utility in urban economics theory, the goal that individuals pursue is to maximise personal needs and desires under the constraints of their disposable resources. In theory, when people choose where to live, the available residence closest to the workplace is selected (E. Mills and B. Hamilton, 1984). But in reality, actual commuting distances far exceeds the theoretical optimum. White (1982) verified and referred to the gap between the actual measured average commuting distance and the theoretically smallest average commuting distance as excessive commuting. Hamilton (1982) analysed 14 cities in the United States in 1972 and found that

the actual commuting distance was eight times the model conclusion. In 1980, when the data analysis of the Los Angeles metropolitan area adopted a more substantial area (31 districts), extreme commuting accounted for 33% of the actual commute; excessive commuting in the smaller square (706 communities) accounted for 66% of the actual commute (Small et al., 1992). In 1991, Cropper and Gordon used a model to predict that the average commuting distance of residents in the Baltimore area was five miles, while the actual commuting distance was ten miles. Dual-employee families and job conversion rates are both non-ignorable reasons why employment balance cannot be achieved. The existence of excessive commuting proves that the accessibility of the place of employment is not a key reason for residents' choice of residence, and the effect is limited.

Some scholars admit that an imbalance between residence and employment can cause traffic congestion, but other more significant factors can also generate traffic pressure. During peak traffic hours in the United States, commuting to and from work is not the main factor, accounting for only a quarter of the total personal travel during the workday (Gordon et al., 1989). The increase in the proportion of women in employment and insufficient infrastructure have had a meaningful impact on traffic congestion, yet have nothing to do with the locations of jobs and residences (Giuliano, 1993). Wachs (1993) used Californian six-year data to prove that even when the JRB improves, there will be an increase in the average commuting time of employed persons. Peng used data from the Portland, Oregon metropolitan area studied in 1997 to prove that only living in an area with extremely uneven employment can this balance have a significant impact on commuting. Such scholars support the adoption of targeted transportation policies, such as diversified public transportation services and the collection of congestion charges, because there are very few extremely unbalanced cities.

2.4 Related studies on international cities

Between 1977 and 1983, the average commuting distance for residents of American suburbs increased from 17.1 kilometres to 17.9 kilometres (Cervero, 1989). Long-distance commuting inevitably brings traffic congestion and air pollution, which has prompted scholars to search for solutions. Frank et al. (1994) studied commuting in the Seattle area in 1989. They concluded that the commuting distance and time of employees in areas where employment and housing are balanced is shorter than those in

unbalanced areas. Ewing (1996) used data from 500 cities and towns in Florida for regression analysis in 1990, and found that the proportion of commuting within the town was positively correlated with the balance of housing and employment. Nowlan et al. (1991) concluded from a study of the Toronto Central Business District, thatas the population of the central area increases, the commute traffic entering the central area on weekdays decreases. Sun (2002) believed that many metropolitan areas in the US lack affordable housing, which does not match the number of jobs, resulting in long-distance commuting and traffic congestion. Weitz et al. (1997) selected two cities in the Oregon region for data comparison, and Horner (2002; 2003) analysed the data of 26 US cities to support this view. These scholars believed that the fundamental way to solve the problem is to achieve a spatial balance between job and residence.

2.5 Related studies on Chinese cities

Zhou (2004) proposed that China learn from relevant research in the US on the spatial mismatch and employment of urban disadvantaged groups based on relevant research in the US. Meng et al. (2009) summarised the formation, development process and calculation method of the JRS concept, and summarised the successful experience of the US in the policy system. They used GIS to study the commuting characteristics of Beijing residents and found that the spatial distribution of work and housing in Beijing was uneven. Liu (2009) used the straight-line distance between the place of residence and the place of work as an indicator, and further research found that employment accessibility in the suburbs of Beijing is lower than that in the central area. Gu et al. (2008) found imbalance in the spatial distribution of employment and housing in Shanghai in two aspects: the number of jobs and population. In the same year, Sun et al. (2008) constructed a work-living space balance index and found that when the work-living space balance in Shanghai decreases, the average commuting time and commuting distance of residents increase. The number of people commuting across regions is also growing. New districts created as a result of the expansion of the city also have more severe imbalances.

At the beginning of planning and construction in 1994, planners proposed to build the Suzhou Industrial Park as a relatively independent new district with balanced residential, industrial and

commercial services. They envisaged that all 110,000 residents of the park would be employed locally. However, there is currently a massive gap between the status of work and residence in Suzhou Industrial Park today. Residents of the district are mostly employed outside the region, and commuting trips to the outside of the district account for more than 80% of the total commute trips; at the same time, the proportion of employees living in the district is only 2% (Liu and Cheng, 2010). This kind of cross-border traffic flow makes the average saturation of roads within the park below 0.5, while the average congestion of routes connected to the outside of the park is above 0.8, reaching 1.18 during peak hours (Xu, 2010). Although the Suzhou Industrial Park case failed, the urban planning department still incorporated the concept of job-living balance into the planning texts and academic research of various cities, such as housing construction in Beijing (2006-2010) and Shanghai (2008-2012) *Principles of planning space layout*. But in fact, there are still no mature methods and applied cases of how to implement the concept of JRB in the setting of planning parameters. Although the concept of JRB is prevalent in urban planning circles, many economists believe that JRB is inevitable and reasonable.

China is witnessing a stage of rapid urbanisation, and the problems of urban housing and labour market segmentation have become increasingly prominent. The 2015 Traffic Analysis Report of Major Chinese Cities released by Gaode Map (AMAP) investigated the rankings of work and life imbalance in four Chinese first-tier cities (Beijing, Shanghai, Guangzhou and Shenzhen). The traffic big-data team also found that during the Spring Festival and weekdays in Shenzhen, the level of congestion dropped significantly, by more than 20%, reaching the most significant decline in the country. Compared with its severe congestion on weekdays, Shenzhen, with the largest number of migrants, is the most deserted city during the Spring Festival. Shenzhen is the city with the highest average annual growth of permanent population from 2016 to 2018, with an average annual increase of 550,000 (Hengda Research Institute, 2019). In 2019, Shenzhen had the highest living costs in mainland China. The immigrant population in Shenzhen accounts for 80.5% of the total population, which is much higher than for the other three first-tier cities. Therefore, it is useful and meaningful to study JRS in the context of this city.

Existing Chinese research on the spatial relationship between occupation and residence is mainly based on traditional data acquisition methods, such as questionnaire surveys. With the development of positioning system services and cloud processing technology, massive databases have broken the

conventional model, and can effectively collect and screen mobile positioning data. Weibo sign-in data can be used to analyse the resident activity space (Wang et al., 2015; Xiong et al., 2014); work and residence space are the most important resident activity spaces. Few scholars have conducted independent research on this, and some scholars can verify their results through comprehensive research on big data. For example, Mao (2015) uses taxi driven route data, Weibo data and mobile phone location data to study the commuting behaviour and spatial structure of work and residence of Shanghai residents. Chu et al. (2017) used a movement map through a software platform to study the transportation and commuting of residents in Beijing's Huilongguan community.

2.6 Research gaps and research questions

Chinese research on the factors affecting JRB primarily conducts overall analysis, and the selected time is mainly before and after system and policy reforms. Song et al. (2007) believed that urban expansion and suburbanisation had led to the aggravation of Beijing spatial termination. Chai et al. (2011) studied the separation of employment and residential space caused by market and institutional factors such as housing reform, from the background of a particular period of Chinese social transition. Chinese research on JRS focuses on larger administrative units such as cities and districts. For example, Sun Bindong et al. (2010) used questionnaire survey data to study the total actual JRR of Shanghai residents' commutes. Zhou et al. (2005) took Guangzhou as an example and analysed the spatial distribution characteristics of occupations and residential areas by using residents' traffic travel survey data and census data. The current research mainly focuses on the analysis of the overall urban commuting distance and the phenomenon of excessive commuting. There is a lack of research on the differentiation of job-residential space and the construction of overall commuting. Case studies on occupations and residential spaces in Chinese cities are mainly based on surveys of residents' commuting behaviour. The survey methods used are mostly questionnaire surveys, and the results contain large errors. There is no further analysis of the differences in the spatial distribution of employment and residential opportunities obtained by residents of different occupations in the city.

3. Methodology and data

This thesis uses a mixed methodology, including quantitative and qualitative methods. The research is mainly based on Sina Weibo and WeChat data, vector data and demographic data of the administrative boundary of Shenzhen City. Among them, Sina Weibo data is obtained through Weibo crawlers, vector data is provided by the Information Centre of Shenzhen Municipal Planning and Land Resources Commission, and demographic data came from the sixth census bulletin in 2010. This section contains the following parts: the selection of research objects and methods, research tools and steps, and ethical norms. Comparing different data types and requirements in Appendix 1, the most suitable quantitative research method for individual researchers is to obtain data through Weibo. By visualising Weibo sign-in data, you can compare the distribution of work and residence.

In 2019, Weibo had 465 million monthly active users, and by 2020 this had risen to 550 million. WeChat monthly active users reached 1.04 billion in 2020, a year-on-year increase of 10.9% (Tencent Financial Report, 2020). According to the ranking of global communication software users, WeChat, following Whatsapp, Facebook and Messenger, became the fourth-most monthly active users worldwide in 2019. On May 29, 2020, the research Institute under YiMagazine released the 2020 City Business Charm ranking list, which showed that Shenzhen was the most active city using Tencent's social software. From the perspective of the proportion of permanent residents of the first-tier cities, Shenzhen has the city with the highest percentage of young and middle-aged people, as high as 67.7%, which is much higher than the other three first-tier cities, by about 30%. The reason for this highest proportion is that Shenzhen, as a newly emerging city after the reform and opening up, originally had very few residents with registered permanent residence. Even among the existing registered population, most are those who settled in Shenzhen after the reform and opening up. Since the software user group and working people are highly overlapped, the sample targets involved in this experimental study are groups that use Weibo and WeChat to socialise.

3.1 Weibo data

Weibo has over 10 million sign-ins in a month. Due to the high crawler limit of Weibo and the low speed of the home network, access to past data is often interrupted. For personal research, obtaining data for the past month and week would represent overloaded. Therefore, considering device performance, equipment capabilities and access restrictions, Weibo data was crawled in order. The time of data capture for the research was 2020.7.6. (00:00-24:00), that is, information on users who signed in on Weibo in Shenzhen within those 24 hours is collected. According to a report of the Shenzhen municipal health commission, there were no more cases of infection in Shenzhen after February 15,2020, and work and production have begun to resume. The latest data for 2020 is from April, when the unemployment rate was 2.18%, which is lower than the 2.26% of April 2019 and the annual average (2.24%) (Figure 1). Taking into account the increase in the employment ratio, the beginning of June is when employment recovery occurred in Shenzhen. Data from the beginning of July can be taken to represent the actual situation. At the same time, other second-hand data, including data from previous years, will help to clarify, analyse and demonstrate the situation.

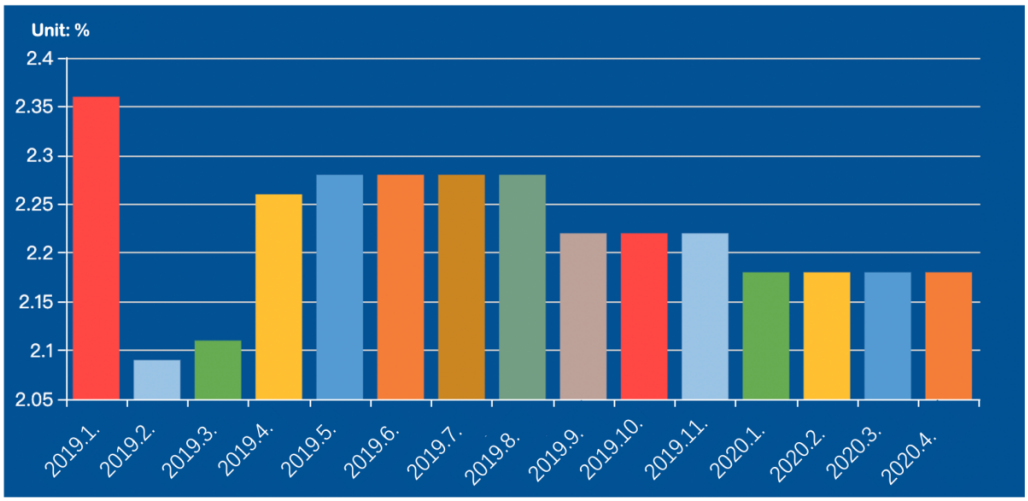


Figure 1. The unemployment rate in Shenzhen between 2019 and 2020

Source: sz.gov.cn, 2020

Sina Weibo API is a data collecting service provided by the Weibo platform that can be used by third parties. The attribute information includes unique identification id, nickname, users' location, gender,

etc. This dissertation uses Python to collect the username, sign-in location and sign-in time of the Weibo sign-in webpage (Figure 2). A total of 74,287 pieces were captured. Figure 2 shows the data processing flow. Since the sign-in data is obtained on a user basis, that is, the sign-in record of each user is collected, there are cases where the sign-in place is not in Shenzhen and the date is not necessarily within the range. The author used the Python toolkit, reXpath over JsonPath, to clean the data, found the sign-in information from Shenzhen, converted the address into latitude and longitude, and stored it to local (Appendix 2-6). After screening by geographical location and date in the preprocessing, there were 14,487 items left . Using Excel's built-in duplicate item check, 11,989 duplicate values were found. After deletion, 2,497 unique values remained (Appendix 7). According to standard work and rest time, only three time intervals (11:00-5:00, 9:30-11:00, and 1:30-5:30) were reserved. After screening, there were 353 pieces of data that meet the requirements. The author divided the username and latitude and longitude into two Excel lists according to time, and then uploaded them to the Lantuhui website to generate coordinates on a map, as a visualised location distribution can be analysed more intuitively.

