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The Social Impacts of Transit Oriented Development (TOD): The Case Study of Chengdu

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Being a dissertation submitted to the faculty of The Built Environment as part of the requirements for the award of the MSc Transport and City Planning at University College London: I declare that this dissertation is entirely my own work and that ideas, data and images, as well as direct quotations, drawn from elsewhere are identified and referenced.

Mianlin Yang

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Abstract

Rapid economic development and urbanisation cause serious traffic problems. To combat the traffic issue, many countries have begun to implement Transit Oriented Development (TOD). TOD can not only promote the development of public transport and alleviate traffic congestion but can also effectively curb urban sprawl and urban land problems, which have an impact on urban social development. This paper will use the city of Chengdu as an example to study the social impact of TOD on urban development. At present, most of the researches on TOD are focused on principles, land use and sustainable development in developed countries (such as European countries, The U.S., Japan and Singapore), while the research on the social impact of TOD in developing countries is lacking. Therefore, this study is based on the actual situation of TOD in Chengdu. Using a questionnaire and satellite analysis method, the results show that, firstly, TOD can affect land use change by affecting the value of the surrounding land: it can change land use patterns and land diversity, but so far has little impact on large-scale green environments. Second, although TOD can help solve many urban problems, such as improving people's quality of life, promoting social harmony and supporting economic development, TOD may also lead to social conflicts and class division due to housing prices. Third, the government, as a decision-maker, must vigorously develop public transport, control land value and coordinate the development of TOD projects. These findings will help the government and other key stakeholders to further understand and improve TOD in China and other developing countries.

1. Introduction

With the rapid development of the economy and accelerated urbanisation—for example, the proportion of urban population in China increased from 18% in 1978 to 54% in 2014 (Zheng et al., 2016)—the number of cars in cities has increased significantly. This is causing serious traffic jams, environmental pollution and other urban problems. If cities continue to use planning methods that encourage motor vehicle travel, they will be unable to effectively alleviate traffic congestion and its associated challenges. To solve these problems, many countries have put forward policies to develop public transportation, and several large cities have proposed the development of urban rail transportation. The process of urban expansion has also brought about other problems. These include rapidly growing urban sprawl, an imbalance amongst different land types and low levels of comprehensive land utilisation efficiency. To improve urban development and address these issues, the concept of transit-oriented development has been proposed. Transit-oriented development (TOD) is a method for planning and designing compact, mixed-use communities within walking distance of existing or new public transport stations (De Vos et al., 2014; Cervero et al., 2004; Calthorpe, 1993). TOD can promote the development of public transportation and alleviate traffic congestion—along with effectively curbing the disorderly spread of cities and urban land use.

TOD is the leading trend in transportation development in China. In recent years, local governments and developers in China have focused on TOD methods when considering urban development. Nearly all cities in China apply the theoretical guidance of TOD practices when constructing and developing rail transit stations (Chen & An, 2018). Many mega-cities—including Shanghai, Guangzhou and Chengdu—have detailed (and at least partially executed) TOD plans. Chengdu has taken this initiative several steps further, by applying TOD as its core development concept to establish an urban network. It is thus providing an example for other large cities in China and across Asia.

In terms of exploring TOD practices, rich case studies and empirical analyses exist at present. However, this research generally focuses on a certain city or a certain subway line and explores and analyses the surrounding land use (Zhao, 2019). Research into the social impact of TOD, in contrast, is lacking. Social impact is a vital element of urban development and is closely related to the economic, environmental and cultural development of urban areas. Research on the social impact of TOD can help scholars, governments, developers and citizens to fully understand it and provide support for its growth.

This research will use Chengdu as an example to study the social impact, benefits and limitations of the TOD model on urban development. The dissertation is organised as follows: Chapter 2 presents a critical review of the literature on TOD, exploring its history in China, its meaning, its dimensions and its social impact in practice. Chapter 3 describes TOD policies and conditions at the national and regional levels, along with presenting Chengdu's TOD plan. Chapter 4 details the methodology and justification for the questionnaire and satellite surveys used in the study. Chapter 5 analyses the data from the questionnaire and satellite survey. Chapter 6 discusses the main research findings, reflecting on the consulted literature. Finally, Chapter 7 draws conclusions from the research, demonstrating its contributions to the literature and its implications in practice.

2. Literature Review

2.1. The course of TOD in China

With the rapid and large-scale construction of urban rail transit in China, the combination of rail transit construction and land use along the rail line has received increasing attention. The theoretical prototype of TOD gradually has emerged as a result (Lu et al., 2016; Wang, 2012). Various Chinese urban planning scholars have conducted research into different aspects of transportation construction and mixed land use in large cities (Wang, 2012). Regarding transport structure and land use, Lu and Zhang (1999) compared Beijing's land use, transport structure and transportation system to explore the relationships between the land-use patterns, transport structure and road traffic network composition of mega-cities and urban traffic demand. Several suggestions have also been put forth for comprehensively solving urban transport problems in terms of land use and transport structure. Regarding land development along the transportation line, Tian (1998; 1999) and Zhuang (1998) discussed the nature and intensity of land use, the formulation of land prices and the control and management of land use in relation to rail transit.

Some studies also described successful foreign cases. Chen (1999) suggested that Shenzhen should learn from the experience and lessons of successful public transportation development in developed countries, to establish transit-oriented land use as soon as possible. Through the large quantity of local research in China and the lessons learned from foreign experience, the concept of TOD was formally introduced to China in 2000. Since then, it has attracted increasing attention from scholars, developers and governments (Zhao, 2019; Wang, 2012). Localised research and practice of TOD strategy have gradually been carried out in Chinese cities (Chen & An, 2018). The national government has also paid attention to TOD strategy and has incorporated it into its urban development planning (Chen & An, 2018). China's TOD theory originated from the United States, and thus has a similar development background; even after localisation, it shares many similarities with American TOD.

American scholar Peter Calthorpe first proposed the concept of TOD in the 1990s (Carlton, 2009). As a model of land development, it was based on public line corridors and transportation stations that were integrated with the functions of transportation nodes (De Vos et al., 2014). The TOD theory originated from the mixed development of railways and real estate, which—as the backbone of the industrial revolution—were the prevailing concepts in practice for many years preceding TOD (Carlton, 2009). After TOD theory was proposed, mixed development was guided by theory, especially the three types of mixed development—original mixed development, East Asian post-war mixed development and Western European post-war mixed development—are closely related to TOD theory. Therefore, new development practices with rigorous theoretical guidance were born around the world. The first was the American-type standard TOD, which was directly developed under the influence of the original theory (Carlton, 2009). The second was the Eurasian mature TOD, which evolved from the post-war mixed development of East Asia and Western Europe (Berolini & Spit, 2015; Chorus, 2012) and is popular in Japan, the Netherlands and other countries. The third type of TOD is that occurring in developing countries, which is characterised by its inclusiveness. This is the current development model in China. This kind of development, which has been practiced around the world and is affected by different local systems, can be said to represent the fusion of theory and practice thus far (Cervero & Murakami, 2008). For example, the Pearl River Delta region is heavily influenced by the Hong Kong Mass Transit Railway, while the TOD strategy of Beijing greatly resembles Tokyo's Nikken design (Cervero & Murakami, 2008).

2.2. Characteristics and Sinicization of TOD

2.2.1. Principles and characteristics

In the process of theoretical and practical development, TOD has formed three principles and six characteristics. The principles are density, design and diversity (Chen et al., 2008; Cervero & Kockelman, 1997). Density refers to land development density; high-density

development can promote the use of public transportation. Design refers to space organisation centred on walking. Traditional neighbourhoods, pleasant streets, comfortable public spaces, diversity of architectural scales and comfortable walking spaces between transport stations can all increase the attractiveness of public transportation. Finally, diversity refers to the land development model. The TOD area adopts a mixed land model of developing high-density residential, commercial and office spaces, while also developing services, entertainment, sports and other public facilities. Mixed land use can effectively reduce trip frequency, reduce travel distance and promote the use of non-motorised transport (Chen et al., 2008; Cervero & Kockelman, 1997).

The characteristics of TOD can be summarised into six aspects (De Vos et al., 2014; Carlton, 2009; Dittmar & Ohland, 2004; Calthorpe, 1993). First is the existence of highly mixed land use areas within walking distance of bus stations. This requires the consideration of population and employment density to place residential and commercial areas, employment parks and civilian facilities within walking distance of bus stations. Second is the growth of compact areas supported by high-quality public transport. This involves the connection of the comfort and capacity of public transportation, the speed and frequency of public transport and public transport nodes. The third aspect suggests that public space be made the focal point of architectural positioning and neighbourhood activities, providing a vibrant environment for surrounding communities. Fourth is protecting sensitive habitats, riparian zones and high-quality open spaces. The fifth aspect demands that a mix of densities, costs and housing types should be provided. Finally, the sixth aspect calls for creating bicycle- and pedestrian-friendly street networks that directly connect to local destinations.

These are the basic principles of TOD and the characteristics widely used in the context of urban environments in the United States. However, these principles and characteristics are difficult to directly apply to Chinese cities; they must instead be localised according to the particularities of the Chinese urban context (Zhang & Liu, 2007).

2.2.2. The types of TOD

The initial stage of TOD can be divided into three types (De Vos et al., 2014). The first type is *new TOD*: establishing compact and multi-functional communities near a new public transportation service station, such as in Stockholm and Copenhagen (De Vos et al., 2014). The land for comprehensive utilisation in these cities is concentrated around public transportation stations, and high-quality public transportation is used to guide urban development (Cervero, 2007). The second type is *high-density TOD*: developing new public transport services in compact mixed-use areas, which means providing high-density and diverse high-quality public transport between existing communities (De Vos et al., 2014). In large cities in Asia, especially, high-density TOD is used to alleviate traffic problems; Shanghai and Seoul are examples of this. The final type is *low-density TOD*: with new public transportation services, the density and diversity of surrounding suburban communities continue to increase, which can improve public transportation services and increase the density and diversity of low-density development projects (De Vos et al., 2014). Especially in places with low population density, such as Australia and North America, low-density TOD is used to reduce car use and relieve urban expansion. Due to high population density and development needs in China, high-density TOD is more suitable. Thus, the characteristics of Chinese TOD are similar to high-density TOD.

2.2.3. TOD and its Sinicization

The Sinicization of the TOD concept must be placed against the backdrop of the Chinese developmental environment and systems and connect with different planning levels. Compared with the United States, where the TOD concept was born, Chinese land systems and residents' commuting habits are quite different (Li et al., 2015). At the same time, TOD development and planning involves multiple spatial levels in execution. Thus, it must rely on the cooperation of local and regional levels to coordinate various policies of urban and transportation development (Li et al., 2015). During the development, application and

promotion of the Chinese TOD model, in addition to considering the three principles and six characteristics mentioned above, the following three principles should be followed (Li et al., 2015; Chen et al., 2008; Zhang & Liu, 2007):

1) Systematisation of the development. The guidance of public transportation to urban development is difficult to achieve through several TOD projects, and several projects must be used as a whole system to guide urban development. This means applying TOD as the basic guiding concept in urban development, along with providing planning guidance and legal support at different levels.

2) Attention to the scientific nature of planning. In their planning and design, TOD projects can make reasonable breakthroughs in standards, design forms and building regulations, along with adopting new technical means, indicators and standards to meet the development needs of high-density TOD, mixed development and high-quality pedestrian space.

3) Feasibility of construction and implementation. The functional result of TOD is vital. It must not only be technically feasible but also consider the overall planning of the building period, the balance of construction funds and the coordination of all stakeholders. There must also be comprehensive supporting policies and measures.

