An Investigation into the Ability of Transport Initiatives to Change Commuter Travel Mode Choices

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Abstract

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Private vehicle use poses a major challenge as a main contributor to climate change. A framework (Avoid/Reduce, Shift, Improve or ASI) has been developed which suggests that a broad approach is required when reducing the effect of transport on climate change. Review of the literature suggests that policy has tended to focus on the shift element of the ASI framework. This raises questions as to whether people would like to shift to public transport, and whether transport policymakers focusing on the shift element of the ASI framework is an effective approach. Further questions also remain with regard to whether the shift element is being adequately implemented. Indeed, internationally governments have tended to take a narrow approach to the shift policy which has focused on pull (incentive) initiatives but neglected push initiatives (disincentives). This thesis critically evaluates the feasibility of this focus on pull initiatives.

This is explored through a case study of New Taipei City, Taiwan, where the government is providing major investment in pull initiatives, particularly Mass Rapid Transit (MRT) infrastructure, to get people to shift to public transport. Adopting a mixed method research approach, commuter surveys and qualitative semi-structured interviews were undertaken to explore both the commuters' perspective and the opinions of key actors and critical observers of the policies implemented.

Car and motorcycle users' main reasons for using private vehicles are comprised of their dependency on using private vehicles, work-related purposes (e.g. job responsibilities, and position), and socio-economic factors. This makes changing their mode of transport difficult, when focusing on a narrow set of pull initiatives. Furthermore, there has been a lack of integration of initiatives such as the MRT infrastructure improvements with new bus services and cycleways, so their pull policies could have been stronger. Consequently, transport officials' efforts to change commuter travel behaviour are less effective than intended. A combination of pull and push initiatives may be a more balanced approach to changing people's behaviour in relation to their trip choice, and thus implementing sustainable transport interventions. However, there is likely to be a lack of political will for push initiatives.

Consistent with previous findings in the academic literature, there is a need to take a broader approach to tackling the effects of transport on climate change. This thesis has provided further evidence to support this argument and questions why policy continues not to adequately reflect the need for a more holistic approach.

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Ella Yi-Chun Lin

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Chapter 1

Introduction

1.1 Statement of the Problem

In the past two decades, many cities have experienced dramatic growth, with rapid population and economic growth occurring in these urban areas. In the world, around 3 billion people now live in urban areas (Cohen, 2006). In the last ten years, economists have pointed out that there will be a continuing increase in the proportion of the population living in urban cities, and they regard urbanization as a positive development on the path toward wealth and prosperity (Bloom et al., 2008). There is a strong correlation between urbanization and economic development; urbanization increases alongside economic growth in both low income countries and high income countries (Roberts and Kanaley, 2006). This is occurring in several rapidly urbanizing countries in Asia, for example, Malaysia has the highest gross domestic product (GDP) ($9,512 per capita) in Asia (MacKinnon and Cumbers, 2007) and the highest percentage (10.8 million) of urban population.

However, along with urbanization and economic development in Global South [1] countries (Button et al., 1993), car ownership and use have expanded throughout these countries as well. Different cities have great variations in dependence on the use of

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[1] The term 'Global South' refers to 'developing countries,' 'less developed countries,' 'less developed regions,', i.e., countries in Africa, Asia, Latin America) Mitlin, D. and Satterthwaite, D. (2013) *Urban poverty in the global south: scale and nature*. Routledge.

private cars; even for city residents with a similar level of income, their car use can be very different (Newman, 1996). Furthermore, car use has grown over time, with many households now relying on a car even for very short trips, without considering other modes of transport (Mackett, 2003).

Commuters also use the car to pick up family or carry out social activities (Hine and Preston, 2003; Schwanen and Mokhtarian, 2005). This is because the car is perceived as being cheaper and more convenient than public transport over a wide range of journey distances, and is experienced as more rewarding than the use of public transport (Mackett and Ahern, 2000). Car use is not only popular because of its instrumental functions, such as financial costs, travel time, convenience, flexibility, but also because of affective factors such as feelings of power, superiority and arousal (Steg, 2005). One of the main reasons why people use cars is for work-related purposes, even on trips of five miles or less. For example, couriers have to drive a car for delivery of goods so it would be most difficult to sway them away from car use for business and work-related trips[2] (Wright and Egan, 2000; Hine and Preston, 2003).

The considerable use of private transport such as cars and motorbikes presents a major challenge in cities, causing serious environmental problems such as the exhaust gases from vehicles at local level (Steg, 2005; Ooi, 2009). As many Asian cities are fast growing, with high levels of private vehicle use, there is thus a significant concern about personal transport emissions (Greening, 2004). Among

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[2]Commuter trips refer to those trips made to engage in work activities, not necessarily made from the home base. Susilo, Y.O. and Kitamura, R. (2008) 'Structural changes in commuters' daily travel: The case of auto and transit commuters in the Osaka metropolitan area of Japan, 1980–2000', *Transportation Research Part A: Policy and Practice*, 42(1), pp. 95-115.

all sectors, the transport sector accounts for 22-24% of global greenhouse gas (GHG) emissions, making it the fastest growing contributor (Wright, 2004). According to the International Energy Agency (IEA, 2011), every day millions of vehicles emit tonnes of vehicle exhaust gases into the atmosphere in cities around the world. CO_2 is the main contributor to global warming, accounting for around 80% of total GHG emissions, which have increased by more than two-thirds over the last thirty years (Ahmad, 2004). Among all sectors, the transport sector contributes 23% (globally) of overall CO_2 emissions from fossil fuel combustion.

Since the main source of air pollution in cities is vehicle fumes, this has become one of a range of motivations for all countries worldwide to reduce CO_2 emissions from motor vehicles (Chan and Liu, 2001). In addition, various factors have been identified affecting CO_2 emissions such as patterns of mobility, and individual lifestyle choices in Global South countries (Dodman, 2009) such as Taiwan. According to Key World Energy Statistics (IEA, 2011), in 2009 the CO_2 released in Taiwan was 250.11 million tonnes, comprising 0.86% of global CO_2 emissions and putting Taiwan in 23rd place. Personal average CO_2 emission was 10.89 tonnes, ranking Taiwan 17th among all Asian countries. Taiwan was the largest CO_2 contributor in Asia, ranking between Estonia and the Russian Federation, and higher than Korea, Japan, and the United Kingdom. Still, it is not easy to make a modal shift for travelers. Commuters have a number of fixed trips, and more trip chains for non-work activities such as shopping, childcare, and visiting friends in addition to a commute trip during the day (Curtis and Headicar, 1997; Eriksson, 2011).

There is no doubt that increased private vehicle use has had many negative effects on the environment, such as air pollution, noise, and traffic congestion. The contribution

of transport emissions to climate change is significant. To lessen these negative impacts, the reduction of cars/motorbike use is an important issue in many cities. However, alongside this deeply challenging climate change threat, many countries are also urbanizing, and becoming richer; this is generating a greater demand for private car/motorbike use.Still, in recent decades, the peak car phenomenon has led to a trend of slower growth and a levelling off in per capita car use (Goodwin and Van Dender, 2013). The phenomenon is a change from a growth to decline trend (quantitatively) in car driver miles per head annually (Headicar, 2013). This can be thus explained as personal daily travel having ceased to grow, although on average travel time, trip rate, and average car travel distance remain steady in the majority of developed economies, starting at a peak before the recession, and may be increasing in some cases (Puentes and Tomer, 2008; Metz, 2010; Le Vine and Jones, 2012; Goodwin and Van Dender, 2013; Metz, 2013). Currently, major cities in developed countries such as London and Tokyo show relatively low car use, because these cities have increased use of public transport by investing in rail-based transport (Metz, 2015). For example, the transport situation in London is that car trips reached a peak and subsequently decreased. Some private transport users have switched from using private vehicles to public transport. This implies that public transport provision such as rail-based systems may be partly effective in reducing and/or leveling off car use in developed countries, setting a good example to the Global South countries.

Many Global South cities tend to be reliant on rail-based transport systems such as Mass Rapid Transit (MRT) (often called 'Metro'), Light Rapid Transit (LRT) or Bus Rapid Transit (BRT) systems to reduce GHG emissions by private vehicles, lower congestion, and enhance the attractiveness of alternative modes of transport (Hayashi et al., 2004; Hossain, 2006; Deng and Nelson, 2011). For example, MRT systems have

long been operating in the Chinese cities of Beijing and Tianjin, and the Indian city of Kolkata. In addition, some Global South cities such as Manila and Shanghai have constructed LRT systems, whereas others such as Beijing, Delhi, Nanjing and Shanghai have put in place MRT systems. Some cities have invested in both LRT and MRT systems, such as Bangkok (United Nations *et al.*, 2008). In recent years, BRT systems, which are already operational in cities in China, Japan, Thailand, India, Indonesia, and Vietnam, have been gaining popularity in Global South cities (Great Britain. Dept. for International Development, 2006). Inevitably this raises the question: will this infrastructure-led approach be sufficient to persuade people to switch from car/motorbikes to public transport?

Since the 1990s, several researchers have indicated that the Avoid/Reduce-Shift-Improve (A-S-I) framework is a useful approach to reducing the negative impacts of motorized vehicle use (Dalkmann and Huizenga, 2010; Enkhbayar, 2011; Zuidgeest et al., 2012; Hanaoka, 2013; Bakker et al., 2014). It aims at reducing GHG emissions from private vehicles, decreasing congestion, and creating sustainable transport, as a sustainable transport system needs improvement in all dimensions such as travel demand, mode choice and technology (Dalkmann and Huizenga, 2010). `A' stands for avoiding or reducing the need for car/ motorbike trips; 'S' stands for shift, meaning use of transport transport policies to encourage people to switch their mode choices away from the private vehicles; 'I' stands for improving and targets technological innovation, including low-emission vehicles (Fujiwara and Zhang, 2013). Switching through infrastructure provision is only one element within the broader ASI framework, and ASI as a markedly expanded approach reveals the narrowness of the primarily infrastructure-led approach adopted in Global South cities.

