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Social Inclusion of Smart Transportation: Case of Shanghai

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Preface

This master thesis marks the end of our study at the Master of Global Management at Nord University. We are so fortunate to participate in the cooperation between East China Normal University in China and Nord University in Norway. Our studies, including stay in Bodø, have been an amazing experience.

We are very lucky to have the opportunity to combine what we have learned in Nord University, smart city related content, with our master thesis. Before writing the paper, we decided to combine smart transportation and social inclusion after many discussions. We have been writing and cooperating as partners. In the discussions, we have learned from each other and exchange our opinions. It has been wonderful for us to cooperate with each other.

In the process of writing the paper, we were also very grateful to our supervisor, Associate Professor Dr. Elena Dybtsyna, who gave us a lot of practical suggestions and help. Her patient guidance and support was invaluable in the writing of this paper, leading us from chaos to organization. It can be said that without her help, this paper would not have been completed. And we would like to thank the other professors and faculty members for their comments and suggestions.

Wenxuan Sun & Shiyu Shen

18th May, 2022

Abstract

The topic of smart cities has attracted a lot of discussion in academic circles in recent years. The healthy development of the city is inseparable from the groups that live there, especially some vulnerable groups. With the continuous development of the economy and society, residents, organizations, governments and other groups have been paying increasing attention to the theme of social inclusion.

This paper examines a case study of Shanghai. It conducts an overall analysis of Shanghai's smart transportation system and its social inclusion policy documents since the beginning of the development of smart transportation in Shanghai. By analyzing policy documents, the paper attempts to describe the characteristics of the development of smart transportation and social inclusion in Shanghai, find out what social inclusion-related problems have arisen in the process of Shanghai smart transportation, and put forward some suggestions.

Shanghai was chosen as a case study because of its particularity. China's smart city development has been increasing rapidly in recent years. As a city that is representative of China, the country's overall smart city development model and social inclusion can be seen through the study of Shanghai. Second, the population base and complexity of Shanghai provides enough data support. At the same time, as an international metropolis, Shanghai is also an important city connecting China with the rest of the world. Thanks to its relatively high degree of internationalization, Shanghai has referential significance for the construction of smart cities in other countries.

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Chapter 1: Introduction

In this chapter, we outline the background for our thesis in section 1.1, followed up by the purpose behind and then we propose our research question in section 1.2. And the significance of the paper can be found in section 1.3, and the scope, structure and limitations of this thesis will be presented in section 1.4. Finally, we outline the remaining chapters of our thesis in section 1.5.

1.1 Background

In considering the public services and urban governance of large cities with millions of people, public transportation is an important way of improving the convenience of urban life, social equity and green development (Wen et al., 2016). With the development of urbanization, information and communication technologies and some other data technologies have been introduced into urban development. By introducing upgraded technologies and smart city governance system into urban services, smart transportation has been formulated to improve traffic management. The design of public transportation has also been upgraded and updated with the support of new technologies, and people are using public transportation in smarter ways.

However, although many scholars have praised smart cities and smart transportation construction, some are concerned about the social problems presented by smart cities. Graham (2002) states that the rapid development of information technology could promote unbalanced development. On the one hand, “super-connected” (p.34) people who work within various technology companies, institutions and modern communities were able to access the convenience created by new technology very quickly. On the other hand, older adults, the disabled, low-income groups and low knowledge-level groups can barely access these modern technologies, forming

clusters and enclaves with different levels of information technology, causing obvious "urban digital divides" (p.35) between social groups. The promotion of science and technology is happening faster than the development of society, and our limited cognitive and learning abilities are making it difficult to keep up with the speed of new knowledge generated by the information explosion, which creates high learning costs for the use of new technologies and products. There are significant differences in learning costs for people of different ages and educational levels. Therefore, with the continuous advancement of smart cities, the differences in the smart services enjoyed by people in different regions and industries will be greater and greater as a result of economic foundations, industrial structure, informatization level, education level and other factors, and "digital divides" will continue to become "smart divides" (Chen et al., 2013, p.48).

In addition, the political problems related to smart cities have caused scholars like Rama et al. (2017) and Zhang et al. (2020) to think about the inclusiveness of smart cities, including the inclusiveness of smart city plans and smart transportation projects, and the potential lack of protection and help for social vulnerable groups in relevant policy design. Many ambitious smart city plans have succeeded in hiding the answers to questions related to social justice and inclusion. In other words, the notion of the smart city itself is not a tool to achieve social justice and inclusion and should only be regarded as a business concept. Rama et al. (2017) found that in order to support the rapid development of smart city projects, governments have approved fast track laws to ensure that social resources can be quickly allocated to smart city projects, ignoring the rights of marginalized communities. Zhang et al. (2020) tested the access difficulty of different groups from Wuhan and Urumqi facing the transformation of smart public transportation and found that a lack of knowledge of smartphone use hindered people's access to smart transportation information, especially among women, middle-aged and older people, manual workers, and ethnic minorities, all of whom had a relative lack of knowledge about the use of smart phones. In their

analysis of the smart transformation of public transportation in some cities in the US, Wang et al. (2021) found that only a few of the tested cities proposed sporadic inclusive smart city strategies to address the specific needs of individuals such as wheelchair users, people with visual impairments, and people with other specific functional limitations.

It is clear that the goals of social justice and inclusion have not been realized by the development smart cities and transportation. Angelidou (2014, p.10) used a smart city project in Rio de Janeiro as a vivid metaphor. The slogan 'Smarter Favela' became characteristic of the project's inability to address the city's severe social inequalities, widening already existing social disparities, and exacerbating spatial polarization. The potential for injustice and exclusion in smart city projects has prompted scholars to think about social inclusion in smart cities.

With this in mind, this paper aims to take a closer look at smart transportation projects in Shanghai as a case study and to conduct a theoretical and empirical exploration of social inclusion by discussing and analyzing what kind of a policy evaluation framework for social inclusion can be developed and implemented for smart transportation in the context of the Shanghai case study.

1.2 Purpose and research question

According to Deloitte China (2019), there are more than 1,000 smart cities in operation or under construction around the world, of which nearly 50% are in China. China has made significant investment in building smart cities over the past decade. The speed of urbanization in China is also very fast, and the gap between the level of urbanization construction and developed countries is constantly narrowing. Shanghai,

as one of the cities with the highest level of economic development, science and technology and internationalization in China, is also one the first rank in China's super smart cities development. And Juniper Research ranked Shanghai as the world's number one smart city in 2022 (O'Halloran, 2022). At the same time, the rapid development of China's smart phones and 5G network and other technologies has promoted the emergence and development of smart navigation and smart travel applications, and the number of downloads on smart phones is considerable. For example, the downloads of the smart navigation APP – Amap have reached 20.33 million in Apple's APP Store (App Store China, 2022), and its open platform provides location services to more than 1.2 billion mobile devices every month (Amap, 2022). Shanghai is a mature and advanced city in China, so the study of smart city and smart transportation projects in Shanghai can reveal the latest changes related to smart cities in China.

Therefore, we hope to learn more about the situation of China's overall smart city and smart transportation development through the study of Shanghai's smart city. At the same time, Shanghai, as a super metropolis, has a long history of traffic congestion, especially in rush hours. In this case, the convenience of vulnerable groups to travel outside and other issues are worthy of attention. We want to study whether the travel inconvenience for these groups can be improved after the implementation of smart transportation in Shanghai. Second, we want to find out the problems and what is worth learning from the development of China's smart city, and thus can have practical implications for China's future development of smart city and smart transportation projects, and also, we want that through our research to make stakeholders and other citizens pay more attention to social inclusion.

Based on the background mentioned above and the purpose of our research, our research question is: *How is the social inclusion tackled and what are the characteristics during the development of smart transportation in Shanghai?*

1.3 Significance

For China and Shanghai itself, Shanghai is usually the pilot city and the first city to carry out innovation in China. Therefore, the systematic study of Shanghai smart transportation is helpful to understand the social inclusiveness status and existing problems in the process of promoting smart transportation in Shanghai. At the same time, it is also helpful to evaluate the comprehensive situation and existing problems of social inclusiveness in the current promotion process of smart cities and smart transportation in China.

Meanwhile, we found out that there is no systematic review on the social inclusiveness of smart transportation in Shanghai at present, so we hope to bring some new insights with our project.

1.4 Scope, Structure and Limitations

The scope of this thesis is to conduct an analysis of the general social inclusion situation of smart transportation projects in Shanghai, where we can look at the different stages of Shanghai's transportation related policies and documents (Section 5.1). And this section is an overview part. According to the actual situation, we divide the development of Shanghai smart transportation into three stages, and our analysis framework is divided into three parts according to the relevant theories of social inclusion. Section5.2 specifically explains the social inclusion problems in Shanghai smart city in these stages. And Chapter 6 and 7 provides our research explanations and conclusions.

For this paper, when we are writing, there is a big outbreak of Covid-19 in Shanghai, so the whole city is lockdown for a very long time, as a direct result, some primary data could not be obtained in our paper writing, and we have to choose to use secondary data. So, there might be some missing data and information. Although the plan has been written in great detail in the official programming documents, there are some follow-up implementation documents that are not clear or we cannot find, which leads to our lack of evaluation in this aspect. In addition, the 13th Five-Year Plan involves the future, and there are some predictable factors that we cannot guarantee will be implemented in the future.

1.5 Thesis Outline

This master thesis mainly examines the Shanghai smart transportation project from the perspective of social inclusion, hoping to establish a set of evaluation system for reference by investigating Shanghai's social reality, policy documents and specific implementation. The whole thesis includes six chapters. Except this first one, the subsequent four chapters are shown below.

Chapter 1: Introduction: This chapter mainly introduces the background of our topic selection, overview content and research question. This can pave the way for the rest of our writing.

Chapter 2: Theoretical framework: This chapter is a review of scholars' research, focusing on the scope of smart transportation, the connotation of social inclusion, and build up our analytical framework.

Chapter 3: The context of Shanghai. In this chapter, we mainly describe the general situation of all kinds of vulnerable groups in Shanghai and we show the overall traffic situation in recent years. This can give us a comprehensive understanding of the transportation and vulnerable groups situation in Shanghai, which can help us to expand the following discussion.

Chapter 4: Research methodology. This chapter mainly provides readers with an overview of how we conduct our research. In this chapter, we describe how we advance our research step by step, what kind of considerations we have been doing and what kind of problem we are facing.

Chapter 5: Empirical chapter: This chapter shows our empirical findings from the case study. We mainly present the of Shanghai society, policy documents of Shanghai smart transportation projects and specific implementation projects. We also present our findings on some forms for the social inclusion of Shanghai smart transportation projects.

Chapter 6: Analytical discussion: Here we analyze and discuss further through the combination of theoretical framework and empirical evidence.

Chapter 6: This part is the conclusion and as well we come up with some practical implications of the suggested system and ideas for further research.

Chapter 2: Theoretical framework

In this section we present the background of smart transportation and social inclusiveness, followed by an explanation of the different concepts we use in this thesis.

2.1 Smart transportation

The concept of smart transportation emerged with the concept of smart city, and continues to evolve, and with the continuous development and improvement of smart city, smart transportation is also very hit nowadays, but now the academia for the definition of smart city is different. To be specific, the original definition of smart city is from IBM, which is defined as the desire to make the most of all connected information available to better understand and control its operation and optimize the use of limited resources (IBM, 2008). This is emphases much more on technology. And now, in the definition of some institutions, it is believed that the development of smart city is "using technology to make the city become more sustainable, attractive, productive and resilient" (Nordic Edge, 2021). And some organizations believe that smart city can improve the quality of government service by using information and technological means, so as to improve citizen welfare (Twi Global, 2022). It can be seen that some are more focused on improving the sustainable development capacity of cities, while others are aimed at improving efficiency. Therefore, for the smart transportation, there also has not a really unified concept.

Research articles with focus on practical applicability, they prefer to use the term Intelligent Transportation Systems (ITS) instead of smart transportation. In some literature the word smart mobility is also used as a synonym for smart transportation (Mazur, 2020). In official documents, the smart transportation always emphasizes on

infrastructure development. For example, in 2010, the European Union defined ITS as a system "in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport." (European Union, 2010, p.23). Further, European Commission considered that "from a social perspective, affordability, reliability and accessibility of transport are key. However, this has not been achieved across the board. Addressing these challenges will help pursue sustainable growth in the EU" (Nápoles et al, 2020, p.215). According to the US Department of Transportation (2016), "Intelligent Transportation Systems apply a variety of technologies to monitor, evaluate, and manage transportation systems to enhance efficiency and safety." While McKinsey's report (2020), states that smart transportation is fundamental to creating and developing smart cities. Smart transportation starts with infrastructure, it needs smart and connected infrastructure. And it means tying policy and process innovation to revenue generation. Smart transportation and intelligent transportation system offer a means of providing innovative services on different modes of transportation and traffic management. Its components include infrastructure, vehicles, and users. Smart transportation is enabled by a number of technologies -- IoT, Wireless Technologies, Sensing Technologies, and GPS (Sadiku, et al., 2017).

Chinese research literature mainly defines smart transportation as a method to change urban commuting. It is essentially reconstruction and upgrade of conventional traffic models, and highly beneficial in solving traffic congestion issues. There are three dimensions of a self-organizing smart transportation system, which including smart cells (like smart cars, unmanned aerial vehicles, smart infrastructure and devices, and smart base stations), ICT (like IoT, big data, cloud computing, mobile internet and artificial intelligence), and developmental mechanisms (Smart traffic rules and operation mechanism of the sharing economy) (Yan et al., 2020). The concept of smart transportation was born with the concept of smart city, and it is also in the

process of continuous development. In terms of its concept, ITS is a multi-party urban comprehensive system project led by Chinese government departments, which integrates smart transportation comprehensive service center, smart road comprehensive service center, smart city traffic command center, smart port and navigation comprehensive service center and other systems (Kui Xu, 2017). Rumin et al (2014) developed some index to evaluate China's ITS system, and they divided indicators into six groups, one of them was the social inclusion. But in their paper, they only sorted out the data roughly, and did not further explain the specific impact of ITS project on social integration. Meanwhile, according to Shanghai Smart City Development Institute (2022), Shanghai's smart transportation (intelligent traffic management) mainly refers to the use of information technology to improve the efficiency of vehicles, improve traffic fluency, optimize citizens' travel experience, and make urban traffic management more refined and intelligent. It contains two two-level index, which are the construction level of intelligent bus stop rate (refers to the smart electronic bus stops number at the city accounted for the proportion of all bus stops) and the public traffic induced information utilization rate (the citizens of this indicator is for driving, refers to in the process of driving, the proportion of citizens obeys smart navigation's guide).