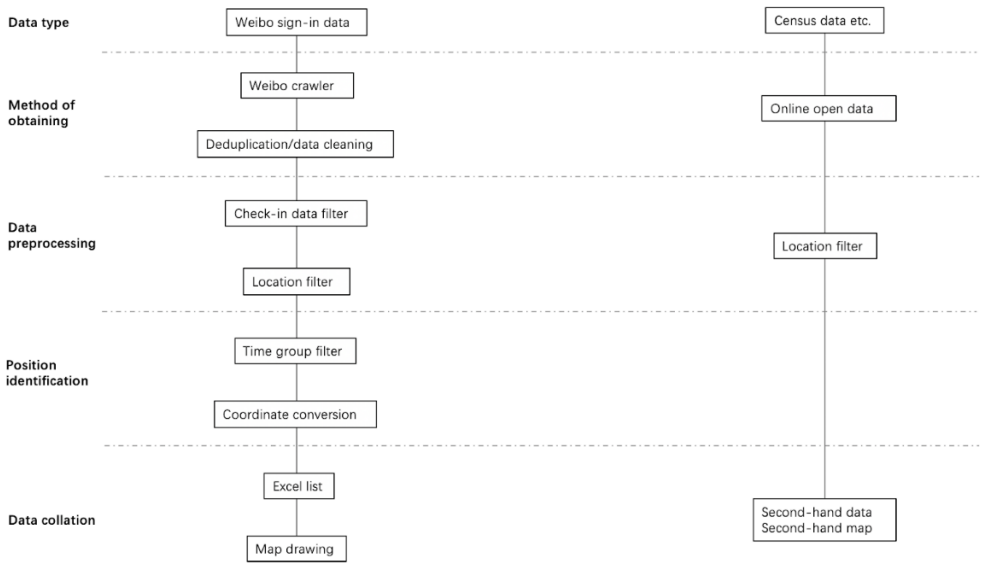


Figure 2. Weibo data processing flow

Source: Author

3.2 Interview data

The original plan for this thesis was to start an offline questionnaire led by the author on June 26, 2020. A total of three subway stations, three bus stations and shared bicycle delivery points in Nanshan District, Bao'an District, and Yantian District were selected for investigation. The original qualitative survey method was to invite passersby on public transportation to participate in a short interview. Since the epidemic in Shenzhen was brought under control, the author primarily went to the subway station and tried to interview passersby for about ten minutes as planned, but the process was challenging. Commuting time was precious in the morning, and commuters were unwilling to stop for interviews. Given the two and a half minutes interval between trains in the morning rush hour, the length of the line efficiency interview would lead to a participant missing at least four subways. It was difficult to conduct a complete conversation. Additionally, Shenzhen is crowded with people during the morning rush hour, and voices are noisy. Everyone wears masks in public spaces, making it difficult to hear each other's conversations clearly. Although the epidemic was under control, due to the long incubation period of the virus and the high-density flow of people might bring considerable risks, so other research methods were chosen.

When collecting online data on Weibo, the author discovered that Weibo had a voting function. Voting on the Weibo platform is very simple and limited to single-choice questions. The author published a multiple-choice question as planned on June 15, 2020, for testing, and collect the results after 15 days. By June 30, the number of participants far exceeded expectations. A total of 2,319 people participated in the vote, and 36 comments were received (Figure 3). To protect personal information, the author's account and location are encoded. With different choices and comments, the author used the private message function of Weibo to ask the commenter if he or she was willing to undertake an interview. Online interviews are mainly consisted of open-ended questions, based on the different lifestyles of each respondent to gain meaningful participation. The meaning of participation refers to the way individuals in the social environment conceive the world and the way they interpret essential events in life (Wang Wenke, 2001). Since it is necessary to obtain the interviewees' real thoughts, questions must be non-standard. The online question and answer method gives interviewees enough time to think and answer, and they can play freely, to obtain information through meaningful participation.

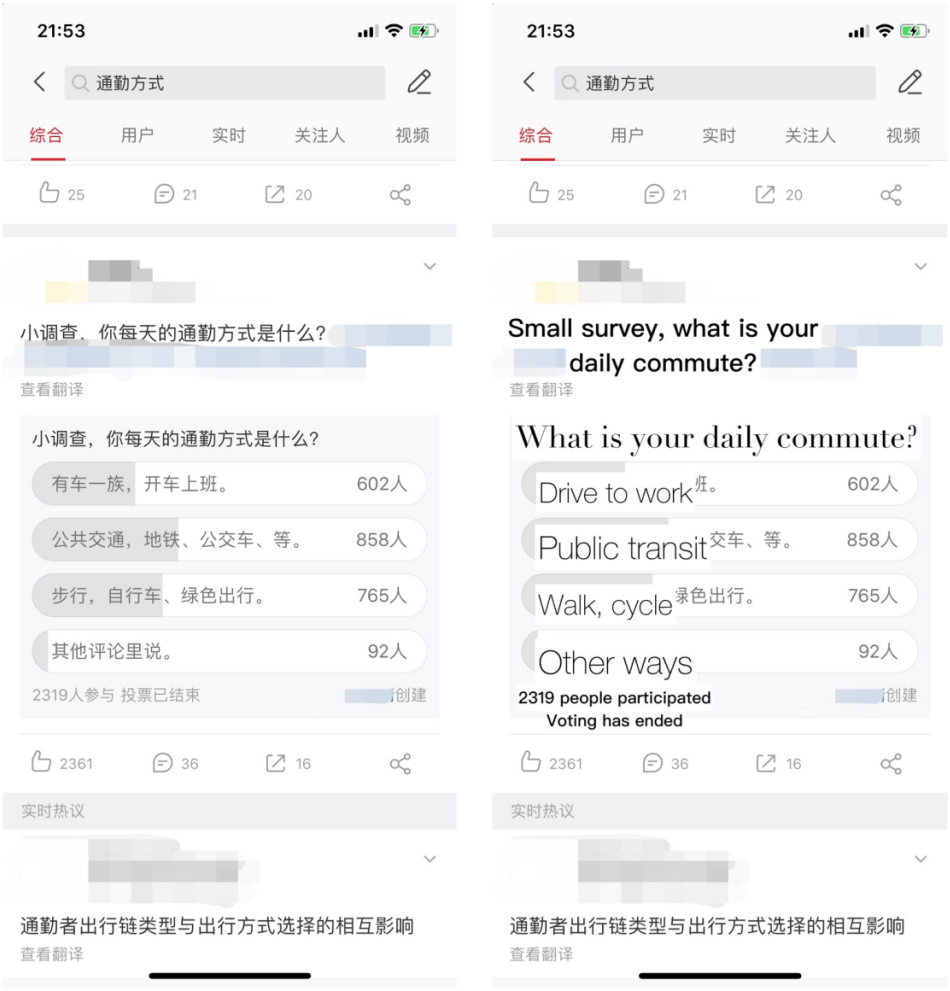


Figure 3. Screenshot and translated version of Weibo voting page

Source: Author

3.3 Research objects and problems

An interview is a purposeful conversation (Eyles, 1988). The advantage of this approach is that it is people-oriented, allowing interviewees to describe and explain in ways that are comfortable to them. This kind of talk provides a wider discussion space than a survey allows. Compared with Weibo statistics, interviews rely more on words and meanings (Flowerdew and Martin, 2005). During the text

conversation, researchers have the opportunity to return to the same topic and ask the same questions in different ways to explore the problem thoroughly. Respondents may suggest keywords that the interviewer has not thought of to help enrich the material (Silverman, 1993; Burgess, 1984). In-depth interviews cannot be used alone. This research method is a supplement to the results of data analysis (Flowerdew and Martin, 2005). The following is a detailed list of key issues. The questions may not be presented in order. The follow-up questions can be increased or decreased according to the different situations of each interviewer.

After two days of screening and contact, a total of six interviewees were identified. The ratio of male to female is balanced and representative. With the permission of the interviewee, the conversation was conducted on the WeChat platform. As a communication platform, WeChat ensures the health and safety of both parties in the conversation and is easy to record. The interview took place on July 3 and lasted two days in total. The length of the interview ranges from 20 minutes to one hour and a quarter. The one-to-one communication helps to reveal the thoughts and opinions on transportation of people living in Shenzhen. WeChat kept all conversations for easy reference at any time. Combined with the secondary data, the obtained information can be further verified. Second-hand data is more accessible and more reliable than primary data (Flowerdew and Martin, 2005). Second-hand data is not flexible and cannot be defined by oneself, so it is used as auxiliary data to help research.

3.4 Moral and ethical norms

This survey will not involve personal privacy issues when collecting Weibo client information. According to Weibo personal information protection policy, everyone who uses Weibo needs to agree to this fundamental legal document. Based on the valid protection of information, Weibo will de-identify the collected information. Weibo has adopted and will continue to foster a transport layer security protocol, encrypt and store user personal information through encryption technology, and isolate it through isolation technology. Weibo has established a strict data use and access system, adopts strict data access authority control and multiple identity authentication technologies to protect personal information and avoid data being used in violation of regulations. The voting link in the collection of public data through the Weibo service, which is within the scope of Weibo information protection.

Weibo will not share data with third parties without my consent unless it is directly related to national security, national defence security, public safety, public health, and general interests without my consent.

Similarly, as an online communication platform, WeChat guarantees the freedom and safety of interviews and makes it easy to record the conversation process. WeChat is affiliated to Tencent. According to the customer security agreement, Tencent will not disclose personal information to other companies, organisations and individuals. When screening interviewees on the Weibo platform, all pre-selected interviewees were aware of the information and general rights involved in the interview. With the permission of the interviewee, they were added as friends to communicate on the WeChat platform. After the interview began, the interviewee could choose whether to disclose his gender and age, whether to answer questions, and had the right to stop at any time. After the interview was completed, the interviewee could choose whether to reopen the conversation. All information collection fully respected the will of the interviewees.

4. Empirical research analysis

4.1 The spatial distribution characteristic of job and residential areas

The distribution of work sites is mainly concentrated in the southwest of Shenzhen; that is, the work site density in the southwest is higher. In terms of distribution characteristics, the average centre of residential areas in Shenzhen is located in the southwest. In terms of distribution characteristics, the average centre of the workplace in Shenzhen is located in the north of Meilin Street, Futian District (Figure 4). The density of working spots near Meiji Street is significantly less than that of residential places (Figure 5). The distribution centre of working is located in the southwest of Shenzhen, about five kilometres away from the southern city government. In terms of distribution patterns, it can be found from the heat map that the residential areas with the highest density are Nanshan District and Futian District, followed by the Luohu District and the junction of Longhua and southern Longgang also featured prominently. The areas mentioned above concentrate about 63% of the work points in this data, and are work clusters (Figure 6).