1.2 Research aim and objectives

Owing to to the difficulty of reducing private transport use, policymakers have implemented various transport policies to change private transport users' travel mode choices. Many Asian governments have made significant financial investments in public transport infrastructure and this has provided the main focus of their transport policy. This research focuses on these narrow infrastructure-led transport projects which focus on the 'shift' element of the ASI framework.

Through considering an infrastructure-led transport policy case study, this research aims to:

- **Explore the potential for changing commuters' travel behaviour to more environmentally-friendly modes of transport:**
  - i.   **by critically evaluating transport policy attempts to increase public transport use;**
  - ii.   **by evaluating commuters' travel behaviour to discover their intentions.**

This research focuses on evaluating the potential for changing travel behaviour following public transport infrastructure investment. The case study design and analysis is informed by conceptual and empirical research relating to modal switching. Figure 1.2.1 shows that Global South cities' policies tend to be reliant on the shift element within the ASI framework, and most of them have focused on using pull initiatives related to public transport infrastructure. However, given previous criticisms that this approach is too narrow, its appropriateness is also evaluated within the context of the literature recommending that the wider ASI framework is adopted within policy development.
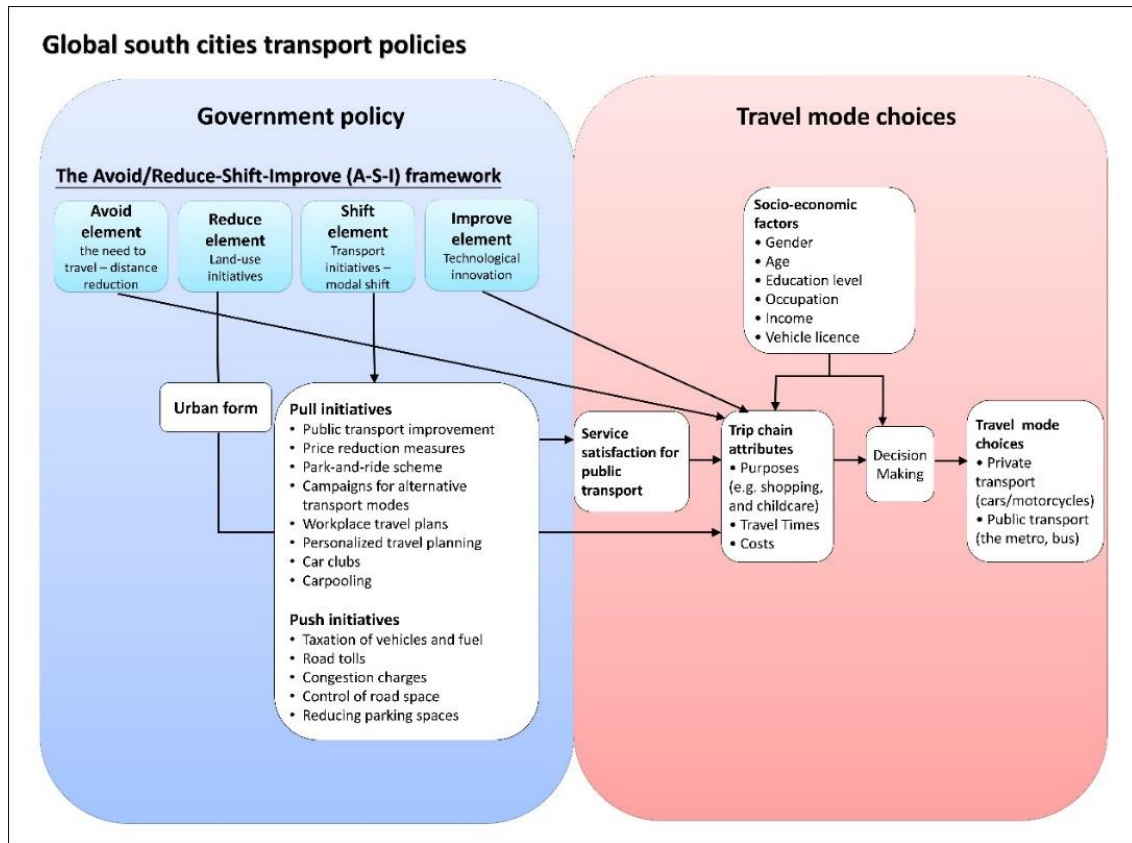
Figure 1.2.1: A conceptual framework for modal shifting in Global South cities
Source: Revised from Figure 1 of (Bamberg *et al.*, 2011: 20).

There are a number of cases of Global South Cities investing heavily in rail-based transport systems, such as MRT, LRT and BRT. For example, MRT systems have long been operational in China, such as in Beijing and Shanghai, in the Korean cities of Seoul and Busan, and in the Indian city of Kolkata (Hayashi *et al.*, 2004; Hossain, 2006; Timilsina and Shrestha, 2009; Deng and Nelson, 2011). Likewise, in New Taipei City, Taiwan, the New Taipei City Government has invested a huge amount of money in constructing the MRT Three Rings and Three Lines, which is an extension to the existing Taipei rapid transit system (New Taipei City Government, 2010). The government is constructing MRT networks, replacing traditional models of buses with more CO_2 efficient types, and improving the service quality of the public transport system. In addition, they are providing financial incentives to the public to use the metro-bus combination, such as discounts for travelling one way on the metro-to-bus

transfer, and free use of the MRT Pilot bus during rush hour. Hence, it is a typical case of this type of investment, and the research will explain the approach they are taking.

The research aims to use the ASI framework to critically examine the effectiveness of significant financial investment in the MRT Three Rings and Three Lines Construction.It is mainly looking at transport initiatives which deliver more highly on the shift element of the ASI framework, including pull initiatives, e.g. the MRT Three Rings and Three Lines construction, and the MRT Pilot Bus. On the demand side, a survey of commuters' transport choices for commuter trips, their satisfaction with the public transport system (the metro/bus), and their socio-economic factors was used in the data collection. All the quantitative survey data were inputted into a survey database for analysis. This was designed to incorporate commuting travel behaviour data for a range of modes of transport, and travel characteristics. On the provision side, interview questions for policymakers and experts were set based on the findings of the commuter survey, and the literature review. Furthermore, secondary data on related transport initiatives were collected at this stage. The policymakers' opinions and insights regarding the findings of the survey, implementing transport policy measures, and new transport infrastructures, are interpreted in detail in relation to the MRT Three Rings and Three Lines Construction, and the MRT Pilot buses. Expert interviews were thus used to understand their points of view regarding transport initiatives, to develop a crucial transport policy evaluation questioning whether this narrow approach is adequate to achieve the goal of 50% public transport use. Current public transport usage is 32.2% in New Taipei City, so it is important to find the lessons that can be learned to make current transport initiatives more effective at fulfilling the aim of having 50% of all trips made by public transport (MOTC, 2013).

1.2.1 Research design

There are three main rationales for the case study selection. Firstly, the New Taipei City Government is attempting to introduce a new extension to the existing Taipei rapid transit system, and they have invested a huge amount of money in the MRT Three Rings and Three Lines Construction as the main initiative to achieve 50% public transport use. Hence, the research seeks to address the possibility that the MRT Three Rings and Three Lines might be a substantial incentive to change behaviour.

Secondly, motorbike use has become a crucial issue to be addressed in Taiwan, because of social pressure as well as cultural challenges. The population of Taiwan is around 23 million and the total number of registered motorbikes was around 14 million in 2013 (Communications, 2013); the average household owns more than one motorbike. New Taipei City is not alone in this, other Global South cities are dealing with similar issues. For example, in Penang state of Malaysia, motorbikes and cars are Malaysians' main travel modes, with the highest motorbike ownership found on Penang Island, growing at a rate of 5.0% to 6.5% annually (Leong and Mohd Sadullah, 2007). In Vietnam, the motorbike is a dominant travel mode and outweighs car use, and mode splits for motorized two-wheelers were 60% motorbike/moped (Mitric, 2008). This demonstrates that the importance of motorbikes in Taiwan makes the study more applicable to other Global South contexts.

Finally, the case study has been chosen because like many other localities it is benefiting from the MRT Three Rings and Three Lines Construction – providing the opportunity for residents to change their behaviour. However, it has also been awarded the No.1 cleanest village in Taiwan. More than 200 environmental volunteers promote environmental protection every day in Xiufeng Village by

picking up litter and flyers wherever they see them in the streets and parks. The case study focus is an embedded unit of analysis – the He Ping Shin Jiun community of Xiufeng village. The residents living in this area may have a clearer understanding of environmental issues and more environmental knowledge than residents in other districts, and could be more likely to switch away from private transport use.

The New Taipei City Government has predominantly focused on the MRT Three Rings and Three Lines Construction, but they have not implemented push initiatives yet. It became the research's aim to examine whether pull initiatives are adequate to reduce private transport use. A mixed methods approach was thus adopted which included semi-structured interviews and the use of questionnaires to critically evaluate transport initiatives, and to examine whether this approach is too narrow to significantly increase public transport use, compared with adopting a wider ASI approach. The purpose of the interviews was to gather data from a multidimensional perspective, and so the views gathered were those of policymakers and experts such as university academics specializing in transport issues, environmental activists, and experts from identified transport consultancies. The objectives that were addressed were:

a. to assess whether the target of 50% public transport usage for all trips by completing the rail transport system in 2030 is realistic;

b. to examine whether rail transport system is the right transport policy priority for the public, and if not, why not;

c. to explore whether the MRT Pilot Bus may be an effective policy measure in shifting car users/motorcyclists into MRT trip-takers.