2.3. Relationship between land use and TOD

TOD, as a kind of urban public transportation, is closely related to land use. The relationship between urban land use and public transportation involves mutual restriction, promotion and influence.

2.3.1. The interactive relationship between urban traffic and land use

The pattern of urban land use is determined by many factors, and urban public transport is one of the most critical. Changes in the urban transportation system will promote the matching and adaptation of urban land use patterns (Liu, 2016). For example, the continuous construction of urban public transportation facilities and systems can improve the accessibility of land areas (Liu, 2016). Increased accessibility makes it more convenient for people to reach an area, and thus the value of the land rises (Liu, 2016). Once developers then develop and utilise the land, the diversity and density of land use changes. Finally, the travel behaviour of transport will be altered, and such changes in travel behaviour will have a direct effect on the urban public transportation system and traffic demand (Liu, 2016). Therefore, the public transportation system will generate a higher load, which will promote the further improvement and optimisation of public transportation facilities (Liu, 2016). The interaction of a series of different factors will produce the interactive relationship between urban public transportation and land use (Figure 1).

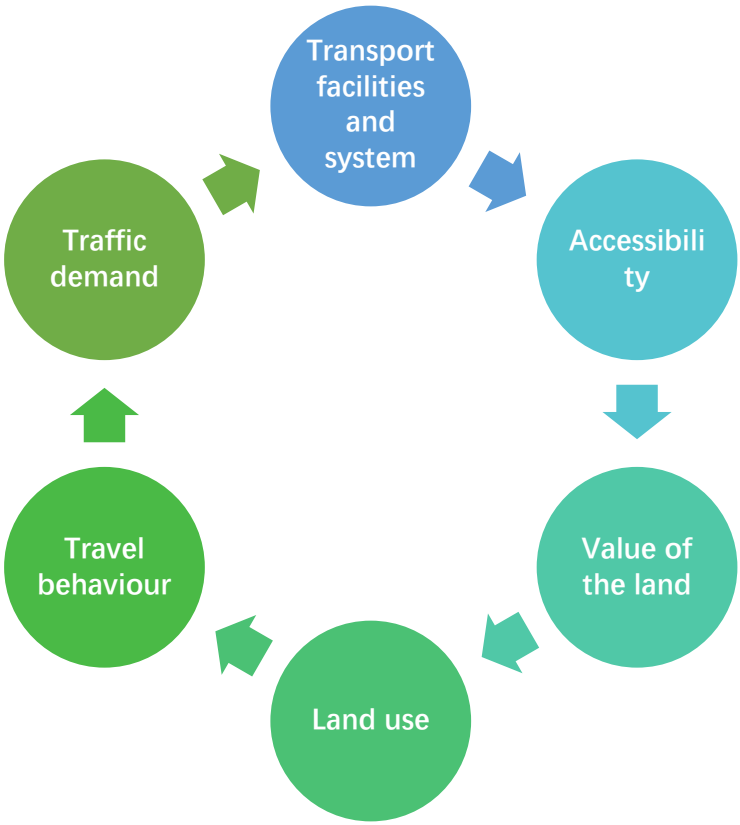

Figure 1. The interactive relationship between urban traffic and land use.

2.3.2. The impact of urban land use on urban traffic

Urban land use will naturally have a decisive impact on urban transportation. For example, the street form and characteristics of residential areas—such as whether the residential area has bicycle lanes, whether the parking of cars is convenient and safe and whether the surrounding streets are quiet or noisy—have a significant influence on distances travelled, frequency of travel and residents' choice of transportation methods (Van Wee, 2002; Meurs & Haijer, 2001; Van Wee & Van der Hoorn, 2001; Hilbers et al., 1999). Nowadays, the development of large and medium cities in China has resulted in wider and longer streets and roads. Although citizens' quality of life has improved, the average travel distance has increased and the accessibility of roads has decreased (Liu, 2016). As a result, urban transportation in China is increasingly dependent on cars. This momentum is not simply the result of market choices. It is also due to land use patterns and road designs, along with the disorderly expansion of urban scales and the deteriorating travel environment. The accessibility of the public transportation system has declined, and urban traffic has naturally become dominated by cars (Tian, 2019; Liu, 2016). The TOD model can construct a new set of urban land use and urban transportation design standards to rebalance the composition of public transportation, walking, bicycles and cars as forms of urban transportation (Vale, 2015). Therefore, Chinese cities need TOD to change urban land use and to develop public transport.

2.3.3. The impacts of urban traffic on urban land use

The impacts of urban traffic on land use is reflected in many ways, including land value, land use layout and diversity. Many studies have shown that rail transit plays a significant role in improving land value, which varies with distance from the rail station (Tian, 2019). A review of relevant research has shown that the prices of residential and commercial areas within 400 meters of a subway station are relatively higher than those in other areas (Debrezion et al.,

2007). Unlike the value of land, which has market economy characteristics, the impact of urban public transport on land use layout and diversity is related to many factors, including policy formulation, planning management and property ownership (Tian, 2019). With the support of policies and plans, TOD projects in China are thus comprehensively developed near public transportation stations and aim to enrich the land layout and increase the diversity of land use.

2.4. The Social Impacts of TOD on Urban Development

TOD changes urban development patterns and optimises the urban spatial form, altering the single centralised structure of urban development that was used in the past. In a city's suburbs, TOD allows for the creation of new transportation hubs, living centres and commercial centres. These come together to build a new pattern of multi-centre urban development. Thus, TOD can affect society and social development. The primary social impacts of TOD are described below.

2.4.1. The impact of TOD on social environment

The aspects of a social environment that are most affected by TOD are the social-ecological and traffic environments. Automobile-dominated urban traffic brings car exhaust emissions and noisy urban roads—both major contributors to the deterioration of the urban environment (Nobis & Welsch, 2003). It leads to more global problems as well, causing air pollution to skyrocket and contributing to global warming (Newman et al., 2006). At the same time, automobile-based urban traffic causes the disorderly expansion of a city, reducing the green area around and inside the city and destroying ecologically important areas. In contrast, TOD has the characteristics of low energy consumption, low pollution, safety and intensiveness (Cervero & Sullivan, 2011). It plays an extremely important role in improving the urban environment and reducing urban energy consumption (Cervero & Sullivan, 2011). The TOD

model aims to encourage more people to choose public transportation, which will improve energy consumption and reduce air pollution. These benefits will, in turn, help solve issues around the urban ecological environment and lessen global warming. Through the efficient planning and practical application of TOD theory, a city will have more space to improve the urban landscape and greenery, as well as to improve the urban social-ecological environment (Cervero & Sullivan, 2011). In terms of the social transportation environment, TOD has the advantages of dedicated roads, large volumes, and increased speed, safety, and punctuality. It serves a function that cannot be replaced by other transportation methods (Xu, 2015). This means that traffic pressure will be reduced, and urban traffic congestion will be alleviated, providing a comfortable, safe and efficient social traffic environment.

2.4.2. The impact of TOD on the social economy

The impact of TOD on the social economy can be roughly divided into two parts: direct and indirect impact. Its direct impact refers to the ways in which TOD—which is fast, convenient, smooth, safe, and conducive to environmental protection and mixed land use—directly promotes the national economy. For example, TOD attracts talent, tourists and companies, and provides greater market access, while creating a mixed and dense architectural environment (Nelson et al., 2015). As a result, TOD could promote the dynamics of agglomeration, thus promoting innovation and productivity, and prospering the economy (Chatman & Noland, 2011). TOD's indirect impact includes the fact that public transport is convenient, allows faster travel times, and is more accommodating for a larger flow of passengers (Xu, 2015). Passenger flow brings not just ticket revenue but a corresponding consumer market, which produces a radiating effect. These effects act on those industries and social groups that do not have a direct business relationship with TOD, thereby indirectly creating additional economic benefits (Van Wee, 2002). The construction, operation and maintenance of a TOD area can bring jobs and promote economic development (Van Wee,

2002). Mixed land use also increases the utilisation rate of the land, maximises land values and improves the social and economic benefits of the entire area.

2.4.3. The impact of TOD on the lives of citizens

The TOD model enables people to share natural and social resource activities more widely. It has a significant impact on the spatial organisation of urban residents' living, working, shopping, leisure and entertainment activities (Xu, 2015). Public transportation in the TOD model is fast, safe and high capacity. It can thus transport a large number of people efficiently, while also greatly improving the accessibility of areas along a travel route (Cervero, 2007). For residents, the subway is the easiest and fastest way to travel through the city. All residents have equal access to public transportation, reducing social conflicts and promoting the development of social harmony (Wang, 2007). The TOD model advocates walking or cycling to meet daily needs near bus stops. This increases the infrastructure for walking and cycling and restricts the entry of private cars (Lund, 2007). A high-quality and safe environment can thus be provided to pedestrians. From the perspective of the global development of large- and medium-sized cities, the competitiveness of real estate projects developed along rail transit lines will be greatly enhanced (Xu, 2015; Lund, 2007). Effective rail transit technology doesn't just provide convenient travel conditions for citizens; it also improves residents' quality of life (Lund, 2007; Xu, 2015).

2.5. Research gap

To research the social impact of TOD in China, it is not enough to simply review the literature. This is because, firstly, there is a lack of literature focusing on the perspective of social impact to support the research. Society, as one of the three elements of urban planning, is closely related to the other two elements, economy and environment. Thus, TOD will bring

about impacts and be influenced by others. Secondly, since China has only recently begun to develop TOD projects, few have been completed in China. Thus, most of the literature studies the possible impact of TOD based on foreign experience and TOD principles. This limits the results of the research, since each country has its own characteristics; the social impact of TOD mentioned in the literature may not be in line with its social impact in China. Finally, most of the analysis in the literature is from the perspective of the governments or the developers; feedback from the public is lacking. One of the key purposes of TOD projects is to serve citizens and provide them with convenient access to transportation. A lack of opinions from citizens implies a clear gap in the research results, which will most likely deviate from the actual situation experienced by the citizen-stakeholders.

3. Methodology

3.1. Research question and objectives

A review of the literature and government policies showed that the existing research has studied the social impact of TOD in an ideal state, yet the actual social impact requires further study. This led to the following research question: *What are the real social impacts of transit-oriented development (TOD) in the context of a big city in China?* The research question was broken down into three research objectives. Table 1 details how the methodology will achieve these objectives.

Research objectives	Methodology
a. To assess the extent to which TOD has transformed the urban environment and land use in terms of mobility	Application of the interpolation method to Google Earth data was used to classify land use of the studied area in order to (1) measure how TOD has transformed the urban environment and land use and (2) analyse the impact of the public transport on land use.
b. To assess the social impacts of TOD in Chengdu	A questionnaire given to Chengdu citizens to (1) assess how TOD impacts societal development and (2) to gauge citizens' satisfaction toward and suggestions for the TOD project
c. To suggest policy implementation criteria for transport and land use, leading to urban social development	Through the literature review in Chapter 2 and the comparative analysis of government policies in Chapter 4, supplemented by the results of the questionnaire

Table 1. Three research objectives and three methodologies.

3.2. Method of data collection

The data collection combines two methods—the questionnaire and Google Earth data analysis—which provide quantitative and qualitative data. An example of the survey questionnaire is included in Appendix A. Quantitative analysis is a precise scientific method. It establishes mathematical models based on statistical data and uses them to analyse quantitative characteristics, relationships and variables. In qualitative research, specific TOD projects are observed and analysed with pictures and text based on the analysis of the nature, characteristics, and law(s) of development of the research object. Thus, two different data models are applied to support the research, which make the research more professional and complete.