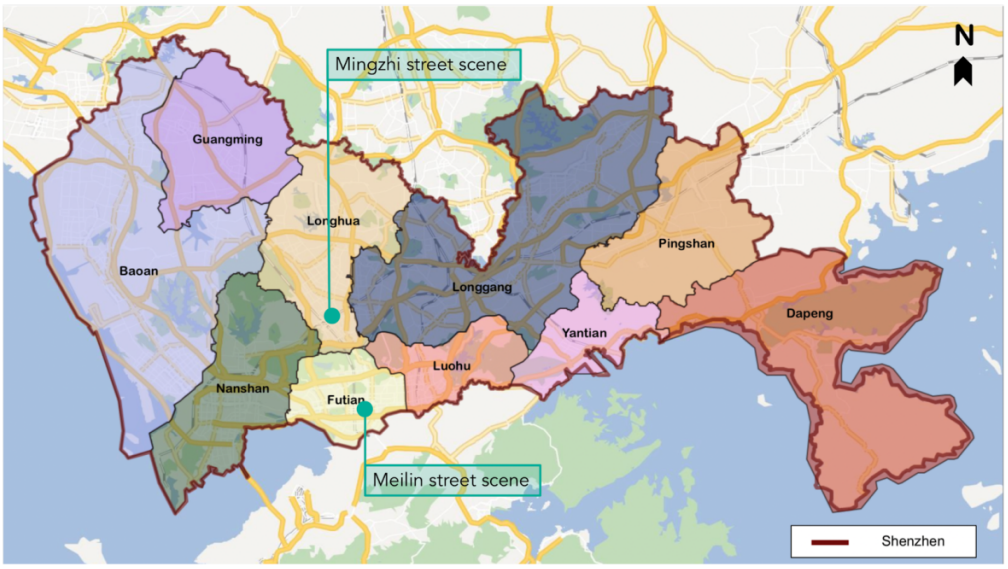


Figure 4. Shenzhen map with locations of Meilin & Mingzhi Street scene.

Source: Author

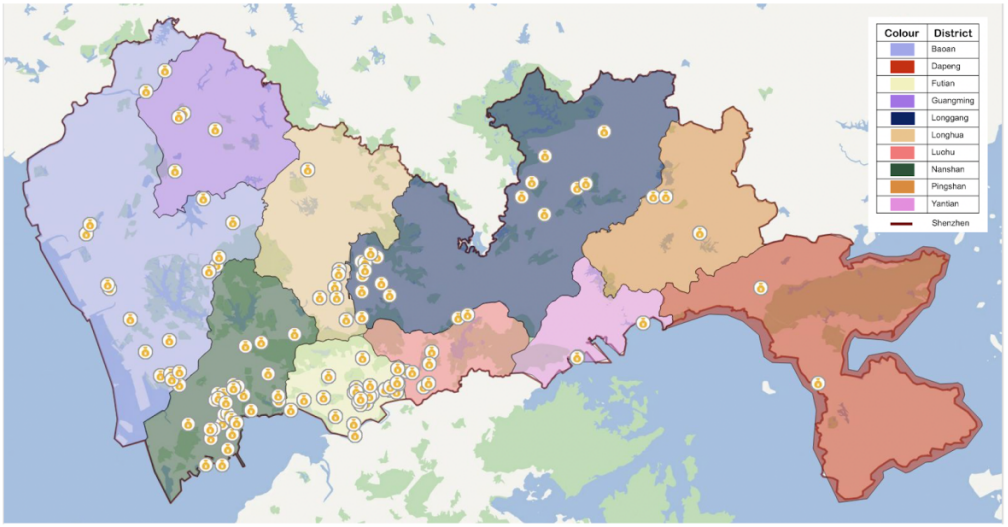


Figure 5. Daytime Weibo working hours check-in data

Source: Author

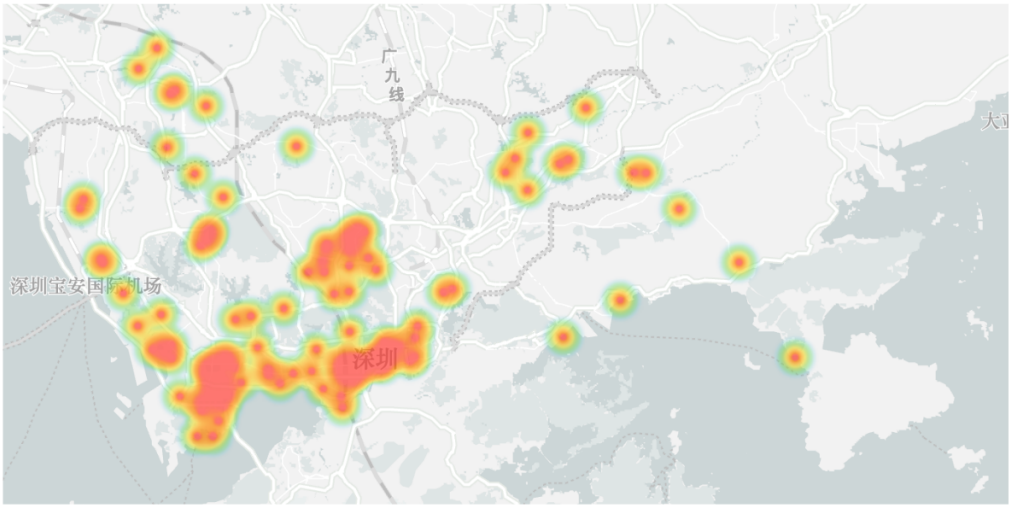


Figure 6. Thermodynamic diagram of workplaces (based on Weibo data)

Source: Author

In terms of distribution characteristics, the central coordinate of residential areas in Shenzhen is located at the southernmost end of Mingzhi Street. It is about seven kilometres away from the location of the municipal government in the south, and two kilometres north of the work centre. The distribution characteristics and patterns of residence are very similar to those of the workplace. Most of the working clusters are also residential clusters, but the working group is more gathered together at the centre than the group of residential sites. The density of residential areas in Guangming, Pingshan and Dapeng New Districts is very low, where residential areas are not even identified (Figure 7). The main shape of the settlements is an east-west ellipse, covering the whole area of Futian District and Luohu District, most of Nanshan District, the south of Longhua District, the southwest of Longgang District and the south of Baoan District (Figure 8).

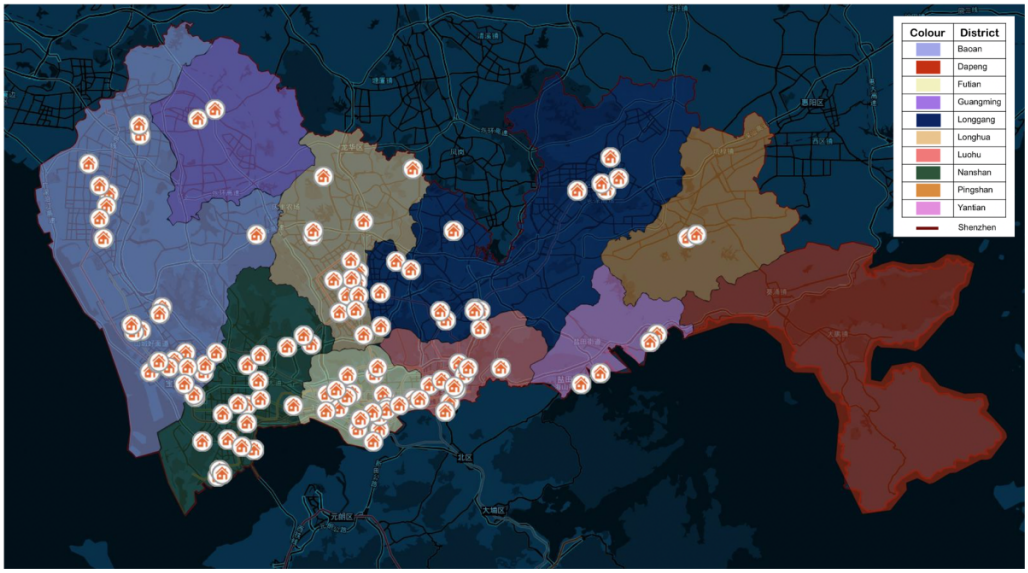


Figure 7. Night-time Weibo working hours check-in data

Source: Author

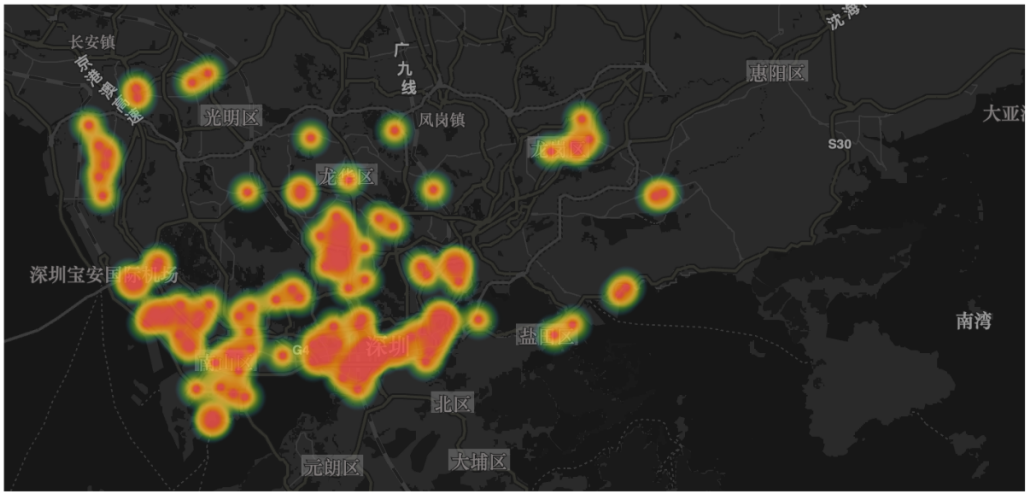


Figure 8. Thermodynamic diagram of residential place (based on Weibo data)

Source: Author

The job-residential ratio is the ratio of the number of jobs in a region to the number of residents, reflecting the JRB situation, and is the most commonly used indicator. The expression is as follows:

JRR = Jn/Rn

JRR is the district's job-to-residential ratio

Jn is the number of jobs in the district according to Weibo data

Rn is the number of residential users in the district according to the Weibo data

District	Number of working units	Number of residential units	JRR
Baoan	29	46	0.630
Dapeng	2	0	0
Futian	33	38	0.868
Guangming	3	3	1
Longgang	27	24	1.125
Longhua	10	19	0.526
Luohu	10	11	0.909
Nanshan	59	25	2.36
Pingshan	3	2	1.5
Yantian	3	6	0.5
SHENZHEN	179	174	1.029

Table 1. JRR of each district

Source: Author

JRR of Shenzhen = total number of work units/total number of residential units = 1.029

JRR of Shenzhen = total value of ten districts' job-residential ratio/10=0.915

No matter which calculation method is adopted, the average value of the job-resident ratio in Shenzhen is around 1, and the median is 1.125. Nanshan District has the highest JRR. As the job centre

of Shenzhen, Nanshan District concentrates a large number of technology companies and industrial parks, providing more jobs. Another reason for the low value in the city centre is that the street area here is small, the housing price is high, and the places of work and residence are more likely to appear in different areas. In comparison, Dapeng New District has the lowest job-resident ratio. Dapeng District was separated from Longgang District and made an independent district in 2011. The economy mainly relies on tourism, therefore the low data is acceptable. The areas with the lowest JRR are located to the north and east of the city centre. For example, Yantian District, Longhua and Baoan Districts have convenient rail transit, so they have become the first choice for people working in the city centre. Compared with high-density residential areas, there are not many jobs, so their employment and housing are relatively low. There are five districts with a job-resident ratio between 0.8 and 1.2, accounting for half of the total. The standard deviation is about 0.483, with fewer extreme values, which proves that the data is more clustered, which means that Shenzhen has a good JRB.

The commuting costs of labour will be capitalised into wages, and thus included in the production cost of the enterprise. This kind of human capital also affects the economic output of enterprises (Zheng et al., 2009). Therefore, types of enterprises, transportation accessibility and social capital in a certain area will affect the matching process of enterprises and labour, forming a specific relationship between employment and residential space. The higher the labour skill level, the fewer employment opportunities that will match it, and the greater the need to find employment opportunities in a larger area. High-skilled labour can also accept long commute distances because they have high wages. This will result in a lower employment index, and the probability of living in the area is smaller. If the work area has convenient transportation and low commuting costs, this index will be further reduced. The distribution of employment is proper proof of this conclusion. Luohu District, Futian District, and Nanshan District with convenient transportation have a large number of innovative high-tech enterprises that require highly skilled labour. Manufacturing and processing enterprises are mainly concentrated in the suburbs, with low-skilled labour and relatively inconvenient transportation. Residents in outlying urban areas, such as Pingshan District and Baoan District, are more inclined to work in their streets.