In addition, the commuters' surveys were designed to obtain data on their mode of transport choices, travel behaviour, service satisfaction with public transport (the metro/bus), and their thoughts on current transport initiatives. Commuters are thought to be a difficult group of transport users whose travel behaviour to change, and therefore have been less researched as a group than other transport users (Curtis and Headicar, 1997; Eriksson, 2011). It is probable that commuters strongly rely on using private vehicles, so they are not susceptible to making a mode shift. Also, they have a number of trip chains for non-work activities as well as work trips. However, given the scale of the initiative the researcher thought that if anything was going to change commuter choices a large scale initiative such as the MRT was likely to do it, and secondly if MRT is going to be successful in its target of 50% of trips becoming public service trips, some of these are going to have to be commuters' trips. So the research decided to make commuters the targeted objects for the data collection survey rather than ignoring them as a group of travelers. Motorbikes and cars are the two main private vehicles used by the public in Taiwan, while public modes are mainly the bus and metro. As a result, this research focuses on four main transport modes: motorbike, car, bus, and metro, the characteristics of these four modes, such as availability or quality, and their potential influence on commuters' travel mode choices. This is reflected in the survey objectives as follows:

  d. to investigate commuters' mode of transport choices for commuter trips, and why these choices were made;

  e. to examine the relationship between socio-economic factors and commuters' travel mode choices, and to attempt to understand why these factors have a significant effect on their travel behaviour;

  f. to understand commuters' environmental knowledge, and their thoughts

on transport initiatives.

1.3 Focus of study

In the last ten years, alongside rapid growth of the urban population and economic development in Asia, many cities have faced serious problems in responding to car dependency (Puppim de Oliveira et al., 2013). This is true of Taiwan, making it a good example of modal changes in travel and transport policies for this research. Taiwan has become wealthier, giving people the opportunity to aspire to private vehicle ownership and use, and among modes of transport, motorbike and car use now represent the largest and second-largest forms of private transport use in Taiwan. According to governmental statistics in 2013, private transport commuter trips make up 75.2% of transport use in Taiwan. Motorbikes and cars account for 49.8% and 24.2%, respectively (MOTC, 2013). The first complete MRT system was constructed in Taipei City of Taiwan, but since 2010 rapid expansion of the existing Taipei rapid transport system has been underway in New Taipei City.

In New Taipei City, use of private transport for commuter trips represented 61.2% of all transport usage in 2013. Among these, 43.9% used motorbikes as the dominant mode of transport, followed by 16.7% using cars. Public transport usage was 32.2% in New Taipei City. The MRT Three Rings and Three Lines Construction will strengthen the role of New Taipei City in the Taipei metropolitan area by activating the surrounding communities and business districts, bringing business opportunities to the locals in Taipei City, New Taipei City, and Taoyuan City. This will be a crucial investment over ten years. In 2010, policymakers designed the MRT network with New Taipei City at its centre, emphasizing the network's primary importance for the city (see figure 1.3.1). The MRT lines form

'Three Rings[3]', and 'Three Lines[4]' covering the northern, western, and southern areas (the Tamsui District, Xizhi District, and Ankeny area) of New Taipei City.

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[3] The first Ring is comprised of Wenhu Line (in brown), Ring Line Phase 1, and 2 (in yellow), the second Ring includes Zhonghe-Newlu Line (in orange), Wanda - Sulin Line (in light green), and Xindian Line (in green). The third Ring is comprised of Airport Line (in purple), Bannan Line (in Navy blue), Dingpu Section of the Tucheng Line extension (in Navy blue), and Sanyin Line (in blue).
[4] The Three Lines are Dahi tram (in indigo), Ankeng tram (in beige), and Minsheng Xizhi Line (in khaki).

Figure 1.3.1: The MRT Three Rings and Three Lines Construction

Source: Revised from (Transportation Department, 2015).

The MRT Three Rings and Three Lines will serve more than six million citizens who live in Taipei City and New Taipei City, making it easy to travel between the districts of New Taipei City (Transportation Department, 2015). New Taipei City surrounds Taipei City, and Taoyuan City is located Southwest of New Taipei City. A considerable number of commuters could effectively shorten their travel time and travel distances using the MRT. As a result, economic and industrial development and investment will keep increasing in these cities, boosting the prosperity of urban as well as rural areas (Yih-Shun, 2011). The Three Rings and Three Lines MRT system benefits a large number of citizens in the Taipei metropolitan area, not only by reducing environmental and traffic problems, but also by boosting local economic development. Regarding the policy measure of the MRT Pilot Bus, which started operating in 2011, this aimed to reduce the inconvenience of road traffic caused by the construction of the MRT Three Rings and Three Lines system. Also, it was intended to encourage the habit of using buses, and then the MRT once it had been constructed. The New Taipei City Government thus provided financial incentives to the public, who could travel on the MRT Pilot Bus during rush hour (6-7 am and 5-6 pm) free of charge. This is a common marketing strategy, and an easy promotion approach to encourage people unfamiliar with bus travel to try it (Fujii and Kitamura, 2003).

There is a wealth of literature concerning how price reduction measures are one of the most important variables to encourage the use of public transport, and are an effective policy measure in encouraging people to use public transport, because public transport demand is focused on fare changes (Bamberg and Schmidt, 2003; Bresson et al., 2003; Nurdden et al., 2007; Gärling et al., 2009). For example, intervention with free bus travel directly affects the frequency of bus use over car

use, as the lack of or reduced fare can impact habits, attitudes, and travel mode choices in the short term. Also, it was found that fare increases or decreases are related to the demands of patronage; when fares are increased, passenger numbers fall, and when fares are decreased, more passengers are likely to take public transport (Balcombe et al., 2004).

Currently, private transport users do not pay the actual costs of using private vehicles, especially the environmental costs. Some of them may not even be aware that their private transport use contributes to environmental problems. Economic theory suggests 'environmental costs associated with these emissions are externalities, since in an unregulated market car users pay no price to emit these pollutants' (Hanley *et al.*, 2013: 207). This theory can be used to evaluate transport schemes in a way which accounts for these environmental impacts. Even if changing private transport users' travel behaviour is difficult, it is likely that the MRT Three Rings and Three Lines construction in New Taipei City will be a substantial incentive to change behaviour. It will become an argument for increasing the use of public transport for trips, and could have the potential to influence private transport users' mode of transport choices.

1.4 Structure of the thesis

This section summarizes the chapters of this thesis. The study is organized into eight chapters. Chapter One sets up the research problem/issue (Section 1.1), explains the overall shape of the research and the research aims/objectives (Section 1.2), discusses the details of the case study (Section 1.3), and how the thesis has been organized (Section 1.4) (see Figure 1.4.1). Chapters Two and Three provide a review of the relevant literature. Chapter Two reviews the literature concerning car/motorbike dependency, and the relationship between socio-economic factors and travel patterns. Chapter Three discusses the ASI framework for reducing CO_2 emissions by motorized vehicles, and creating sustainable transport systems. It introduces the objectives of ASI and looks at policies which could support the shift element, and how these measures effectively make changes in the use of private transport. Chapter Four explains the methodological approach to data collection, the process of the survey design, sample collection, and interview design, to achieve the research objectives.

Chapter Five sets out the transport organization and transport policy of New Taipei City, the current transport system in New Taipei City, and the urban form of The MRT Three Rings and Three Lines Construction as well as the He Ping Shin Jiun community of Xiufeng village. Chapter Six analyzes policymaker and expert viewpoints, and considers the initiative of the MRT Three Rings and Three Lines Construction, and the MRT Pilot Bus. Chapter Seven analyzes the results of the commuters' survey data, and the relationship between socio-economic factors and travel distances, identifying commuters' attitudes towards climate change and their understanding of transport policies, as well as comparing the characteristics of samples and governmental statistics. Chapter Eight presents a critical reflection on the research findings and discussion, and suggestions for future research.
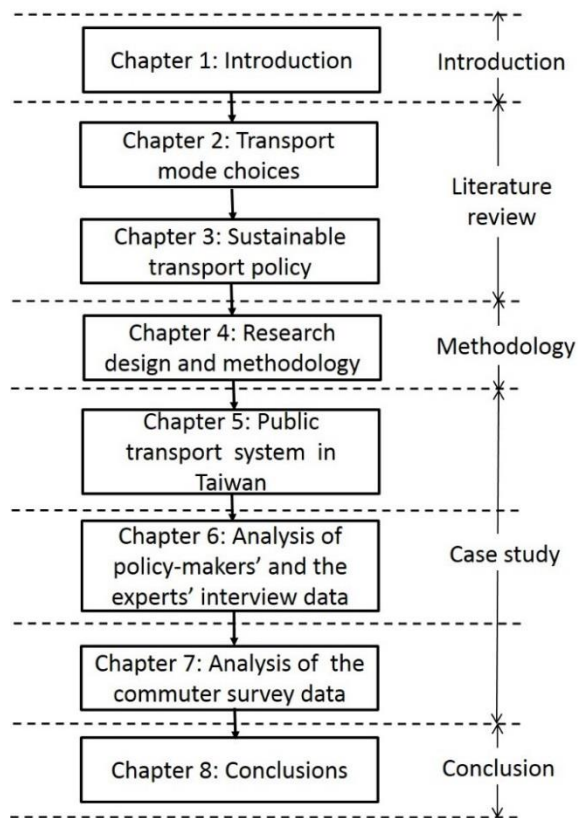
Figure 1.4.1: Structure of the thesis

The next chapter presents and discusses the literature in relation to car dependency, motorbike dependency, and the relationship between socio-economic factors and travel patterns, as well as improvements to public transport services.

Chapter 2
Travel mode choices

2.1 Introduction to the Literature Review

Chapters Two and Three provide a review of the relevant literature. Chapter Two offers an understanding of the relevant determinants affecting travel mode choices in relation to individuals' own socio-economic factors and the quality and availability of transport provision, to better reflect on the potential for influencing these choices[5] in line with this research's second aim. Then Chapter Three illustrates types of transport policy approach for reducing CO_2 emissions of motorized vehicles, and creating sustainable transport. It draws on the individual elements of the ASI framework, and particularly focuses on the Shift element, including pull/push initiatives.