3.2.1. Data collection: Google Earth analysis

There are many methods available to achieve change detection analysis (Lu et al., 2003). The choice of method depends on the type of imagery available, the type of change detection and the final purpose of the study (Tanmoy, 2009). Remote sensing and GIS have been combined to efficiently create land use maps and to quantitatively reveal the change detection in each category (Taylor et al., 2000).

To study urban land use, three different stations, which are Chunxi Road Station, Chengdu North Station and Tianfu Square Station, involved in the Chengdu TOD project were chosen. Google Earth's high-resolution satellite imagery, viewed at a 200-meter altitude, was then analysed for each. In addition, Google Earth's historical imagery facilities provide a fast and efficient way to analyse changes in an area. Satellite imagery for two different time periods was observed for the land use change detection study. KML files were also created for the land use features. DNRGarmin was used for georeferencing and shapefile conversion, and the

necessary ground referencing was carried out. Finally, all data were integrated into GIS software (ArcMap) to generate the final georeferenced land use maps. Graphs and charts were created via Microsoft Excel 2020 to facilitate understanding of the land use changes in the study area.

3.2.2. Data collection: Questionnaire

A web-based questionnaire was created via Xuanjuan Star, a convenient online survey platform. The questionnaire was divided into several categories: personal background, travel habit, impact of public transportation, satisfaction toward and suggestions for TOD and the perceived social impact of TOD. Twenty-three questions were asked, including 3 multiple choice questions, 5 Likert scale/ matrix/ ranked questions, 6 open-ended questions and 10 single-choice questions. Using Likert scales was important to permit themes to emerge while also allowing respondents to further consider the topics and answer freely. To ensure all respondents completed the questionnaire smoothly—including those lacking prior knowledge of TOD—the questionnaire provided an explanation of TOD, using an example in Tokyo, Japan. The open-ended questions also aimed to help respondents understand TOD and guide them in answering the questions.

3.3. Data analysis and presentation

The Google Earth data includes information for each of the three sites at two points in time: the before-build period and now. The land use for each site was analysed via Google Earth and GIS was used for plotting. The area of each of the various types of land was then calculated through GIS and compared.

For the survey, 75.2% of the 226 respondents were male and 24.8% were female. Most of the respondents were over the age of 26. Over 70% of all respondents earned salaries of over

5000 RMB per month, exceeding the average salary of China's second- and third-tier cities (National Bureau of Statistics, 2020). More than 40% of all respondents earned salaries of over 10,000 RMB per month. Just 13.7% of all respondents claimed their highest level of education was a college degree or below. According to these demographic statistical variables, most survey respondents were young or middle-aged men with educated backgrounds and a certain degree of economic strength and vision. Even if they were unfamiliar with the TOD concept, they could understand it through the questionnaire's guidance.

Thirteen questions were designed using Likert's 1–5 grade scoring form. After collecting the data, a reliability analysis was carried out to test the questionnaire. As seen in Table 3, Cronbach's α was 0.738, which indicates that the questionnaire had both reliability and consistency (Sijtsma, 2008). To investigate the main aspects of TOD's social impact, the questions were divided into 4 principal components according to their meaning. Four scale dimensions were thus established: social environment, social economy, citizen life and social risk (Table 4).

	Option	Frequency	Percentage (%)
Gender	Male	170	75.2
	Female	56	24.8
Age	18–25	55	24.3
	26–45	108	47.8
	46–65	63	27.9
Income (per month)	Below 2500 RMB	8	3.5
	2500–4999 RMB	44	19.5
	5000–9999 RMB	75	33.2
	Over 10,000 RMB	99	43.8
Education	College degree	31	13.7
	Undergraduate degree	156	69.0
	Postgraduate degree	30	13.3

PhD	9	4.0

Table 2 Analysis of respondents' basic information

Reliability Statistics	
Cronbach's α	N of Items
0.738	13

Table 3. Cronbach's α

Social environment	Study the impact of TOD on the social environment from the perspective of citizens	Q1 Q2 Q3 Q4
Social economy	Study the impact of TOD on the social economy from the perspective of citizens	Q5 Q6 Q7
Citizen life	Study the impact of TOD on citizen life from the perspective of citizens	Q8 Q9 Q10
Risk	Study the impact of TOD on risk from the perspective of citizens	Q11 Q12 Q13

Table 4. The 4 main aspects of TOD's social impact

3.4. Research Limitations

Questionnaires cannot prompt respondents for additional data as they answer, so there is the possibility of missed useful information. Additionally, if a questionnaire is not suitable

for certain types of respondents, or if a question cannot be answered properly, the results of the questionnaire may be affected. At the same time, the response rate of questionnaires distributed through the Internet is low, so there may not be enough data to support research. Furthermore, the risk of losing data is greater, which may affect the entire research's progress (Bryman, 2012).

3.5. Research Strengths

Questionnaires are inexpensive and easy to administer. They also cannot be influenced by a respondent like an interviewer could be. Finally, they are a convenient way for respondents to participate in researches (Bryman, 2012).

3.6. Ethical Considerations

Throughout this study, the researcher ensured ethical standards were adhered to. This dissertation is the researcher's own work and does not include misleading information. For this research, ethical considerations included documentary analysis and collection/use of locational data. Employing content analysis and accessing publicly available resources online is a socially non-invasive form of research. The confidentiality of research data was a principal concern and the anonymity of participants was respected throughout the study. All research participants were made aware that their anonymised responses would be used for this academic work. Thus, the study should not cause any mental or physical harm.

4. TOD in Chengdu and the City's Transport Planning

4.1. Transport conditions and policy in China

According to the social form of socialism with Chinese characteristics, local governments should rely on the central government when they draft their choices and arrangements around local policies and planning (Jin, 1999; Pan, 1997). At the same time, the central government is the leader (Jin, 1999; Pan, 1997). Traffic policy, which is defined by the central government, has a powerful impact on local planning and development. In 2012, China's State Council put forward guidelines on the priority development of public transportation in cities, pointing out that the development of urban transportation must strengthen the comprehensive development around the public transportation area. The guidelines also specified that the aboveground and underground spaces of public transportation facilities should be developed in accordance with the principles of marketisation, to develop the comprehensive multi-dimensional model (The State Council of China, 2013). Against the dual backdrop of the central government's promotion of public transportation and the boom of the TOD concept, cities at various levels have issued policies on public transportation complexes and TOD. This has led to TOD projects springing up throughout China in recent years. As of January 2019, more than 50 cities across the country have built or are building rail transit, while 36 cities have opened subways and have put TOD on their urban development planning agendas (Li & Bai, 2019).

4.2. The context and TOD plan of Chengdu

Chengdu's position is strategically important as the centre of science and technology, finance, commerce, transportation and communication for the entire southwestern region of

China (Jiang, 2013). As the political, economic and cultural centre of Sichuan Province, Chengdu has been approved by the State as a national key comprehensive reform city (The State Council of China, 2009). For Chengdu to achieve its developmental goals and positioning, it must establish a comprehensive transportation system that is reasonable and efficient (Jiang, 2013). Only in this way can it provide the necessary external conditions and effective facilities required to boost Chengdu's economic progress and overall development.

Since 2010, Chengdu has vigorously developed its rail transit and has consciously developed the TOD model. From 2015 to 2018, Chengdu greatly expanded its rail transit network; total passenger volume also grew rapidly (see Table 5), which means it provided favourable conditions for the construction of TOD projects

	2015	2016	2017	2018
Line length (km)	86	106	179	225
Total passenger volume (millions)	339	562	782	1158

Table 5. Urban traffic statistics, 2015–2018 (Data from the Statistics Bureau of Chengdu and NBS survey office in Chengdu, 2016–2019)

On September 11, 2018, a professional meeting on comprehensive TOD was held in Chengdu, aiming to encourage an in-depth understanding of the vital strategic significance of comprehensive TOD for the city (Li & Bai, 2019). The government decided to learn from the advanced experience at home and abroad, adapt to local conditions, develop and innovate, and build high-standard and high-level TOD projects (Li & Bai, 2019). By 2019, 13 demonstration sites in Chengdu had been completed or were under construction, and new TOD sites had been added to the planning and construction docket (Chengdu Daily, 2019; Li & Bai, 2019).

5. Findings and analysis

5.1. Google Earth and GIS analysis

Using Google Earth and GIS software, land use was analysed around each of three TOD projects in Chengdu in a one-kilometre radius. The software also analysed the changes in land use, both prior to construction and after. Figure 2 shows the land use one kilometre around Chunxi Road Station in 2010 and 2020. Chunxi Road Station is located in the centre of the city; there is no industrial land, the land is not unused and the green area is relatively small. In 2010, it was mainly residential with a small amount of commercial land. By 2020, with the station as the centre, some mixed land had been developed to replace residential land. The subway station is also located in the complex, so the residential land had been significantly reduced (Figure 3). At the same time, commercial land also increased near the subway station. As a result, some residential areas became comprehensive areas of diversified land development.