4.2 Online interviews

Appendix 8 lists essential information on the interviewees. After sorting out online interview information, it was found that the interviewees understood that Shenzhen's population density is too high. From 2015 to 2018, it was the city with the most massive annual increase in permanent population, with an average annual growth of 550,000. Although the permanent population of Shenzhen reached 23 million in 2019, the number of commercial housing units is only 1.81 million. According to research data from 2019, the housing ownership rate in China reached 73.9% (Hengda Research Institute, 2019). The housing ownership rate in Shenzhen is the lowest among the four first-tier cities, only 23.7%. The housing ownership rate in Shanghai and Beijing is as high as 70%, while in Guangzhou, this figure is 54.9%, more than double that of Shenzhen. Only two of the interviewees own a house in Shenzhen (living with their parents). When the other interviewees rented a house, singles paid more attention to commuting distance. In comparison, those with families paid more attention to whether there were complete facilities around, such as hospitals and schools. All interviewees were relatively satisfied with their current commuting distance and time, including interviewee No. 4, who had the longest commuting time (Appendix 8).

The interviewees believed that there were four attributes explaining why Shenzhen traffic was in trouble. Buses driving too fast was the first reason. Although this should not account for the inefficiency of transportation, everyone agreed on this point. The number of public transport operations in Shenzhen reached 35,809 (Figure 9) in 2019, the most significant number in China, but not many people are willing to ride. Taking environmental protection into consideration, the Shenzhen government replaced gasoline buses with electric buses in 2017 (Shenzhen Transportation Commission, 2019). Electric vehicles are so powerful that they start, drive and brake too fast, making it difficult for people to adapt. The terrain of Shenzhen slopes gently, and many people would rather walk or ride a shared bicycle than take a bus. Whether you are cycling or driving, you will encounter the second difficulty: Shenzhen traffic lights take too long. According to a traffic analysis report on major cities in China (Gold, 2015), Shenzhen has an average red light waiting time of 31.7 seconds during peak traffic, making it the most patience-testing city in China (Figure 10). Traffic lights are inefficient, leading to poor traffic flow and causing traffic jams.

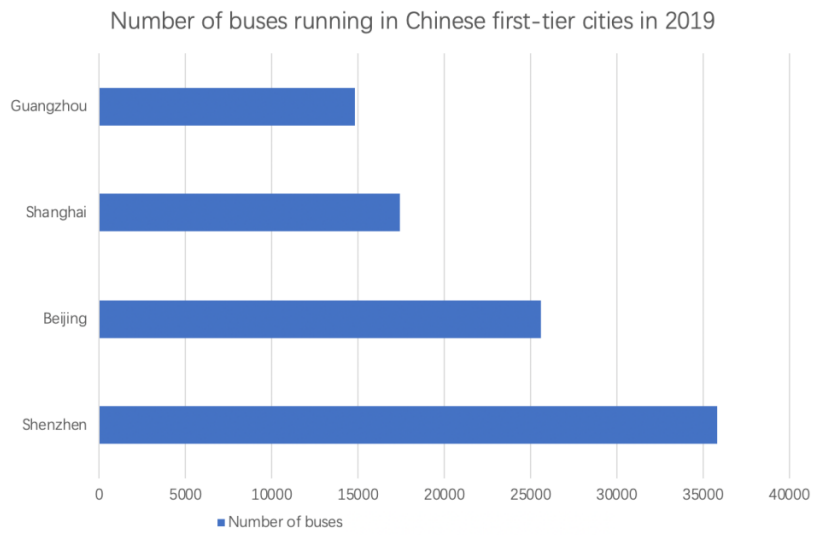


Figure 9. Number of buses running in Chinese first-tier cities in 2019

Source: http://www.199it.com/archives/823584.html

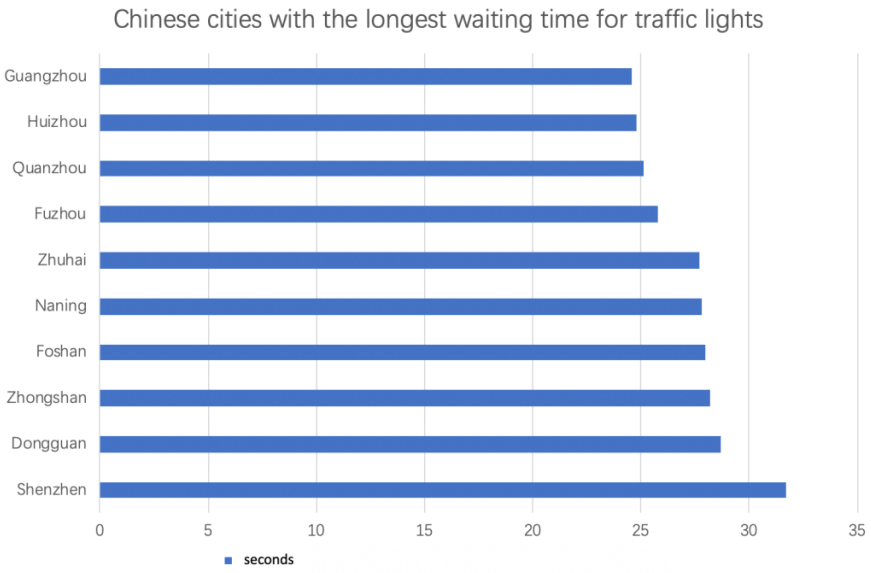


Figure 10. Chinese cities with the longest waiting time for traffic lights

Source: http://www.199it.com/archives/823584.html

The third reason is that there are no bicycle lanes. An interviewee said that when a friend rode a bicycle to work in the ROC new area, because there was no bicycle lane, he had to ride on the highway. The traffic police fined him 50 yuan (about five pounds). From the perspective of the traffic police, the fine is intended to make the cyclist responsible for his safety. But his friend felt this was unfair, because he would like to use a bicycle lane, but there was no bicycle lane to use. As a Chinese first exclusive economic zone, Shenzhen has experienced very fast economic development, followed by a rapid growth in automobiles. At present, cars in Shenzhen account for more than 50% of the city road resources, and bus lanes account for 8%. Bicycle lanes account for only 6%, and most of the bicycle lanes are mixed with sidewalks. With the increasing emphasis on the concept of green travel, and the rapid development of shared bicycles, food delivery, and express delivery, the existing roads cannot meet the rapidly growing demand for non-motor vehicle transportation (Shenzhen Transportation Committee, 2018). This is also one of the critical reasons for the increase in urban bicycle road traffic accidents. There are almost no non-motorised lanes in Shenzhen, which is a disaster for a city with a conservative estimate of 3.85 million non-motorised vehicles. Non-motor vehicles and motor vehicles share the same road, leading to traffic chaos and high safety risks. The last reason is that subway repairs have further compressed road space. In 2020, Shenzhen will have 17 subway lines and extension lines under construction (Bendibao.com, 2020). Cyclists often need to occupy car lanes, and subway repairs further squeeze the road space (Figure 11).

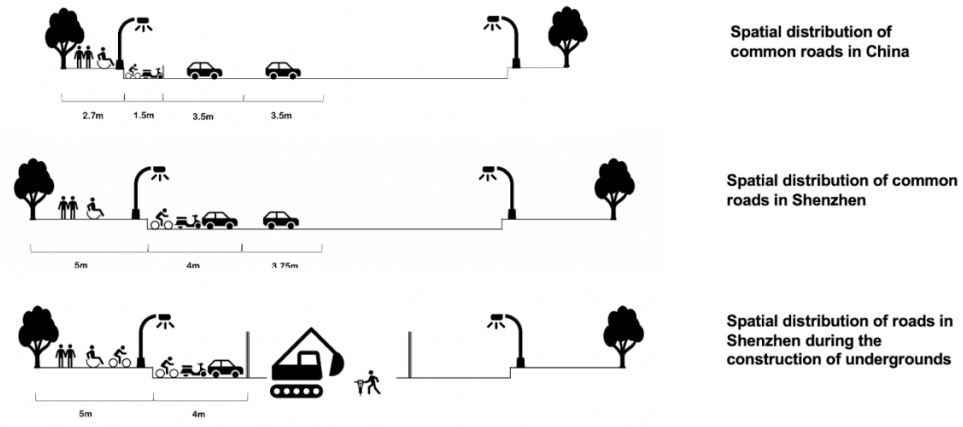


Figure 11. Comparison of 3 different road conditions

Source: Author

4.3 Findings

The quantitative data obtained from Weibo can be summarised in the following three points. First, the author uses the check-in time and POI type to identify the spatial location information of the Weibo check-in data to determine users' workplace and residence. Removing uncertain information can increase overall accuracy. By analysing the distribution characteristics and the distribution model to compare the JRB, the following could be obtained: Shenzhen's overall JRB is good, and the spatial distribution of JRB has an apparent hierarchical structure. Futian District, Luohu District, and Nanshan District are the innermost part of the hierarchy. This level has a high JRR, low independence, and insufficient JRB. The second tier is composed of Futian District, Luohu District, the surrounding streets of Nanshan District, Longgang District, and Longhua District near the city centre. The job-to-residence ratio at this level is low, and independence and JRB are poor. The third level is composed of Longgang District, Longhua District, Bao'an District and other streets away from the city centre. The JRR of these places is around 1, and the independence and JRB are good. The fourth layer is also the outermost layer, including the northwest and northeast areas of Shenzhen. These areas border Dongguan and Huizhou, and the job-to-residence ratio is close to 1. JRB is very good. Dapeng District and Yantian District have less job-residential identification, and the job-resident balance index is abnormal, which is caused by insufficient data being collected.

Second, the spatial distribution of commuting features in Shenzhen is arranged on the same level as that of JRB. The average commuting distance of the innermost layer is short, and the proportion of commuting across districts is high. The average commuting distance of the middle two levels is longer, and the proportion of commuting across districts is medium. The average commuting distance of the outermost layer is long, and the proportion of commuting across districts is low. Commuter flows mainly occur in Luohu District, Futian District and Nanshan District, and at the junction of these three districts and other districts. Third, the spatial distribution of average commuting distances in Shenzhen also has obvious levels. The basic rule is that the average commuting distances from the city centre get longer and longer. Areas with shorter average commuting distances are located in the city centre, including Futian, Luohu, and Nanshan. In short, the average commute distance of Shenzhen from the city centre is gradually increases, the further you get from the centre. This level of hierarchy indicates that Shenzhen's commuting out of the city mainly flows to the city centre, resulting in a shorter average

commuting distance for people near the city centre (Appendix 9&10).

The quantitative data from the interviews described the nature of residence. First, when choosing a place of residence, the interviewees paid the most attention to the convenience of transportation. They believe that convenient transportation means shorter commuting time. The second most crucial factor in the process of residence selection is the nearest work. 50% of interviewees prefer to live in a place closer to their workplace. For interviewees with families, it is also vital for the spouse to go to work and children to go to school. In addition, there are not many residents who see housing prices as significant, which is inconsistent with common perceptions. It is generally believed that housing prices are a factor that people attach great importance to when choosing a place to live. But according to the interviews, when people choose a place to live, they have subconsciously delineated a range of housing prices they can afford. It is worth pointing out that residents attach great importance to a clean, comfortable and safe living environment, but the interviewees had no clear preference for the type of residence. For non-family renters, Shenzhen urban village was a good choice, with low prices and proximity to companies. Interviewees with a family are more influenced by their preference of the school and medical environment. For those who already own a personal home or live in their parents' house, willingness to switch to a new place is very low even if their fixed residence is far from their work position, because of the cost of moving.

5. Discussion

Research has confirmed that JRB has a close relationship with commuting in Beijing, Shanghai and Guangzhou. With increased JRB, the commuting time of administrative districts and individuals is decreasing, and the commuting efficiency of the entire cities has been improved. It is difficult to achieve consistency between the mobility of jobs and housing. Coupled with factors such as the increase in dual-income families, the negative externalities of the market economy, and the lack of government balance awareness, it is difficult to achieve JRB fully. Even if the total number of jobs and the resident population are balanced, it is not easy to achieve a reasonable balance in structure. Therefore, advocating JRB is only a conceptual guiding direction. This guidance is confirmed in the

analysis of Beijing, Shanghai and Guangdong (Meng et al., 2009; Liu, 2009; Gu et al., 2008; Sun et al., 2008; Liu and Chen, 2010). These three cities have reduced cross-regional traffic by rationally arranging urban land and other measures, effectively reducing commuting and alleviating congestion.