From these different concepts we can see that both Chinese and Western literature mention the development of infrastructure and updating of science and technology as the foundation of smart transportation, and they also both believe that the development of smart transportation is beneficial to urban governance and traffic order. However, China's concept of smart transportation emphasizes that it hopes to solve or improve traffic congestion through Intelligent Transportation System. This is due to China's high population density and severe traffic congestion in some large cities, like Shanghai.

Despite the benefits of smart transportation, and many researchers see these projects as promising, there are institutions and authors who think that there are some disadvantages in its development. For example, some authors believe that the "digital divide" caused by the development of smart cities makes the marginalized people unable to enjoy the convenience brought by smart cities, and this is especially true for smart transportation (Padrón, et al, 2021). Deloitte also points out in a report (2015) that the needs of some special groups may not be fully met during the development of smart transportation. And smart transportation development may squeeze the development space of traditional transportation modes, making some vulnerable groups unable to adapt. In addition, some scholars believe that in the process of smart transportation development, the needs of some vulnerable groups often are ignored (Li & Woolrych, 2021).

2.2 Social inclusion in the context of rapidly developing smart cities

Social inclusion, also called social inclusiveness, is the opposite of social exclusion. In 1995, the United Nations defined an inclusive society as a society that respects the human rights, fundamental freedoms, diversity, and social justice of all members and the special needs of vulnerable and disadvantaged groups (UN, 1995, p.34 & 65). Therefore, social inclusion goes far beyond just reducing or eliminating economic poverty, and the needs of health, education, and affordable access to other public services such as justice, housing, and mobility should be considered as indicators of social inclusion (UN, 2010). Earlier studies dealing with inclusive education assumed that inclusive education would reduce the gap between different groups. Scholars like Knoster and Lapos (1993) and Thomas (1997) agreed with the point of view that schools should reduce the negative effect of natural or acquired disadvantages and nurture a sense of mental belonging, using institutional integration and support to create inclusion as the outcome or by product. Oliver and People (1999) explained

that with the increasing expenditures of modern life, the result of industrialism and modernity have meant that many marginalized groups and individuals are seen as the burdens on society and national finances. Underpinning these opinions is the belief that some limitations on individuals' ability to exist in mainstream society can stop these vulnerable groups being integrated into the communities and institutions. Thus, the problem facing the development of an inclusive society is how to enable every vulnerable group to be included by different institutions even if there are obstacles to them getting access to services and welfare. Just as a school's function is teaching useful knowledge and skills, one viable approach is to equip these vulnerable groups with knowledge and skills.

In addition to paying attention to the physical and intellectual disadvantages of vulnerable groups, some scholars have focused on the impact of the social and political institutions on social inclusion. Scholars like Atkinson (2002) and Labonte (2004) believed that the process of social inclusion should not only focus on social policies that solve disadvantages but also the integration of economic and social policies to combat poverty and social exclusion instead of creating them. Farrington and Farrington (2005) also explained that if governments want to achieve greater social inclusion and justice, an interactive and integrated system of policy sectors is needed to prevent solutions that are an afterthought. In particular, Farrington and Farrington (2005) noted that public mobility was important for rural places to reduce the negative effect of unevenness of vehicle ownership (p.11). Cai (2009) argued that the core of inclusion was removing the poverty of social rights, and that three principles help to build an integrated system of policy-making: guaranteeing development, fair opportunities, and minimum standards. These arguments imply that policies that influence the supply side of social resources can either improve or damage social inclusion.

Since excluded groups are very varied, support should also be differentiated to fit their diverse needs. For example, among older adults in China, where the population aged 60 and over exceeds 264.02 million, accounting for 18.70% of the total (Ning, 2021), the traditional focus of research on older adults was usually physical health and cognitive function. However, Warburton et al. (2013) pointed out that neglecting the effects of ageing on society could mean that older adults are excluded from society and the key events associated with later life including retirement and widowhood and that limited mobility could bring about discrimination, ageism, and exclusion from social resources. Therefore, the wide variety of vulnerable groups can make the development of social inclusion difficult and the numerous causes of physical barriers must be clarified.

Clearly, unequal access to various kinds of resources is the main reason for the vulnerability and discrimination of marginalized groups and mere declaration of abstract equality will be of no use to such groups. Therefore, a more scientific design for policy making of "protective discrimination" or "adventitious aids" would be necessary to fill the gap between them and the mainstream (Kumar, 2012, p.45). Hicky and Toit (2013) summarized the relationship between adverse incorporation and social exclusion and thought that forced incorporation may create chronic poverty since it does not solve the vulnerability of excluded groups that stems from a lack of political power, a rough market, a disadvantageous institutional system, and limited opportunities. The essence of these opinions is that the principle of the supply of diverse social resources should be more active to introduce "protective discrimination" as supportive policies involving the political participation, practical accessibility, and institutional protection. As more and more categories and standards of public services are created, it is increasingly important to emphasize the equity of obtaining rights. Otherwise, as more outdated technology is eliminated, marginalized groups will still be excluded.

Owing to different national conditions and circumstances, the development of social inclusion in China has been closely related to economic development. Inclusive growth is a very popular concept in China and is considered to be a reflection of the rapid but unequal development over the last decades. Since it was first proposed by the Asian Development Bank in 2007, this term has also been used by the former President of China Hu Jintao, who explained that the fundamental purpose of inclusive growth is to make sure that the achievements of economic globalization and development benefit all countries and regions and all groups of people (Hu, 2010). Inclusive growth was then introduced to the public service system as a way of realizing equal opportunities and reducing the intergenerational transmission of poverty (Xiang, 2011). During the same period, China began its smart city development plan, which is defined as a new concept and a technology-oriented model to promote the smartness of urban planning, development, management, and services by using a new generation of information technologies such as the Internet of Things, cloud computing, big data, and spatial geographic information integration.

As smart cities have developed, the accessibility and availability of information communication technologies (ICT) and smart services for marginalized has caught the attention of scholars. Many opposing opinions on social inclusion in the context of smart cities and smart transportations have appeared. Meijer and Bolívar (2016) summarized the application of smart technology, human resources as the centrality of resources, and smart governance systems among different stakeholders. Owing to the existence of the digital gap and its adverse impact on the ability of the poor to get access to information, knowledge, and other resources, there can be no final conclusion as to whether smart cities and these projects can facilitate social inclusion or even make it worse.

Proponents of smart cities like Gonçalves (2001) and Li (2016) have argued that the optimization of technology, business, and governance models could promote the fair

development of an information society and the implementation of technologies to help vulnerable groups, and provide supportive opportunities to participate in society for the poor and marginalized. On the other side of the argument, Warschauer (2004) analyzed an Irish plan called 'Information Age Town' and found that owing to the knowledge barriers caused by the digital gap, many unemployed people had trouble with receiving payments from the social welfare office and were deprived of an important opportunity for socializing. Other opponents like Lloyd et al. (2010) and Monzon (2015) have argued that marginalized groups have been much affected by factors including information poverty, the rising use cost of technical services, and ICT illiteracy, creating continuous marginalization and disenfranchisement from mainstream society and the benefits of smart cities. In comparing both sides, the factor that decides the 'good or evil' of ICTs is whether there is a knowledge barrier. Social inclusion cannot be achieved if the disadvantaged lack the knowledge to use ICTs, even if specialized policies are formulated for them.

Similarly, different development paths profoundly determine the difference in resource allocation and the order of policy beneficiaries. While optimistic scholars argue that the smart city model can promote coordination between public sectors and improve the utilization level of public services (Lu et al., 2014), critics argue that smart cities mean that citizens play a secondary role in a utopian world overseen by technocratic governments (Vanolo, 2016), as the authorities and technology providers often ignore the voices of the public in these processes (Hu & Chen, 2013). In another analysis of the 'Information Age Town' in Ireland, other well-functioning social systems were disrupted in order to make way for the showcase technology (Warschauer, 2004). In addition, as mentioned above, the blind pursuit of smart cities greatly hides other problems like inequity, imbalance, and inadequacy that fundamentally plague social development (Angelidou, 2014). As a result, the benefits created by smart cities will not necessarily be distributed to marginalized groups and lack of access can be produced owing to the development itself.

In general, the development of ‘smartness’ does not necessarily lead to social justice, as the rapidly evolution of smart operation system exacerbates the process of marginalized groups being excluded from information services. For vulnerable groups, lack of access to some smart urban services mainly stems from physical disability or intellectual illiteracy, but the policy-oriented development path may also cause their participation to be neglected. Therefore, protective support should be introduced into institutional and regulatory systems to improve their position in the distribution of social resources.

Factors	Meanings
Physical accessibility	Some special design to ensure vulnerable groups can get access to social resources physically.
Informative and intellectual accessibility	Vulnerable groups will not be excluded owing to illiteracy about information and knowledge.
Guaranteed participation	Vulnerable groups can express their attitudes.
Protective support	The other regulatory support for their capability to get social welfare.

Table 1: Factors of social inclusion for vulnerable groups in smart cities

Based on these considerations, we can define (see **Table 1**) that social inclusion in the background of modern smart cities is to ensure the physical, informative and intellectual accessibility by introducing protective support and guaranteed participation from policy-making side of smart city projects.

2.3 Defining social inclusion in the context of smart transportation

According to WHO Social Exclusion Knowledge Network, social exclusion is characterized as dynamic, multi-dimensional processes driven by unequal power relationships and then leads to unequal access to resources, capabilities and rights (Popay, 2010, p.1). Thus, there can be a deduction that social inclusion of smart transportation is that all the members in the society should have equal enough rights to participate in public transportation systems and in order to realize this goal, some special needs of marginalized groups must be concerned throughout the whole process of smart transportation like designing, purchasing, pricing and introducing.

Public transportation, as a public service, needs to be made available to all who wish to use it, especially in the context of an ageing global population and an increase in the number of people with disabilities, the positive externalities of public transport have great potential to play a role in social equity (Marshall et al, 2009). Ye (2015) makes a statement that the unbalanced development and exclusion in a relatively closed politics and institutional system had widen the gap between the rich and the poor, the urban and the rural areas, and the people who lived in the marginalized communities and rural areas got less support like medical care and public transportation. Based on this circumstance, the provision of public transportation can be indeed part of indicators within the consideration an inclusive growth. The strong practical demands make the government has to consider the needs of marginalized groups, but the demand of rapid development makes the government must reduce other expenses for obtaining a higher developing speed. As part of the fast growth, ‘a fast smartness-oriented reform in the transportation sector, particularly in the mobility service provision since 2012 (Zhang et al, 2020, p.179) and the upgradation of technology has made the smartness penetrated deeper into transportation systems. China also regards smart transportation technology as the way of comprehensive transportation development and management in the future. The principle of taking

technology and industry as the core makes the attention to the participation of vulnerable groups possibly not be regarded as a main goal. Thus, the vulnerable groups may get exposed to risks of lacking the knowledge and approach of getting involved in smart transportation system. Ranchordas (2020) argues that the premise of smart transportation projects was that transportation users were digitally literate, capable of autonomous driving, and able to afford public or private transportation, but the existence of often overlooked transportation poverty restricted the upward mobility of individuals and prevented them from exercising social and economic rights. Groth (2019, p.60) argued that one of the reasons why "transport poverty in smart mobility trends" is reproduced is the fast but unequal integration of smart transportation services excluded marginalized groups from having a suitable choice of mobility models. The tests conducted by Zhang et al (2020) in Wuhan and Urumqi found that privacy issues reduced the intensity of people's use of smart transportation information, that was, the crisis of trust and unfamiliarity would prompt the public to establish an invisible technological boundary by themselves, thereby reducing the efficiency of smart city construction. In particular, the lack and lag in the system, law, and social credibility of the rapidly developing smart transportation application can further reduce the public's trust in it (Chen,2013). Since most of the tested American cities had not completed the inclusion of vulnerable groups, Wang et al (2021) suggested to expand the understanding of underrepresented populations and build up the channels for outreach and communication to vulnerable groups when pushing forward the smart transportation projects.

Yan et al (2020) thought that there would still be loads of development of technology in smart transportation, so the future or true smart transportation would change and the society should establish the laws, rules and development mechanisms for the future, rather than leave it to technology. By placing some digital equipment and infrastructure and making some mobile application specially designed for the elderly, Padrón Nápoles et al (2020) envisaged some means to utilize bus stops and other open

space in the public transportation to make it more convenient for the elderly to obtain information services and book travel needs. Pan et al (2021) believed that when smart transportation provided services for marginalized people, it should be based on the four principles, barrier-free design in the whole process, barrier-free for all objects, systematization of barrier-free and "people-oriented" barrier-free design, respectively.

In conclusion, the essence of ensuring social inclusion in the context of smart transportation is the ability to identify the difficulties of vulnerable groups, whose needs determine the resilience and extension of smart transportation. The social inclusion of smart transportation is not just the inclusion of vehicles. The configuration of transfer space facilities, the choice of vehicles and the design of smart mobile applications can all be related to social inclusion.

2.4 Analytical framework

Following our review of factors of social inclusion for vulnerable groups in smart cities, and smart transportation, we have decided to choose physical accessibility", "informative and intellectual accessibility", "guaranteed participation" and "protective support" as the four main areas of evaluation of social inclusion in smart city transportation projects (**Table 2**).

	Factors of social inclusion
Social inclusion in smart city transportation projects	Physical accessibility for different kinds of transportation
	Informative and intellectual accessibility for transportation and smart application knowledge
	Guaranteed participation
	Protective policy support

Table 2: Framework for social inclusion in smart city transportation projects

For these specific factors, of the four different vulnerable groups in Shanghai are relevant: elderly, the disabled, pregnant women and migrant workers with low literacy as the target groups. Below we elaborate, based on our understanding of previous research literature, on our analytical framework on what is to be included when analyzing or evaluating the social inclusion in the smart city transportation projects.

Firstly, physical accessibility. For the elderly, the disabled and pregnant women (including women traveling with babies), barrier-free travel and availability of public transportation are one of their most important needs. For people with visual impairment, how to obtain real-time traffic information is very important. Therefore, the real-time broadcasting system of stations and public vehicles needs to be considered. Meanwhile, public transportation stations represented by subway stations need to consider the emergency help and special needs of relevant groups.

Secondly, informative and intellectual accessibility. With the in-depth binding of public transportation and ICTs technology, more intelligent transportation service operation has created a threshold for some elderly people and migrant workers with low literacy. Therefore, this field mainly focuses on the popularization of operational knowledge of smart APPs.

Thirdly, guaranteed participation. For vulnerable groups, whether they can participate in smart transportation projects will affect their interest expression. This exists not only in the process of project planning, but also in the follow-up feedback. Vulnerable groups are usually at the edge of society, so it is difficult for them to participate in the public opinion expression, which means that they need the special care of administrators. Therefore, we have considered the investigation of effective information feedback channels.

The last area is protective support. Different from the popularity of usage knowledge by the government and community, specialized smart APPs refer to whether these apps take into account the usage habits of vulnerable groups and their acceptance of operation difficulty. Protective constructions refer to whether smart transportation projects have tendentious support for vulnerable groups, including the transformation of old facilities and the construction of new projects.