Chapters Two and Three are literature reviews covering these aspects, and the two chapters are linked to each other. As part of the discussion this chapter explores why car-dependency is so intransigent, reflecting on car users and motorcyclists and the quality of public sector service provision, ahead of exploring the literature on potential policy initiatives attempting to change transport mode choices in Chapter Three.

The purpose of this chapter is to understand the relative determinants influencing the public's travel mode choices and travel behaviour. It is important to explore to what extent private transport users rely on cars/motorbikes, and how socio-economic factors e.g. income, gender, age, education, occupation and employment status, car ownership

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[5] Travel mode choice means that people choose different means of transport, such as car, bus, bicycle, train, and walking, for each trip. Bamberg, S., Ajzen, I. and Schmidt, P. (2003) 'Choice of travel mode in the theory of planned behavior: The roles of past behavior, habit, and reasoned action', *Basic and applied social psychology*, 25(3), pp. 175-187. It covers the different habits of all individuals who travel by particular modes of transport (e.g., they may go by car or by public transport) regularly in similar situations, and develop a stronger travel mode habit. Matthies, E., Kuhn, S. and Klöckner, C.A. (2002) 'Travel mode choice of women: the result of limitation, ecological norm, or weak habit?', *Environment and behavior*, 34(2), pp. 163-177.

and availability and household size/structure affect travel patterns. In addition, it is important to understand how the attributes of public transport services e.g. service reliability, comfort and cleanliness affect passengers' intentions to use public transport systems. Based on this understanding, it may be possible to change their mode choices by the Avoid/Reduce, Shift and Improve (ASI) framework (see as Figure 1.2.1; Section 1.2).

Section 2.2 illustrates the relationship between socio-economic factors and travel patterns. Car dependency and motorbike dependency are discussed in Section 2.3 and 2.4 respectively. Section 2.5 presents the attributes of public transport services which influence public transport use.

2.2   The relationship between socio-economic factors and travel patterns

A substantial amount of research suggests that socio-economic factors may affect decisions on travel behaviour in democratic societies (Stead, 2001; Stead and Marshall, 2001; Petter, 2003; Brand and Boardman, 2008; Brand and Preston, 2010; Söderholm, 2010). Travel patterns vary depending on personal characteristics, which include demographics (e.g. age and gender), socio-economic features (e.g. education and professional status), personal resources (e.g. income and access to a car) and attitudinal factors (e.g. environmental beliefs and personal norms). Stead revealed that socio-economic factors, including car-ownership as well as socio-economic group and employment levels, have the most significant impact on individuals' travel behaviour and travel patterns, and these factors explain the majority of the difference in travel patterns (Stead, 2001).

There is a wealth of UK literature showing that the difference in socio-economic factors causes the difficulty in establishing relationships between land use characteristics and travel patterns. A later study (Brand and Preston, 2010) examined household and individual levels of GHG emissions and focused on how they varied in relation to geographical area, socio-demographic factors, car ownership, accessibility, and other personal characteristics. Brand and Preston found that the relationships between outcomes (e.g. emissions, travel activity) and predictors (socio-economic and other factors) were significant. Variables associated with income, age, car availability, gender,

and household location were also significant, but others were not, especially accessibility variables.

Interestingly, several studies report that socio-economic factors are linked to each other, so it is hard to separate their effects from one to another. Stead stated that land-use characteristics account for a third of the difference for making trips, and there may also be two-way and three-way interactions between these factors (Stead, 2001). For example, the income of an individual is linked to employment status and employment type (full-or part-time), and these factors may affect car ownership and use. In addition, Stead also indicated that socio-economic factors and travel patterns are linked by one or more intermediate variables such as income, employment type, and working status. Similarly, car ownership and car use are also affected by driving licence ownership, gender, and age (Stead, 2001). The interactions between eleven socio-economic factors, namely income, car ownership and availability, possession of a drivers' licence, working status, employment type, gender, age, household size and composition, level of education, attitude, and personality type, are shown in Figure 2.2.1. The diagram is more focused on car dependence and socio-economic factors, however, we can also think about this in relation to other travel modes such as the metro, bus, and motorbikes. These socio-economic factors and their relationship to each other and to travel patterns are discussed more fully below.
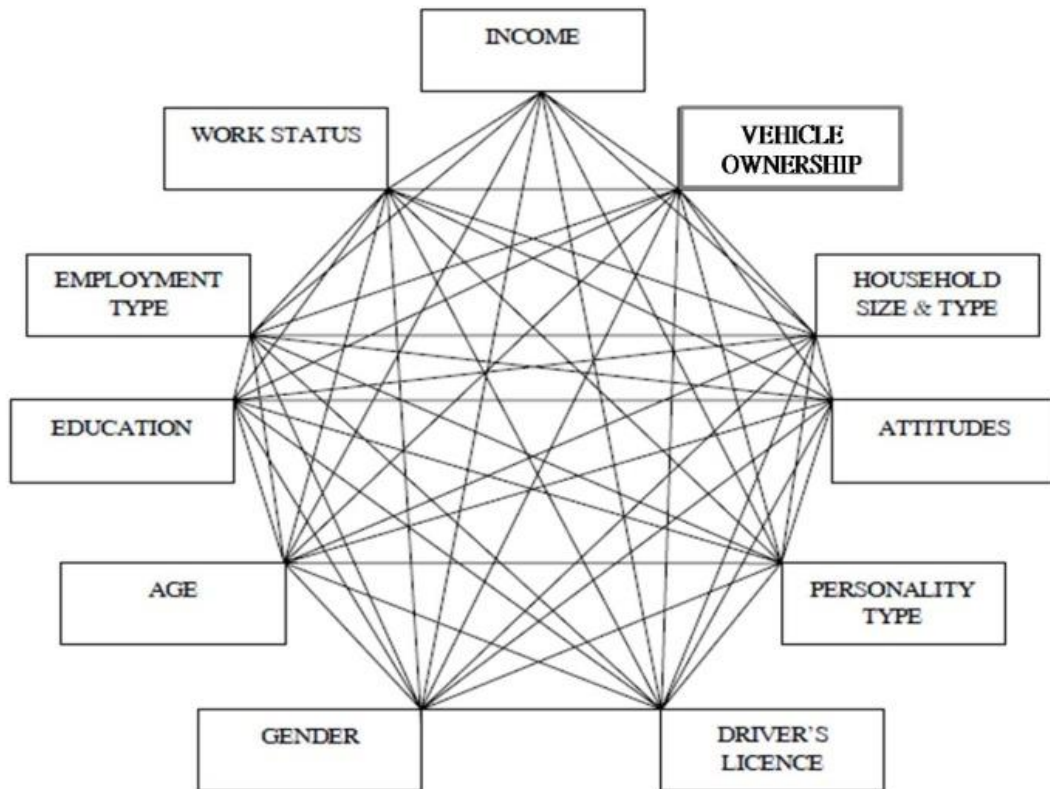
Figure 2.2.1: Interactions between socio-economic factors
Source: Adapted from(Stead and Marshall, 2001: 133).

2.2.1 Income

Travel activity varies based on various socio-economic factors, and income is highly determinant for travel patterns (Hanson, 1982; Naess and Sandberg, 1996). . For example, central offices housing higher order business activities tend to be located in cities, often at the centre of cities; higher status work tends to be located in central offices, so higher status work tends to require individuals to commute longer distances unless they live centrally (Lee and McDonald, 2003). Therefore, there is a strong correlation between commuter journey times/distances and work status, with increased work status tending to be reflected in increased commuter journey times and commuter journey distances. The same correlation exists between income and commuting distances, with rises in income correlating strongly with rises in commuter distances (Cervero, 1996). The highest income group make over twice as many trips and use cars more than three times more than people who are in the lowest income quintile group (Næss, 1993; Cervero, 1996; Carlsson-Kanyama and Lindén, 1999; Brand and Preston, 2010).

In addition, income relates to travel patterns, explaining some changes of travel patterns

in different locations. Mogridge's findings illustrated how increase in average incomes in Paris and London is related to the increased distance from central locations, although residents who lived within approximately four kilometres of the city centre were the exceptions (Mogridge, 1985). The wealthier people tended to live further from the centre so they had to travel further than the poorer. Differences in disposable income also have an impact on travel patterns because people choose to take longer or shorter trips, depending on their financial situation (Pucher, 1999). For example, high income groups make more car trips daily, because they can undertake more social trips, and travel further distances to shop (Hanson and Hanson, 1981). Likewise, a higher income enables people to travel farther for leisure and service purposes.

2.2.2 Gender

Gender is a highly significant factor in explaining work-related travel behaviour (Hanson and Hanson, 1981). Gordon concluded that women make shorter commuter trips than men due to features such as income, occupation, marital and family status, mode of travel, and location (Gordon *et al.*, 1989). They tend to have a lower income, are more likely to take lower status jobs closer to home for family reasons, and are also more likely to use other modes of transport than the car, particularly in one car households where the male partner may commute using the car. In other words, women are more likely to choose public transport and undertake trip chains than men, while men are more likely to choose a car/motorbike than women (Gärling et al., 2000). However, newer reports have found that there is no significant difference between women and men regarding commuting time and distance in some areas (Crane, 2007; Scheiner, 2010). This may be because the whole populations' travel distances depend on other characteristics of sampled individuals, such as high occupational status and car availability (Van Acker and Witlox, 2010). For example, socio-economic factors are related to who the workers are, while locational factors are related to the locations of house or work (Van Acker and Witlox, 2010; Sang *et al.*, 2011). Also, it is likely that women's working habits have changed significantly since the 80s in many countries.

2.2.3 Age

Age is another of the determinant socio-economic factors which affect trip distance. Several studies have found that young people's demands for mobility and accessibility

are increasing, although they are still lower than middle aged individuals (Smith and Sylvestre, 2001; Su and Bell, 2006). The main correlation between age and travel mode use is the rate of car trip chain, in particular people who are 40-44 years old where it reaches a peak. On average, people aged between 30 and 39 travel more than other age groups, and hence they contribute to transport energy consumption and GHG emissions at a higher rate (Stead, 2001). Interestingly, older people's data shows necessity of trips to be as high as those of young people and middle aged individuals (Golob and Hensher, 2007).