Choice of the study area has an essential influence on the results (Peng, 1997). Peng believes that the metropolitan area as a research area facilitates the direct translation of research results into policies and helps improve urban land use. In research into JRS in big cities, international scholars tend to lean towards the middle level. Both Peng (1997) and Sultana (2002) used dynamic buffer technology in GIS to measure the JRR in the buffer. The advantage of using this method is to ensure the comparability of study areas. Considering that the limitations on personal information collection capabilities makes it impossible to make detailed comparisons within administrative regions, this research uses different districts of Shenzhen as the research unit at the middle level. The author calculated the JRR of each district in Shenzhen through Weibo data, and finally figured that the JRR of Shenzhen was 1.029, which is within the 0.8-1.2 balance interval defined by Cervero (1996). Since reform and opening up, Shenzhen has developed rapidly. Under the influence of the market, the urban spatial structure has undergone rapid changes, and the government lacks practical and rational guidance. The Shenzhen government suppressed secondary industry and developed tertiary industry. The large-scale transformation of the central city has effectively promoted job mobility and housing mobility. Although there is a gap between the two, it is relatively small compared to the other three first-tier cities. For Shenzhen, where the JRR is relatively balanced, this factor is not the main reason for difficulty in urban traffic operation. Peng (1997) pointed out that changing jobs and reducing commuting distance are key reasons for choices of residence. The high mobility of employment and diving in Shenzhen helps to maintain JRB.

Scholars who are sceptical of JRB's ability to improve traffic conditions believe that living near their place of employment may not be a priority for most people. In addition to housing prices, many other factors will affect JRB. Therefore, even if jobs and housing are roughly balanced spatially, people may not choose to live near their place of employment (Giuliano, 1991). From research and analysis into JRB effectiveness by international and Chinese scholars, it can be seen that the proportion of commuter transportation stations in the city and the residential choice preference of residents will directly affect the effectiveness of the equilibrium. If residents do not have a strong preference for

living close to jobs, then advocating for JRB is meaningless (Song, 2010). Whether residents prefer housing close to their place of employment has become an important factor in JRB's effectiveness, so the author designed related questions in the survey.

As Jacobs(1961) said, urban development should take into account users' ideas. All interviewees thought that the traffic in Shenzhen is relatively congested and very congested. From the perspective of residence choice preference, although the selection process for Shenzhen residents has become more complicated, perceived distance (commuting time) and actual distance (commuting distance) are still top priority factors. This situation is in line with the urban spatial equilibrium model (LRH model) proposed by Lucas and Rossi-Hansberg (2002). Agglomeration economy and commuting cost are the two main factors in Shenzhen residents' choices of where to work and live. In the 1980s, the reform of the market economy made many non-core functions of the work unit disappear, including the provision of housing for employees. The newly formed employment organisations only provides primary benefits such as wages and insurance, leading to the strengthening of JRS (Wang and Chai, 2009). The market-oriented reform of the housing system broke the traditional work unit. However, many companies in Shenzhen still considered the issue of employee housing, and 51.16% of the people said that their company provides dormitories for their employees (Wang, 2015). Rents in Shenzhen are rising, and living in company dormitories can save a lot of money. For ordinary salaried workers, it can indeed relieve a lot of pressure. High rents are unaffordable on meagre salaries, especially for those born in the 90s who have just entered the workplace. Most companies that provide staff dormitories are located in industrial parks, so companies with higher industrial agglomeration are more willing to pay higher wages for long-distance commuting (Zheng et al., 2009).

Urbanisation and urban spatial expansion inevitably lead to an increase in the spatial distance and time cost of residents' commuting. High-income people have a higher willingness to mitigate for the long commute distance by improving transportation methods, and are more willing to move to higher-income occupations or better-quality housing at the expense of longer transportation distances. Low-income groups are disadvantaged in the housing market. Due to their low ability to pay, they have few opportunities to move or improve their housing. Residential suburbanisation and JRS are most likely to cause living difficulties, such as increased commuting costs and reduced facility accessibility, for low-income groups. The most effective way to alleviate this situation is for the government to intervene

effectively. Faced with the extension of travel distance and time caused by decentralisation, Gordon et al. (1991) believe that households and businesses always periodically adjust their spatial locations to achieve JRB. However, the realisation of this theory has certain prerequisites: the government must create a significant possibility of choice of residence. Under the conditions of a market economy, especially during the transition period of Chinese system, the relationship between employment and residential space is very complicated and objective.

The curve law of differential rent leads to excessively high housing prices, and the government has not taken adequate or timely measures in time to guarantee the provision of affordable housing in employment-intensive areas (Xu et al., 1997). Therefore, a complete market economy system, will easily give rise to the separation of various types of land use, form exclusive land zoning, and further lead to JRS. Most of the respondents affirmed that they would like to move to a place closer to their workplace. But for renters, the most prominent hindrance is that the housing prices near the workplace are too high, beyond the scope of individual affordability. Half of the interviewees said that the possibility of changing residences was constrained by high housing prices and rental prices. Those with families felt that relocation could cause inconvenience at work for their spouse or education problems for their children. The number of multi-employed households continues to increase, and the choice of location becomes more complicated (Levine, 1998). When there are two or more employees in the family, it is impossible to choose a place of residence that will suit every member of the family (Cervero, 1989; Giuliano, 1991; Levine, 1998). The probability that all members of the family can find jobs in nearby places is very low (Cervero, 1989; Giuliano and Small, 1993).

Among the factors influencing the relationship between occupation and residence (Zheng and Cao, 2009), the spatial distribution of housing opportunities and public service facilities can be improved in Shenzhen. In addition to the four main reasons listed by scholars, Shenzhen has its unique circumstances. In Shenzhen, JRR is in a balanced state in most areas, and the overall average is also excellent. There are other more significant causes of traffic stress. Travelling to and from work is only part of the daily travel of urban residents. As the diversified life of urban residents in China improves, the proportion of travel spent commuting is gradually decreasing. In 2016, the proportion of commuting trips in Shenzhen had dropped to 48%. A large part of non-commuter travel consists of journeys to various public service facilities (Zheng, 2016). The biggest problem in Shenzhen is the lack

of road spatial planning and unreasonable public transportation. Fortunately, road space problems will be alleviated by waiting for the completion of the underground construction.

6. Conclusion

6.1 Summary and results

This dissertation first describes the research background and significance of urban JRB and commuting characteristics, and summarises the research status. At present, there are very few results from using Weibo sign-in data to conduct JRB research. This dissertation was completed in this context. With the addition of the research methods of online interviews, the lack of attribute information in Weibo data can be compensated to a certain extent. Although Shenzhen has the highest population density in the mainland, the overall state of its JRB is fine. The spatial distribution of Shenzhen JRB is a circle structure centred on the city centre. House prices in the inner circle are high, and the JRB is relatively poor, while the JRB in the outer ring is better. Residents care more about the convenience of travel than JRB. The interviewees expressed their satisfaction with their current living and working distance and their understanding of the difficulty of travelling during peak hours in Shenzhen. From the perspective of urban users, the unreasonable allocation of urban space is the main cause of this. Due to the rapid development of Shenzhen, the infrastructure cannot meet the current travel needs, and, currently, the construction of multiple subway lines makes the traffic worse.

Since Chinese reform and opening up, the process of urbanisation has accelerated, and the spatial structure has continually been changing. Under the influence of market economy and national policies, the system of employment and living space within cities has undergone tremendous changes. Due to the impact of land rent, agglomeration effects and industrial pollution, the phenomenon of industrial suburbanisation is apparent, and the original old city is repurposed for the service industry and as a commercial centre (Wang, 1990). Due to housing market reforms and the influence of government policies, housing prices in the city centre have continued to rise, and industrial parks and residential areas have emerged in the suburbs. Still, they are separated from each other (Li, 2013). The continuous

improvement of urban transportation infrastructure construction and the diversification of transportation tools provide more choices, and also intensify the reconstruction of urban occupation and housing space (Huang, 2006). As a result, the balance of work and housing space is getting worse, especially in the first-tier cities in mainland China (Beijing, Shanghai, Guangzhou, Shenzhen). Effectively understanding the characteristics of urban residents' work and residence distribution, and commuting characteristics can help to alleviate a series of social problems such as traffic congestion and environmental pollution.

Based on related theories on the influencing factors of JRB and its spatial difference, this paper conducts an empirical analysis on the spatial difference of the two JRB indexes. Results find the level of labour capital, rail transit accessibility and enterprise ownership composition will significantly affect the employed housing balance index of the block. The residential block will be affected by the level of labour human capital, rail transit accessibility, family size, and family responsibilities, which will significantly affect the occupant employment balance index of the block. Since these influencing factors have obviously vary between various blocks, the JRB index will inevitably have significant spatial differences. JRB means that the number of jobs and the number of houses in a block are equal (or approximately equal). It does not conform to the laws of the objective market and is therefore difficult to achieve. This means that urban planners and managers should have a more in-depth understanding of the economic mechanisms that shape the urban job-residential spatial relationship to set more scientific planning indicators, form a reasonable job-resident relationship, improve urban spatial efficiency, and improve the quality of life of residents.

6.2 Limitations and contributions

There are several shortcomings to the research method of using Weibo sign-ins. This dissertation identifies occupation and residence based on generalization about occupation and residence land and time, but not all information conforms to these ideas. For example, a sign-in located in a mixed-use building at night may not necessarily be from someone in their place of residence, but might be from someone who works at night. When manually screening by reading the content of Weibo, the information that did not indicate work or home was uniformly deleted. Although this increased data

credibility, it reduced the number of samples. The existence of people who come to Shenzhen to travel and live in friends' houses can generally be proved from other Weibo content posted by users. In the collected data, there are cases where user information cannot be determined. These cases have been deleted to ensure accuracy. There are slight errors in microblog positioning and position conversion. Weibo user groups have their limitations. Only the vocational and residential groups who sign in with Weibo will be identified, so there is user bias. The generated map cannot show the personal trajectories, and cannot confirm whether there is a separation of job and residence, but can only show the overall situation.

In proportion to the total number of people voting, the number of interviewees selected through Weibo voting is relative. There are shortcomings, but according to the comparison of land use types and second-hand data, the identification method here is significant. It can be used to analyse JRB and commuting characteristics. Since the use of Weibo login data to study the JRB and commuting characteristics of the city is a non-traditional method, it can provide very little reference. This research is undergoing preliminary exploratory analysis, and other related work needs to be carried out. The mentioned shortcomings can be improved by collecting different data through a more massive information collector, solving the problem of user bias and improving accuracy. Studying smaller scales, such as streets, could help verify the results. Future research could be aimed at using a population as the research object; the data obtained by the survey would then better reflect reality.

6.3 Political and further research

Urban public policies should be dedicated to providing individuals in markets with more choices, so that people can make rational choices after considering their social benefits and costs, and form reasonable job-residence relationships. For example, in the process of urban spatial planning and land supply, the full concentration of industrial land should be promoted. At the same time, the development density of residential land around the employment centre should be appropriately increased to increase the stock housing turnover rate. In terms of transportation, it is possible to consider building rapid transportation facilities (such as rail transit) extending from the employment centre to the periphery of the city, and provide sufficient residential land around the rail transit, while

reducing residents' housing and transportation costs. In terms of public services, the spatial layout of public service facilities should be gradually adjusted to change their over-concentration in urban centres, and coordinate them with the suburbanisation of industries and residences. Then, residents will be better able to balance the accessibility of work opportunities and housing costs to reduce the excessive degree of separation of work and housing. These measures will help to optimise the urban spatial structure, improve urban efficiency and the quality of life of residents.

Housing stock in Shenzhen is low, but office buildings in oversupply. The office vacancy rate in Shenzhen is as high as 25.4% (Sina.2020), which is the highest among first-tier cities. However, office buildings are still the first choice of land use types in the city centre because Shenzhen's industries are dominated by technology and finance. The main reason for the severe divergence between the residential and office markets in Shenzhen is that there are too many new office buildings. HongKong's economic and financial depression has created an indirect negative for the demand for office buildings in Shenzhen. These premium areas cannot be attained by those who have housing needs, which reduces the efficiency of urban resource allocation. Second, high-quality public service facilities are mostly concentrated in central areas, and the process of suburbanisation has caused additional commuting. Third, urban planning does not fully consider the decisive role of the market. Urban planners and managers have a responsibility to actively guide functional zoning through urban planning and land use actively, enhance the complex nature of zoning land functions, and improve the matching degree of employment opportunities and residential opportunities. Also, the government should improve the system and reduce the institutional constraints on the free choice of locations for labour.