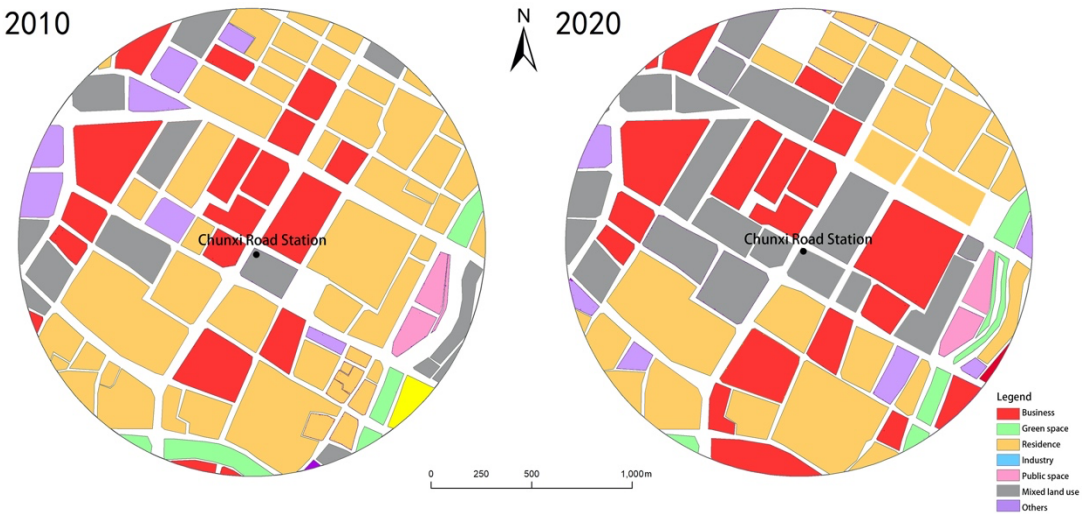

Figure 2. The land use of Chunxi Road Station in 2010 and 2020

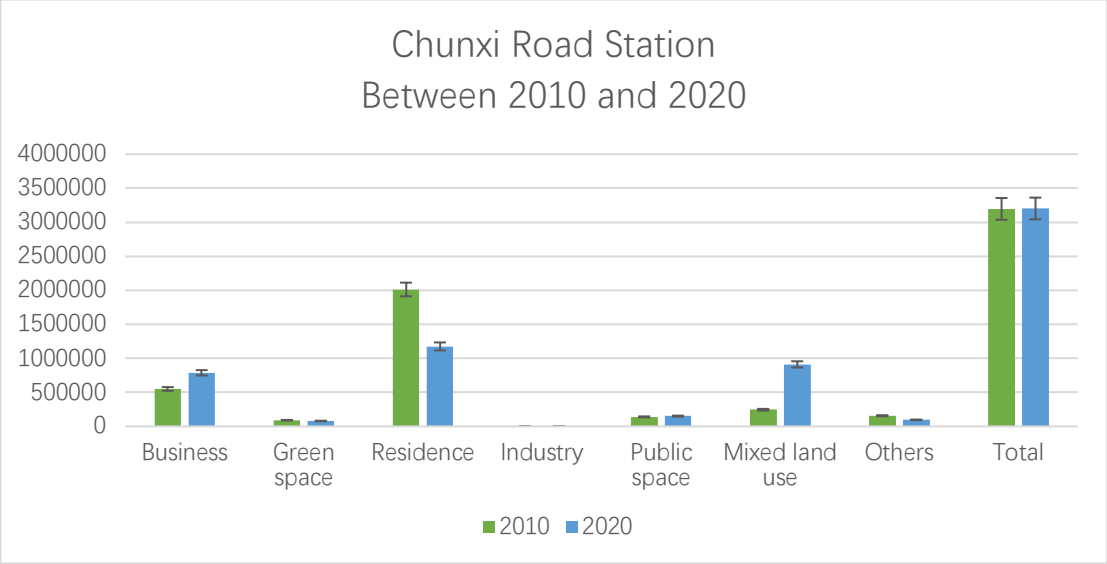

Figure 3. Chunxi Road Station changes between 2010 and 2020

Figure 4 shows the land use one kilometre around Chengdu North Station in 2007 and 2020. Chengdu North Station is a large traffic hub with trains and subways. Because it is not in the centre of the city, there is some industrial land and green space. In 2007, although trains passed by, it was mainly residential with a small amount of commercial land, mixed land and green space. By 2020, some mixed land had developed around the station to replace residential land. The station is also located in the complex, resulting in a reduction in residential land (Figure 5). It can also be noted in Figure 5 that other land uses increased significantly. These include construction land and/or open space; however, it is impossible to determine the specific use without field investigation. In addition, some commercial land changed to mixed land. It can be seen from Figure 5 that the commercial and residential areas have been significantly reduced and the mixed land has greatly increased.

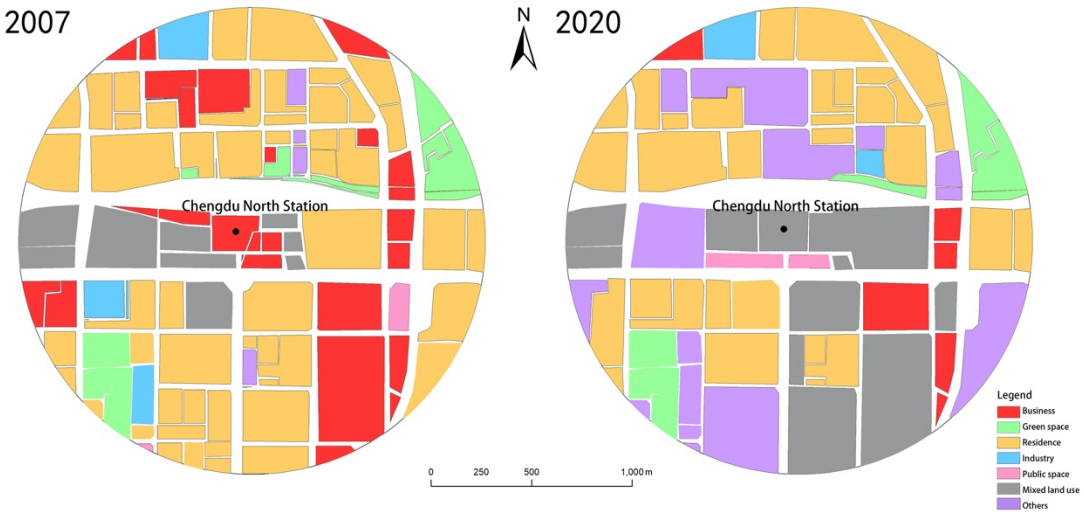

Figure 4. Land use of Chengdu North Station in 2007 and 2020

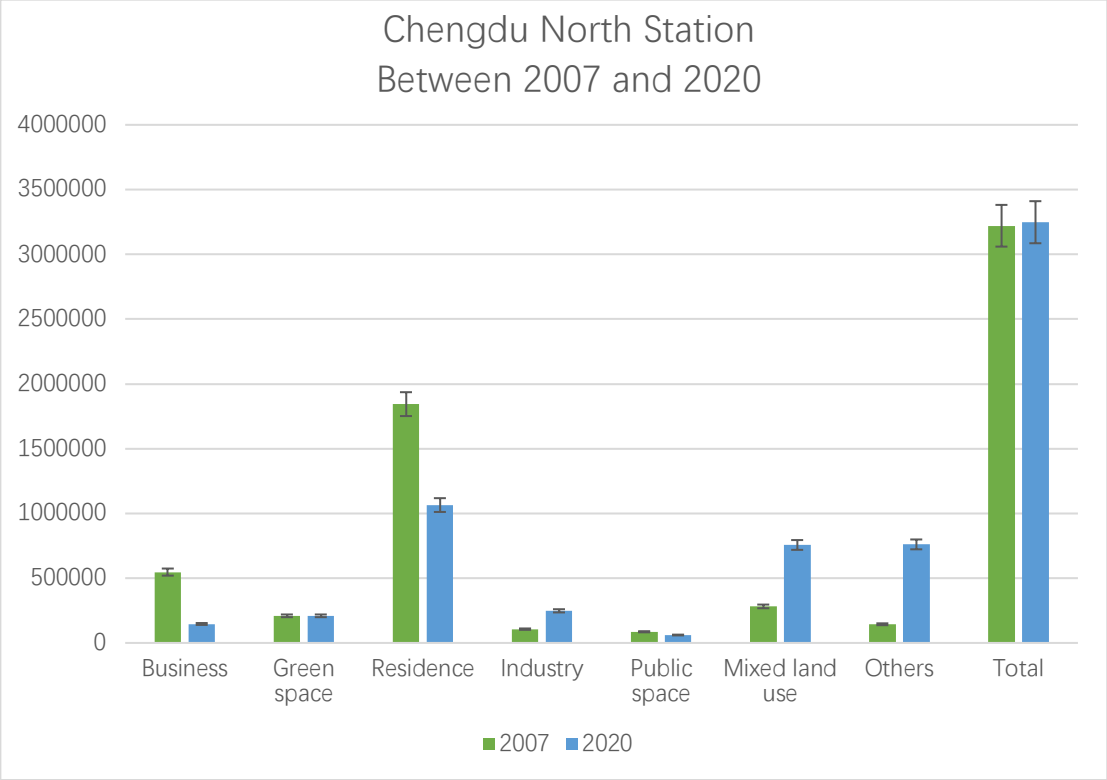

Figure 5. Chengdu North Station changes between 2007 and 2020

Figure 6 shows the land use one kilometre around Tianfu Square Station in 2010 and 2020. Tianfu Square Station is near the square in the centre of the city and is an area for leisure

and entertainment. In 2010, due to the early development of the area, commercial, mixed land, residential and green spaces were all found here. Figure 7 shows that residential land accounted for most of the property in 2010. By 2020, mixed land developed and replaced some residential land. The station is located in the complex, resulting in further reduction of residential land. The area of mixed land around the station has increased, and the distribution of land use around it has changed significantly.

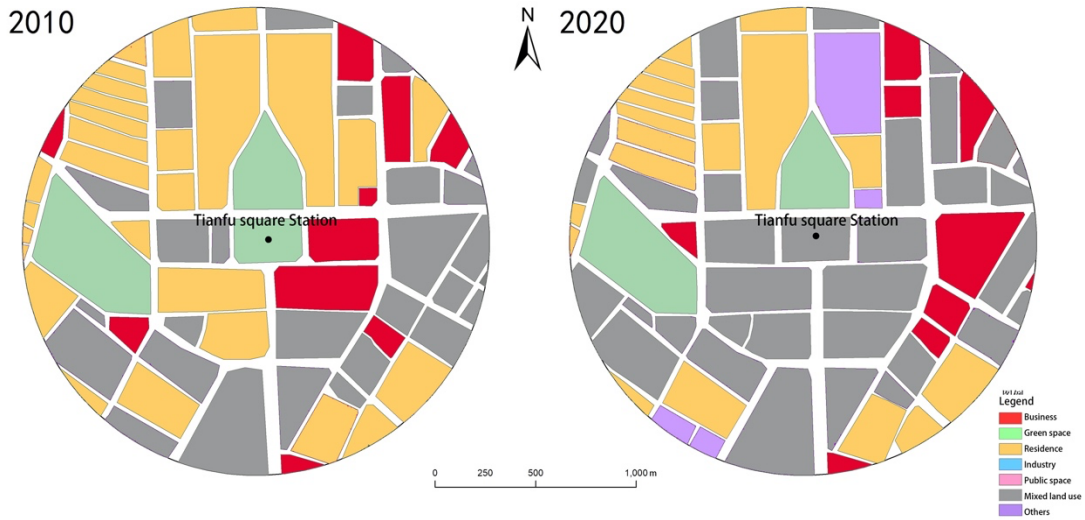

Figure 6. Land use of Tianfu Square Station in 2010 and 2020

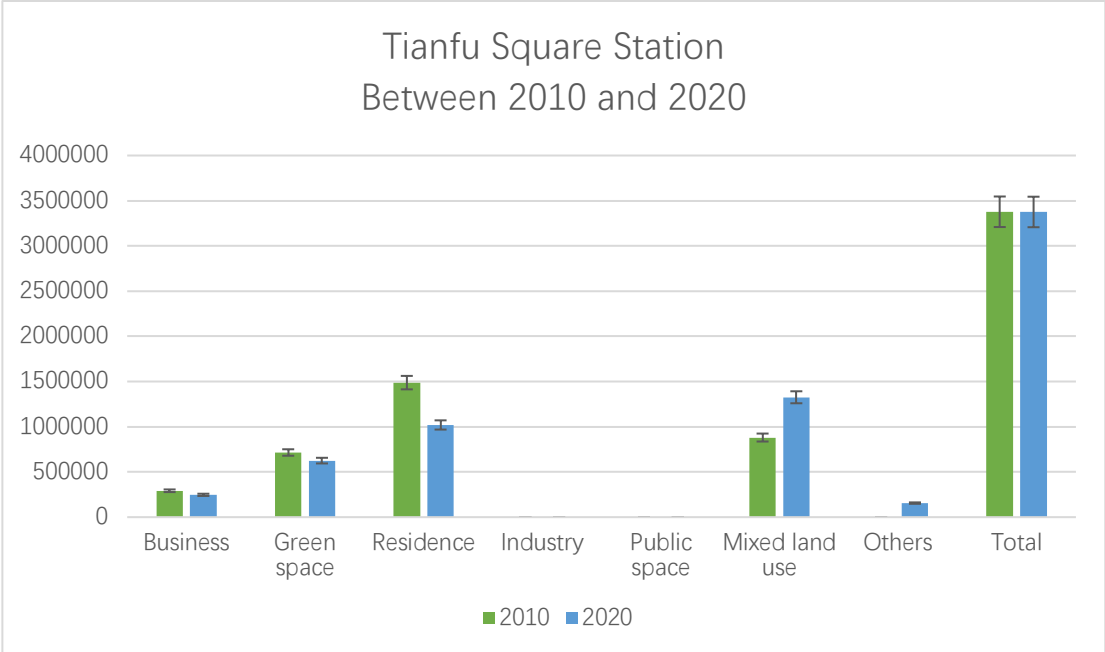

Figure 7. Tianfu Square Station changes between 2010 and 2020

5.2. Survey and Statistical Product and Service Solutions (SPSS) analysis

To help respondents better grasp the concept of TOD, the questionnaire set up some questions about public transport and subways which aimed to guide the respondents in this understanding. At the same time, their replies to these questions also provided insight into the impact of the TOD project. According to the data (see Figure 8), the most important factor affecting the respondents' use of the subway was convenience. Thus, a TOD project that is built around a subway station can promote its use—and the success of the overall project—by focusing on convenience.