2.2.4 Education

It has been found that people with higher educational attainment levels generate increased GHG emissions through patterns of travel. When compared to household educational level at high school or lower, greater educational levels are coincident with higher emissions levels (Greening et al., 1997). This is not surprising as higher levels of education are often associated with higher level occupations, so people tend to have a higher standard or quality of life, and their personal car transport increases along with their living standard. Interestingly, educational attainment is related to home location, with higher educated workers on average having longer travel commute distances and times. Furthermore, level of education has also been related to travel frequency. Higher educated workers have longer travel distances and times than lower educated workers (Groot, 2012).

2.2.5 Employment status

It has been known for some time that employment status is an important variable in influencing travel patterns and travel behaviour, which in turn influences transport-related emissions. Employment status is one variable that can influence travel to work, and has an impact on the number of commuter trips and the amount of time available for discretionary activities (Davies, 1969; Potter, 1977; Hanson and Hanson, 1981). A study has indicated that people with higher-status occupations travel further than those with lower-status occupations, though their travel times are the same (Potter, 1977). In addition, other studies have demonstrated that employment status also has an impact on overall travel frequency, because people in work make more trips than those who do not work (Doubleday, 1977; Hanson, 1977). Likewise, the findings of Potter's study

suggest that people with higher status occupations have longer shopping distances, and more trips than those people in lower status occupations (Potter, 1977). This is consistent with the result that car availability is positively related to trip generation, so a person's higher employment status influences their travel patterns (Doubleday, 1977).

2.2.6 Vehicle ownership and availability

Perhaps inevitably, given the nature of the research, car ownership is recognized as one of the most important socio-economic factors and correlates consistently strongly with travel distance, trip frequency, and transport energy consumption. People with higher car ownership travel more than those in areas with low car ownership (Stead, 2001). This is in accordance with previous research which indicated that travel distance increases in areas where the level of car ownership increases, alongside transport energy consumption and the proportion of car trips (Næss, 1993; Naess and Sandberg, 1996). The type of driving licence possessed also has an impact on travel distance, as those residents with a licence travel further than those with only a provisional licence or without a licence (Stead, 2001). Average travel distance is relatively high in areas in which each household has a high proportion of driving licences. Besides, the relationship between car/motorbike licence and travel mode choice raises the issue of how holding a car/motorbike licence is associated with age, and what effect the ability to travel by a car/motorbike has on the switch to car/motorbike as a passenger or to using public transport (Golob and Hensher, 2007). In addition, the number of car and motorbike licence holders in a household influences the likelihood of owning a motorbike. It was found that motorbikes are one of the major modes of transport, especially among low and middle income groups in Malaysia (Leong and Mohd Sadullah, 2007). Conversely, for household members with a car licence, the likelihood of owning any motorbike decreases.

2.2.7 Household size and structure

Household size is significantly associated with the travel frequency of the person. Travel time increases as household size increases, whilst household size is positively related to transport energy consumption (Hensher, 1976; Hanson, 1982; Banister et al., 1997) as there are more people with more travel time. The number of persons in the household significantly determines household trip-generation rates, and each person's

travel decisions are made within the context of household demands (Oi and Shuldiner, 1962; Heggie and Jones, 1978).

In this section it was found that socio-economic factors are significantly related to individuals' travel patterns. Also, these factors are linked to each other, and there may be two-way and three-way interactions between these factors. For instance, the income of an individual is linked to employment status and employment type, and these factors may affect car ownership and use. It is hard to separate the effects from one another. Hence, six socio-economic variables (gender, age, education level, occupation, income, and car/motorbike licence) were selected to include in the survey to examine the relationship between socio-economic factors and commuters' travel mode choices. The details are fully discussed in Chapter 7.

2.3   Car dependency

The car is the dominant means of transport for the majority of people in many countries such as the USA and in European countries, whether measured by travel distance, frequency, or duration of travel (Carlsson-Kanyama and Lindén, 1999; Hine and Preston, 2003). Cars are used at higher frequency, and regarded as a more reliable mode of transport than any other. Cars enable travel over a wide range of distances, more conveniently and more cheaply than using public transport (Mackett and Ahern, 2000). As a consequence, car dependence[6] has grown over time, so many households have become very car dependent, and this is a rising trend. They travel by car even for very short trips without considering the use of other means of transport (Mackett, 2003), although some people have sensible rationales for using cars even for very short trips, such as returning home late at night. It was found that short trips of five miles or less made by car were often for work-related purposes (Wright and Egan, 2000; Hine and Preston, 2003).

In order to reduce private transport use and increase public transport use, it is important to understand the reasons why people choose to use cars. Several studies have pointed out that driving motivation is broadly divided into instrumental (utilitarian) motives and

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[6] Car dependence refers to people who use cars as their dominant modes of personal movement. Jones, P. (2011) 'Conceptualising Car 'Dependence'', *Auto Motives: Understanding Car Use Behaviours*, pp. 39-61.

affective motives (Gray et al., 2001; Steg, 2005; Gardner and Abraham, 2007). Instrumental motives for car use include financial costs, travel time, convenience, physical exertion, and flexibility (i.e. less reliant on schedules, route, distance, and weather conditions) (Gatersleben and Uzzell, 2007). It is possible that other obstacles influence changing car use such as the unexpected need to use cars (Gray et al., 2001; Jakobsson, 2004; Anable, 2005). For instance, sometimes people forget to buy something from the shops. On the other hand, if car users use public transport then they feel stressed and bored due to delays and waiting times, so their attitudes toward using public transport on commuter trips are less positive than the attitudes of regular users of other modes of transport.

Affective motives refer to 'emotions evoked by driving a car', such as excitement, uncertainty, security, and enjoyment (Steg, 2005: 150). If these motives dominate instrumental motives such as travel costs, time, and security, car use is likely to be more impulsive. Steg et al. stated that the 'car satisfies the need to express yourself and your social position, and further categorize an underlying dimension of car use as the expression of self-identity that is related to freedom' (Steg et al., 2001: 164). In addition, Mackett and Ahern suggested that the purpose of the trip, e.g. load-carrying, shopping, child escort, time pressure, and trip chain, is the dominant factor affecting car use even for a short journey (Mackett and Ahern, 2000). That is to say daily movements relatively affect travel mode choices for many activities, as it is difficult to use public transport for all these actions (Eriksson, 2011). If car users choose to use public transport, they have to take more travel time than when they take the car because it takes longer by bus or walking.

It is evident that the personal decision to use a car is a possible starting point for reducing car dependence. However, it seems difficult to alter the habits and lifestyle of car users once they have acclimatised to travelling by car for any kind of trip (Goodwin et al., 1995). Reflecting on whether perceptions of environmental costs altered people's behaviour, Steg and Tertoolen pointed out that individuals may believe that the total environmental cost and risk of their behaviour is minor enough to be negligible (Steg and Tertoolen, 1999). Furthermore, Heath and Gifford revealed that, even if people have a strong awareness of environmental risk and problems caused by car use, they still think that the personal benefits of car use take priority over the environmental problems

that come from car use (Heath and Gifford, 2002). Likewise, another study concluded that from the individual's perspective, the advantages of using cars outweigh the negative effects, such as CO_2 emissions, security risks, and other environmental problems (Handy et al., 2005). Individuals are reluctant to eschew using their car to prevent environmental problems, because cars are not the only cause of these problems. They believe that society should solve the problems caused by car driving (Jensen, 1999). Some car users who travel to work by car are sympathetic to the environmental problems caused by using motorized vehicles, but few are willing to pay the costs through taxes, or expanding the public transport system. Many car users are not likely to forgo using a car and do not think that driving is the main contributor to environmental problems.

The car is the largest means of daily travel in developed countries, but not all trips made by cars are car dependent. Approximately 20% - 80% of different groups highly rely on car use (Jones and Sloman, 2003). Some people who use cars for all trips do not like driving in cities at peak times, while others see driving a car as convenient for all trips. The latter think that car provides independence rather than dependence (Studies, 1995). In a UK attitudinal study, car users reported that less than 50% of their annual driving was 'necessary,' with around 18% being 'not very important' and another 10% rated as 'not at all important'. Similarly, another attitude survey by RAC Motoring Services investigated 1,100 British drivers' thoughts about their annual driving and established four categories: 'necessary', 'important', 'not very important', and 'not at all important'. Participants estimated how much of their driving would fit into each category by distributing ten points across the four groups (Williams *et al.*, 2000). The findings showed that less than half of annual driving was categorized as necessary, and the scores of the average level of necessity of their car trips for women (5.1) were higher than men (4.3), for men and women of 35-54 years old.

While some car use is due to necessity, a notable share of car driving may be due to choice (Handy et al., 2005). Conversely, Jones and Sloman's study concluded that depending on residential area and trip purpose, between a quarter and a third of respondents indicated that they would like to use their car less (Jones and Sloman, 2003). Therefore, it is clear that even if people generally regard the car as a necessary means of transport in many situations, this does not mean that driving a car is always the

preferred mode of travelling in daily life.

2.4   Motorbike dependency

As a mode of urban transport, the fast growing rate of motorized two-wheeler[7] (motorbikes, mopeds, scooters) ownership has become a critical issue in need of address in Global South countries, especially in the Asia region, such as in Taiwan, Vietnam, Malaysia, and Indonesia (Sillaparcharn, 2007; Joewono et al., 2013; Nguyen et al., 2014). Due to the motorbike being one of the major means of transport in several Asian countries, people use it for a wide range of purposes such as leisure, business, and shopping trips. As can be seen from Figure 2.4.1, Taiwan has the largest motorbike population at 555 units per 1,000 people, whereas in the capital city of Taipei City it is 338. The second largest motorbike population is 380 in Ho Chi Minh City, Vietnam, followed by 339 units per 1,000 people in Jakarta, Indonesia.