On July 15, 2020, Shenzhen issued the most stringent housing control regulations in history. To buy a house in Shenzhen, you need to settle down for three years or pay five years of social security. Secondly, the down payment ratio for a second home has been increased to lower the threshold for luxury property tax. Second-hand houses are sold in less than five years and attract value-added tax. Despite this, the unit price of second-hand housing in Shenzhen did not fall but rose by more than 10% (Jiang, 2020). This policy is aimed at people with high purchasing power. Setting against the attraction of an improved living environment, a slightly higher price will not affect purchases. The price control is bad news for people with low purchasing power. As cities and industries are upgraded, talents and

purchasing power are also upgraded. Housing prices in Shenzhen will only rise and not fall. Land expansion and housing price classification may improve the situation in Shenzhen. Shenzhen can actively strive to form special cooperation zones with other regions, expand the land area of Shenzhen, and establish low-cost residential areas. Through the high-density construction of subways, intercity rails, and optimisation of the bus operation system, the central region and the suburbs can be linked together.

It is recommended that one or two new cities are built outside the gravitational radius of Shenzhen city centre (Sun, 2009). Greening and public space can be increased in the central urban area, and the floor area ratio and total building volume can be reduced. Under the premise of ensuring reasonable population capacity and smooth traffic in the central city, the total amount of regulation and control of residential development is approved (Sun et al., 2009). The construction of rapid rail transit between the new towns and the central city is the key to joint development. In addition to providing a high-quality living environment and sufficient employment opportunities, the new town will be indispensable for convenient transportation. The problems that plague the interviewees, of jammed commuting traffic and congested lines from the centre to the suburbs during holidays, can be improved. The large population and low-income level determine that transportation between the central city and suburbs of Shenzhen should be based on a fast and convenient rail transit network.

Due to the particularity and historical path dependence of Chinese urban spatial structure and local public service supply system, many high-quality public services in Chinese cities are concentrated in urban centres. It is difficult, especially in cities with explosive and rapid development like Shenzhen, for public service facilities to keep up with the speedy expansion of urban development. In the process of rapid urbanisation and suburbanisation, the scope of the towns has expanded rapidly, but public services, such as high-quality education and medical resources, have not increased. The spatial layout of facilities should be gradually adjusted to harmonise with the suburbanisation of industry and residence.

The limited distribution of urban public service facilities and housing opportunities will cause residents to incur additional costs to use these resources, and limit affordable housing. The balanced distribution of urban public facilities (especially basic education and medical facilities) will promote urban space

reasonably. Residents would not need to consider the location of public service facilities too much when choosing a place of residence. Entirely new shopping centres, parks and hospitals in the suburbs can be substituted for the living environment of the central city. In short, as a solution to the traffic congestion in Shenzhen, upgrading JRB by increasing affordable housing faces less room and more challenges. Taking into account the current situation in Shenzhen, improving road space planning and improving public service facilities will be most effective.

7. References

199it.com. 2016. *高德：2015 年度中国主要城市交通分析报告（附下载）*. [online] Available at: <http://www.199it.com/archives/431059.html> [Accessed 12 July 2020].

360doc.com. 2019. *特稿 | 职住平衡：深圳上班之路有多长？*. [online] Available at: <http://www.360doc.com/content/19/0914/12/34062252_860891579.shtml> [Accessed 3 July 2020].

36kr.com. 2020. *重磅！中国城市"通勤半径"排名：买房的边界值都在这了*. [online] Available at: <https://www.36kr.com/p/722788686629000> [Accessed 3 July 2020].

Baijiahao.baidu.com. 2020. *写字楼空置率暴增的背后真相*. [online] Available at: <https://baijiahao.baidu.com/s?id=1671968437896662715&wfr=spider&for=pc> [Accessed 6 July 2020].

Barr, S., Fraszczyk, A. and Mulley, C., 2010. Excess travelling — What does it mean? New definition and a case study of excess commuters in Tyne and Wea, UK. *European Transport Research Review*, 2(2), pp.69-83.

Beke1898.com. 2018. *轨道交通建设对深圳市人口分布的影响研究*. [online] Available at: <http://www.beke1898.com/h-nd-159.html> [Accessed 6 July 2020].

Bendibao, 2020. *2020 深圳 17 条在建地铁一览*. [online] Jt.sz.bendibao.com. Available at: <http://jt.sz.bendibao.com/news/2017223/789428.htm> [Accessed 1 August 2020].

Boussauw, K., Meutens, T. and Frank, W., 2011. Minimum commuting distance as a spatial characteristic in a non-monocentric urban system: the case of Flanders. *Papers in Regional Science*, 90(1), pp.47-65.

Buliung, R. and Kanaroglou, P., 2002. Commute minimization in the greater Toronto area: Applying a modified excess commute. *Journal of Transportation Geography*, 10(3), pp.177-186.

Cervero, R., 1989. Jobs-housing balancing and regional mobility. *Journal of the American Planning Association*, 55(2), pp.136-150.

Cervero, R., 1991. Jobs-housing balance as public police. *Urban Land*, (10), pp.4-10.

Cervero, R., 1996. Jobs-housing balance revisited. *Journal of the American Planning Association*, 62, pp.492-511.

Charron, M., 2007. From excess commuting to commuting possibilities. *Environment and Planning*, 39, pp.1238-1254.

Chen, J., 2015. *Jobs-Housing Space Distribution And Its Impacts On Commuting Behaviour In Shenzhen*. Master. Harbin Institute of Technology.

Chen, H., 2000. Commuting and land use patterns. *Geographical and Environmental Modelling*, 4(2), pp.163-173.

Cheng, S., 2018. *为什么深圳人都爱城中村？*. [online] Sohu.com. Available at: <https://www.sohu.com/a/229474714_234784> [Accessed 8 June 2020].

Chu, Y., Mao, M., Gao, S. and Lu, X., 2017. 数据如何驱动设计——以回龙观社区品质提升为例. *Planners*, (2), pp.81-89.

Cloud.tencent.com. 2018. *深圳地铁运能有多紧张？客流大数据告诉你真相*. [online] Available at: <https://cloud.tencent.com/developer/article/1180778> [Accessed 3 July 2020].

Cropper, M. and Gordon, P., 1991. Wasteful commuting: a re-examination. *Journal of Urban Economics*, 29(1), pp.2-13.

Du, C., 2018. *地铁日益发达让上海通勤圈"膨胀"，嘉定松江等郊区新城"独立指数"下降--上观*. [online] Jfdaily.com. Available at: <https://www.jfdaily.com/news/detail?id=99252> [Accessed 19 August 2020].

Flowerdew, R. and Martin, D., 2005. *Methods In Human Geography*. 2nd ed. New York: Pearson Education Limited.

Finance.eastmoney.com. 2020. *央行重磅！我国城镇住房自有率达 96% 户均资产超 300 万！_东方财富网*. [online] Available at: <http://finance.eastmoney.com/a/202004251466981140.html> [Accessed 4 May 2020].

Finance.sina.com.cn. 2019. *深圳著名城中村拆除重建 或将诞生 1878 个亿万富翁*. [online] Available at: <https://finance.sina.com.cn/china/dfjj/2019-09-24/doc-iicezueu7940672.shtml> [Accessed 12 August 2020].

Finance.sina.cn. 2020. *1200 万还是 2200 万 深圳到底有多少人口？*. [online] Available at: <https://finance.sina.cn/2019-01-13/detail-ihqhqcis5857700.d.html?vt=4&pos=17> [Accessed 3 July 2020].

Finance.sina.com.cn. 2020. *2019 中国城市发展潜力排名：深北上广稳居前四名*. [online] Available at: <https://finance.sina.com.cn/china/gncj/2019-08-23/doc-ihytcern2845069.shtml> [Accessed 6 July 2020].

Finance.sina.com.cn. 2020. *去年哪十个城市房价最高、涨幅最大？机构报告这样说*. [online] Available at: <https://finance.sina.com.cn/china/gncj/2020-02-03/doc-iimxxste8485797.shtml> [Accessed 3 July 2020].

Frost, M., Linneker, B. and Spence, N., 1998. Excess or wasteful commuting in a selection of British cities. *Transportation Research*, 32(7), pp.529-538.

Giuliano, G., 1991. Is jobs-housing balance a transportation issue?. *Transportation Research Record*, 1305, pp.305-312.

Giuliano, G. and Small, K., 1993. Is the journey to work explained by urban structure?. *Urban Studies*, 30(9), pp.1485-1500.

Hamilton, B. and Rell, A., 1982. Wasteful commuting. *The Journal of Political Economy*, 90(5), pp.1035-1053.

Hamilton, B., 1989. Wasteful commuting again. *The Journal of Political Economy*, 97(6), pp.1497-1504.

Horner, M., 2002. Extensions to the concept of excess commuting. *Environment and Planning*, 34(3), pp.543-566.

Horner, M., 2004. Spatial dimensions of urban commuting: A review of major issues and their implications for future geographic research. *The Professional Geographer*, 56(2), pp.160-173.

Horner, M., 2007. A multi-scale analysis of urban form and commuting change in a small metropolitan area (1990-2000). *Annals of Regional Science*, 41(1), pp.315-322.

Horner, M. and Murray, A., 2002. Excess commuting and the modifiable areal unit problem. *Urban Studies*, 39(1), pp.131-139.

Horner, M. and Murray, A., 2003. A multi-objective approach to improving regional jobs-housing balance. *Regional Studies*, 37(2), pp.135-146.

Jtys.sz.gov.cn. 2020. *2020 年 1-3 月深圳交通运输行业统计数据解读 - 数据解读 - 深圳市交通运输局（深圳市港务管理局）*. [online] Available at: <http://jtys.sz.gov.cn/zwgk/sjfb/sjjd/content/post_7367000.html> [Accessed 3 July 2020].

Kim, S., 1995. Excess commuting for two-worker households in the Los Angeles metropolitan areas. *Journal of Urban Economics*, 38(2), pp.166-182.

Levine, J., 1998. Rethinking accessibility and jobs-housing balance. *Journal of the American Planning Association*, 64(2), pp.133-149.

Li, J., 2020. *城中村是深圳的奶娘*. [online] Szdesigncenter.org. Available at: <https://www.szdesigncenter.org/ktkxy> [Accessed 6 July 2020].

Li, J. and Lu, M., 2018. 城市人多添堵？——人口与通勤的实证研究和中美比较. *World Economic Papers*, (6), pp.1-16.

Li, L. and Di, F., 2020. *"抢人大战"谁赢了？2019 年常住人口增长"黑马"竟是这两个城市*. [online] Shanghai Observer. Available at: <https://www.jfdaily.com/news/detail?id=245714> [Accessed 6 September 2020].

Li, Z., 2020. *中国城市的居住分异*. [online] Wechat Public Platform. Available at: <https://mp.weixin.qq.com/s/E_J76r6CiaAwdK_iQ-URrQ> [Accessed 3 September 2020].

Liang, H., Meng, B. and Li, C., 2014. 大城市职住分离的区域测度方法探究——以北京市为例. *Population Journal*, 36(4), pp.16-25.

Lin, X., 2019. *这10个城市人口增长最快，杭州人口增量首次领跑*. [online] Yicai.com. Available at: <https://www.yicai.com/news/100606913.html> [Accessed 6 September 2020].

Liu, W., Yan, X. and Fang, Y., 2008. 广州市过剩通勤的相关特征及其形成机制. *Acta Geographica Sinica*, 63(10), pp.1085-1096.

Liu, Y., Zhao, H. and Zhou, Y., 2015. 大型城市职住分布与通勤出行相关关系的网络动力学模型. *Shandong Science*, 28(1), pp.56-63.

Lu, M., 2018. *城市人多添堵？——人口与通勤的实证研究和中美比较*. [online] Zhihu.com. Available at: <https://zhuanlan.zhihu.com/p/54284855> [Accessed 5 July 2020].

Ma, K. and Banister, D., 2006. Excess commuting: a critical review. *Transport Reviews*, 26(6), pp.749-767.

Ma, K. and Banister, D., 2007. Urban Spatial change and excess commuting. *Environment and planning*, 39(3), p.630.