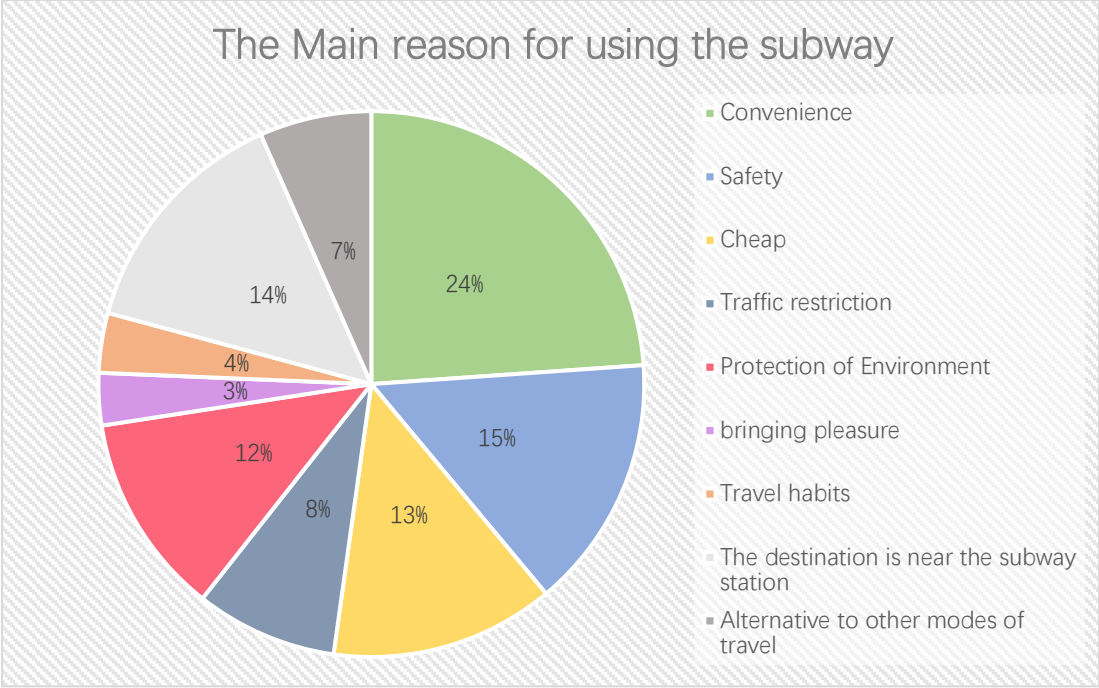

Figure 8 Respondents' main reason for using the subway

Table 6 shows that subways and cars are currently the most common means of transportation used by the interviewees. Yet the subway allows interviewees to avoid traffic

jams and is one of the most convenient public transportation tools in modern times. The interviewees' general use of cars also meets the above-mentioned inference that most of the respondents enjoy a certain level of economic strength. Commuting to and from work and shopping are the interviewees' main purposes for using the subway. No traffic jams face those who commute to work by subway; it is fast and saves time. Most shopping malls are built near subway stations to meet people's shopping needs. This also meets the principles of TOD.

	Option	Frequency	Percent (%)
Main means of transportation	Walking	74	32.7
	Cycling	41	18.1
	Electric vehicle	11	4.9
	Bus	64	28.3
	Subway	173	76.5
	Car	137	60.6
	Other	4	1.8
Main purpose of using subway	Commuting	123	54.4
	Going to school	9	4.0
	Shopping	116	51.3
	Travelling	53	23.5
	Relaxing	103	45.6
Familiar service facilities within one kilometre of TOD	Hospital	101	44.7
	Shopping mall	202	89.4
	Supermarket	177	78.3
	Office building	172	76.1
	Residence	172	76.1

Table 6 Travel situation of respondents

According to Table 7, about half of the respondents knew about TOD in this phase of the process. This is higher than expected and indicates that the Chengdu government has popularised the concept of TOD to some degree. It is also possible that the public has been proactively informing themselves, since they know how convenient TOD may be, although the effect is not yet universal. At this stage, about half of the respondents have accepted the spatial relationship of TOD and half are willing to invest in the TOD project area. This shows that the advantages of the TOD project are obvious and that people are willing to accept the concept of TOD—which promises to be very advantageous in its future development.

	Option	Frequency	Percent (%)
Have you learned about TOD?	YES	100	44.2
	NO	126	55.8
Favourite spatial relationship between subway station and complex?	Independent of each other, with a certain distance	30	13.3
	The station and the complex are embedded in each other	77	34.1
	The station is integrated into the complex	119	52.7
Invest in the area because of TOD?	NO	106	46.9
	YES	120	53.1

Table 7. Understanding and acceptance of TOD from respondents

Table 8 shows the average value, from 1–5, that respondents attributed to each of the four dimensions of TOD studied: social environment, social economy, citizen life and risk. The average value given to the social environment was 4.09. The average value ascribed to the social economy was 4.13 and the average value of citizen life was 4.23. These averages are

slightly above “agreement”—meaning that most respondents agreed that the TOD project’s construction will have an impact on the urban social environment, social economy and citizen life. This is especially true for the aspect of citizen life. Most respondents agreed that TOD can improve their quality of life and provide better public infrastructure. For risk-related questions, in contrast, the overall average was low, at 2.72. This falls below the “neutral” value of 3 points, implying that there may be perceived risks in the development of TOD, but that they are not powerful enough to affect the acceptance of TOD by respondents.

Mean			Mean
Social environment	4.09	Q1	4.31
		Q2	4.17
		Q3	3.96
		Q4	3.92
Social economy	4.13	Q5	4.17
		Q6	4.19
		Q7	4.04
Citizen life	4.23	Q8	4.39
		Q9	3.94
		Q10	4.35
Risk	2.72	Q11	2.85
		Q12	2.52
		Q13	2.81

Table 8. The mean of 13 responses on the 4-dimension scale

Next, Statistical Product and Service Solutions (SPSS) was used to study the correlation among the four dimensions. Table 9 shows that social environment, social economy and citizen life are significantly positively correlated with each other. For example, when respondents had

a high level of recognition of TOD's impact on the social environment, their recognition of the impact of TOD on social economy and citizen life was also high. Risks were negatively correlated with the social environment, social economy and citizen life. When respondents perceived the risks involved in TOD to be high, their recognition of the impact of TOD on the social environment, social economy and citizen life was lower.

	Social environment	Social economy	Citizen life	Risk
Social environment	1			
Social economy	0.585**	1		
Citizen life	0.502**	0.511**	1	
Risk	-0.251**	-0.205**	-0.459**	1

** indicates that the significance is < 0.05*

*** indicates that the significance is < 0.01*

Table 9. The relationship between different dimensions

To understand whether different types of respondents showed differences in the overall mean values of the four scales, a one-way analysis of variance (ANOVA) was carried out on the four scales according to respondents' demographic characteristics and their self-reported degree of understanding of TOD. People of different genders, ages, incomes and educational backgrounds were analysed separately. First, in terms of gender, SPSS 26.0 software was used to adopt an independent t-test method and analyse whether there was a difference in the overall mean of the four scale dimensions between male and female. Table 10 shows that the P values corresponding to all dimensions are greater than 0.05, indicating that there is no significant difference in the overall mean values of these dimensions between male and female. This implies that gender factors do not affect recognition of the social impact of TOD.

	Gender		t	P
	Male	Female		
Social environment	4.12±0.79	3.99±1.03	1.037	0.301
Social economic	4.13±0.95	4.15±0.99	-0.131	0.896
Citizen life	4.26±0.8	4.13±1.09	0.925	0.356
Risk	2.65±1.23	2.95±1.21	-1.545	0.124

Table 10. One-way analysis of variance (Gender)

Second, in terms of age, SPSS 26.0 software and the ANOVA method were used to analyse whether there was a difference in the overall mean of the four scale dimensions by age group. Since the independent t-test method can test only two factors, the ANOVA method should be used when the factors are greater than two. Table 11 shows that the P values corresponding to social environment and risk are both less than 0.05, indicating that the overall mean values of these two dimensions are significantly different at different ages. Among them, awareness of TOD's impact on the social environment is highest in the 26–45 age group and lowest in the 46–65 age group. This shows that young to middle-aged people are slightly more aware of the social impact brought by TOD than are older people, who may be less able to accept the new planning concept. At the same time, the risk dimension is also the highest in the 26–45 age group. This may be due in part to the higher awareness around TOD amongst young and middle-aged people, who can thus consider its risks along with its different effects in many aspects.

	Age			F	P
	18–25	26–45	46–65		
Social environment	4.01±0.77	4.31±0.77	3.79±0.97	7.998	<0.001
Social economic	4.13±0.86	4.25±1	3.94±0.94	2.155	0.118
Citizen life	4.24±0.78	4.3±0.92	4.08±0.9	1.191	0.306
Risk	2.41±1.03	2.93±1.32	2.66±1.17	3.381	0.036

Table 11. One-way analysis of variance (Age)

Next, in terms of monthly income, SPSS 26.0 software was used and the ANOVA method applied to analyse whether there was a difference in the overall mean of the four scale dimensions with different income levels. Table 12 shows that the P values corresponding to all dimensions are greater than 0.05, indicating that there is no significant difference in these dimensions according to overall income. This implies that all income groups can be affected by the TOD project, not just high-income groups, and that the TOD project provides fair transportation services.

	Income (per month)				F	P
	Below 2500 RMB	2500–4999 RMB	5000–9999 RMB	Above 10,000 RMB		
Social environment	4.13±0.88	3.99±0.95	4.12±0.92	4.11±0.77	0.227	0.877
Social economic	4±1.32	3.97±1	4.18±0.99	4.18±0.88	0.627	0.598
Citizen life	4.58±0.68	4.33±0.75	4.16±1	4.2±0.86	0.774	0.509

Risk	2.21±0.8	2.63±1.12	2.76±1.33	2.78±1.23	0.661	0.577

Table 12. One-way analysis of variance (Income)

Finally, in terms of education, SPSS 26.0 software analysed via ANOVA whether the overall mean values of the four scale dimensions varied for different education levels. Table 13 shows that the corresponding P values of the social environment, social economy and residents' lives are all less than 0.05, indicating that the overall mean values of these three dimensions are significantly different for different educational backgrounds. Respondents with PhDs showed the highest value in these three dimensions, especially in the socio-economic aspect. Those with a college degree or below demonstrated the lowest value in the three dimensions. This shows that the higher the educational background, the higher the recognition of TOD's social impact. Unlike the social environment and citizen life, which can be more directly perceived by respondents, citizens' knowledge about TOD's impact on the social economy may need boosting to ensure that this dimension is more deeply recognised.