Figure 2.4.1: Trends in motorbike ownership in some global south cities and countries
Source: Adapted from Figure 3 (Nguyen et al., 2014).

There are four key factors associated with motorbike use in these Global South countries: weather conditions, due to being located in tropical and sub-tropical areas with milder climates; high population density; cultural habits; and the size of urban areas combined with scarcity of road space (Musso et al., 2010). Motorbikes are a cheaper alternative to cars so they are usually bought before a car (Joewono et al., 2013).

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[7]Motorized two-wheelers refer to motorbikes, mopeds, scooters with engine capacities over 50 but less than 200 cc Haworth, N.L., Greig, K. and Wishart, D.E. (2008). Road Safety 2008 Conference.

A study pointed out that there are multiple factors influencing motorbike use, comprised of cost (e.g. vehicle purchase, fuel efficiency, parking, maintenance), practicality (e.g. small in size, giving manoeuvring flexibility) and capabilities (e.g. time efficiency, and the freedom to park it almost anywhere) (Hsu et al., 2003; Blackman and Haworth, 2010; Nguyen et al., 2014). For example, motorbikes are seen as time efficient, need less space for parking, and are more convenient for commuting within the city area, especially during periods of traffic congestion, due to their smaller size and higher manoeuvrability (Leong and Mohd Sadullah, 2007). This can make motorbikes a better alternative to cars even for those for whom cars are affordable (Hsu et al., 2003).

In addition, several studies have found that motorcyclists think the combined costs of moped use (e.g. registration and insurance fees, vehicle purchase, maintenance and servicing, the cost of fuel and parking fees in the city, and other incidental expenses) are invariably cheaper than using public transport. Some participants noted that motorbike use has safety and environmental concerns, but they put personal reasons and costs as a priority (Leong and Mohd Sadullah, 2007; Blackman and Haworth, 2010). Due to motorbikes being the dominant travel mode in Global South countries, especially in Taiwan, this research will now discuss motorbike ownership/use in Taiwan, Vietnam, Malaysia, and Indonesia in order to understand the proportions of people who rely on motorbikes as their main travel mode in these countries.

In Taiwan, motorbike use accounted for 49.8% of journeys (MOTC, 2013). On average, one household has more than one motorbike and a car. It was found that the majority of people use motorbikes as their main travel mode due to their high mobility and capabilities, low costs and convenience (Hsu et al., 2003). In another global south city, Hanoi City in Vietnam, many households also have more than one motorbike (Musso et al., 2010). The motorbike is Vietnam's dominant travel mode and outweighs car use. In 2009, the population was around 3.2 million. There were around 1.5 million motorbikes and only 150,000 cars, though the latter is growing quickly as well. Similarly, in Malaysia, motorbikes are one of the major modes of transport. Among all the cities of Malaysia, the highest motorbike ownership is on Penang Island, growing at a rate of 5.0% to 6.6% annually. The majority of the low to medium income groups prefer to use motorbikes as their primary mode of transport because they are affordable (Leong and Mohd Sadullah, 2007). In Indonesia, in 2007, motorbike ownership was

approximately 37 million units, comprising 78.3% of all travel mode uses (LUbis, 2009). It should be mentioned that in both of Malaysia and Indonesia, the service quality of public transport is not good, and the majority of people are in medium to low income groups. Their personal reasons for using motorbikes are strong enough to outweigh the issues of safety and environment. Hence, they prefer to use motorbikes as the main low cost travel mode.

In summary, it was found that people prefer to use cars due to four main factors: financial costs, travel time, convenience, and flexibility (Gatersleben and Uzzell, 2007). They think travelling by car is cheap, time-saving, and provides access everywhere without time limitations. Even though the car is the largest mode of daily travel in developed countries, it does not mean that all trips made by cars are car-dependent. Some car users use it as their main mode of travel because of choice rather than necessity. Regarding motorbike uses, high motorbike volume is a usual traffic situation of Asian countries such as those mentioned above. With the existing mixed-traffic situations, there are recurring patterns in these Global South countries, such as Taiwan, Vietnam, Indonesia, and Malaysia, which are similar to and typical of Mediterranean areas (Hsu et al., 2003).

2.5 Improvements to public transport services

This section focuses on the quality of the public transport system – how this is perceived and how this perception potentially changes transport users' mode choice. Also, it reflects on the attributes/characteristics of the means of transport, particularly public transport. There is a wealth of literature on both reducing private vehicle use and increasing public transport use. It is widely agreed that the car is the most attractive mode of private transport due to its convenience, speed, and comfort, as well as personal freedom (Jensen, 1999; Hagman, 2003; Anable, 2005), particularly when compared with public transport. However, a considerable number of policymakers recognize that more sustainable modes of transport should be promoted and used (De Witte et al., 2008; Lai and Chen, 2011). Many countries and cities are committed to promoting transport policies and measures which provide alternative modes to reduce car use. Nevertheless, it is hard to reduce private vehicle use, because people's travel behaviour is complicated. Different people have different needs, and are motivated to choose particular means of transport by several factors. People's daily mobility is affected by various factors, such

as personal socio-economic factors, lifestyle, and types of journey. Furthermore, people's attitudes towards transport are an important determinant for mode option in the longer term. For every trip, people have to make travel mode choices between different travel modes, and every mode comes with different characteristics, advantages, disadvantages, and costs.

Prioni and Hensher's (2000) study demonstrated that attitudes towards transit services and the service quality of public transport is an important element of users' travel demands. As several studies have pointed out, the service level of the transport system affects travel behaviour so in public transport systems it is necessary to provide a high quality service in order to attract considerable numbers of private transport users (Hensher, 1998; Fujii and Kitamura, 2003). Hensher demonstrated that public transport needs to be adjusted so that the service meets consumer needs, is more attractive, and effects a travel modal shift. Other related research has indicated that customer satisfaction, associated with perceived service quality, is widely recognized as the most important element for helping people to choose public transport (Jen and Hu, 2003; Petrick, 2004; Chen, 2008). Satisfaction is an effective variable for evaluating public transport improvements, so it is a key point in developing public transport, whether in theory or practice. If public transport users or non-users recognize a good quality public transport service, they have high satisfaction from using public transport, and they are likely to use it again (Lai and Chen, 2011). If people are not satisfied with the service quality of public transport e.g. the MRT or buses are not punctual or the seats lack comfort, they are more likely to switch to using cars, because they do not think public transport is a reasonable alternative (Beirão and Sarsfield Cabral, 2007; Popuri et al., 2011).

The level of service quality of public transport should be designed to meet customers' service satisfaction, and also to attract other potential users to increase public transport use (Beirão and Sarsfield Cabral, 2007). Because service quality is measured from the customer's perspective, which depends on their perception of each attribute characterizing the service (de Oña et al., 2013); if their perception of the services of buses or trains is low, they are unlikely to use it for commuter trips even if the services are improved. The factors that are associated with public transport quality are: access to bus stops, wait time, trip length, vehicle design,

drivers' interaction with users, and travel information (Prioni and Hensher, 2000).

The literature reviewed categorized two main perceived service qualities in public transport services (Friman et al., 2001; Friman and Gärling, 2001). The first part was reliability of public transport including clarity of service information, such as departure and destination information, and factors such as the design of, and space within, vehicles, including comfort, security, and cleanliness; the second was how passengers were treated by staff, e.g. their attitude to service, their knowledge, and their ability. Tyrinopoulos and Antoniou analyzed the users' behaviour changes and their satisfaction toward the use of public transport systems (Tyrinopoulos and Antoniou, 2008). The findings of the survey showed that the most important satisfaction attributes were service frequency, vehicle cleanliness, waiting conditions, transfer distance, and network coverage. Another study indicated that car users frequently switch to using public transport because of three attributes: increased service frequencies, shorter travel times (including a direct bus service), and lower fares (Kingham *et al.*, 2001; Eriksson, 2011).

It appears that a considerable number of studies have found that the service quality of public transport influences public transport users' and non-users' mode of transport choice. The key elements of service satisfaction for public transport are reliability, frequency, comfort, cost, information, driver behaviour, and cleanliness (Eboli and Mazzulla, 2010; Eriksson, 2011). Customers also emphasised other quality attributes, such as information provision, waiting and in-vehicle conditions, accessibility, and transfer coordination. The three most important attributes to improve the attractiveness of public transport are shorter travel time, increased frequency of service, and lower fares.

This helped the researcher to reflect on which attributes of public service providers' service had to be considered, and how to do that. Therefore, Parts II and III of the survey were designed regarding ten indicators of service quality attributes: reliability, comfort, cleanliness, safety, information, quality of staff behaviour, availability, route characteristics, and fares (see Table 2.5.1).

Table 2.5.1: Service quality attributes

Attribute	Description
Service reliability (Punctuality)	The ability of public transport system to adhere to its schedule
Comfort	The cleanliness of bus/metro interior and exterior e.g. the waiting areas at bus stops/metro stations and the seats
Cleanliness	Cleanliness of interior, seats, windows, and the comfort of seats and waiting areas
Safety and security	Reliability of public transport or drivers' ability to allow the passengers to get on and off the metro/bus safely
Information provision	Availability of schedule/maps at bus stops/metro stations
Frequency	This refers to how often the transit service is provided, e.g. the average number of runs scheduled for each hour of the day
The quality of staff behaviour	Politeness and courtesy towards passengers
Availability	Availability of bus stop/metro station near home
Route characteristics	Route characteristics (number of bus stops, distance between bus stops and so on)
Fare	Cost/affordability

Sources: Adapted from Table 1 of (Beirão and Sarsfield Cabral, 2007; Eboli and Mazzulla, 2007; Eboli and Mazzulla, 2011; Popuri *et al.*, 2011).