Manning, A., 2003. The real thin theory: monopsony in modern labour markets. *Labour Economics*, 10, pp.105-131.

Merriman, D., Ohkawara, T. and Suzuki, T., 1995. Excess commuting in the Tokyo metropolitan area: measurement and policy simulations. *Urban Studies*, 32(1), pp.69-85.

Na, T., Chai, Y., Zhang, Y. and Sun, D., 2017. Understanding job-housing relationship and commuting pattern in Chinese cities: Past, present and future. *Transportation Research*, (52), pp.562-573.

Nbd.com.cn. 2018. *上班族通勤画像：北京人最辛苦，广州人最折腾！来看看你的城市 | 每经网*. [online] Available at: <http://www.nbd.com.cn/articles/2018-06-16/1226545.html> [Accessed 3 September 2020].

Nbd.com.cn. 2019. *深圳人有多拼？超8成人在工作，领先其他一线超20个百分点 | 每经网*. [online] Available at: <http://www.nbd.com.cn/articles/2019-10-26/1381487.html> [Accessed 3 July 2020].

New.qq.com. 2020. *一线城市房价结构大比拼，北京最高冷、广州最亲民、上海更有温度*. [online] Available at: <https://new.qq.com/omn/20190919/20190919A06WCW00.html> [Accessed 6 July 2020].

Niedzielski, M., 2006. A spatially disaggregated approach to commuting efficiency. *Urban Studies*, 43(13), pp.2485-2502.

Niu, X. and Ding, L., 2015. *手机数据揭示上海职住关系：中心城就业通勤距离更长_市政厅_澎湃新闻-The Paper*. [online] Thepaper.cn. Available at: <https://www.thepaper.cn/newsDetail_forward_1373048_1> [Accessed 19 August 2020].

Peng, H., 2011. 中国适度普惠社会福利的两翼：理论发展与制度建构. *Welfare China*, (4).

Peng, Z., 1997. The jobs-housing balance and urban commuting. *Urban Studies*, 34(8), pp.1215-1235.

Ren, Z., 2019. *中国十大最具潜力都市圈：2019*. [ebook] Evergrande Research Institute, pp.13-20. Available at: <http://pdf.dfcfw.com/pdf/H3_AP201906241336134765_1.pdf> [Accessed 6 June 2020].

Rodriguez, D., 2004. Spatial choices and excess commuting: a case study of bank tellers in Bogota, Colombia. *Journal of Transport Geography*, 12(1), pp.49-61.

Schafer, A., 2000. Regularities in travel demand: an international perspective. *Journal of Transportation and Statistics*, 3, pp.1-31.

Scott, D., Kanaroglou, P. and Anderson, W., 1997. Impact of commuting efficiency on congestion and emissions: case of the Hamilton CMA, Canada. *Transportation Research*, 2(4), pp.245-257.

Shen, L., Zhang, C., Li, H. and Wang, Y., 2020. *Interaction Between Commuting Modes And Job-Housing Imbalance In Metropolis: An Empirical Study By Bayesian-Tobit Analysis In Beijing*. [online] Dlyj.ac.cn. Available at: <http://www.dlyj.ac.cn/article/2018/1007-6301/1007-6301-37-9-1277.shtml> [Accessed 1 June 2020].

Shenzhen Human Resources and Social Security Bureau. 2020. *数据发布_深圳市人力资源和社会保障局*. [online] Available at: <http://hrss.sz.gov.cn/sjfb/> [Accessed 1 August 2020].

Shenzhen.sina.com.cn. 2017. *全国人口密度深圳超北上广排第一 未来或继续升高*. [online] Available at: <http://shenzhen.sina.com.cn/news/s/2017-05-22/detail-ifyfkqks4407235.shtml> [Accessed 6 July 2020].

Shenzhen.sina.com.cn. 2020. *深圳的非机动车道太少太难走了 市民呼吁加快建设*. [online] Available at: <http://shenzhen.sina.com.cn/news/s/2020-04-24/detail-iircuyvh9517782.shtml> [Accessed 1 August 2020].

Sina.com. 2020. *你知道深圳为什么没有一条完整的自行车道路呢？*. [online] Available at: <https://k.sina.cn/article_6429032062_17f333e7e001008nkb.html?from=travel> [Accessed 6 July 2020].

Small, K. and Song, S., 1992. Wasteful commuting: a resolution. *The Journal of Political Economy*, 100(4), pp.888-898.

Sun, Q., 2002. 美国近代郊区化及其原因. *Journal of Hebei Normal University*, 25(5), pp.66-62.

Suh, S., 1990. Wasteful commuting: an alternative approach. *Journal of Urban Economics*, 28(3), pp.277-286.

Sultana, S., 2002. Job/housing imbalance and commuting time in the Atlanta metropolitan area: exploration of causes of longer commuting time. *Urban Geography*, 23(8), pp.728-749.

Szcaupd.com. 2020. *深圳市城市总体规划（2010-2020） - 中国城市规划设计研究院深圳分院*. [online] Available at: <http://www.szcaupd.com/project-ztgh-i_11235.htm> [Accessed 6 September 2020].

Sz.gov.cn. 2020. *深圳将打造"自行车友好城市"*. [online] Available at: <http://www.sz.gov.cn/cn/xxgk/zfxxgj/zwdt/content/post_6648091.html> [Accessed 6 July 2020].

Sz.news.fang.com. 2019. *影响超过400万人，这或许是深圳城中村发展的最好出路！*. [online] Available at: <https://sz.news.fang.com/open/32669971.html> [Accessed 3 July 2020].

Tang, X., Zhou, T. and Liu, Y., 2016. 基于手机信令的重庆主城职住关系. *Golbal City Geography*, 4(4), pp.10-15.

Thurston, L. and Yezer, A., 1991. Testing the monocentric urban model: evidence based on wasteful commuting. *Journal of the American Real Estate and Urban Economics Association*, 19(1), pp.41-51.

Transformcn.com. 2016. *深圳市自行车基础设施建设*. [online] Available at: <http://www.transformcn.com/Topics/2018-09/26/content_213090.htm> [Accessed 6 July 2020].

Walsh, N., 2020. *The Curious History And Beauty Of Shenzhen's Urban Villages.*. [online] ArchDaily. Available at: <http://www.archdaily.cn/cn/933988/tan-suo-shen-zhen-cheng-zhong-cun-de-qi-miao-li-shi> [Accessed 3 July 2020].

Wang, B., Zhen, F. and Zhang, H., 2015. 基于签到数据的城市活动时空动态变化及区划研究. *Geographical Science*, 35(2), pp.151-160.

Wang, F., 2020. *城市通勤报告：哪座城市的居民通勤幸福度最高？ - 21财经*. [online] M.21jingji.com. Available at: <https://m.21jingji.com/article/20200522/herald/73ac1f2aba023b796f142a95643754c7.html> [Accessed 16 June 2020].

Wang, Y., 2017. *找到这些职住平衡的宜居地，彻底告别"通勤难"*. [online] Zhihu. Available at: <https://zhuanlan.zhihu.com/p/32431559> [Accessed 6 September 2020].

Wang, Z., Zhang, Z., Du, C., Gao, G., Hu, Q. and Chen, R., 2019. 轨道交通站点周边职住平衡与通勤特征分析. [online] Available at: <https://kns.cnki.net/KCMS/detail/detail.aspx?dbcode=CPFD&dbname=CPFDLAST2020&filename=ZHCG201910005045&v=MDAyMjdxcXhkRWVNT1VLcmlmWmVadkV5anRVN2pJSmxzVFB5WElhYkc0SDlqTnI0OUZZZXNMQ1JOS3VoZGhuajk4VG5q> [Accessed 6 September 2020].

Wenku.baidu.com. 2020. *2016年深圳居民出行调查主要结论*. [online] Available at: <https://wenku.baidu.com/view/f670e129dcccda38376baf1ffc4ffe473368fdcc.html> [Accessed 7 July 2020].

White, M., 1988. Urban commuting journeys are not wasteful. *The journal of political economy*, 96(5), pp.1097-1110.

Yang, C. and Wang, C., 2013. 城市过剩通勤与职住平衡模型. *Journal of Tongji University*, 41(11), pp.1712-1716.

Yang, J., 2008. Policy implications of excess commuting: examining the impacts of changes in US metropolitan spatial structure. *Urban Studies*, 45(2), pp.391-405.

Yin, X., Yan, X. and Xue, D., 2009. *The Informal Sector In "Urban Village" And "Urban Village" Transformation In Rapid Urbanization Region: Case Of Caiwuwei And Yumincun,Shenzhen*. [ebook] pp.44-53. Available at: <http://www.mur.cn/nsfiles/f99d1fcf6a0fff0a8243fb6d1805c0ac09-03-06.pdf> [Accessed 3 June 2020].

Zhang, X., Dou, Q. and Zhao, L., 2017. 职住空间关系研究的比较述评与展望. *World Regional Studies*, 26(1), pp.32-44.

Zhao, H., Yang, J. and Liu, C., 2020. 职住分离的度量方法与空间组织特征——以北京市轨道交通对职住分离的影响为例. *Progress in Geography*, 30(2), pp.198-204.

Zhao, Y. and Gu, J., 2020. *深圳城中村租住质量调查报告*. [online] Sznews.com. Available at: <http://www.sznews.com/zhuanti/content/2018-08/22/content_19928019.htm> [Accessed 2 June 2020].

Zheng, S., Peiser, R. and Zhang, W., 2009. The rise of external economies in Beijing: Evidence from intra-urban wage variation. *Regional Science& Urban Economies*, 39(4), pp.449-459.

Zheng, S., Xu, Y. and Zhang, X., 2015. 职住平衡指数的构建与空间差异性研究：以北京市为例. *Tsinghua Science and Technology*, (4), pp.475-483.

Zheng, S., Zhang, X. and Xu, Y., 2016. 城市空间失配与交通拥堵——对北京市"职住失衡"和公共服务过度集中的实证研究. *Reform of Economic System*, (3).

Zhou, J., 2004. 空间不匹配假说与城市弱势群体就业问题：美国相关研究及其对中国的启示. *Modern Urban Research*, (9), pp.8-14.

8. Appendices

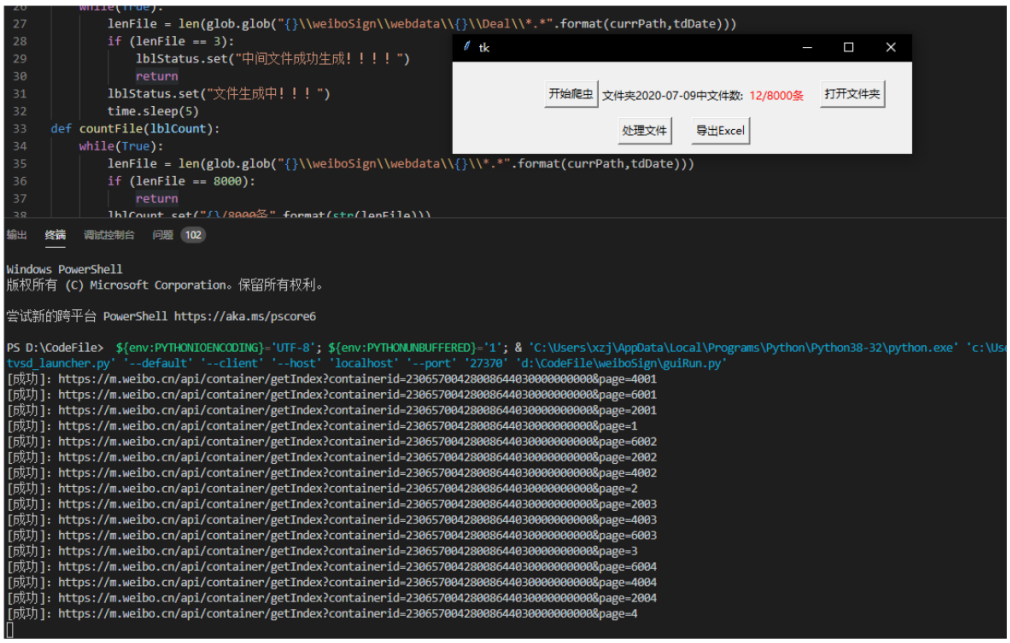
Appendix 1. Different types of data

Data type	Ease of obtaining	Sampling bias	Amount of data	Contains personal information
Phone location data	Very difficult	All groups except for some children and the elderly	Extra large	No
Taxi travel data	Difficult	Mainly for the non-private cars of low- and middle-income groups	Large	No
Didi travel data (similar to Uber)	Very difficult	Mainly for the non-private cars of low- and middle-income groups	Extra large	No
Bus card data	General	Mainly for the non-private cars of low- and middle-income groups	Large	No
Underground card data	General	Mainly for the non-private cars of low- and middle-income groups	Large	No
Sharing bike data	Difficult	Mainly for the non-private cars of low- and middle-income groups	Large	No
Weibo data	General	All groups except for some children and the elderly	Large	Yes
QQ, WeChat and other social software data	Very difficult	All groups except for some children and the elderly	Extra large	Yes