Chapter 3: the Context of Shanghai

3.1 Defining the need of social inclusion in Shanghai

Shanghai is one of the biggest cosmopolitan cities in China. According to China's seventh national census (2020), by the end of 2020, Shanghai had a permanent population of 24.88million. And for this research, the number of elderly people, disabled people, newborns and migrant workers in Shanghai is of particular concern to us. According to Shanghai Bureau of Statistics, there are 5.33 million old people in Shanghai, including 1.51 million people aged 60 to 64, and the number aged 65 to 79 is 3 million, and 0.82 million aged 80 and above (**Table 3**). As we can see from this data that the elderly account for about 21.42 percent of the total population of Shanghai. The aging population is a common problem all over the world (United Nations, 2019). Meanwhile, we can see that the aging level in Shanghai has been relatively high. The deterioration of various bodily functions makes the elderly an important part of the vulnerable groups in society. And for the elderly, they are always "heavy-headed" when they use smart phones and other devices in smart transportation, and how to correctly use smart apps is also a big problem.

District	Total	60 ~ 64	65 ~ 79	80 and above
Total	**533.49**	**151.05**	**299.92**	**82.53**
Pudong New Area	102.78	28.84	58.43	15.52
Huangpu	32.56	9.94	17.66	4.97
Xuhui	33.48	9.11	18.29	6.09
Changning	22.42	6.51	11.92	3.99
Jing'an	36.29	10.81	19.84	5.63
Putuo	36.68	10.99	20.32	5.37
Hongkou	29.48	8.72	16.09	4.67
Yangpu	41.00	12.50	22.10	6.40

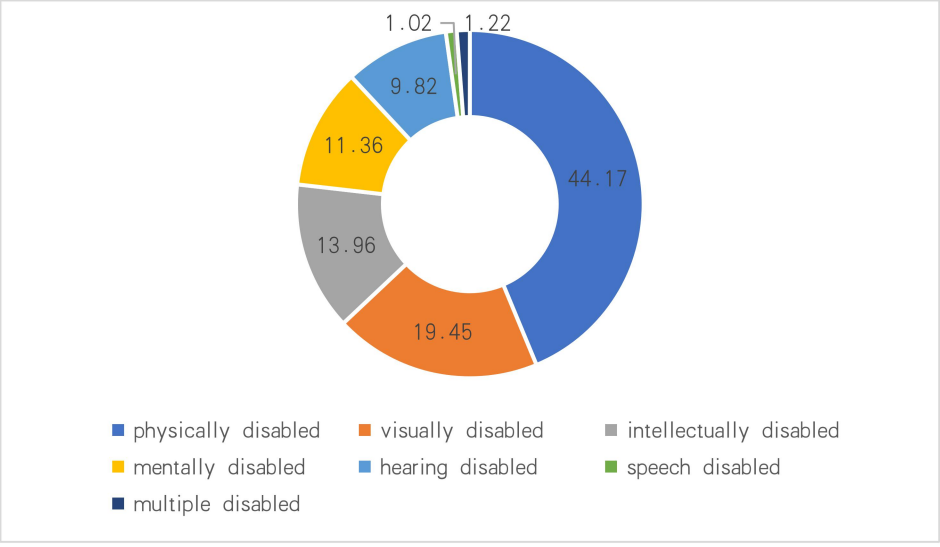
Minhang	37.90	10.16	21.83	5.91
Baoshan	38.15	11.22	21.76	5.17
Jiading	23.51	6.42	13.59	3.49
Jinshan	17.80	4.56	10.56	2.68
Songjiang	20.11	5.09	12.00	3.02
Qingpu	16.52	4.37	9.62	2.53
Fengxian	18.72	5.00	10.93	2.80
Chongming	6.09	6.81	14.98	4.30

Unit:10 000 persons

Table 3: Age structure of registered elderly population in each district in Shanghai (2020)

Source: Shanghai Bureau of Statistic.

In terms of the number of disabled people, the Second National Sample Survey of Disabled People in China (2006) shows that there are 942,000 disabled people in Shanghai, accounting for 5.3 percent of the city's total population. Based on this data, the China Center for Disability Studies at Fudan University (2015) conducted another survey on disabled people in Shanghai, and the results showed that in 2014, there were 401,300 persons with disabilities in Shanghai, among whom 44.17 percent were physically disabled, 19.45 percent visually disabled, 13.96 percent intellectually disabled, 11.36 percent mentally disabled, 9.82 percent hearing disabled, 1.22 percent with multiple disabilities and 1.02 percent with speech disabilities (**Figure 1**). Disabled people have diverse needs for smart transportation. For example, for the blind, how to get to the right subway or bus is the priority consider. And for people with mutilated limbs, how to get on and off the bus is the key.



Unit: percentage

Figure 1: The proportion of different types of disability in Shanghai (2014)

Source: China Center for Disability Studies at Fudan University

And for the newborns, according to data from the past five years (2016-2020) (Shanghai Bureau of Statistics, 2022), the annual birth population in Shanghai fluctuated around 100,000, with 130,700 in 2016, 117,700 in 2017, 98,400 in 2018, 91,400 in 2019 and 78,800 in 2020 (**Figure 2**). For newborns, the most important consideration for parents to lead them to travel is safety. Whether smart transportation can improve the safety of travel is an important factor to be considered.

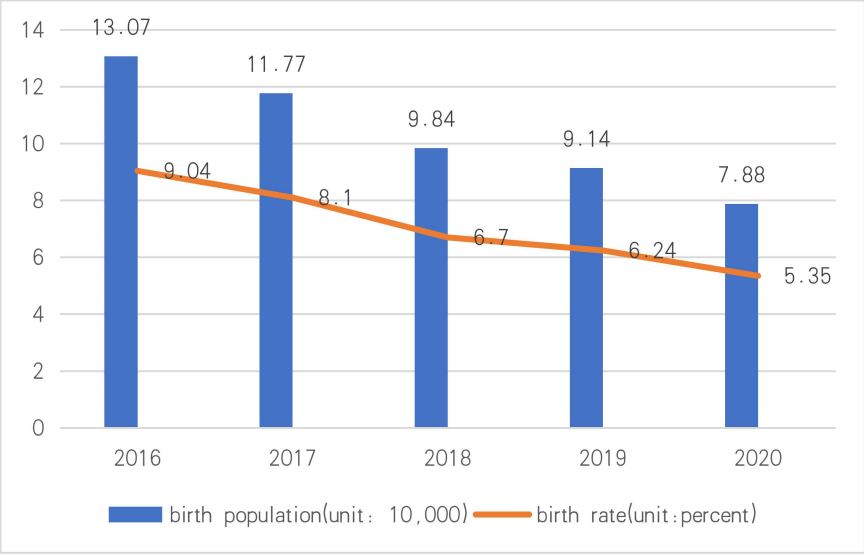


Figure 2: Birth population and birth rate in Shanghai (2016-2020)

Source: Shanghai Bureau of Statistics

In terms of migrant workers, Shanghai's migrant population reached 10.47 million by the end of 2020 (Shanghai Bureau of Statistics, 2022). From this, we can see that the migrant population in Shanghai accounts for almost half of the population. We included this group in our research because a large part of these immigrants have low education level (Yunjia et al.,2020), low acceptance of emerging things and new modes of transportation, and difficulty in understanding intelligent life style. At the same time, they maybe have low-income problem, so such groups must be taken into consideration under the social integration in Shanghai.

To sum up, for different types of vulnerable groups, although different groups have different demands for smart transportation, there are many general features, such as the convenience of getting help, the convenience of using smart transportation related software, the improvement of convenience-related facilities and so on. Therefore, we hope to define the degree of social inclusion in the construction of Shanghai smart city by investigating the location and reasonable quantity of barrier-free facilities in Shanghai smart transportation, the safety of facilities, and the convenience for vulnerable groups to use smart facilities.

3.2 The transportation system of Shanghai

As an international metropolis, Shanghai has a wide variety of public transportation routes. If we want to better analyze the social inclusion of smart transportation in Shanghai, we first need to have a comprehensive understanding of the overall transportation system of Shanghai. The following is the number of different types of

routes and other information in Shanghai's transportation system sorted out according to official information.

First of all, we want to take a look at the overall traffic situation in Shanghai. According to the statistical Bulletin of Shanghai National Economic and Social Development in 2021(Shanghai Statistics Bureau, 2022), As for subway, by the end of 2021, the city had 20 subways rail transit lines in operation, the length of which reached 831 kilometers, and 508 stations in operation. And there were 17,600 buses operating on the ground. Among them, there were 16,700 national V-standard buses and zero-emission buses, accounting for 94.4 percent of all buses in operation (**Figure 3**).

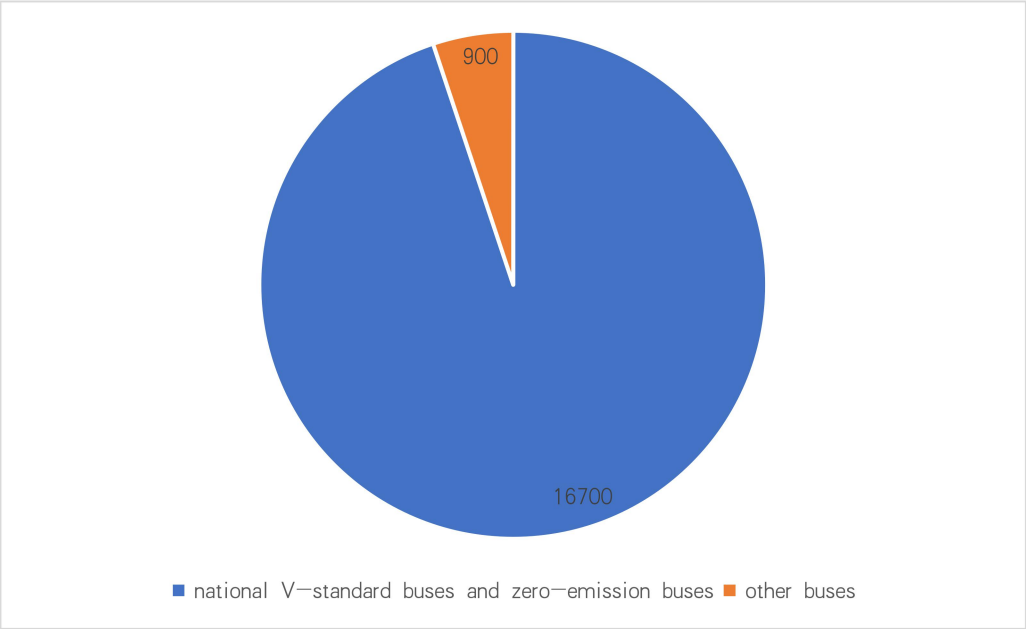


Figure 3: The number of buses operating in Shanghai
Source: Shanghai Bureau of Statistics

And there were total 1,596 bus routes in operation with a network length of 9,243 kilometers. And there were 35,300 taxis, making 202 million passenger trips a year. The total number of public transport trips was 5.106 billion, with an average of 13.9879 million trips per day, an increase of 20.6 percent over the previous year, including 3.572 billion rail transit passengers, up 26.1 percent; 1.495 billion bus and

tram trips, up 9.5percent and ferry passenger volume was 38.8949 million, up 3.1 percent (**Table 4**).

Type of public transportation	Annual	Average (per day)	Increase rate (compared with that in last year)
Total	5.11 billion	13.99 million	20.6%
Rail transit	3.58 billion	9.81million	26.1%
Bus and tram trips	1.50 billion	4.11 million	9.5%
Ferry passenger	38.90 million	0.11million	3.1%

Table 4: Shanghai public transport passenger load and growth rate (2021)
Source: Shanghai Bureau of Statistics

In addition, Yu (2022) summarized the daily passenger volume of various transportation modes in Shanghai in nearly 10 years (**Figure 4**). From it, we can see clearly that after 2016 years, as smartphones became more popular and mobile network grew, the online car-hailing taxis has became a new type of travel patterns, this travel mode compressed the traditional taxi market. It meant such as low culture crowd and the elderly vulnerable groups may feel confused when facing new way to travel. Second, we can see that the proportion of rail transportation is increasing, while the proportion of bus and other ground transportation are gradually decreasing. We can also see that in 2020, due to the impact of COVID-19, the number of travels in Shanghai has seen a big drop.

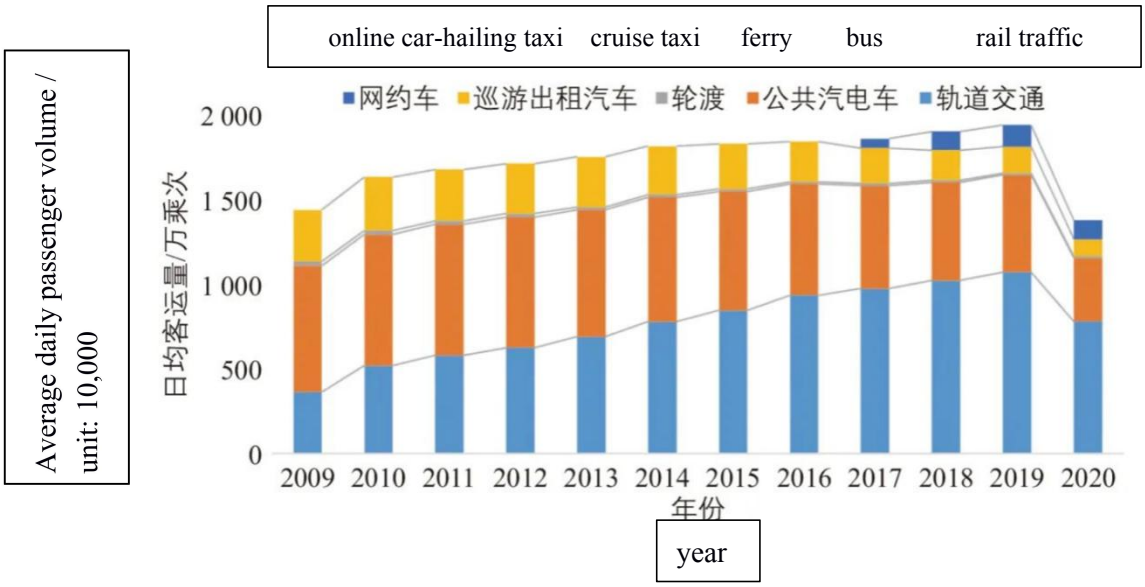


Figure 4: Average daily passenger volume of Public transport in Shanghai(2009-2020)

Source: Yu (2022)

Second, is an overview of barrier-free facilities. According to the government affairs public documents of Shanghai Transportation Association (2021), by the end of 2020, there were more than 2,400 barrier-free (low-floor) buses in Shanghai, involving 179 routes, among which 81 routes were all barrier-free low-floor buses.