	Education				F	P
	College degree	Undergraduate degree	Postgraduate degree	PhD		
Social environment	3.6±0.97	4.1±0.85	4.35±0.6	4.72±0.44	6.417	<0.001
Social economic	3.86±1.1	4.1±0.96	4.34±0.77	4.89±0.24	3.343	0.020
Citizen life	3.91±0.95	4.2±0.92	4.54±0.51	4.63±0.59	3.343	0.020
Risk	2.78±1.12	2.7±1.25	2.82±1.64	2.85±1.64	0.159	0.924

Table 13. One-way analysis of variance (Education)

Considering that the knowledge of TOD may affect the overall mean, a one-way analysis of variance was performed on the four scales according to the respondents' degree of knowledge of TOD. Using SPSS 26.0 software, the independent t-test method was used to analyse whether the overall mean values of the four scale dimensions were different. Table 14 shows that the P values corresponding to social economy and risk are both less than 0.05. This indicates that the overall mean values of these two dimensions are significantly different. The overall mean value of respondents who have learned about TOD is higher in both dimensions than those who have not. This means that respondents who know about TOD have a greater recognition of its social impact. However, respondents who know about TOD are more likely to believe that there is risk involved than are respondents who do not know about TOD. This may be because respondents who have a more comprehensive understanding of TOD can more thoroughly analyse its pros and cons.

	Have you learned about TOD?		t	P
	YES	NO		
Social environment	4.11±0.88	4.08±0.84	0.279	0.780
Social economy	4.28±0.88	4.02±1	2.054	0.041
Citizen life	4.27±0.92	4.19±0.85	0.672	0.503
Risk	2.94±1.28	2.55±1.63	2.343	0.020

Table 14. One-way analysis of variance (Knowledge about TOD)

In addition to multiple-choice questions and scale questions, there were also some open-ended questions. These focused mainly on how TOD improves citizens' lives and its other social impacts. The following are examples of respondents' answers:

1) *'I think TOD improves the surrounding green environment and solves the pollution problem, noise pollution and air pollution'.*
2) *'TOD project can best meet the needs of shopping, education, entertainment, hospital and leisure for different age groups, and reduce the travel time and transportation cost in big cities'.*
3) *'TOD can improve the quality of life, optimize the quality of life, perfect supporting facilities to make life convenient and improve the efficiency of work and study time'.*
4) *'Public transport in TOD improves travel efficiency and reduces traffic congestion'.*
5) *'When using non-motor vehicles to travel, I can enter TOD nearby, and I can quickly reach the outer suburbs or railway stations and airports through subway and public transportation'.*

In the realm of improving residents' lives, the respondents focused mainly on the environment, quality of life and travel; they most frequently mentioned improving the quality and efficiency of life. Due to the construction of a TOD project, the service facilities around a living area are gradually improved, as is the public environment of transport. In the near vicinity of their living area, people can quickly and conveniently walk to a public transport station and meet their daily needs. At the same time, the use of public transport increases, traffic congestion drops, and urban pollution is reduced. A TOD project can reduce the need for cars, improve the green environment, and increase green spaces—leading to a dramatic improvement in citizens' quality of life:

1) *'TOD can help Chengdu to improve its quality and image as an international metropolis'.*
2) *'The comprehensive ranking of cities in China will be improved, people's quality of life and happiness will be improved, and the number of tourists will increase, which will contribute to GDP, increase the employment rate and attract more talents to settle in Chengdu'.*
3) *'Rising house prices do increase people pressure of living'.*
4) *'TOD can bring land appreciation, increase government revenue, improve social efficiency and reduce energy consumption'.*

In addition to the impacts on social environment, social economy and citizen life mentioned previously, respondents mentioned that TOD can improve the city's image and create an environmental and healthy city brand—which is also conducive to the long-term development of the city. Improving the city's image can also attract more human resources and tourists and promote the development of the city. Mixed use of urban land may also lead to an increase in land value. Although this can increase government revenue, it may also cause economic pressure on citizens, damaging urban development. Other risks include the potential for gentrification and a widening gap between the rich and the poor. These risks could eventually lead to additional social contradictions.

6. Discussion

Previous work has shown that TOD will affect land use, social environment, social economic factors and citizens' living standards. The current research has been established, but no empirical study has yet analysed the real social impact of TOD projects—whether under construction or completed—on China's citizens. To study the social impact of TOD, the previous work and the actual survey results should be combined and discussed.

6.1. Interpreted main findings

The main findings of this study can be divided into three parts, according to the research objectives.

6.1.1. Objective (a), To assess the extent to which TOD has transformed the urban environment and land use in terms of mobility

Google Earth and GIS software were used to analyse land use changes and environmental changes near TOD projects. This study's findings are consistent with those of Tian (2019), who believed that rail transit plays an important role in improving land value, which changes according to the distance from the station. For example, near Chunxi Road Station, some mixed land developed around the station to replace residential land. The land value close to the station improved, so it is used to develop mixed land and commercial land. However, the impact of land value changes 500 meters away from the station is smaller than those within 500 meters of the station. Thus, the original residential land is maintained. The results of this study confirm the idea of Debrezion et al. (2007), who found that residential and commercial areas within 400 meters of a subway station are relatively more expensive than other areas. At the same time, land diversity in the vicinity of the three TOD projects was

affected; they all have more diverse land use patterns. This supports Tian's (2019) argument that urban public transport affects land diversity. However, from the map analysis, the green environment around the three TOD projects has not changed over a large area, so the impact on the green environment is not significant. Generally speaking, a TOD project can affect nearby land use change by changing land value, but it has little impact on the overall green environment.

6.1.2. Objective (b), To assess the social impacts of Chengdu TOD

The questionnaire survey and SPSS software were used to analyse the social impact of the TOD project. In terms of social environment, the questionnaire survey found that most of the respondents, especially the middle-aged and young people aged 26–46, agreed that the TOD project had improved the urban environment and solved the problems of air pollution, noise pollution and energy consumption. This provides evidence for researchers such as Cervero and Sullivan (2011), who stated that TOD plays an extremely important role in improving urban environment and reducing urban energy consumption. Cervero and Sullivan (2011) claimed that under effective planning of TOD theory, cities would have more space to improve urban landscape and greening, and the urban social and ecological environment would be enhanced. At the same time, our findings are consistent with previous studies showing that TOD has the advantages of dedicated roads, large traffic volume, faster travel speed, safety and punctuality (Xu, 2015; Cervero & Sullivan, 2011). TOD can thus provide a better public transport environment and provide public transport efficiency.

In terms of social economy, the development of a TOD project contributes to the GDP, provides employment opportunities and promotes the development of the surrounding economic market. The findings of this study are consistent with the findings of Van Wee (2002), who believed that the construction, operation and maintenance of a TOD area can bring employment opportunities and promote economic development in the region. The study also found that TOD can improve a city's image and brand, thus attracting more human resources

and tourists and promoting the development of the city. In terms of residents' lives, as Yang (2015) said, TOD can provide a fair way to travel and residents have equal access to using public transport. Research shows that people with different income levels can use TOD public transport fairly, which can reduce social conflicts and promote the harmonious development of society. At the same time, the research shows that most respondents believed TOD provides a fast and convenient way of transportation, which can improve quality of life and living standards. The results of this study confirm the ideas of Lund (2007) and Xu (2015), who found that convenient rail transit technology not only provides convenient travel conditions for citizens, but also provides high-quality and safe environments for pedestrians and improves the quality of life of residents. However, the research results also show that TOD may have adverse social effects. For example, the development of TOD may aggravate the gap between the rich and the poor and increase gentrification in urban development, eventually leading to social conflicts. Therefore, while a TOD project can have favourable social impacts on urban development, there are still some risks.

6.1.3. Objective (c), To suggest policy implementation criteria for transport and land use leading to urban social development.

According to the findings from the literature and surveys, TOD can bring social impacts to the nearby area via the development of both public transportation and the surrounding land resources. To maximise the beneficial social impacts of TOD while avoiding its potentially adverse effects, supportive policies must be put into place. In terms of transportation, its development should be prioritised. Investments should be made in public transportation to establish effective facilities and build a successful public transportation environment overall. At the same time, the government needs to promote the concepts of TOD and 'TOD cities', encouraging more people to learn about TOD and, in turn, to invest in TOD and participate in TOD projects. In terms of land use, the government should plan before starting the project; determine the land use pattern and diversity of the site, as well as of the surrounding area; and

improve land use efficiency overall. Excellent advanced planning can provide citizens with a variety of facilities to meet their various life needs. At the same time, the government should control the value of the land at the project site. While enhancing land value and developing the economy, it should also strive to avoid social conflicts caused by excessive housing prices.

6.2. Recommendations for practice

Providing recommendations for practice—to be considered by TOD planners, the government and developers—was a key aim of this research into the social impact of TOD in Chengdu. This study explored the social impact of TOD on land use, social economy, social environment and residents' lives. In contrast with the existing literature, this research has made an in-depth study of the actual social impact of China's TOD project process. For the national government, this study offers insight into the vital importance of developing public transportation, leveraging favourable impacts for the benefit of all citizens. The national government should call for the development of public transportation and TOD models based on effective policies and should analyse the advantages that TOD can bring to the country. Local governments can then apply these conclusions to understand how best to develop TOD—giving full play to its advantages while avoiding risks. Local governments should also plan TOD projects according to local conditions. This means combining an in-depth understanding of basic local conditions with TOD theories and citizen needs, to develop TOD projects that are beneficial to all of society.

7. Conclusion

This study describes new research into the social impact of TOD in China, via the case of Chengdu, and answers three core research questions. The survey of Chengdu citizens helps fill a major gap in research on the social impact of TOD in real life. This chapter summarises the study's main findings, discusses its limitations, and makes recommendations for future research.

7.1. Main findings

The researcher first sought to understand the social impact of TOD by studying and analysing the literature—including that regarding the localised development and changes around TOD in China and its social impact on land use, social environment, social economy and citizens' living standards. The existing literature was found to be overly theoretical and focused mainly on foreign cases; there was no previous research around Chinese cases, either under construction or completed. To fill this research gap, a progressive investigation of Chengdu's TOD cases was carried out. By collecting data through Google Earth and questionnaires and then analysing the data through GIS and SPSS software, valuable feedback was gained from Chengdu citizens regarding the actual situation in the city. Most respondents did anticipate a social impact of TOD on land use, social environment, social economy and living standards, while also noticing its possible risks.

In chapter 6, this article combines the findings of the two parts and discusses the research questions. The first question aims to assess the extent to which the TOD project has transformed the urban environment and land use in terms of mobility. TOD projects can affect land use changes by impacting the value of the surrounding land. They can change the land use pattern and land diversity but tend to have little impact on the large-scale green environment. The second question is to assess the social impacts of Chengdu's TOD. While TOD can help

solve many urban problems—providing efficient public transportation, improving people's quality of life, enhancing a city's image, promoting social harmony and supporting economic development—it may also cause social conflicts and class divisions due to housing prices. The third and last question aims to suggest effective policy implementation criteria for transport and land use leading to urban social development. The government, as a decision-maker, needs to vigorously develop public transportation and control land value, among other tasks, to coordinate the development of TOD projects. These research findings can help the government and other key stakeholders to further understand and develop TOD in China.

7.2. Limitations

This article has critically studied the development and situation of TOD in China, providing help for people to understand the social impact of TOD. At the same time, it proved the value of the social impact of TOD. However, there are some limitations in the research. Firstly, because TOD is in the initial stages in China, there are fewer TOD projects that have been built, and most of the projects with construction have not yet shown the advantages expected. It may cause the social impact of TOD to be insignificant, leading to a bias in the settlement. Secondly, the concept of TOD is not popular in China and most people still don't understand it, which may have an influence on the results of the questionnaire. Although TOD was introduced in this questionnaire, there are still some influencing factors, which were uncontrolled, such as wrong understanding of TOD, not combined with the actual situation and fill in at will. Finally, due to the impact of COVID-19, no site visits were conducted, and interviews could not be conducted near specific TOD projects. Because of this, interviewees could not come to the coverage area of the TOD projects, which may have affected the survey results.