2.5.1 Service reliability

Service reliability is an important factor for public transport users, and is regarded as the impact on the use of time. Owing to traffic or system problems, sometimes buses or trains arrive late, increasing waiting or in-vehicle times excessively for passengers (Paulley et al., 2006; Eboli and Mazzulla, 2011). Hence, reliability is an important factor in altering users' perceptions and levels of using public transport.

2.5.2 Comfort and cleanliness

Comfort and cleanliness are qualitative service features related to the vehicles or to the stations/stops. Popuri stated that improving the quality of alternative modes, such as having better seats and sound and navigation systems, is important for attracting people who could drive, and thus reducing traffic problems such as congestion, accidents, energy consumption and transport emissions (Popuri et al., 2011). Another study found that, for metro users, the most important satisfaction variables are vehicle cleanliness, followed by the behaviour of staff (other than the driver), and ticketing systems (Tyrinopoulos and Antoniou, 2008). While, for bus users, the most important satisfaction attributes are service frequency, vehicle cleanliness, and network coverage. Additionally, the different situations of users may influence their perceptions of comfort and cleanliness. People with higher

incomes place more importance on the attributes of reliability and convenience and ride comfort, compared to people who have lower incomes (Habib et al., 2011). In terms of gender, men's expectations relating to the attributes of reliability, convenience and ride comfort were lower than women's. A difference is also seen in age, with older people (over 65) being more positive about reliability, convenience and ride comfort.

2.5.3 Safety and security

A study indicated that passengers evaluate services based on safety and security of stations, bus stops and vehicles (Eboli and Mazzulla, 2011). Also, it is pointed out that various factors, e.g. vehicle safety, facility cleanliness, and complaint handing all have a significant impact on passengers' behavioural intentions (Lai and Chen, 2011).

2.5.4 Information provision

This covers sufficient provision of information such as routes, stops, departure/arrival times, and tickets at stations and stops (Tyrinopoulos and Antoniou, 2008), a factor of service quality which influences users' service satisfaction and travel mode choices.

Several studies have indicated that information displays are useful for reducing perceived waiting time of passengers, and uncertainty in particular (Consortium, 1998; Dziekan and Kottenhoff, 2007; Nijkamp et al., 2012). This positively affects passengers' perception of waiting time; due to knowing the actual arrival time or time remaining before public transit departure, they may feel less stress and uncertainty in the presence of information displays (Dziekan and Kottenhoff, 2007). Even if service reliability actually decreases, passengers still feel they can control their time and plan better (World Congress on Applications of Transport and Intelligent Vehicle-Highway, 1995). . For instance, in a study from Birmingham, a fifth of people who checked information displays used the remaining time to do some quick shopping (Nijkamp et al., 2012). Clearly, information displays are helpful for passengers to save perceived waiting time for doing other activities, and to avoid uncertainty. This could increase the possibility of attracting people to make trips by public transport.

2.5.5 Frequency

Service frequency refers to how often the transit service is provided (Eboli and Mazzulla, 2011), calculated as the average number of runs scheduled per hour of the day. Kingham et al. identified how willing people are to change their current modes of transport and how they can be encouraged to do that (Kingham et al., 2001). People stated that the most important improvements to the public transport system were strongly associated with the efficiency of the service, e.g. frequency and reliability of services, an integrated network, convenient transport hubs, and discounted tickets. Thus, these attributes may encourage a considerable number of car users to stop using their cars.

2.5.6 The quality of staff behaviour

Employees' attitude and behaviour, reliability, punctuality of service, and information displays are the most important attributes of service quality of public transport (Tyrinopoulos and Antoniou, 2008). Staff include all personnel of the transport operator, such as bus drivers and reception staff at stations, and staff behaviour refers to their communication and interaction with passengers. Also, it should be noted that staff response to complaints and negative events is an important concern (Frima et al., 1998). If passengers have a bad impression of the staff of public transport, this might influence their willingness to use public transport next time. This research focuses on understanding how satisfied respondents were with bus drivers' and metro station staff's attitudes, as well as their dress/uniform.

2.5.7 Route characteristics

Route and service characteristics are the characteristics of the route path, the number of bus stops, the distance between house and bus stops, the location of bus stops, and attributes of the service, including frequency and daily service time (Eboli and Mazzulla, 2011). The route characteristics influence people's travel time, because if there are many bus stops, people take a longer time to commute. This may influence people's satisfaction with public transport.

2.5.8 Fare

Many studies have found that both fare levels and speed play an important role in

affecting customer satisfaction with public transport quality (Andreassen, 1995; Eboli and Mazzulla, 2008). A study investigating employees' understanding of their mode of transport choices in commuter trips (Kingham et al., 2001) found that more than 80% of employees used cars in commuter trips, but most of them stated that if the service quality of public transport was improved and the ticket prices were lower, they would consider using public transport. A later study concluded that negative satisfaction is strongly affected by travel time and fare, while frequency and ease of getting a seat are the largest contributors of positive satisfaction (Hensher et al., 2003). Hensher also added that customers' perceptions are that current ticket prices are too high in relation to the service quality of provision, but the solution is not to reduce fares. Instead, providers are likely to raise customer satisfaction by improving service quality characteristics to meet their expectations for the existing fares.

2.6 Summary

This chapter has reviewed the literature concerning socio-economic factors and travel patterns, car/motorbike dependency, as well as how/why public transport services need to be improved. It is widely agreed that travel patterns and mode of transport decisions are not only affected by car use, but are dependent on socio-economic factors. For example, increasing income correlates with both commuting distance and the choices of mode in commuter trips. Commuting distance increases in relation to job status, so people in higher income groups are required to make more, and longer, vehicular trips per day. In addition, car driving is a more stable context for travel behaviour than other modes of transport, because of the advantages of car use as the dominant mode of transport in terms of speed, flexibility, security, and personal space. Many households are becoming very car dependent, using the car even for very short trips. Regarding motorbike use, this is a major travel mode in Italy, and in some Asian countries, due to environmental and cultural factors. Service quality of public transport also affects individuals' travel mode choices. Customer satisfaction is the most important factor in favourable behavioural intentions, and customers' perceptions of service quality and value (Jen and Hu, 2003; Petrick, 2004; Chen, 2008).

This research concerns car/motorbike dependency, and car/motorbike use, and

seeks to consider lowering emissions via reducing commuter trips in private vehicles. Based on the literature review, the six socio-economic factors of income, gender, age, education, occupation, and car/motorbike licence, and ten characteristics of public transport service, quality, punctuality, comfort, cleanliness, safety, stability of service, information, quality of staff behaviour, fare, availability, and route characteristics, were employed in the survey design (more details are shown in Chapter 7).

The next chapter presents the ASI framework as well as its objectives, and discusses how shift transport initiatives might be used to encourage people to change their behaviour.

Chapter 3

Policies for shifting commuters to more sustainable transport

3.1 Introduction

The purpose of this chapter is to explore how transport policies encourage commuters to shift to more sustainable transport modes. These policies are considered as part of a broader set of policies to encourage sustainable transport, and are best described through the ASI framework. The emphasis of this chapter is on gaining an appreciation of how effective different transport policies are at achieving modal switching. Due to the New Taipei City Government being mainly focused on the Shift element to change public travel behaviour and increase public transport use, it is important to understand the effectiveness of Shift initiatives and other transport initiatives at changing travel behaviour.

The ASI framework and its objectives are introduced in Section 3.2. Then Section 3.3 analyses various initiatives within the shift element of the ASI framework. The acceptability and effectiveness of transport initiatives at switching travel behaviour are discussed in Section 3.4. Section 3.5 explains how environmental concerns influence travel behaviour, and Section 3.6 presents transport policies based on the Avoid/Reduce and Improve elements.

3.2   The Avoid/Reduce, Shift and Improve framework

Figure 1.2.1 in Chapter 1 illustrates how government policy influences sustainable transport, mainly focusing on the shift policies typically applied by global south cities. The Avoid/Reduce-Shift-Improve (A-S-I) framework is constructed in such a way that if followed, future travel demand is reduced or avoided, travel is shifted to more environmentally friendly modes, and technology measures improve the vehicle fleet and fuels (Dalkmann and Brannigan, 2007; Hanaoka, 2013; Bos and Temme, 2014). The ASI framework was initially developed to address environmental sustainability issues in the late 20th century (Kagermeier, 1998), but

it has become of greater significance in the last ten years. The purposes of the ASI framework are to reduce GHG emissions from private vehicles, decrease congestion, and create sustainable transport, as a sustainable transport system needs improvement in all dimensions, including travel demand, mode choice and technology (Dalkmann and Huizenga, 2010). Table 3.2.1 describes each element of the framework further.

Table 3.2.1: The ASI framework for the sustainable development of transport

The framework	Contents
Avoid/Reduce (trip substitution)	Aims: avoiding or reducing the need for car/ motorbike trips • The substitution of travel, encouraging employees to work at home, and the ability to reduce travel due to the emergence of information and communication technologies (ICT) • Integration of transport and land-use planning to implement sustainable mobility into patterns of urban form, and to reduce trip length.
Shift (modal shift)	Aims: to change transport mode choices away from private vehicles This kind of policy promotes a modal shift towards more environmental friendliness by reducing levels of car use, stimulating walking and cycling, and making public transport more attractive • Non-Motorised Transport (NMT): walking and cycling are the most sustainable travel mode choices • Public Transport (PT): PT emits less CO_2 per passenger kilometre (PPK) than cars, as it generates lower specific energy consumption PPK with higher occupancy levels such as interchange improvement compared to rail, BRT, buses, and para-transit
Improve (increase efficiency)	Aims: improving vehicles to reduce environmental impacts. • Targets technological innovation and low-emission vehicles • Technological efficiency is used to improve the energy efficiency of transport modes and related vehicle technology, such as electric cars, with a focus on increased fuel efficiency to reduce emissions per kilometre

Source: Revised from (Hanaoka, 2013; Bos and Temme, 2014).