In terms of plans, the government planned to renovate five barrier-free elevators, escalators and 15 toilets by 2021 in underground transportation. And as for ground transportation, 400 barrier-free buses and 100 barrier-free taxis were planned for 2021. Road traffic planned to complete 80 kilometers of blind road rectification task. In addition, Shanghai government also hoped to carry out barrier-free facilities transformation for bridge. By the end of 2021, the city has a total of 275 pedestrian Bridges (264 existing Bridges, 11 planned and under construction (including reconstruction) Bridges). After screening, the authorities found that a total of 31 flyovers need to be equipped with elevators, which they hope will be “fully installed” by the end of 2022.

Chapter 4: Research methodology

In this chapter, we present the research methods, research design, the reliability and validity of this research, ethical considerations that have been used to collect the empirical data, and limitations.

4.1 Research design

Through our previous discussion, we have described our research problems, research significance and other contents. Here we explain how we design our subsequent steps and how we collect data. Generally, research is divided into qualitative research and quantitative research. Qualitative research involves “understandings of the complexity, detail, and context of the research subject, often consisting of texts, such as interview transcripts and field notes,or audiovisual material. (Hox & Boeije, p.593)” and qualitative research involves “Data that can be described numerically in terms of objects,variables,and their values. (Hox & Boeije, p.593)” By the above description, we define our research as a qualitative research, because we conduct our research and draw conclusions based on the analysis of relevant documents and policies of Shanghai’s smart city and smart traffic in different stages, rather than using data or experiments or mathematical calculation to carry out our discussion. And there are five qualitative traditions to inquiry, which are “narrative research, phenomenology, grounded theory, ethnography, and case studies” (Lewis, 2015). We chose the case study to conduct our research (The reasons are described in detail in Section 4.3).

The next step for us is decided what kind of data we need to conduct the research. There are different sources of data, for example, primary and secondary data. Primary data are “collected for the specific research problem at hand” (Hox & Boeije, p.593).

For specific research, primary data always fit best. When the data are collected, stored it become second-hand data, and these data can be reused by other researchers. In this study, we use the secondary data. First, it is because of the conditions limitation (this explains in detail in Section 4.5). Second, we are doing the government's policy analysis, hoping to draw our conclusions by analyzing the social inclusion situation characteristics in the development of Shanghai smart city in different periods, which are very related to the government official public data, so from this perspective, secondary data is also more convenient for us to use.

4.2 Research process

As mentioned above, this paper mainly uses qualitative research. We combine the specific guidance and practice from the source like government documents, documents of disabled persons' associations and use the United Nations Sustainable Development Goals (SDGs) as the standard. According to the actual situation, we divided our case study into three periods for horizontal comparison. For the policy documents of the smart city projects, as mentioned above, this paper collected and studied the original policies of the Shanghai transportation development and transformation project after 2009, and reviews the guiding documents of China's central government after 2011. On this basis, the smart transportation projects in Shanghai were classified according to different public transportation systems, and the items in similar time periods were evaluated as a whole project. The investigation on the objectives of the projects is mainly based on the official data of Shanghai Municipal Transportation Commission and Shanghai Municipal Commission of Housing and Urban-rural Development and the bidding plan or consultation draft of each smart transportation project. Some supplementary information comes from Shanghai Jiushi Public Transport Group Co., Ltd. (operating and developing bus lines in Shanghai), Shanghai Shentong Metro Co., Ltd. (operating and developing Shanghai

metro lines) and some other companies which engage in Shanghai's smart transportation.

We also studied and summarized the press conferences, interviews and official statements of the above government departments, as well as the relevant information provided by the above enterprises, which serves as an important basis for our evaluation of the project results. In addition, data from other vulnerable groups' associations such as Shanghai Disabled Persons' Federation and Shanghai Women's Federation were also taken into account. At the same time, some material media coverage was also considered as source of information.

4.3 Case study

According to Gerring (2004) "the case study as an intensive study of a single unit for the purpose of understanding a larger class of (similar) units" (p.343). Fahai and Yingchu (2004) believed "Case study method is suitable for an in-depth and comprehensive investigation of a complex and specific problem in reality. And it is also an important way to find solutions to existing problems" (p.116). This means that, through case studies, we can delve into a phenomenon, have a deeper understanding of the phenomenon and draw our conclusions from "small to big".

In our study, we hope to make the research more practical and reality and we want it can solve some specific problems, so we choose case study. And the case comparison work of multiple cities is very complicated, and it may be difficult to compare because of cultural, political, economic, scientific and technological development level and other reasons. Meanwhile, we hope to study a city more deeply, so we only choose Shanghai as a case study.

As we mentioned above, Shanghai is an advanced international metropolis. This is where cutting-edge technological change (like 5G, internet, IoT) usually takes place. At the same time, Shanghai has shouldered the important responsibility of connecting China with the international community. This means that the changes in Shanghai can reflect the changes both in China and the international community at the same time. In addition, the complexity of Shanghai's population structure and large population base make the case study of Shanghai more comprehensive, and can also be used for reference to solve the social inclusion problems of other cities in smart transportation projects. Therefore, we decided to choose Shanghai as a case for our research.

4.4 Validity and reliability

In research, validity includes two important parts, which are internal and external (Lakshmi & Mohideen, 2013). They said that: "Internal validity encompasses whether the results of the study are legitimate... And the internal validity is also called credibility... External validity, often called 'generalizability', involves whether the results given by the study are transferable to other groups of interest (p.2752)".

As for internal validity, the documents selected for our study are from the concept of smart transportation in Shanghai raised (around 2009) to the latest documents in 2022, which is a relatively large time span. At the same time, we sort out the data and documents in stages according to China's five-year plan. And since we want to provide a relatively detailed case explanation through the case study of Shanghai and hope it can help to understand other cities' case, this is where the external validity lies.

As for reliability, Fitzner (2007) defined that "Reliability indicates that something can be measured consistently" (p.776). For this paper, the secondary data we used came

from the official websites of the Chinese government, the Shanghai government, Shanghai Transportation Commission official website, the official websites of China or Shanghai Disabled Persons' Federation, smart transportation projects related companies' official website and other influential media. When we used some documents, we also used them through other channels for secondary verification to make the data is real.

4.5 Methodological limitations

For this paper, one limitation is that at the time of writing, there is an outbreak of COVID-19 in Shanghai, so the whole city is lockdown, which makes some related institutions have staff working from home or on leave, and we could not contact some of them for first-hand information. As a result, some materials we need to use may be incomplete, and all documents and information we used from public documents or public media.

Second, the secondary data we use are all information from authoritative official websites, but because of the huge number of policy documents, we cannot guarantee that we can find and read every policy document carefully. At the same time, some of the early documents were missing due to limited search time on the official website, which led to a lack of analysis of some of the early documents.

Third, although the official programmatic documents have written the plan in great detail, some of the subsequent implementation documents are not clear or we cannot find, leading to our lack of evaluation in this aspect. In addition, the 14th Five-Year Plan involves the future, and there are some predictive elements that we cannot guarantee will be implemented in this way in the future. We can only guarantee that our research is relevant in the present.

Chapter 5: Empirical chapter

5.1 Defining the stages of smart transportation projects in Shanghai

For Shanghai, the concept of smart transportation development has been around since the 1980s. The word used in this period was intelligent, and the main measure was the introduction of Australia's Sydney Coordinated Adaptive Traffic System (SCATS). At the beginning of the 21st century, Shanghai's smart transportation has developed further, mainly by building a comprehensive transportation information platform. Electronic station board system and ETC non-stopping electronic toll collection system were introduced, which have helped build smart transportation system nowadays. After 2010, with the rapid development of the Internet, smart transportation has achieved comprehensive development, and real-time interaction and other information platforms have continued to develop (Shanghai Transportation Commission, 2018). In addition, the development of Shanghai World Expo has promoted the construction of barrier-free environment in Shanghai and accelerated the pace of international standards. Although Shanghai put forward the concept of intelligent traffic in the last century, it was only a very rough concept at that time, and it was very different from the concept of smart transportation that we discuss today. Therefore, in the following discussion, we start around 2010, when the concept of smart city was widely mentioned and the development of smart transportation in Shanghai became more modernized, as the core period of our discussion in this paper.

In addition, in China, for national economic and social development, a plan is issued every five years, known as "the Five-year Plan". The plan is similar to various white papers and plays an important role in China's periodic development. As for China, governments at all levels in China build on this foundation to formulate clearer and more enforceable plans. For example, Shanghai government formulates some policy papers for transportation based on the policies of the central government, and these

policy documents always contain criticisms of the previous five-year plan and evaluation of its completion, which are really helpful to understand the overall situation of Shanghai's transportation system.

Since there is not much mention of smart city or smart transportation before 2011, for the completeness of our discussion, we sort out all five-year plans and other policy documents before 2011 as our background in this study. And because of this period is highly related with the first stage we discuss below, we put this part into the first stage. And the first stage includes the time before and the twelfth Five-year Plan (2011-2015), the second stages include the period of thirteenth Five-year Plan (2016-2020) and the third stage includes the period of 2020-2021 and what is planned for fourteenth Five-year Plan (2021-2025). Below, we discuss in detail Shanghai's policies on smart transportation and relevant measures on social inclusion in these four periods.

5.1.1 Stage 1 (before 2015)

Before 2011, the concept of smart city had not been proposed, but because of the growing popularity of the Internet, there were some smart city related words like "informatisation" had been mentioned, and in the study of policy report, we found before 2011, these policies had obvious technology oriented, and due to the upcoming World Expo, Shanghai accelerated the pace of in line with international standards, the installation of barrier-free facilities had been explored, and from 2011 to 2015, the impact of the Expo on transportation and social inclusion in Shanghai continued to play. It can be said that through this stage, the infrastructure needed for the development of smart transportation in Shanghai has been systematically constructed. So, this stage can be seen as a fundamental stage.

Although all measures and policies taken before 2015 are collectively called Stage 1, since Shanghai officially put forward "smart transportation system" in 2011, therefore

we treat Stage 1 as two parts, namely before 2011 and 2011-2015. In the following discussion, We start with the former one.

During the tenth Five-year Plan period (2001-2005), Shanghai began to lay out rail transit and put forward the development strategy of "public transportation priority (Shanghai Municipal Traffic Management Bureau, p.19)". During the eleventh Five-year Plan period (2006-2010), Shanghai inherited the strategy of the tenth Five-year Plan, and accelerated the upgrade of the urban transportation system through the opportunity of the World Expo. The Shanghai government calculated that the city would need to handle 70 million to 80 million people a day during the Expo. Therefore, it was necessary to speed up the improvement of urban traffic system in Shanghai.

During the eleventh Five-year Plan period, Shanghai put forward four development elements for transportation planning, which are "point, line, side and block". Point referred to "promoting the construction of transportation hub (Shanghai Municipal Government, 2007, p.20)". Shanghai treated each hub as a point, and it is a base, then connect it with various transportation lines. Line meant "speeding up the construction of rail transit, bus rapid transit system and bus professional lanes (p.20)". Side was "optimizing the traffic structure of the central city, developing the traffic system of the suburbs, and speeding up the urban-rural integration construction (p.20)". And last, block stood for "promoting connectivity and sustainable development of major transport systems (p.20)". Here we can see that Shanghai's strategy in public transport layout was to gradually expand "from point to block". It had laid a good foundation for the development of the transportation system of the whole city.

Besides to laying a foundation for the overall transportation planning of Shanghai, a certain foundation has been laid for smart transportation. There are two main points. The first is that the concept of "informatisation construction" had been put forward in

this period. Specifically, passengers in Shanghai's rail transit begun to use "all-purpose card" to entry or exit the stations. At the same time, Shanghai actively promoted the rail transit and ground bus connection. In terms of ground transportation, it tried to use information technology to make bus routes more reasonable. In terms of taxis, Shanghai encouraged the construction of on-board smart systems (like guidance systems) and tried to improve the taxi system's network coverage. The second is about smart transformation. At this stage, Shanghai implemented digital transformation of some bus stops and promoted dynamic guide information service.

In terms of social inclusion, there was not much discussion before 2011. The clearest point was for taxi using, it proposed to establish a service database for disabled people and other vulnerable groups, and establish a guarantee mechanism such as telephone taxi booking and real-time priority car supply to guarantee car services for vulnerable groups.

Then we move to part 2 (2011-2015). Shanghai inherited the contents of the eleventh Five-year Plan, hoping that the transportation projects carried out because of the Expo can continue to have a follow-up effect and continue to improve the modernization of transportation in Shanghai. Compared with the eleventh Five-year Plan period, it hoped the annual growth rate of Shanghai's smart transportation system industry could reach more than 30 percent during the twelfth Five-year plan period. In this stage, Shanghai also put forward more policies to protect vulnerable groups.

According to the Twelfth Five-year Plan for The Development of Shanghai's Comprehensive Transportation system (2012), one of the most obvious was the increased emphasis on smart transportation. Besides to the "bus priority" strategy mentioned in the eleventh Five-year Plan, the term "smart and efficient" was added during the twelfth Five-year Plan. In 2011, Shanghai was listed as a pilot city for smart city development in China. Therefore, the document explicitly proposed the

plan of development of smart transportation system in twelfth Five-year Plan. It said that “All application fields of smart transportation system should be fully developed, forming the basic pattern of smart transportation industrialization.”

Specifically, Shanghai put forward at this stage to “explore the IoT technology based on RFID and other sensor technology”, and on the basis of before, it wanted to do “further research and development of electronic bus stop bus information service functions and buses arrive station forecast”. To realize comprehensive transportation information service of public transportation hub, Shanghai tried to develop public transport hub multimodal transport information service system. In addition, the document said “information services such as the Internet, telephone, television networks, radio and mobile media should be fully utilized…which can provide citizens with traffic information services, dynamic vehicle navigation, personalized travel route services, etc.” So, Shanghai could build a traffic information service chain.

With regard to social inclusion, two points are clearly mentioned in relevant documents. The first is to “protect walking space and improve walking environment. Pedestrian transportation facilities are planned and designed humanely, with minimum pavement width, and with full consideration to the needs of the elderly and the disabled.” And the second one was “Maintain good order of road traffic. Implement traffic management measures aimed at protecting children, the elderly and the disabled.” In addition, Shanghai proposed three goals to improve accessibility of public transport, which were, “basically realizing barrier-free public transport infrastructure”, “implementing barrier-free facilities in passenger transport hubs” and “implementing barrier-free facilities in bus terminals”. We can see that compared with the eleventh Five-year Plan period, the protection of vulnerable groups was expanded from taxi to traffic laws and regulations at this stage, and the protection of vulnerable groups was gradually increased.