Appendix 2. Code snippet of the crawler

```
data = {
    "access_token": "",
    "local_batch_id": 7,
    "local_province_id": "45",
    "local_type_id": "1",
    "page": 2,
    "school_id": "102",
    "signsafe": "609f91125b4f9bba20ceae1c82f9b8d9",
    "size": 10,
    "uri": "apidata/api/gk/plan/special",
    "year": 2019
}
index = input("输入前缀")
url = "https://m.weibo.cn/api/container/getIndex?containerid=2306570042800864403000000000&page={}"
for i in range(1,1000):
    try:
        text = json.loads(GetMsgFromWeb(url.format(str(i)),headers,"","utf-8"))
        # print(text)
        print("[成功]: {}".format(url))
        with codecs.open("webdata\{}-web-{}.txt".format(index,str(i)),"w","utf-8") as f:
            f.write(str(text))
        # time.sleep(1)
        # input()
    except:
        time.sleep(5)
```

Appendix 3. Crawler interface



Appendix 4. Code snippet for importing data into Excel

```
def set_style(name,height,bold=False):
    style = xlwt.XFStyle()
    font = xlwt.Font()
    font.name = name
    font.bold = bold
    font.color_index = 4
    font.height = height
    style.font = font
    return style

#写Excel
def write_excel(dataList):
    f = xlwt.Workbook()
    sheet1 = f.add_sheet('签到数据',cell_overwrite_ok=True)
    row0 = ["用户名","签到日期","签到点","签到内容","经度","纬度"]
    # colum0 = ["张三","李四","恋习Python","小明","小红","无名"]
    #写第一行
    for i in range(0,len(row0)):
        sheet1.write(0,i,row0[i],set_style('Times New Roman',220,True))
    #写第一列
    for i,msg in enumerate(dataList):
        sheet1.write(i+1,0,msg[0])
        sheet1.write(i+1,1,msg[1])
        sheet1.write(i+1,2,msg[2])
        sheet1.write(i+1,3,msg[3])
        sheet1.write(i+1,4,msg[4])
        sheet1.write(i+1,5,msg[5])
        print(i)

    f.save('test.xls')

if __name__ == '__main__':
    write_excel(final)
```

Appendix 5. Code snippet for address conversion

```
data = {
    "access_token": "",
    "local_batch_id": 7,
    "local_province_id": "45",
    "local_type_id": "1",
    "page": 2,
    "school_id": "102",
    "signsafe": "609f91125b4f9bba20ceae1c82f9b8d9",
    "size": 10,
    "uri": "apidata/api/gk/plan/special",
    "year": 2019
}
# index = input("输入前缀")
url = "https://restapi.amap.com/v3/place/text?s=rsv3&children=&key=8325164e247e15eea68b59e89200988b&page=1&offset=108
for i in range(1,1000):
    print(123)
    text = GetMsgFromWeb(url,headers,"","utf-8").replace("jsonp_357914_(","").replace(")","")
    text = json.loads(text)
    if len(text["pois"]):
        # print(text["pois"])
        # print(text["pois"]["name"])
        print(text["pois"][0]["name"] + ":" + text["pois"][0]["location"])
```

Appendix 6. All relevant source codes

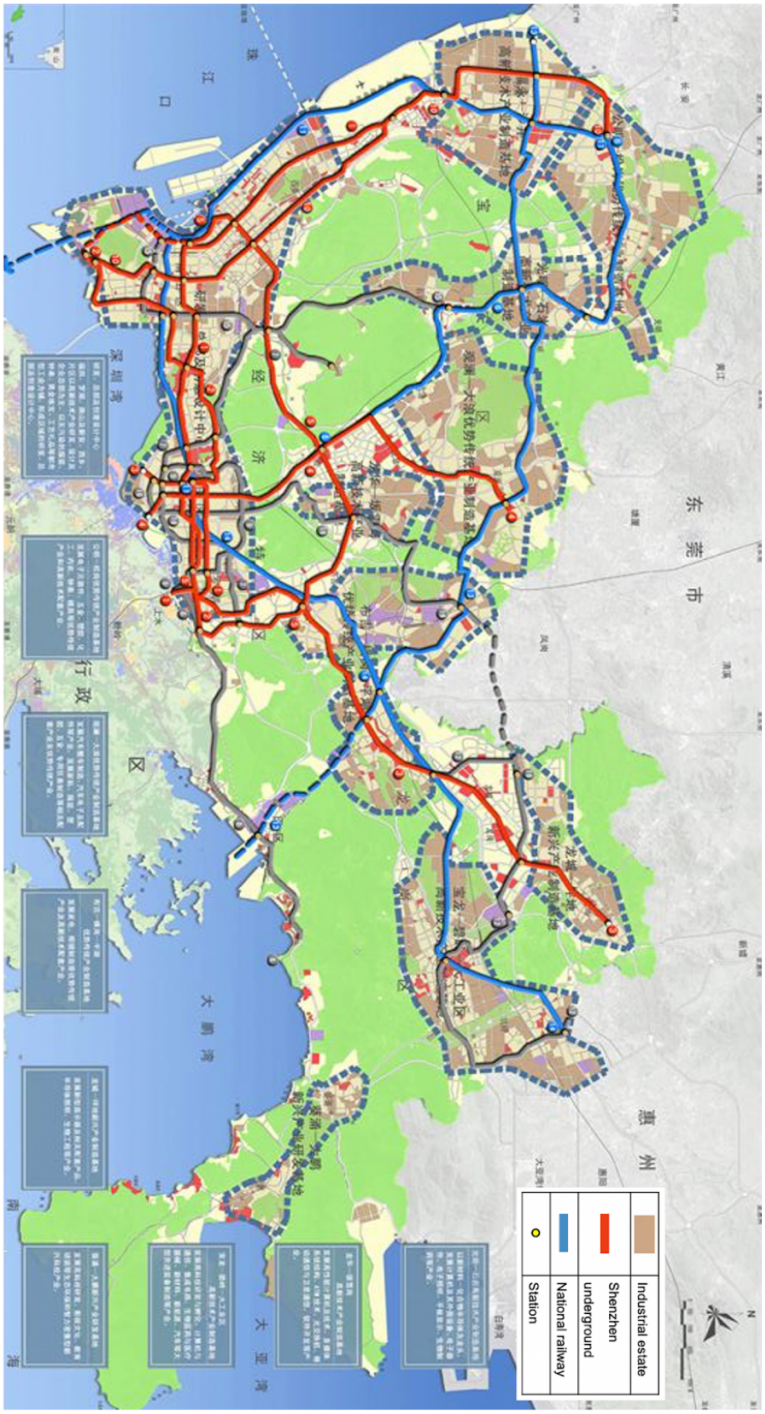
Appendix 7. Data filtering and its translated version

Appendix 8. Information on Interviewees

Intervie-wees	Gender	Age	Local or not	Time lived in Shenzhen	Housing type	Mode of transport	Time
1	Female	48	No	6yrs	Rent	Electric bike	15mins
2	Male	51	No	7yrs	Rent	Drive car	15mins
3	Male	23	Yes	23yrs	Own	Drive car	10mins
4	Female	25	Yes	25yrs	Own	Underground 1hr + walking/ sharing bike	1hr 20mins
5	Male	28	No	10yrs	Rent	Drive car/ taking bus	30mins
6	Female	not given	No	3months	Rent	Drive car	40mins

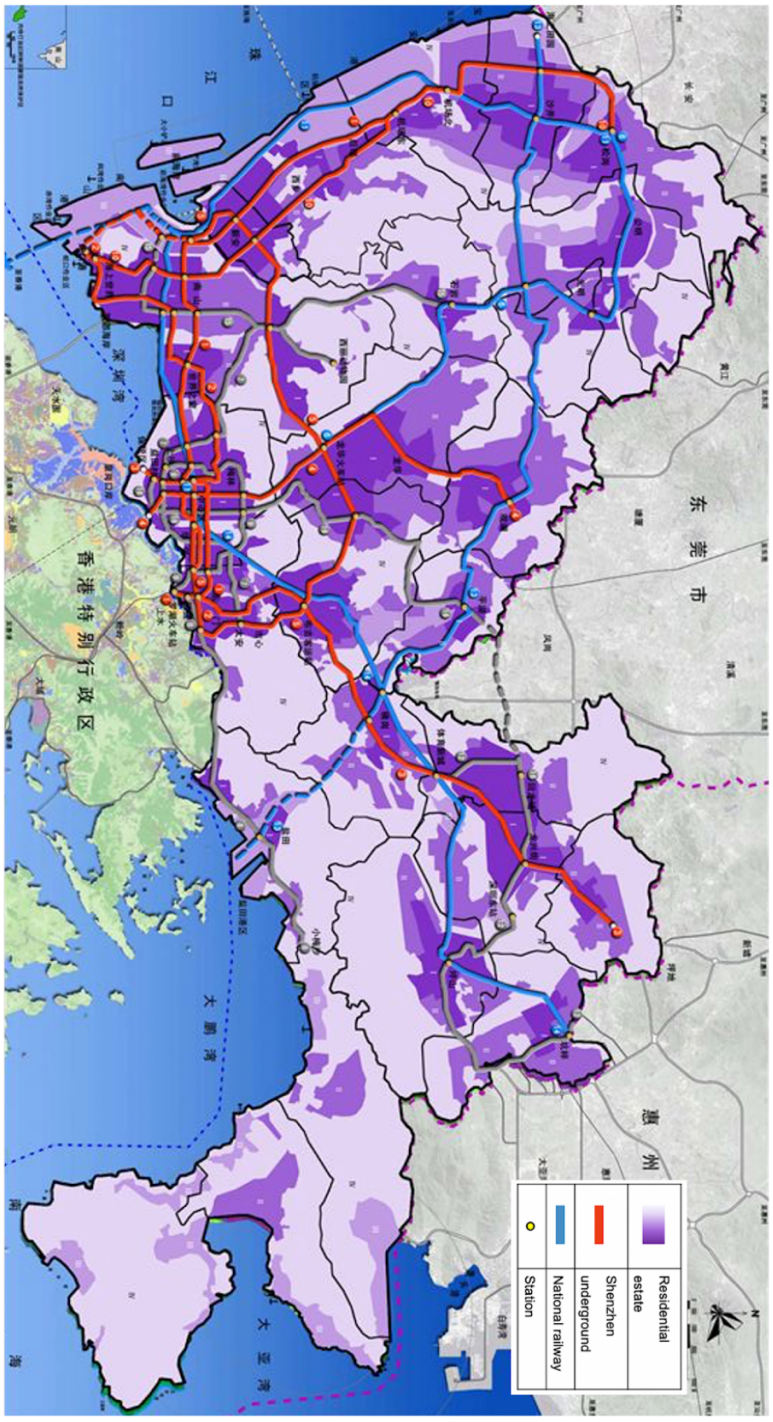
Appendix 9. Shenzhen transportation rail distribution map with industrial estate

Source: http://www.beke1898.com/nd.jsp?id=159



Appendix 10. Shenzhen transportation rail distribution map with residential estate

Source: http://www.beke1898.com/nd.jsp?id=159



19083466

GRADEMARK REPORT

FINAL GRADE

/100

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18

PAGE 19

PAGE 20

PAGE 21

PAGE 22

PAGE 23

PAGE 24

PAGE 25

PAGE 26

PAGE 27

PAGE 28

PAGE 29

PAGE 30

PAGE 31

PAGE 32

PAGE 33

PAGE 34

PAGE 35

PAGE 36

PAGE 37

PAGE 38

PAGE 39

PAGE 40

PAGE 41

PAGE 42

PAGE 43

PAGE 44

PAGE 45

PAGE 46

PAGE 47

PAGE 48

PAGE 49

PAGE 50

PAGE 51

PAGE 52

PAGE 53

PAGE 54

PAGE 55

PAGE 56

PAGE 57