7.3. Suggestions for future research

There is still a lot of potential research to do on the social impact of TOD. With continuous development and construction of TOD projects in China, more and more citizens will understand them, so the locations that can be inspected in China will increase. Furthermore, in addition to studying the social impact of TOD in big cities, small and medium-sized cities should also be considered for evaluation. Interviews and questionnaires can be conducted with different people in mind, such as government officials, developers and citizens, to consider the social impact of TOD on different beneficiaries. Extensive research on TOD can help it to develop efficiently and bring benefits to urban development.

References

Bertolini, L., & Spit, T. (2005). *Cities on rails: The redevelopment of railway stations and their surroundings*. Routledge.

Bryman, A. (2012) *Social research methods / Alan Bryman.* 4th ed., Oxford: Oxford University Press.

Calthorpe, P. (1993) *The Next American metropolis: Ecology, community, and the American Dream.* Princeton Architectural Press.

Carlton, L. (2009) 'Histories of Transit-Oriented Development: Perspectives on the Development of the TOD Concept', *UC Berkeley: Institute of Urban and Regional Development.* [Online]. Available from: https://escholarship.org/uc/item/7wm9t8r6#main (Accessed: 5th September 2020).

Cervero, R. et al. (2004) *Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects.* Washington: Transportation Research Board. [Online]. Available from: https://www.valleymetro.org/images/uploads/general_publications/TCRP-Report-102_TOD-in-the-US-Experiences-Challenges-and-Prospects_10-04.pdf (Accessed: 5th September 2020).

Cervero, R. (2007) 'Transit-Oriented Development's Ridership Bonus: A Product of Self-Selection and Public Policies', *Environment and Planning A: Economy and Space*, 39(9), pp. 2068-2085. [Online]. Available from: https://doi.org/10.1068/a38377 (Accessed: 5th September 2020).

Cervero, R., & Murakami, J. (2008). 'Rail + Property Development: A model of sustainable transit finance and urbanism', *UC Berkeley: Center for Future Urban Transport: A Volvo Center of Excellence*. [Online]. Available from: https://escholarship.org/uc/item/6jx3k35x (Accessed: 5th September 2020).

Cervero, R. & Sullivan, C. (2011) 'Green TODs: marrying transit-oriented development and green urbanism.', *International journal of sustainable development and world ecology*, 18(3), pp.210–218.

Chatman, DG. & Noland, RB. (2011) 'Do Public Transport Improvements Increase Agglomeration Economies? A Review of Literature and an Agenda for Research.' *Transport Reviews*, 31 (6), pp. 725–42.

Chen, S. et al. (2008) 'Intension Analysis and Implementation Framework for TOD', *Urban Transport of China*, 6, October, pp.57-63. China Academic Journal Electronic Publishing House: Beijing.

Chen, X. & An, M. (2018) 'A Further Discussion on the Development Mode of TOD in China.', *Transport Engineering,* 5, October, pp. 1-7.

Chen, Y. (1999). 'Discussion on the strategic goals of Shenzhen's urban construction', Special Economic Zone, 7.

Chengdu Daily. (2019) 'Construction of TOD in Chengdu', Chengdu Daily,3, October, pp 7.

Chorus, P. (2012). *Station Area Developments in Tokyo: And what the Randstad Can Learn from it*. Delft: Eburon.

De Vos, J., Van Acker, V., & Witlox, F. (2014) 'The influence of attitudes on Transit-Oriented Development: An explorative analysis', *Transport Policy*, 35, September, pp. 326-329. [Online]. Available from: https://www-sciencedirect-com.libproxy.ucl.ac.uk/science/article/pii/S0967070X14000754 (Accessed: 5th, September 2020).

Debrezion, G., Pels, E. & Rietveld, P. (2007). 'The Impact of Railway Stations on Residential and Commercial Property Value: A Meta-analysis', *The journal of real estate finance and economics*, 35(2), pp.161–180.

Dittmar, H. & Ohland, G. (2004) *The New Transit Town: Best Practices in Transit-Oriented Development*, Island Press, Washington; 2004.

Hilbers, H.D., Wilmink, I.R. & Droppert-Zilver, M.N. (1999) *Evaluatie mobiliteitseffecten VINEX-locations.* Eindrapport. TNO-Inro, Delft

Jiang, Y. (2017) *The Study on Sustainable Development of Urban Traffic in Chengdu,* Southwest Jiaotong University.

Jin, T. (1999) 'The current situation and Countermeasures of the relationship between the central government and the local government in contemporary China', *Chinese Administration*, 7, pp. 67-71.

Li, Y. & Bai, F. (2019) Study on Urban Development Strategies Under TOD Mode ——A Case Study of Chengdu. Urban Housing, 26(9), pp. 95-98

Li, T., Shi, Y., & Fu, W. (2015) 'Evolving TOD Concept and Its Sinicization', *Urban Planning International*, 30, pp. 72-77. [Online]. Available from: http://www.upi-planning.org/files/hjcsgh/magazinehtml/20150310.htm#outline_anchor_9 (Accessed: 5th, September 2020).

Liu, Q. (2016) *Research on urban land development and utilization based on TOD mode.* Capital University of Economics and Business: Beijing.

Tong, Y. et al. (2017) *China's great urbanization / edited by Yongnian Zheng, Litao Zhao, and Sarah Y. Tong.*

Lu, D.et al. (2003) 'Change Detection Techniques', *International Journal of Remote Sensing*, 25 (12), pp. 2365 –2407.

LU, H. & Zhang, P. (1999). 'Fully integrate urban public transportation', *Urban Rail Transit Research*, 1, pp. 29-32.

LU, K. et al. (2016) ‘Urban Rail Transit in China: Progress Report and Analysis (2008–2015)’, *Urban Rail Transit*, 2, December, pp. 93–105. [Online]. Available from: https://doi.org/10.1007/s40864-016-0048-7 (Accessed: 5th, September 2020).

Lund, H. (2007) ‘Reasons for Living in a Transit-Oriented Development, and Associated Transit Use’, *Journal of the American Planning Association*, 72(3), pp.357–366.

Meurs, H. & Haijer, R. (2001) 'Spatial structure and mobility', *Transportation Research Part D: Transport and Environment*, 6, November, pp. 429-446

National Bureau of Statistics. (2020) *China Statistical Yearbook 2019*. China Statistics Press: Beijing.

Nelson, A. et al. (2015) *Do TODs Make a Difference?* National Institute of Transportation and Communities. [Online]. Available from: http://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1006&context=trec_reports. (Accessed: 5th, September 2020).

Newman, P., Beatley, T. and Boyer, H. (2009) *Resilient cities: responding to peak oil and climate change*, Washington, DC: Island Press.

Nobis, C and Welsch, J. (2003) *Mobility management at district level: the impact of car-reduced districts on mobility behavior.* Paper presented at: The 7th European Conference on Mobility Management, Karlstad, Sweden.

Pan, X. (1997) ‘The relationship between central government and local government’, *Political Science Research*, 3.

Sijtsma, K. (2008) ‘On the Use, the Misuse, and the Very Limited Usefulness of Cronbach’s Alpha’, *Psychometrika*, 74(1), pp.107–120.

Statistics Bureau of Chengdu and NBS Survey office in Chengdu. (2016) *Chengdu Statistical Yearbook 2016. China Statistics Press Co., Ltd: Beijing.*

Statistics Bureau of Chengdu and NBS Survey office in Chengdu. (2017) *Chengdu Statistical Yearbook 2017. China Statistics Press Co., Ltd: Beijing.*

Statistics Bureau of Chengdu and NBS Survey office in Chengdu. (2018) *Chengdu Statistical Yearbook 2018. China Statistics Press Co., Ltd: Beijing.*

Statistics Bureau of Chengdu and NBS Survey office in Chengdu. (2019) *Chengdu Statistical Yearbook 2019. China Statistics Press Co., Ltd: Beijing.*

Tanmoy, D. (2009) *Land Use / Land Cover Change Detection: an Object Oriented Approach*, Institute for Geoinformatics, University of Münster, Germany.

Taylor, BT. et al. (2011) 'Measuring the Quality of Public Open Space Using Google Earth', *American Journal of Preventive Medicine*, 40(2), pp.105–112.

The State Council of China. (2013) *Guiding opinions of the State Council on giving priority to the development of public transport in cities.* [Online]. Available from: http://www.gov.cn/zhengce/content/2013-01/05/content_3346.htm (Accessed: 5th, September 2020).

The State Council of China. (2009) *The State Council approves a pilot plan for the overall reform of the urban and rural areas in Chengdu.* [Online]. Available from: http://www.gov.cn/jrzg/2009-05/21/content_1321579.htm (Accessed: 5th, September 2020).

Tian, L. (1999) 'Study on Land Use along High - speed Railway Transit', *Urban Research*, 3, 28-31.

Tian, L. & Zhuang, H. (1998). 'Research on the mechanism of joint development of urban rapid rail transit construction and real estate -- a case study of Guangzhou', Urban Planning, 2, pp. 30-34.

Vale, D.S. (2015) 'Transit-oriented development, integration of land use and transport, and pedestrian accessibility: Combining node-place model with pedestrian shed ratio to evaluate and classify station areas in Lisbon.' *Journal of transport geography*, 45, pp.70–80.

Van Wee, B. (2002). 'Land use and transport: research and policy challenges', *Journal of transport geography*, 10(4), pp.259–271. [Online]. Available from: https://www.sciencedirect.com/science/article/pii/S0966692302000418 (Accessed: 5th, September 2020).

Van Wee, B. & Van der Hoorn, T. (2001) 'Land-use impacts on passenger transport: a comparison of Dutch scenario studies', Transport and Environment: In Search of Sustainable Solution.

Wang, C. (2012) 'A Review on the Localization Course of Transit-Oriented Development in China', *Huazhong Architecture,* 5, May, pp. 9-12. [Online].

Wang, G. (2007) 'Promoting Advances in Urban Science and Harmony in Society through Transit Priority Strategies', Urban Transport of China, 5(1), January, pp.6-10.

Xu, M. (2015) Impact of Development of City Rail Transit Technology on Social Development – Take N for Example. Jiangxi Agricultural University

Zhang, M. & Liu, Q. (2007) 'The Chinese Edition of Transit-Oriented Development', Urban Planning Journal, 1, September, pp.91-96.

Zhao, S. (2019) 'Analysis of TOD development model in China.', *Consume Guide*, 9, August.