For the whole stage, we can see that through Shanghai Expo, transportation system had a chance to have a rapid updates and transformation, and this laid a good foundation for the later development of smart transportation. And then, in 2011 Shanghai mentioned issues related to smart transportation and social inclusion and explored them in various aspects. And it was worth noting that in this stage, for the vulnerable groups, attention had been paid more and more. And this stage wanted to use technology to promote social inclusion, but not on the basis of the related groups of stakeholders-oriented. And the design of each project lacks integrity. At the same time there were some projects proposed for the World Expo, but these projects carried out too fast, lack of follow-up development and other problems. These are the reasons why we say this stage is still a start period.

5.1.2 Stage 2 (2016 - 2020)

This stage was the inheritance of the previous stage, and the implementation of the 2018 China International Import Expo, like Stage 1, promoted the further development of smart transportation.

To be specific, the construction of smart transportation in this stage still showed obvious technology-oriented. At this stage, with the continuous development of modern technology, the gradual popularization of smart phones and the further development of the IoT, the wording in policy documents also changed significantly. For example, in the document named the Thirteenth Five-year Plan for The Development of Shanghai's Comprehensive Transportation system (2016), it said that "With the rapid application of new technologies such as the IoT, cloud computing and big data, there should be higher requirements for innovative modes of traffic management and traffic policy making" and it required the related departments to meet the public's travel needs because of innovative technologies.

But the most important point of the thirteenth Five-year Plan period was the proposal to “comprehensively improve the level of smart transportation”. It can be said that during the thirteenth Five-year Plan period, Shanghai had put the development of smart transportation in a very important position. The Shanghai government proposed in the report to “provide comprehensive smart transportation services”. Specifically, there were the following points. The first was to improve the level of comprehensive traffic information services. It required relevant departments, enterprises and other stakeholders to provide comprehensive and multi-level information services covering public transport, external transport and road transport. Compared with the previous two stages, in addition to developing some previously mentioned content, such as real-time road conditions, dynamic information of bus arrival and parking, the content of “provide information exchange in the process of travel route planning” and “provide information exchange and other services in the process of hiring cars” was also added. The second was about using big data to upgrade the traffic system. Third, it was to establish industry-wide smart operations. It said “using of smart vehicle-mounted information system to improve the upgrade to promote the development of s mart transportation. Promoting the transformation of traditional transportation industry with information technology.”

In terms of social inclusion, the document at this stage proposed to “provide equitable and shared transportation resources to meet diversified transportation needs.” In order to realize this target, the problem of elderly people having difficulty taking a taxi due to their unfamiliarity with smart phones and smart taxi apps has attracted increasing attention, and Shanghai had tried many measures to handle this. For example, building more than 200 taxi waiting stations for them. In addition, Shanghai has paid more and more attention to the procurement and use of barrier-free buses.

Another interesting point to note is that since Shanghai underwent a change of government personnel in 2017, there had been some changes in the specific

implementation after 2017. To be specific, before 2017, there exited sometimes that the planning was good, but the implementation did not meet expectations. However, after 2017, various proposed projects had been rapidly rolled out, such as barrier-free elevator renovation plans in important areas (especially in central city), and barrier-free subway car procurement significantly faster than before.

In general, at this stage, the policies and implementation of smart transportation and social inclusion in Shanghai were further promoted on the basis of the previous stages, making some policies more implemented. At the same time, we can feel that Shanghai's protection measures for vulnerable groups are increasing. The whole shows a positive trend. However, the problem is that during this period, Shanghai's attention to vulnerable groups was mainly focused on the disabled and the elderly, but not on pregnant women, children and other special groups.

5.1.3 Stage 3 (2021 -)

This stage showed obvious continuity and systematic from the previous stage, and the concepts of smart transportation and social inclusion were further expanded, showing more humanistic care and showing obvious progress. Because this stage is the latest one, the documents for this time period is the largest and relatively more comprehensive than other two periods. Although the documents at this stage still mentioned the use of technology to improve the level of intelligent transportation, generally speaking, humanistic care and people-oriented thought are improved obviously.

In the document named the Fourteenth Five-year Plan for The Development of Shanghai's Comprehensive Transportation system (2021), the importance of smart transportation has been raised to a higher level, and it said that Shanghai should "vigorously promote the deep integration of digitalization and transportation industry, and promote intelligent and digitalization of transportation facilities, travel services

and traffic governance." In addition, it was proposed that Shanghai should focus on the development of smart city, actively build a new model of smart transportation services, and improve the modernization level of comprehensive urban transportation management.

In terms of measures to promote the construction of smart transportation, in addition to continuing to promote the construction of electronic bus stops in previous stages, it was clearly proposed to achieve full coverage of real-time bus arrival forecast services in the central city and five new cities areas. The most up-to-date point was that smart transportation should be integrated into new infrastructure in the transportation sector. The report called for smarter transport infrastructure; it said Shanghai should accelerate the integration of the IoT, 5G and other technologies with transport, and promote the simultaneous planning and construction of new facility awareness systems and infrastructure. Finally, there was something interesting in the report, which mentioned speeding up talent training and selection in the field of smart transportation, and positioning smart transportation as a key field. We can see that Shanghai has paid more and more attention to the development of smart city and smart transportation, which is not only reflected in the upgrading of transportation system and other hardware equipment, but also in the emphasis on talents.

In this stage, social inclusion of smart transportation was more humanized and covers a larger range. In the document, it said "to form a high-quality transportation environment for all-age friendly and barrier-free travel, so that citizens can feel the temperature of urban traffic in efficient and safe travel", which meant that besides the elderly and the disabled, the previously neglected needs of infants, children and pregnant women, they would also be taken into account for smart transportation development. The guidance document clearly put forward, "strengthen the construction of barrier-free environment and suitable for aging transformation, pay attention to the effective and orderly connection with other modes of transportation",

and “realize convenient sharing in operation organization, passenger transport service, information service and other aspects.” At the same time, from the taxi side, we can clearly see the continuity with the previous phase. For example, some documents clearly put forward the idea of “forming a situation of joint development of cruise taxis and online ride-hailing taxis, and improving the unified dispatching service platform of cruise taxis”, which obviously echoed the policy of facilitating taxi taking for the elderly in Stage 2.

In order to make relevant policies of the four stages more intuitive and convenient for comparison, we sorted out the important contents of the policies (Table 5). It can be seen that smart transportation in Shanghai is developing gradually, and social inclusion is also being attached great importance in this process. But there are still some problems to be solved.

Period		Smart transportation	Social inclusion
Stage 1 (Before 2015)	**Part 1**	Background of “Informatization” has been proposed 1. Develop digital transformation of bus stop signs; 2.Promote ride dynamic guide information service.	Care for the disabled begins 1. Establish a service database for the disabled and other special groups. 2.Establish a guarantee mechanism such as telephone car booking and real-time to ensure car services for special groups.
	Part 2	The beginning period “Smart transportation system” has been used and very rely on technology 1. further research and development of electronic bus stop bus information service functions and buses arrive station forecast 2. development of public transport hub	There are several policies mentioned 1. Ensure the minimum width of sidewalks, with full consideration to the needs of the elderly and the disabled 2. Implement traffic management measures aimed at protecting children, the elderly and the disabled

		multimodal transport information service system 3. usage of Internet, telephone, television networks, radio, mobile media, etc.	
Stage 2 (2016-2020)		The developing period Propose the idea of comprehensive construction of smart transportation Very rely on technology 1.use information exchange in the process of travel route planning 2. provide information exchange and other services in the process of hiring cars	More attention is paid to the vulnerable groups 1.build more than 200 taxi waiting stations for elderly. 2. pay more and more attention to the procurement and use of barrier-free buses
Stage 3 (2021-)		Higher status Involving a wider range of coverage 1. achieve full coverage of real-time bus arrival forecast services in the central city and five new cities areas 2. smart transportation should be integrated into new infrastructure in the transportation sector 3. speed up talent training and selection in the field of smart transportation	A wider range of coverage 1.besides the elderly and the disabled, the previously neglected needs of infants, children and pregnant women are also taken into account for smart transportation development 2. form a situation of joint development of cruise taxis and online ride-hailing taxis 3.improve the unified dispatching service platform of cruise taxis

Table 5: Summary of smart transportation and social inclusion in four periods

In summary, throughout Stages 1-3, there has been a relative focus on the development of technology and industry-oriented industries. Therefore, Shanghai's transportation planning, including smart transportation planning, is more inclined to

the basic development of technology and industry, and less consideration has been given to the inclusion of vulnerable groups from a humanistic aspect. However, in recent years, with the continuous improvement of the economy, rising expectations for standards of living, and the continuous attention given to humanistic care and other aspects, China has paid more and more attention to vulnerable groups and their social inclusion, which led to the increase of social inclusion during Stage 3.

5.2 Social inclusion in smart transportation projects

5.2.1 Physical accessibility

5.2.1.1 Stage 1

In 2003, Shanghai took the lead in promulgating and implementing 'the Administrative Measures of Shanghai Municipality on the Construction and Use of Barrier-free Facilities' in China. In 2006, Shanghai traffic management department (now known as Shanghai Municipal Transportation Commission) proposed for the first time to improve the humanized service level of the transportation department in the field of waterway passenger transportation in Shanghai by improving the barrier-free passage for the blind. In 2007, Shanghai issued the first regulations on the management of barrier free taxis, and introduced the concept of barrier free taxis in Shanghai. It mainly makes standardized management for the modification of existing taxis, and does not directly introduce professional barrier free taxis. Since 2008, Shanghai has used social security cards in public transportation to give free access to the registered residence population aged 70 or above during the off peak hours (the policy was stopped in 2016). Overall, as the beginning of Shanghai's exploration of social inclusion in the development of public transportation sector, Shanghai tried to

extend the experience of other developed cities in inclusive transportation development to its transportation during this period.

A very noteworthy event was that Shanghai hosted the World Expo in 2010. As a window for China's opening to the outside world and its modernization, Shanghai launched the '600 day action plan for welcoming the World Expo', and carried out barrier-free transformation and new construction of municipal and transportation facilities such as public toilets, pedestrian overpasses and urban roads, so as to facilitate the disabled and the elderly and display the achievements of Shanghai's urban civilization development. For example, in February 2009, Shanghai traffic management department proposed to update 4000 buses and build 3400 waiting kiosks with complete functions and beautiful appearance before the Shanghai World Expo in May 2010, and basically realize the information system of public transportation operation service and supervision in Shanghai through the information and smart public transportation management system. Another example was the introduction of 110 barrier-free passenger cars in Shanghai at the end of 2009. Therefore, at that time, the main goal of Shanghai transportation department was to quickly update and transform the traffic facilities in the central urban area with the Expo Park as the core, while the integration of social inclusion in the level of system and management norms was relatively lagging behind. In addition, because some projects were carried out in a hurry before the World Expo, even if objectively speaking, the development speed of these projects was very high, the effect was still low. For example, there were more than 10000 buses in Shanghai, and the introduction of 110 barrier free buses accounted for less than 1%. However, although the concept of smart transportation has not been fully defined, Shanghai has shown its consideration of social inclusion, and some of its hasty projects have objectively achieved contact with social inclusion.

Immediately after the WorldExpo, in 2011, with Shanghai being listed as a pilot city for the development of smart cities in China, the "12th Five Year Plan" of Shanghai officially began. Shanghai clearly put forward the smartness of "comprehensive transportation" and proposed to improve the ability of comprehensive transportation organization, operation and management through the development of smart transportation technology and industry. It also clearly stipulated the humanized planning, design and guarantee of "pedestrian transportation facilities", but it did not fully consider introducing smartness into the support for vulnerable groups. Therefore, it can be seen that the "'12th Five Year Plan' of Shanghai Comprehensive Transportation Development" shows obvious technology and industrial development orientation, rather than stakeholder orientation based on relevant groups. However, it is undeniable that the earlier development had established a solid foundation for Shanghai's smart transportation system. Before the start of Shanghai's "12th Five Year Plan", more than 10000 buses in the city had installed and used the on-board smart system, basically realizing smart dispatching. Based on the consideration of the future development of public transportation system, it gradually met the needs of vulnerable groups in the future development of public transportation system.

In the "12th Five Year Plan' of Shanghai Comprehensive Transportation Development", it puts forward three objectives to improve the accessibility of public transportation, namely 'basically realizing the accessibility of public transportation infrastructure', 'implementing the construction of barrier-free facilities of passenger transportation hub' and 'implementing the construction of barrier -free facilities at the beginning and end stations of public transportation'. However, this does not mean that Shanghai has accelerated the replacement of barrier free buses for non barrier free buses. Compared with the speed of less than one and a half years between 2009 and the first half of 2010 when Shanghai purchased 110 barrier-free buses, Shanghai only added nearly 800 barrier free buses in the next eight years from 2011 to 2018. Obviously, the replacement project of barrier-free buses did not receive the attention

of the Shanghai Municipal Government, especially compared with the fact that there were five new subway lines built up within these eight years. In 2014, Shanghai began to introduce special barrier-free taxis. Similarly, in the form of small batch introduction as a pilot, the number of vehicles introduced in the first round in Shanghai was 50, while the whole plan of the first batch was only 200. Compared with the number of more than 40000 taxis in the city, the barrier free exploration of taxis in Shanghai also shows the characteristics of fast start but slow follow-up development. Until 2020, the barrier-free taxis in Shanghai still stay in the original procurement plan of 200 taxis. Another feature is that the 50 barrier-free taxis purchased in the first round are models with relatively luxurious prices and relatively high operating costs. Even if the price was unreasonably higher than that of ordinary taxis, there were losses in the subsequent operation process. By 2017, all the vehicles purchased in the first round withdrew from operation and were replaced by more economical models. During this period, the replacement of other comprehensive transportation fields, such as subway, ferry and other barrier-free vehicles, also began to be explored, but it did show the problem of insufficient follow-up development, which even continued to the next stage, the 13th Five Year Plan. To it credit, compared with the insufficient supply of physical accessibility, Shanghai has realized the development of barrier-free vehicles in terms of systems and norms. For example, Shanghai formulated and promulgated the regulations of Shanghai on the administration of barrier-free taxis in 2015.

During this period, the technology-oriented development mode of smart transportation in Shanghai also innovatively applied smart transportation technology in other fields to help vulnerable groups obtain transportation services. With the continuous emergence and development of taxi online applications, the way of waiting a hand to hail a cab, which is used mainly and habitually by the elderly and technical illustrate, was negatively affected. In 2015, Shanghai took the lead in cooperating with relevant taxi service companies to jointly build off-line on-board

transportation service stations. This smart transportation technology was first applied to hospitals, business districts and communities. Vulnerable groups can complete orders and reservations offline and complete online call services through Internet information technology. This project was even ambitious to complete the construction of 500 offline network stations in less than one year. However, like other projects mentioned above, its exploration speed was obviously faster than its follow-up development speed. Due to high management cost, initial investment and modification difficulty, this plan was obviously out of touch with reality. Other relevant was that due to the different construction periods of different subway lines, the new subway lines and expanded subway stations have introduced the design of social inclusion, but the reform of existing subway stations began gradually after 2014, and subject to the construction difficulties brought by the existing design, the progress of reconstruction was even significantly slower than that of new stations.

In general, Shanghai has made clear the position of the concept of social inclusion in the comprehensive transportation development in the 12th Five Year Plan, and the support for the physical accessibility of vulnerable groups has also been explored in various means of transportation. However, compared with some projects that developed rapidly before the Expo, whether continuing the former or new projects, their speed has slowed down significantly. Therefore, we can say that the Stage 1 of Shanghai's comprehensive transportation development guided by the technological and industrial development of smart transportation has consideration of social inclusion, which was basically a comprehensive exploration of the application of social inclusion in the development of smart transportation. However, the design of various projects lacks integrity, and the follow-up development of the project lacks coherence and continuity.

5.2.1.2 Stage 2

Similar to the 12th Five Year Plan, Shanghai has also shown obvious technical and industrial orientation in the beginning of its 13th Five Year Plan. The positioning of smart transportation in citizens' daily travel was revised to meet diversified and high-quality transportation demands. It is worth noting that from this period, especially after 2017, Shanghai has increased its consideration of public suggestions and proposals from deputies to the National People's Congress and members of the CPPCC. As Shanghai has increased the control of taxi parking for a long time, it became difficult for the elderly who are not used to using smart transportation applications to obtain taxi services. At the same time, the plan of offline network station appointment was subject to cost and technical difficulties and has not been promoted in the follow-up. Therefore, the difficulty of taking a taxi for the elderly has attracted more and more attention. In a sense, the reason for this problem was not only the 'smart divide' brought by smart transportation, but also the negative effect brought by Shanghai in solving the problem of road congestion in some sections and illegal taxi behavior. For this man-made trouble, Shanghai has rearranged the temporary taxi parking locations in the urban area since 2017, focusing on commercial outlets, schools, hospitals and other areas to serve the elderly, children and patients in need. On the other hand, taking advantage of the progress of smart transportation technology, Shanghai has restarted the project of developing taxi waiting stations with information-based taxi Hailing function after 2019. By the end of 2020, more than 200 taxi waiting stations have been built in the central urban area of Shanghai, basically covering important commercial and public service areas in the urban area, which has greatly improved the problem of the difficulty to use taxis for vulnerable groups. In addition, this plan took into account the needs of passengers who were not good at using mobile apps. Through the application of voice recognition and broadcasting technology in smart transportation, it finally realized the function of 'one-click call'.

2017 is a very important time node for both China and Shanghai, when the Chinese government held the 19th National Congress of the Communist Party of China, and the Shanghai municipal government also held a new term, new governors brought a new concept of development. In the second half of 2018, Shanghai held the first China International Import Expo, which also had an impact on Shanghai's smart transportation projects similar to that of the 2010 World Expo. In terms of the barrie-free vehicles policy mentioned above, Shanghai renewed its attention to them in early 2018 and accelerated the procurement and use of barrier-free buses and subways. By the end of 2020, more than 1500 barrier-free buses had been purchased in Shanghai, making the coverage of barrier free buses in the city reached more than 20%, involving 179 lines, of which 81 lines were equipped with barrier-free low floor vehicles. At the same time, in the procurement of subway trains and the renovation of Huangpu River cruise ships and ferries, Shanghai has also made clear the accessibility requirements to ensure that they are convenient for the disabled. In addition, the lack of barrier free facilities in old subway stations, which has been criticized since the 12th Five Year Plan, also received renewed attention in 2017 as barrier-free elevators and toilets were gradually installed in subway stations and important transfer stations in some central urban areas. As of 2019, 24 toilets and 14 barrier free elevators have been renovated in Shanghai, and portal gates have been fully promoted in the newly-built subway stations. It was planned that the vehicles newly purchased and operated on the new line would all be barrier-free trains. This renovation project was continued and extended to other traffic areas in the next '14th Five Year Plan', such as pedestrian overpasses and underpasses. As some old stations and traffic facilities are difficult to transform and lack of space, the principle adopted is 'if it can be transformed, it shall be included in the transformation plan'. In addition, Shanghai also tried to launch 'mother and child seats' on buses to serve parents with babies, but the social response was poor after the launch, and all the projects were subsequently cancelled.

In general, Shanghai has shown a change in the 13th Five Year Plan, that is, before 2017, all projects continued from the 12th Five Year Plan were only relatively slow development. After 2017, its inclusive smart transportation projects have been paid more attention and maintained rapid development, which is greatly affected by the new governors. In terms of results, after 2017, Shanghai's smart transportation projects put great emphasis on inclusive support for vulnerable groups, with the most projects involving the elderly and the second projects involving the disabled. Therefore, at this stage, the social inclusive of Shanghai smart transportation projects can be mainly characterized by re-entering the track of rapid development, and the project obviously ensures the physical accessibility of relevant vulnerable groups to public transportation services, covering the most important vulnerable groups. Of course, they also had some shortcomings, showing a policy preference for the elderly and the disabled, and insufficient attention to pregnant women and mothers with babies.

5.2.1.3 Stage 3

"'14th Five Year Plan' of Shanghai Comprehensive Transportation Development", which began in 2021, clearly shows the inheritance and development for the main projects above-mentioned in the 13th Five Year Plan. For the first time, barrier-free and aging adaptation development have been included in the working document, and the service and support for vulnerable groups have been re and systematically emphasized. First of all, Shanghai has maintained its continuous attention to barrier-free vehicle projects. Shanghai has completed the replacement of 400 barrier-free buses in 2021 and set the goal of adding 1000 barrier-free buses in 2022. The barrier-free cab project, which was shelved for a long time, has also been restarted and there were 100 new barrier-free cabs put into operation in 2021. After the success of the smart taxi waiting station project with "one-click call", Shanghai maintained its investment in this project. In the last stage, the project was mainly

distributed in the functional areas of the urban area, so, after 2021, 100 new taxi call stations in Shanghai began to be popularized in the community, covering the whole urban area and some more developed suburbs, and expanding the distribution of hospitals in the urban area. However, the project has not yet begun to reach communities in remote areas.

Shanghai has also expanded the scope of inclusive transportation development, taking into account the traffic needs of the blind in subway stations for the first time, and completed the reconstruction and repair of blind roads in nearly 300 subway stations. Before that, Shanghai's attention to the blind road was limited to whether the blind road on the sidewalk was occupied. At the same time, the reconstruction projects of other barrier-free facilities in the subway station have also been promoted. In 2021, reconstruction projects including a total of 5 barrier-free elevators and escalators and 15 toilets have been implemented. Continuing the focus on barrier-free facilities, a new barrier-free project focuses on the barrier-free and aging transformation of pedestrian overpasses. In fact, Shanghai Municipal Transportation Commission received the proposal of barrier-free reconstruction of pedestrian overpasses in some sections in 2018 and responded in the same period. After nearly two years of investigation, Shanghai Municipal Transportation Commission completed the investigation on the conditions of 264 pedestrian overpasses in the city. It was found that there were no elevators and escalators installed in near half of which. Then, from February 2021, Shanghai began the first batch of reconstruction plans for 38 old pedestrian overpasses, which are mainly distributed in key areas such as the central urban area, around transportation hubs, around large hospitals, main commercial areas and large residential areas. In contrast, pedestrian overpasses in suburbs and some communities have not been paid attention to.

Comparing the inclusive smart transportation projects of Shanghai in Stage 2 and Stage 3, we can point out that they have obvious continuity and systematicness, and

the concept of social inclusion of smart transportation has been further developed and refined. However, in addition, Shanghai's smart transportation projects have obvious preferences for urban areas and central towns, and the physical accessibility of vulnerable groups in suburban and rural areas where the development level of public transportation itself is not high is obviously insufficient.

Period	Performance of Shanghai smart transportation projects in physical accessibility of vulnerable groups
Before 2010	(although they are not smart transportation projects under the concept of the smart city) The speed of implement of social inclusion and development of projects was fast, but the effect was far from enough owing the shortage of time.
Stage 1	This period basically completed a comprehensive exploration of the application of social inclusion in the development of smart transportation. However, the design of various projects lacks integrity, and the follow-up development of the project lacks coherence and continuity.
Stage 2	There were a swift that before 2017, the physical accessibility of vulnerable groups has not been significantly improved, but it has been highly valued and developed since 2018.
Stage 3	There is obvious continuity between this period and the previous stage. The physical accessibility of vulnerable groups has been further improved, but the vulnerable groups in suburban and rural areas have not been significantly improved.

Table 6: Performance of Shanghai smart transportation projects in physical accessibility of vulnerable groups (based on different period)

Shanghai has shown some similarities and differences in the three stages after entering the smart city development, and its performance in the physical accessibility

of vulnerable groups is also different. The same characteristics are that, first of all, each stage shows an obvious driving role of major events, which means that if major events exist, the social inclusion of Shanghai's smart transportation projects will develop rapidly, while on the contrary, the speed will decrease significantly. Secondly, technology and industry-oriented smart transportation projects can innovatively apply technology to improve the physical accessibility of vulnerable groups. In addition, even if the guiding document does not necessarily further emphasize the concept of social inclusion, the scope of social inclusion of Shanghai's smart transportation project has been expanded at different speeds at each stage. What's more, the inclusive smart transportation project in Shanghai shows an obvious preference for the urban area, which may further weaken the physical accessibility of vulnerable groups in the suburbs. The difference is that, first of all, the first and second periods put great emphasis on the development of smart transportation technology, while in the third period, it emphasized the responsibility of smart transportation projects to citizens. Secondly, the development of social inclusion of smart transportation in Shanghai has slowed down significantly in the 12th Five Year Plan and then affected the 13th Five Year Plan. However, since the new mayor and Secretary of the Municipal Party committee took office, it has accelerated significantly in the second half of the 13th Five Year Plan and continued to the 14th Five Year Plan, greatly improving the physical accessibility of vulnerable groups.

5.2.2 Informative and intellectual accessibility

5.2.2.1 Stage1

In 2010, which was the last year of "the 11th Five Year Plan", Shanghai Municipal Government started a barrier-free transformation project for the official website, using voice broadcasting technology to ensure more convenient access to information for people with visual impairment. At the same time, similar to Shanghai's performance

in physical accessibility, Shanghai quickly carried out large-scale construction of electronic stop boards of bus stations in the central urban area before the 2010 World Expo.

At the beginning of stage 1, Shanghai Municipal Government put forward the requirements of "timely publishing information about public transport" and "ensuring the level of information disclosure by relying on various convenience service centers, community service centers, neighborhood committees, village committees and other places" in its "key points of information disclosure of the municipal government in 2011". Therefore, ensuring the access of all kinds of people to information and knowledge has actually become a part of the goal of Shanghai comprehensive transportation development plan. In the same year, China's Central Government issued the "opinions on deepening the openness of government affairs and strengthening government services", which further took ensuring that community residents have a timely understanding of relevant public services as a guiding opinion. Therefore, Shanghai has attached importance to the guarantee of accessibility of information and knowledge in policy, which is manifested in the refinement and emphasis on different public services. For example, in conjunction with its community bus project, Shanghai Municipal Transportation Commission used its official website to register and update public transportation information such as community buses. At the beginning of 2015, the official website of Shanghai Municipal Transportation Commission launched the "barrier-free browsing" function on the home page and provided content page voice service.

In terms of publicity, Shanghai Municipal Government would choose to carry out publicity and education in communities, transportation hubs and means of transportation through open letters, posters, videos, news programs and other means in key projects. This work characteristic is not only the characteristic of a certain period, nor is it the characteristic of a certain project. In fact, any project that is

considered to be the focus of work can be widely publicized and reported. This is because compared with the special political system in the west, politics and administration are not separated, and the grass-roots organizations of the Communist Party of China are greatly embedded in streets, communities and villages. Therefore, without considering the cost, any project can exist in community publicity activities and media reports for a long time. For example, Shanghai has always been cracking down on illegally operated passenger vehicles, which has continued from Stage 1 to Stage 3, constantly becoming the main content of the government's publicity to the community and the main focus of media reports. Of course, these activities called "entering the community" are generally to popularize relevant policies and knowledge and provide voluntary care services to some vulnerable groups, although they may not be formal, regular or often, usually some special memorial days and holidays. The governor and other officials of Shanghai's transportation department are no exception and held similar activities to popularize various newly issued transportation policies to the masses. However, limited by the number of activities and an extremely large number of communities, the biggest problem of such activities is that it is difficult to cover every community and every vulnerable group.

In the face of such problems, Shanghai's solution was to rely on the grass-roots party branches of the Communist Party of China to carry out an activity called "100 party branches and 100 service stations", which aims to set up fixed liaison officers in major communities to be responsible for publicizing policy contents to local residents and collecting people's views. The initial focus of work was placed on the field of transportation, which was in the charge of the leaders of Shanghai Municipal Transportation Committee. The project sought to establish an information collection platform to make up for the slow speed of information release and reflection of problems, and cooperate with the staff from the neighborhood committee and other departments to improve the efficiency of traffic management in the urban area and reduce traffic violations. In order to ensure the smooth progress of this project,

Shanghai Municipal Transportation Commission not only carried out staff training activities, but also set up a supervision and evaluation system covering each month, quarter and year. This policy has also been further developed and guaranteed in policy in the next stage.

Thanks to the large-scale updating and transformation of buses and station shelters before the 2010 Shanghai World Expo, Shanghai has basically realized the language broadcasting in buses and the real-time arrival information updating of bus stops, and the electronic screens in some shelters have played a role in providing passengers with social public information dominated by public transport. As a product of ICTs, this project has been valued by the technology-oriented Shanghai smart transportation project and listed as three major smart transportation application terminals. For example, a smart transportation procurement project of the transportation department of Pudong New District in 2013 included the bidding for the screens of 5000 electronic stop boards. This project has continued to be valued in the next stage. Similarly, the information stop board of community buses was also required to provide basic vehicle arrival time.

Generally speaking, in Stage 1, Shanghai shows the following two characteristics in providing information and intellectual accessibility for vulnerable groups: first, whether an inclusive smart transportation project can be valued largely depends on the work focus of Shanghai Municipal Transportation Commission; Secondly, with the help of the embedding of the Communist Party of China into the society, Shanghai Municipal Transportation Commission has carried out the publicity of information and knowledge related to smart transportation projects. These two characteristics are also clearly reflected in the next stage.

5.2.2.2 Stage 2

During this period, relying on the project called “100 party branches and 100 service stations”, Shanghai Municipal Transportation Commission further developed this policy. The main change in the working mode is that senior officials of Shanghai Municipal Transportation Commission are required to engage in information publicity and consulting services in some communities at least once a week. This measure can ensure the effective operation of community information service stations at the institutional level.