Zheng, Y. et al. (2016) *China's great urbanization / edited by Yongnian Zheng, Litao Zhao, and Sarah Y. Tong.*

Appendices

Appendix A. Questionnaire survey

Survey on the usage and opinions of Chengdu TOD Project

1. Gender
   A. Male
   B. Female

2. Age
   A. Less 18
   B. 18 –25
   C. 26-45
   D. 46-65
   E. Over 65

3. Income
   A. Less than 2500 RMB
   B. 2500 RMB - 4999 RMB
   C. 5000 RMB – 9999 RMB
   D. More than 10000 RMB

4. Education level
   A. College degree
   B. Undergraduate degree
   C. Postgraduate degree
   D. PhD

5. Which the district do you live in Chengdu

6. Normal travel distance (one way)

   A. 0-5km

   B. 6-10km

   C. 11-15km

   D. 16-20km

   E. More than 20km

7. What kind of transport mode do you usually use? (Multiple choice)

   - Walking
   - Cycling
   - Electric cycling
   - Bus
   - Subway; Metro
   - Car
   - Other

8. Your main purpose of using the subway is (Multiple choice)

   - Working
   - Going to school
   - Shopping
   - Travelling
   - Other

9. The Main reason for using the subway

A. Convenience

B. Safety

C. Cheap

D. Traffic restriction

E. Protection of Environment

F. Bringing pleasure

G. Travel habits

H. The destination is near the subway station

I. Alternative to other modes of travel

10. Your opinion with the following description (1 strongly disagree, 2 disagree, 3 neutral, 4 agree, 5 strongly agree)

I like to take the subway

I feel safe when taking the subway

I think the subway can replace car

I think the subway price is very affordable

I can reach most of my destination by subway

I think using public transportation can alleviate urban traffic congestion

11. Have you learned about TOD?

A. YES

B. NO

Since the TOD system research is professional, in order for everyone to complete the questionnaire smoothly, the questionnaire provides an explanation of TOD. Please read the introduction of the TOD complex in Tokyo, Japan. Thanks.

Transit Oriented Development, TOD for short, mainly refers to the development of public transportation hubs and stations, with a radius of 500-1000m (5-10 minutes' walk) to build a comprehensive integration of work, commerce, culture, education, and residence area.
Take TOD in Shibuya, Tokyo, Japan as an example. TOD in Shibuya transfers transportation facilities on the ground to underground, builds super high-rise buildings on the ground, and develops integrated spaces with multiple floors and multiple heights. It realized "zero distance" transfers between various rail transit lines and bus lines. At the same time, it will promote the development of the surrounding areas, provide convenience for the living, work and entertainment to nearby residents, and will realize both the urban appearance and the value of the land.
Show the Figure, such as
Sectional drawing of Tokyo Shibuya TOD
Rendering of Tokyo Shibuya TOD

12. Your most familiar TOD (station name)
13. What are the most impressive features of this TOD that you are familiar with?
14. What are the shortcomings of this TOD that you are familiar with?

15. Dose the following living service facilities and buildings include within one kilometre of this TOD? (Multiple choice)
    - Hospital
    - Shopping mall
    - Supermarket
    - Office building
    - Residential

16. Which is the spatial relationship between subway station and complex that you favourite? (taking the relationship between Chengdu Chunxi Road Station and Metro Line 3 as an

example)

A. Independent of each other, with a certain distance
B. The station and the complex are embedded in each other, but the overall layout is relatively independent in a building, with independent entrances and exits.
C. The station is integrated into the complex, and the entry and exit spaces are highly

17. Your opinion with the following description of social environment (1 strongly disagree, 2 disagree, 3 neutral, 4 agree, 5 strongly agree)
    - TOD can reduce energy consumption and reduce air pollution
    - TOD can increase green spaces and optimize urban landscape
    - TOD can enhance the connection between public transportation and reduce the use of private cars, thereby achieving the purpose of reducing traffic congestion.
    - TOD can improve the environment of public transport.

18. Your opinion with the following description of social economy (1 strongly disagree, 2 disagree, 3 neutral, 4 agree, 5 strongly agree)
    - TOD can increase employment opportunities
    - TOD can improve land utilization
    - TOD can drive the surrounding economic development

19. Your opinion with the following description of citizen life (1 strongly disagree, 2 disagree, 3 neutral, 4 agree, 5 strongly agree)
    - TOD can improve the quality of life and be easier to meet the needs of life
    - TOD can provide affordable public transport
    - TOD can provide better public infrastructure

20. Your opinion with the following description of risk (1 strongly disagree, 2 disagree, 3 neutral, 4 agree, 5 strongly agree)

- TOD may be difficult to change citizens' travel habits in the short term
- TOD may destroy the original appearance of the city
- TOD may not be suitable for domestic urban development and cannot achieve the expected results

21. Are you willing to invest in the area because of TOD?

A. YES

B. NO

22. How do you think TOD has changed your quality of life?

23. TOD in Chengdu will continue to develop in the future. More intercity rails or subway lines will be added, and urban comprehensive building will continue to be built around them. What do you think the development of TOD has any social impact on Chengdu?

Appendix B. Risk Assessment Form

RISK ASSESSMENT FORM

FIELD / LOCATION WORK

The Approved Code of Practice - Management of Fieldwork should be referred to when completing this form

http://www.ucl.ac.uk/estates/safetynet/guidance/fieldwork/acop.pdf

DEPARTMENT/SECTION TRANSPORT AND CITY PLANNING

LOCATION(S) CHENGDU, SICHUAN, CHINA

PERSONS COVERED BY THE RISK ASSESSMENT Mianlin Yang

BRIEF DESCRIPTION OF FIELDWORK

Internet questionnaire will be conducted.

Consider, in turn, each hazard (white on black). If **NO** hazard exists select **NO** and move to next hazard section.

If a hazard does exist select **YES** and assess the risks that could arise from that hazard in the risk assessment box.

Where risks are identified that are not adequately controlled they must be brought to the attention of your Departmental Management who should put temporary control measures in place or stop the work. Detail such risks in the final section.

ENVIRONMENT	**The environment always represents a safety hazard. Use space below to identify and assess any risks associated with this hazard**
e.g. location, climate, terrain, neighbourhood, in outside organizations, pollution, animals.	Examples of risk: adverse weather, illness, hypothermia, assault, getting lost. Is the risk high / medium / low ? **NO environment related risk**

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	work abroad incorporates Foreign Office advice
	participants have been trained and given all necessary information
	only accredited centres are used for rural field work
	participants will wear appropriate clothing and footwear for the specified environment
	trained leaders accompany the trip
	refuge is available
	work in outside organisations is subject to their having satisfactory H&S procedures in place
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EMERGENCIES	**Where emergencies may arise use space below to identify and assess any risks**
e.g. fire, accidents	Examples of risk: loss of property, loss of life

NO risk

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	participants have registered with LOCATE at http://www.fco.gov.uk/en/travel-and-living-abroad/
	fire fighting equipment is carried on the trip and participants know how to use it
	contact numbers for emergency services are known to all participants
	participants have means of contacting emergency services
	participants have been trained and given all necessary information
	a plan for rescue has been formulated, all parties understand the procedure
	the plan for rescue /emergency has a reciprocal element
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EQUIPMENT	**Is equipment used?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. clothing, outboard motors.	Examples of risk: inappropriate, failure, insufficient training to use or repair, injury. Is the risk high / medium / low ?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	the departmental written Arrangement for equipment is followed
	participants have been provided with any necessary equipment appropriate for the work
	all equipment has been inspected, before issue, by a competent person
	all users have been advised of correct use
	special equipment is only issued to persons trained in its use by a competent person
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

LONE WORKING	Is lone working a possibility?	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. alone or in isolation lone interviews.	Examples of risk: difficult to summon help. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	the departmental written Arrangement for lone/out of hours working for field work is followed
	lone or isolated working is not allowed
	location, route and expected time of return of lone workers is logged daily before work commences
	all workers have the means of raising an alarm in the event of an emergency, e.g. phone, flare, whistle
	all workers are fully familiar with emergency procedures
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

ILL HEALTH	**The possibility of ill health always represents a safety hazard. Use space below to identify and assess any risks associated with this Hazard.**
e.g. accident, illness, personal attack, special personal considerations or vulnerabilities.	Examples of risk: injury, asthma, allergies. Is the risk high / medium / low? **LOW**
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	an appropriate number of trained first-aiders and first aid kits are present on the field trip
	all participants have had the necessary inoculations/ carry appropriate prophylactics
	participants have been advised of the physical demands of the trip and are deemed to be physically suited
	participants have been adequate advice on harmful plants, animals and substances they may encounter
	participants who require medication have advised the leader of this and carry sufficient medication for their needs
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

TRANSPORT	**Will transport be**	**NO**	**NO**	**Move to next hazard**
	required	**YES**		**Use space below to identify and assess any risks**
e.g. hired vehicles	Examples of risk: accidents arising from lack of maintenance, suitability or training Is the risk high / medium / low?			
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**			

	only public transport will be used
	the vehicle will be hired from a reputable supplier
	transport must be properly maintained in compliance with relevant national regulations
	drivers comply with UCL Policy on Drivers http://www.ucl.ac.uk/hr/docs/college_drivers.php
	drivers have been trained and hold the appropriate licence
	there will be more than one driver to prevent driver/operator fatigue, and there will be adequate rest periods
	sufficient spare parts carried to meet foreseeable emergencies
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

DEALING WITH THE	**Will people be**		**If 'No' move to next hazard**

PUBLIC	**dealing with public**	**NO**	**If 'Yes' use space below to identify and assess any risks**
e.g. interviews, observing	Examples of risk: personal attack, causing offence, being misinterpreted. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	all participants are trained in interviewing techniques
	interviews are contracted out to a third party
	advice and support from local groups has been sought
	participants do not wear clothes that might cause offence or attract unwanted attention
	interviews are conducted at neutral locations or where neither party could be at risk
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

WORKING ON OR NEAR WATER	**Will people work on or near water?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. rivers, marshland, sea.	Examples of risk: drowning, malaria, hepatitis A, parasites. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	lone working on or near water will not be allowed
	coastguard information is understood; all work takes place outside those times when tides could prove a threat

	all participants are competent swimmers
	participants always wear adequate protective equipment, e.g. buoyancy aids, wellingtons
	boat is operated by a competent person
	all boats are equipped with an alternative means of propulsion e.g. oars
	participants have received any appropriate inoculations
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

MANUAL HANDLING (MH)	**Do MH activities take place?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. lifting, carrying, moving large or heavy equipment, physical unsuitability for the task.	Examples of risk: strain, cuts, broken bones. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	the departmental written Arrangement for MH is followed
	the supervisor has attended a MH risk assessment course
	all tasks are within reasonable limits, persons physically unsuited to the MH task are prohibited from such activities
	all persons performing MH tasks are adequately trained
	equipment components will be assembled on site
	any MH task outside the competence of staff will be done by contractors
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

SUBSTANCES	**Will participants work with substances**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. plants, chemical, biohazard, waste	Examples of risk: ill health - poisoning, infection, illness, burns, cuts. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	the departmental written Arrangements for dealing with hazardous substances and waste are followed
	all participants are given information, training and protective equipment for hazardous substances they may encounter
	participants who have allergies have advised the leader of this and carry sufficient medication for their needs
	waste is disposed of in a responsible manner
	suitable containers are provided for hazardous waste
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

OTHER HAZARDS	Have you identified any other hazards?	NO	If 'No' move to next section If 'Yes' use space below to identify and assess any risks
i.e. any other hazards must be noted and assessed here.	Hazard: Risk: is the risk		
CONTROL MEASURES	**Give details of control measures in place to control the identified risks**		

Have you identified any risks that are not	**NO**	**NO**	**Move to Declaration**
adequately controlled?	~~**YES**~~		**Use space below to identify the risk and what action was taken**

Is this project subject to the UCL requirements on the ethics of Non-NHS Human Research? No

If yes, please state your Project ID Number

For more information, please refer to: http://ethics.grad.ucl.ac.uk/

DECLARATION	The work will be reassessed whenever there is a significant change and at least annually. Those participating in the work have read the assessment.

Select the appropriate statement:

√	I the undersigned have assessed the activity and associated risks and declare that there is no significant residual risk
√	I the undersigned have assessed the activity and associated risks and declare that the risk will be controlled by the method(s) listed above

NAME OF SUPERVISOR

**** SUPERVISOR APPROVAL TO BE CONFIRMED VIA E-MAIL ****

Beatriz Mella Lira