In the technology-oriented smart transportation projects, by 2016, Shanghai had completed the installation of more than 1600 electronic stop boards, and the project has also reached a new round of official policy endorsement, as one of the key work objectives of Shanghai’s smart city. And with the further development of ICTs, the information provided by electronic stop signs began to include diversified information such as real-time road conditions, congested sections, driving speed and traffic accidents. Inherited from the “Shanghai public transportation” application, which was mainly developed in Stage 1, Shanghai Municipal Transportation Commission has also launched a new application called “Shanghai transportation”, so that citizens’ mobile phones can search relevant information in real time. This is the positive side of the technology-oriented development of smart transportation in Shanghai. The negative side is that the rapid development of smart transportation applications has produced "digital divisions" described by Graham (2002). Since around 2014, a number of smart taxi applications have been put into use in Shanghai. Some vulnerable groups represented by the elderly do not know how to use these smart transportation applications. After the failure of the taxi service station project in 2015, Shanghai turned to two ways to solve this problem. First, government staff went to the community to carry out knowledge popularization activities to explain to the elderly how to register and use such applications, but this action was not gradually carried out until 2018. On the other hand, it sought to work with companies

developing related applications to design a simplified operation mode to serve these people. Obviously, this mode is based on the first method. Moreover, the design of these simplified programs has obvious lag, which was far from the original. As for some smart transportation information service programs developed by Shanghai municipal government, so far (May 2022), barrier-free version and elderly version have not been developed. Obviously, Shanghai has not made enough progress in the aging of smart transportation applications.

As the previously mentioned taxi call service stations have not been further invested after the pilot in 2015, the 100 taxi call station projects implemented at the end of Stage 2 and the beginning of Stage 3 have been welcomed by many people. They have been used more than 10000 times in two months, especially 74% of the orders were completed through offline payment, which was mainly the payment method used by the elderly. Therefore, in fact, this reflects the needs of the elderly group for being included into smart taxi service. Other projects that have not received sustained attention include the tactile map of the subway station for the blind, which was piloted in 2014 to help the visually impaired eliminate the “information blind area”. Although, internationally, earlier tactile maps have appeared in Britain, the United States, Sweden, Japan and other countries, Shanghai has not maintained its continuous investment in the project in Stage 2.

Another problem that is the same as stage 1 is that from stage 2, in addition to the problem of illegal passenger transport that Shanghai has been paying attention to, another focus of attention is the most important problem fed back by the public, the difficulty of parking in the urban area. Therefore, Shanghai Municipal Transportation Committee department held large-scale publicity activities in the community and joint publicity activities with various public transportation workers almost every month. It can be said that Shanghai’s attention to these two issues has been throughout Stage 2 and continued to Stage 3. In contrast, the publicity of all kinds of new smart

transportation information had not received this degree of attention, and was usually only used as a giveaway for these two projects.

In short, on the path of promoting the information and knowledge related to smart transportation projects to be transmitted to vulnerable groups, Shanghai's practice has proved its ability to ensure that the information is effectively transmitted. However, similar to the first stage, whether inclusive smart transportation projects can be paid attention to largely depends on the work focus of Shanghai Municipal Transportation Commission. Therefore, the technology-oriented smart transportation in Shanghai is more inclined to develop smart transportation projects related to ICTs and their products, which is also consistent in the information publicity and knowledge dissemination of smart city projects.

5.2.2.3 Stage 3

At the end of 2020, China's Central Government issued the "implementation plan on effectively solving the difficulties of the elderly in using smart technology". One of the work objectives is to improve the convenience of daily transportation for the elderly, which was divided into public transportation services and taxi services. In response to this requirement, Shanghai has implemented the "1 million person time action to improve the application ability of smart technology for the elderly" since February 2021 to solve the "digital divide" of the elderly. This action has brought greater integration of social forces. The Shanghai municipal government has joined many stakeholders, including elderly care service institutions, public welfare bases and communities, to participate in the project. As of September 2021, Shanghai has completed 1502987 person times of service and completed the set work goal ahead of schedule. In June of the same year, the Shanghai municipal government announced the "'14th Five Year Plan' for the development of Shanghai's aging cause", and the transportation of the elderly was recognized as a part of the social preferential

treatment system for the elderly. It can be said that in stage 3, the elderly have received the key attention of the government in terms of system and regulation, which is in line with the growing realistic needs of aging in Shanghai. However, due to the impact of Covid-19 on Shanghai in early 2022, a large number of volunteer services and community projects failed to be carried out, and many other smart city projects were forced to be suspended.

Period	**Performance of Shanghai smart transportation projects in informative and intellectual accessibility of vulnerable groups**
Stage 0	The 2010 Shanghai World Expo gave it an opportunity to quickly carry out some projects to improve the information and intellectual accessibility of the city's traffic information.
Stage 1	Whether an inclusive smart transportation project would be valued or not largely depends on the work focus of Shanghai Transportation Commission. In addition, Shanghai Municipal Transportation Commission publicized the information and knowledge related to smart transportation projects with the help of the embedding of the Communist Party of China into society.
Stage 2	Similarly, technology-oriented smart transportation in Shanghai tended to develop smart transportation projects related to ICTs and their products.
Stage 3	The elderly have become the chief aim, but Covid-19 has affected the implementation of some projects.

Table 7: Performance of Shanghai smart transportation project in informative and intellectual accessibility of vulnerable groups (based on different periods)

In general, Shanghai's solution to the problem of information dissemination and knowledge illiteracy is constantly improving, especially for the refitting of buses, subways and other public vehicles commonly used by the elderly and their stations,

which basically achieves the coverage of information. However, the technology-oriented smart transportation in Shanghai is more inclined to develop smart transportation projects related to ICTs and their products. At the same time, like physical accessibility, the elderly have become the main target of stage 3, and other vulnerable groups have received relatively little attention.

5.2.3 Guaranteed participation

5.2.3.1 Stage 1

In the early days, the basic idea of Shanghai's public transportation policy adjustment and reform was to collect the opinions of the district transportation authorities and relevant operating enterprises and groups, complete the relevant involvement in combination with the problems reflected in the letters and visits of citizens, and then carry out publicity and opinion consultation. For ordinary citizens, the ways they can choose to participate are email and telephone. For example, through the collection of the problems reflected by the calls from the elderly citizens, Shanghai started to solve the problems such as the high temperature of the seats in the bus station in summer and the potential safety hazards caused by the excessive inclination of some seat planes. Since 2009, the official website of transportation department has opened the "director's mailbox", which was much earlier than many other cities in China, added new participation and communication channels, and made the relevant feedback results public for the first time in December 2009. By comparing the case of "director's mailbox" disclosed by Shanghai Transportation Commission, we can find two characteristics. First, the problems fed back by the public through the "director's mailbox" can effectively enter the government's work plan of the year. For example, the feedback of the people in Jiading District on the lack of sufficient public transport support for the new large residential area was included in the work plan of the same year. Second, the information disclosure of the "director's mailbox" of Shanghai

Municipal Transportation Commission has been changed to non-public after 2014, and only the sender itself can see the reply. Therefore, we lack information from 2015 on the public participation in this channel.

Similar to the "entering the community" activity mentioned earlier, Shanghai also uses this method to improve residents' participation. In fact, some government officials and deputies to the National People's Congress take the opportunity to listen to the voice of residents by going into the community. It is a consistent tradition of governments all over China. It is called "going to the grass-roots level" or "the mass line". Its purpose is to listen to the voice of the masses and convey the work content related to the lives of the masses. However, of course, the purpose of these activities is certainly more than that, and many times these activities are not fixed daily department work content, and their content and date may be fixed, but largely depends on the personal decisions of officials and representatives. At the same time, the content of the activity is not necessarily related to the work field of their department. It may only be some material donation activities or Party member league construction activities. Therefore, not every activity can bring opportunities for residents to speak. However, some officials of Shanghai's transportation department were also deputies to the people's congresses of some districts. Therefore, they participated in the Party member theme day activities held by some communities (including but not limited to the Communist Party of China, considering the dominant position of the Communist Party of China in grass-roots governance). From this perspective, deputies to the people's Congress can effectively contact the voices of community residents, especially vulnerable groups.

At the same time, in line with the activity of "100 party branches and 100 service stations" mentioned above, in 2015, Shanghai Municipal Transportation Commission institutionally launched eight rules for senior officials to contact the masses directly. Thus, senior officials of Shanghai Municipal Transportation Commission were

institutionally required to have at least one person in the community every week to conduct research, and at least one senior official directly faced the visiting masses to understand and solve relevant problems. At the same time, with the exploration of the construction of community service outlets in Shanghai, the administrative ability of Shanghai Municipal Transportation Committee was improved. Therefore, the project received continuous attention and its senior officials were then required to go to a certain outlet at least twice a year to engage in information consultation with the masses.

In addition, 2014 was the year for Shanghai to carry out the fifth comprehensive traffic survey, which is held every five years. At the same time, as the first period of the first smart transportation project and the year when the first three-year plan of Shanghai smart city was completed, Shanghai Municipal Transportation Committee asked citizens for evaluation of smart transportation projects on its official website in the same year. In contrast, the former mainly adopted the survey method of offline interview, while the latter only was by its online website. At the same time, because the relevant information has not been disclosed, information about the standard and distribution of the selected families and the proportion of families of vulnerable groups cannot be obtained through secondary data.

In general, Shanghai has no special system and policy guarantee to ensure the participation of vulnerable groups, and subject to the mechanism of information disclosure, the degree of participation of vulnerable groups is difficult to determine.

5.2.3.2 Stage 2

With the construction of new subway lines, some low-grade bus lines, which mainly operate in one certain district, were designed and put into operation under the jurisdiction of the local government. In this regard, the local government repeatedly

consulted the views of relevant streets and people along the subway line in the design of these bus lines, ensuring the participation of the people. However, due to the lack of sufficient details on how they collected relevant views and information, whether they could ensure the full participation of vulnerable groups is an unknown problem, so more fieldwork is needed to understand this mechanism. At the same time, this issue can also be used as policy suggestions, which is about how the Shanghai municipal government can improve its own information transparency.

Yet, what deserves a positive evaluation is that letters from the masses can be considered to be able to change government policies to a certain extent. For example, in 2018, due to the joint letter of the masses, the No. 776 bus line that was originally to be canceled was retained, and the No. 931 bus line that was canceled was inherited and replaced by another bus line. At the same time, after Shanghai's public transportation entered the stage of rapid development again after 2017, the voice of residents seems to be more involved in the planning and practice of urban public transportation development. For example, after the difficulty of mobility for the elderly has been paid attention, Shanghai chose to directly open new bus line and this measure has clearly improved relevant problems without considering cost investment. However, more discussions are needed on whether residents' views have really achieved a more important position. Especially considering that the speed of implementing relevant public transportation projects in Shanghai has increased tremendously after 2017, one possibility that cannot be ruled out is the increased participation of vulnerable groups was the result of the increase in the number of public transportation projects. However, in policy-making and decision-making, the disadvantages of vulnerable groups still existed. For example, expect for the representatives from government, the main participants in the consultation meeting of the research project on barrier-free environment development and rights protection of persons with disabilities were experts. Although some experts were from Shanghai Disabled Persons' Federation, vulnerable groups lacked direct participation.

5.2.3.3 Stage 3

As various projects in stage 3 are still in progress and affected by Covid-19, many activities and projects are at a standstill, but the lack of participation of vulnerable groups began to change. In March 2021, the "measures for the construction and management of barrier-free environment in Shanghai" was issued, which proposed that "when constructing and rebuilding barrier-free facilities, the construction unit can invite representatives of social members such as the disabled and the elderly to have a trial experience according to the actual needs when organizing the completion acceptance". Yet of course, this instruction lacks rigid requirements and regulations on operation practice, which is affected by covid-19. At present, this policy lacks practical cases.

Period	**Performance of Shanghai smart transportation projects in guaranteed participation of vulnerable groups**
Stage 1	Shanghai performed well in ensuring citizens' participation in smart transportation, but it lacked special institutional and regulatory guarantee to ensure the participation of vulnerable groups, and the degree of participation of vulnerable groups was difficult to determine due to the mechanism of information disclosure.
Stage 2	The influence of citizens on smart transportation projects appears to have increased, but the participation of vulnerable groups has not been directly improved.
Stage 3	Shanghai began to take the elderly as the representative to try to let vulnerable groups directly participate in smart transportation projects, but affected by covid-19, this policy lacks practical cases at present.

Table 8 : Performance of Shanghai smart transportation project in guaranteed participation of vulnerable groups (based on different periods)

In general, the level of public participation in Shanghai's transportation projects has been continuously improved. However, for vulnerable groups, although smart transportation projects related to them have always existed, it is not until Stage 3 that vulnerable groups can be guaranteed by the system to directly participate in smart transportation projects, and the elderly are still given priority.

5.2.4 Protective support

5.2.4.1 Stage 1

Since 2008, Shanghai has launched the project of free public transportation for the elderly. Owing to the vigorous implementation of this inclusive policy and wider coverage in Shanghai, the number of elderly people who took buses for free has increased from 510000 person times a day in 2010 to 795000 person times a day in 2015, showing a good coverage rate for the elderly. In addition to the most important modes of transportation mentioned above, the ferry crossing the Huangpu River, which accounts for a small share of public transport in Shanghai, also made the decision to equip professional guides at the cruise terminal to provide escort services for special groups such as the disabled and the elderly over the age of 80. In terms of policies for low-income migrant workers, the Shanghai Municipal Transportation Commission inspected and reviewed 315 transportation construction sites under construction in Shanghai according to the "implementation opinions of the Ministry of transportation on providing services for migrant workers in the transportation industry" issued by China's Central Government. Before the order was issued, Shanghai did not take the initiative to implement similar policies, which means that the low-income migrant workers were gradually concerned by the transportation department at the end of Stage 1, and so far, Shanghai has not provided any convenience and support to this vulnerable group in other transportation projects.

Considering the inferior position of this group in the social security system, they are actually excluded from Shanghai's public service system, including smart transportation projects.

However, in terms of system, Shanghai passed the "Shanghai rail transit operation service specification" and "Shanghai barrier-free taxi management regulations" at this stage, and the protective support for vulnerable groups such as the elderly, the disabled and pregnant women has been determined at the institutional level.

5.2.4.2 Stage 2

Since 2016, Shanghai has abolished the policy of free public transport for the elderly, and instead provided transportation subsidies for the elderly. In a survey, the data found that the number of elderly people taking the bus in the rush time decreased by 56%, 67.7% of respondents supported it, and in 58% said it could reduce the traffic pressure. Moreover, since the subsidy fund is not set to be used for public transportation merely, it actually becomes a direct payment for some elderly people with low travel demand. Later, in 2017, the disabled in Shanghai were also included in the public transportation subsidy system for the first time. In addition, Shanghai also started the barrier-free transformation of parking lots during this period to meet the needs of special motor vehicles for the disabled.

Secondly, another category of events similar to the publicity activity of "entering the community" mentioned above is that government staff go to the streets and communities as volunteers. Such activities include comforting the elderly and poor families; helping people with mobility difficulties get on and off the train at the station; providing one-to-one services for the elderly and the disabled to buy tickets and take the bus; and subsidizing poor students. Since Stage 2, these activities have increased significantly and continued to Stage 3, so they can be regarded as a specific

and regular “work custom” by default, but the specific content of these activities is not entirely to help vulnerable groups. For example, in 2017, the specific content of some of these activities were mainly switched into the publicity of policies against illegally operated passenger vehicles.

Third, Shanghai has always been concerned about the difficulty of passing the “the last kilometer”, which can be considered as assistance to vulnerable groups. In terms of policy, Shanghai has clearly put forward various “the last kilometer” projects, including community bus projects, to ensure consideration of the elderly, the disabled and other people with mobility difficulties. Taking a specific project as an example, the cross-road corridors project with canopy started to be built in 2018 to protect the elderly, the disabled and pregnant women from the impact of bad weather.

In addition, the management policy of illegal parking implemented in Shanghai since 2017 indeed affected the boarding and alighting of the elderly and the disabled. For Shanghai, which has a huge population and urban area, it is obviously not flexible to set up batch by batch of taxi stops and temporary boarding places through the government. Therefore, in a strict sense, Shanghai’s attention to the travel problems of people with mobility difficulties is not to protect these vulnerable groups, but to remedy the negative externalities of other policies. Similarly, there was the prohibition of tricycles in Shanghai because of its insecurity, which made it inconvenient for some elderly people who were used to shopping with tricycles. Therefore, Shanghai had to open more community bus lines to solve this contradiction.

5.2.4.3 Stage 3

In March 2021, Shanghai issued the “measures for the construction and management of barrier-free environment in Shanghai”, which promoted barrier-free environment

as the key goal of smart city development in the new stage. The policy is led by the Shanghai Disabled Persons' Federation, and transportation, housing construction, medical and health departments need to cooperate with them to complete their attention in their respective fields. At the same time, Shanghai also launched a new pilot project that was "district temperature regulation" in summer that the air conditioning temperature of the front and rear carriages of the train is adjusted to "weak cold", and the temperature of the weak cold carriage is about 2 degrees higher than that of the ordinary carriage, so as to meet the elderly, children and other frail and chilly passengers. However, due to the influence of Covid-19, many volunteer activities were forced to be suspended in 2022.

Period	**Performance of Shanghai smart transportation projects in protective support of vulnerable groups**
Stage 1	At the institutional level, the protective support of Shanghai's smart transportation project for vulnerable groups such as the elderly, the disabled and pregnant women has been determined.
Stage 2	Shanghai expanded the scope of protective policies, but some protective support is a remedy for the negative externalities of other projects.
Stage 3	At the institutional level, Shanghai has innovatively established a multi sectoral joint working mechanism to ensure the protection of vulnerable groups, and has made new innovations in the subway.

Table 9 : Performance of Shanghai smart transportation project in protective support for vulnerable groups (based on different periods)

In general, the scope and degree of protective support for the registered residence population in Shanghai are expanding, especially the innovation at the institutional level, which makes the barrier-free projects in Shanghai a systematic design. However,

low-income migrant workers have received little attention, and in fact, they are excluded from the smart transportation project in Shanghai.

To summarize all four factors in these stages, it can be found out that there are some common characteristics among each factors in different stages. Firstly, major events obviously provide great acceleration for the degree of social inclusion particularly in 2010 and 2018 when Shanghai World Expo and Shanghai Import Expo and change in government respectively happened in Shanghai. Also, Shanghai smart transportation development features smart technologies and products as the centrality because they are believed as the future solution of urban traffic management. Certainly, these development modes pushed many pilot projects to be conducted. What's more, after the implementation of inclusive projects got accelerated again since 2018, the main beneficiary group is the elderly, followed by the leg disabled, and a system of barrier-free facilities are being developed to handle with the aging Shanghai. Nevertheless, the degree of development of each factor is different. Compared with other factors, physical accessibility has constantly emphasized and more institutional mechanisms improving informative and intellectual accessibility and other protective support have been established than guaranteed participation.

Chapter 6: Analytical chapter

This paper examines Shanghai's smart transportation projects from 2011 to the present with a focus on how to develop social inclusion in Shanghai's smart transportation projects. On this basis, this chapter analyses the performance of these projects from the perspective of social inclusion.

The social inclusion of Shanghai's smart transportation projects basically involves the four factors discussed in Chapter 2 based on the existing research literature and which made up the analytical framework to study the performance of different factors in general and under four time periods. The empirical findings (**Table 10**) show that Shanghai smart transportation projects are in line with the development model of the utilization and industrialization of smart technology and relevant products as centrality defined by Meijer and Bolívar (2016).

As a result, the development of the social inclusion of Shanghai's smart transportation plan also reflects the direction of industrial development. New technologies and new ideas are used to promote pilot urban inclusion initiatives. Furthermore, the development speed of comprehensive transportation projects in Shanghai before 2010 and after 2017 is significantly faster than that in other times, showing a correlation with major events. In addition, at the end of the second phase and the beginning of the third phase, older adults have gradually become the main objective of Shanghai's smart transportation projects. This feature is reflected in every factor of social inclusion, followed by people with disabilities. Therefore, just as Shanghai determined the development of barrier-free environment in the form of a regulation, with multiple departments working to achieve this goal, the main focus of social inclusion in Shanghai's smart transportation projects has become barrier-free accessibility.

After slowing down after 2011, physical accessibility accelerated again after 2017 when the new mayor and Secretary of the Municipal Party Committee took office. At the same time, Shanghai's smart transportation plan has done the most work and demonstrated the best performance in terms of physical accessibility. By Stage 3, Shanghai had basically established a complete framework on how to protect the physical accessibility of vulnerable groups. Among them, older adults and people with disabilities received the most attention, and urban and regional centers have received more investment than suburban and rural areas.

In terms of ensuring the information and intellectual accessibility of vulnerable groups, Shanghai's ability to solve the problems of information disclosure and knowledge illiteracy has continuously improved. In particular, the use habits of older habits have been taken into account. Moreover, Shanghai has also conducted effective explorations for an institutional perspective. Relying on the embedding of grass-roots organizations of the Communist Party of China at the community level, Shanghai Municipal Transportation Commission has improved the efficiency of information dissemination, and its value has been reflected in the follow-up improvement of vulnerable groups' participation and the protective support offer to them. However, like the measures to ensure the physical accessibility of vulnerable groups, older adults have received significantly more attention than other vulnerable groups.

Due to the similarity of some working mechanisms, the measures to protect the right of political participation of vulnerable groups are similar to the means to ensure that information reaches vulnerable groups. Senior officials from the Shanghai Municipal Transportation Commission are required to go to communities to contact residents. Senior officials, such as deputies to the National People's Congress, can more effectively express the views and needs of the people in their constituencies in the political and policy-making systems. On the whole, public participation in smart transportation projects in Shanghai has been increasing during these three stages, but

due to the mechanism of information disclosure, the participation of vulnerable groups in the first two stages is difficult to determine.

As for the final factor, the scope and degree of protective support for the registered residence population in Shanghai are expanding, particularly innovation at the institutional level, giving barrier-free projects in Shanghai a systematic and scientific design. This mechanism is, in fact, a pilot to promote the direct participation of vulnerable groups. However, due to the negative externalities of some other projects, some protective support has naturally been a remedy for these negative externalities. In addition, low-income migrant workers are mostly excluded from smart transportation projects in Shanghai. Although this social exclusion is not only in the field of smart transportation, Shanghai's experience of providing a higher level of barrier free environment for older adults and people with disabilities can actually be used as a reference for formulating protective policies for other excluded groups.

Period/ Performance	**Physical accessibility**	**Informative and intellectual accessibility**	**Guaranteed participation**	**Protective support**
Stage 1	The speed of implementation was fast, but the effect of various projects lacks integrity. Follow-up development lacks coherence and continuity.	The 2010 Shanghai World Expo improved the informative and intellectual accessibility by embedding of the Communist Party of China into society.	It lacked special institutional and regulatory guarantee and also lacked enough and detailed information disclosure.	Protective support has been determined at the institutional level.
Stage 2	It didn't have significant improvement before 2017, but has been highly valued and developed since 2018.	Facilitation of informative and intellectual accessibility is related to ICTs and their products.	The participation of vulnerable groups has not been directly improved.	Some support is a remedy for negative externalities of other projects.

Stage 3	Obvious continuity exists after 2018 and physical accessibility has been further improved, but the vulnerable groups in suburban and rural areas got less than who in urban districts.	The elderly have become the chief aim, but Covid-19 has affected the implementation of some projects.	Shanghai began to take the elderly as the representative in smart transportation projects, but owing to Covid-19, this policy lacks practical cases now.	Shanghai established a multi-sectoral joint working mechanism at the institutional level.

Table 10: Overview of the empirical findings on performance of the factors on social inclusion in the smart transportation projects in Shanghai under different periods of time

The main difference between Shanghai's smart transportation projects and the model of smart technology as addressed by Meijer and Bolívar is that it is not the private sector providing the technology, but Shanghai Municipal Government (or Shanghai Municipal Transportation Commission) who is both the main buyer and provider of products and services. The purpose of this is to pursue more efficient urban smart governance. Therefore, the development model of inclusive smart transportation projects in Shanghai is guided by technology investment and infrastructure construction, with the government as the main force and society as the beneficiary, which is used to improve the support and management of urban vulnerable groups. This largely explains why Shanghai has improved the physical accessibility of vulnerable groups through a large number of infrastructure construction projects and transformation and government procurement. At the same time, since older adults are easily excluded from smart transportation systems, whether they can be included in smart transportation projects affect the management of such groups in Shanghai. Therefore, as Shanghai's ageing population increases, older adults have naturally become an important group for the government. In addition, there is the obvious driving role of major events, which can result in the rapid development of Shanghai's

smart transportation, and the development of social inclusion in these projects is related to these major events. Therefore, the development speed of smart transportation projects in Shanghai is not constant. Generally, items related to physical accessibility will get more attention because they are more intuitive and visual.

Another finding is that low-income migrant workers, represented by rural residents who come and work in cities, often have difficulty in obtaining the same rights as local citizens. In this case, the social inclusion factors related to smart transportation are obviously not suitable for this kind of people, because their identity needs to be recognized first. In other words, including them in smart transportation projects is obviously only a part of their needs, and they need to be included in smarter Shanghai as a whole. Their needs for physical, informational, and intellectual accessibility are more diverse, and their ways of participating in urban development are more specialized. Therefore, inclusive policies and special communication channels need to be set for low-income migrants as an underrepresented groups according to Wang et al. (2021).

Chapter 7: Conclusion

As a city with a complex intelligent transportation system, Shanghai's smart transportation projects have different results in various factors of social inclusion. Generally speaking, in terms of development mode, Shanghai smart transportation project is strongly oriented by smart technology and the industrialization of intelligent transportation products, so as to improve the traffic management level of the city.

In our study we have the following research question that how the social inclusion is tackled in smart transportation in Shanghai and what it takes on as characteristics during each development period? In detail, we endeavour to figure out how social inclusion is embedded in Shanghai's smart transportation development and how to understand its different characteristics in each stage. Our empirical results and analysis show that there are some common characteristics for each factors in different stages. The effects of major events can always accelerate the speed of inclusive projects especially in 2010 and 2018 when some major exhibitions and change in government happened in Shanghai. Also, after the implementation of inclusive projects got accelerated again after 2018, the main beneficiary group is the elderly, as barrier-free facilities are considered as the solution of the aging Shanghai. Besides, smart technology and its products have always been regarded as the centrality of Shanghai's smart transportation and even smart city, as they are believed as the future solution of urban traffic management. Nevertheless, the degree of development of each factor is different. Physical facilities which are mainly related to physical accessibility has constantly emphasized and more institutional mechanisms improving informative and intellectual accessibility and other protective support have been established than guaranteed participation.

Thus, when it comes to practical implications, based on our research study, we suggest four policy recommendations to better integrate the concept of social

inclusion into the smart transportation project in Shanghai. First of all, from the perspective of institution, regulations and practice, Shanghai should systematically improve the participation of vulnerable groups in smart transportation projects, so that vulnerable groups have a higher status, rather than just users of smart transportation projects. They can be participants in policy design, project designers and critics of work results. Secondly, Shanghai should maintain the design of smart transportation applications suitable for the elderly and those who lack the knowledge of using smart phones, and expand the knowledge popularization from mainly the elderly to any people with such difficulties. In addition, attention should be paid to other vulnerable groups except for the elderly and disabled people with mobility inconvenience. In other words, policies need to be further refined, and the different needs of vulnerable groups need to be carefully defined, rather than a simpler answer through consolidation of diverse demands. Shanghai's work experience in providing a higher level of barrier-free environment for the elderly and the disabled can actually be used as a reference for formulating protective policies for low-income migrant workers, so as to improve the quality of life of this huge population.

We can say that the factors of social inclusion in the smart transportation projects we discussed and analyzed are in line with the research literature, however we also see that some of the features in the context of Shanghai have been little discussed. For example, Ranchordas (2020) states that smart transportation projects set a threshold for digitally illiterate users, but based on the experience of Shanghai's taxi call stations that have located in both streets and communities, advanced artificial intelligence and speech recognition technology can help vulnerable groups overcome the limitation of their knowledge disadvantage. Also, the phenomenon like ignorance of citizens' benefits and exclusion of some vulnerable group described by critical scholars like Vanolo, Hu and Chen et al did not conform Shanghai's result. It is true that vulnerable groups play a secondary role in a utopian world created by technocratic governments, as they actually always did before, but it does not means

that the vulnerable groups are becoming excluded. We thus think that these deviations with critical school should be taken into considerations by researchers dealing with social inclusion of the smart transportation.

Therefore, when it comes to the ideas for further research, due to some factors, this study has some deficiencies and problems that need to be further addressed. The factors limiting this study mainly include the information disclosure mechanism of Shanghai Municipal Transportation Committee, the influence of covid-19 and the complexity of Shanghai smart transportation plan itself. Firstly, the information disclosure mechanism of Shanghai Municipal Transportation Committee has changed before and after, and the details of the information disclosed are insufficient, especially in the political participation of vulnerable groups. Therefore, for vulnerable groups' rights for guaranteed participation, a more rational method is to collect first-hand data through field surveys such as questionnaires or interviews. Secondly, Covid-19 in 2022 forced the termination of many projects in Stage 3 that should have been carried out normally, and some new pilot projects were difficult to collect specific practical results. Third, the Shanghai smart transportation plan covers many projects such as buses, subways, taxis, pedestrian overpasses, transportation hubs and scattered stations. Therefore, the huge plan not only needs long-term attention, but also will get better results by changing the research focus to a specific kind of smart transportation projects or a specific district.

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