3.3 Shift: Transport initiatives – modal shift

This section explores shift pull policies in the context of wider policies within the ASI framework. Figure 1.2.1 lists the shift policies in terms of pull/push initiatives. These will provide the focus of this section. Within the ASI framework, this section

reflects on the literature associated with the modal shift element for reducing levels of private vehicle use, and encouraging private transport users to use more sustainable travel modes such as public transport, walking and cycling (Fujii and Gärling, 2003; Bamberg, 2006; Gärling and Schuitema, 2007; Söderholm, 2010).

Table 3.3.1 shows the classifications of modal shifting policy that have frequently been implemented, namely pull/push policies, and hard/soft policies. There is a wealth of literature concerning how transport policies are mainly divided into two types: one is called a carrot or pull policy to encourage the use of alternative modes (Schade and Schlag, 2003; O'Fallon et al., 2004; Möser and Bamberg, 2008). For example, the northern European countries are focused on promoting walking and cycling, providing lower fares of public transport, and higher levels of service (Buchanan, 2003). The other is a so-called stick or push policy, to restrict car use, alter the individual's context, and discourage car use e.g. increasing transport prices and parking fees or restricting cars entering city centre (Gärling *et al.*, 2002a; Schade and Schlag, 2003; O'Fallon *et al.*, 2004). It is likely to interrupt car users' strong car dependence habits and reduce their freedom of choice. Moreover, as shown in Table 3.3.1, transport initiatives are also classified into two other types: hard policies (fiscal instruments), and soft policies (pleas for commitment), which can be applied to alter problematic behaviour (Fujii and Taniguchi, 2006; Matthies *et al.*, 2006; Cairns *et al.*, 2008; Möser and Bamberg, 2008; Richter *et al.*, 2009; Friman *et al.*, 2013).

Notably, push policies/initiatives are negative policies e.g. increasing transport prices, reducing parking spaces or preventing cars from entering certain areas, while pull policies are positive policies (incentives), which are likely to include hard initiatives e.g. physical improvements to transport infrastructure or operations, and traffic engineering. Hard policies also include negative policies (disincentives, or push policies) such as increased costs for car use, prohibition or rationing of car use, road tolls, congestion charges, control of road space, and increased fuel prices. Pull, push, and hard policies are external factors, trying to change people's behaviour possibly without changing their attitude, whereas soft policies aim to change people's attitudes, beliefs, values, and personal norms, discouraging private transport use by using environmental education and so on (Fujii and Taniguchi,

2006; Matthies *et al.*, 2006; Cairns *et al.*, 2008; Möser and Bamberg, 2008). They can also be push or pull policies, e.g. the government uses moral incentives (push)/disincentives (pull) to argue for behaviour change.

Table 3.3.1: The classifications of modal shifting policy

Shifting policy	Meaning	References
Pull policies (tend to be hard)	Encouraging other modes of transport use by making them more attractive; improving the services of public transport or increasing the availability of cycleways	(Schade and Schlag, 2003; O'Fallon *et al.*, 2004)
Push policies (are hard policies)	Breaking a habit but not necessarily yielding a new behaviour; making car use less attractive or discouraging car use	(Gärling *et al.*, 2002a; Schade and Schlag, 2003; O'Fallon *et al.*, 2004)
Hard policies (external/externalized factors) (can be push or pull policies)	Infrastructure, technology, measures in the system; alter the problematic behaviour	(Matthies *et al.*, 2006; Möser and Bamberg, 2008; Richter *et al.*, 2009; Friman *et al.*, 2013)
Soft policies (internalized factors) (can be push or pull policies)	Information, communication; measures in the mind; target the moral dimension of environmental behaviour	(Fujii and Taniguchi, 2006; Matthies *et al.*, 2006; Cairns *et al.*, 2008; Möser and Bamberg, 2008)

Source: Classified by the author.

In Taiwan, the New Taipei City Government is primarily focused on policies of pull initiatives based on the shift element within the ASI framework, but they have also used other relevant policies such as Push/pull/hard/soft to address some of the other elements of ASI. However, this research has focused on those transport initiatives which tend to deliver more highly on the shift element of ASI. According to a wide range of transport policy literature about travel reduction, it is essential to develop a framework which encompasses a broader range of modal shifting policies. This research revised this systematic framework of tools from previous studies (Wright and Egan, 2000; Cairns et al., 2008; Friman et al., 2013) as a basis to discuss the effectiveness of transport initiatives for switching travel behaviour. Eight pull initiatives of modal shifting policies (in order of appropriateness to Global South countries) are shown in Table 3.3.2, namely public transport improvement, price reduction measures, park-and-ride scheme, campaigns for alternative transport modes, workplace travel plans, personalized travel planning, car clubs, and carpooling schemes.

Table 3.3.2: Pull initiatives of modal shifting policies

Type of measure	Explanation
Public transport improvement (Explored in this research)	Constructing public transport infrastructures and improving public transit service quality, including increased service speed, frequency, convenience, comfort, user information, affordability and ease of access.
Price reduction measures (Explored in this research)	Measures taken to reduce travel expenses in order to encourage people to travel by public transport.
Park-and-ride scheme (Explored in this research)	Integrating private and public transport modes through providing parking facilities in the outskirts of cities, combined with a public transport connection such as an MRT station to encourage drivers to park their cars/motorbikes there and to complete their journey by public transport
Campaigns for alterative transport modes (Explored in this research)	Increasing understanding of problems with certain transport choices
Workplace travel plan (Not explored in this research)	Encouraging and enabling employees to commute to work more sustainably
Personalized travel planning (Not explored in this research)	Encouraging people to travel more sustainably through personalized travel information
Car clubs (Not explored in this research)	Offering shared vehicles that are paid for upon actual use
Carpooling (Not explored in this research)	Encouraging people to share use of their private vehicles

Source: Revised from (Stern, 2000; Gärling *et al.*, 2002a; Cairns *et al.*, 2008; Friman *et al.*, 2013).

This research is focused on the first four policies: public transport improvement, price reduction measures, park-and-ride schemes, and campaigns for alternative transport modes. These policies are not only commonly used in New Taipei City, but also they are public sector/government responses to the issue rather than business responses.

3.3.1 Public transport improvement

In recent years, Global South countries have been going through rapid motorization at an alarming rate (Townsend, 2001; ESCAP, 2005), and they are facing problems of congestion and traffic-related pollution. Many global south cities have extremely high private transport use, especially for motorcycles. For example, in the cities of Hanoi and Ho Chi Minh in Vietnam, motorcycle use was found to account for 81% and 90%, respectively, of all motorized trips (JICA, 2004; Schipper *et al.*, 2005). Also, in Malaysia, car use represented 40% of mode share (Nurdden *et al.*, 2007). In Thailand, many provincial cities have recorded motorcycle shares of half of all travel trips, such as 49% motorbike use in Khon Kaen City. Car dependency and motorbike dependency were discussed in Section 2.2 and 2.3 respectively. However, it is generally agreed that improved public transport can help to reduce GHG emissions from private vehicles, lower congestion, and enhance the attractiveness of alternative modes (Hensher, 2007).

Currently, policymakers tend to rely on constructing public transport infrastructures with high capacity along with high-quality service (Deng and Nelson, 2011). In global south cities, infrastructure-led approaches such as MRT, LRT and BRT have long been the preferred transport improvement options. Shanghai, for example, has the largest-scale underground rail network in the world, 588 km in total in 2016. In New Taipei City, Taiwan, the government has invested in constructing the MRT Three Rings and Three Lines, which is an extension to the existing Taipei rapid transit system (New Taipei City Government, 2010). They aim to reduce motorized vehicle usage, and achieve 50% public transport usage on all trips (public transport use is 32.2% in 2013) (MOTC, 2013). In recent years, some cities have put LRT systems in place, such as Manila, Philippines, and Kuala Lumpur, Malaysia (United Nations *et al.*, 2008); for example, in Kuala Lumpur, two LRT systems have been constructed; one is the STAR LRT system, two routes (26km route length) which were implemented in 1996-1998 (Hossain, 2006). Another is the PUTRA LRT system (29km route length), which was constructed during 1995-1999. In addition, BRT systems to relieve traffic congestion are growing in popularity throughout the world, notably in global south cities, Europe and South America, because of the affordable investment and operating costs compared with MRT systems (Wright and Fulton, 2005). BRT systems are already operational in some cities of China, Japan, South Korea, Thailand,

India, Indonesia, and Vietnam.

Nevertheless, these infrastructure-led approaches may not adequately achieve the expected targets of public transport use in these cities. The possible reasons include high motorization, poor service of existing public transport, high fares, and poor connections between existing public transport systems causing access difficulties . For instance, lack of commuter satisfaction with public transport has resulted in low system performance and decreased funding in two rail systems of Bangkok, and the MRT of Manila (Okada *et al.*, 2003; Cervero and Golub, 2007). Similarly, the service quality of the public transport system is not good in Indonesia, e.g. fares are expensive, and the transport is not comfortable, but the government has not provided any priority policy for improving it yet, and so motorbike ownership/use cannot be reduced (LUbis, 2009).

As private vehicles, especially motorbikes, are the dominant modes for the public in many global south cities, it is challenging to encourage modal shift from motorcycles/cars to alternative modes. Policymakers have thus invested hugely in constructing public transport infrastructures to increase public transport use, and reduce private transport use. In this research, New Taipei City, Taiwan is adopted as an example of a global south city to examine whether these infrastructure-led approaches are adequate for switching travel behaviour. The details will be fully discussed in Chapter 6.

3.3.1.1 Integration of public transport systems

Integration of public transport systems aims at getting passengers from one place to another by using different transport modes to complement each other (Ibrahim, 2003; May *et al.*, 2006). It enables convenient transfer between the public transport modes by their close physical location and integration of timetable planning, including location of bus stops, MRT stations, and interconnections for making multi-modal trips easier such as bus-rail interchange points and rail-link bus services (Potter and Skinner, 2000). Integration between public transport modes reduces the costs and inconveniences of commuters' travel demands. For example, park and ride schemes use the provisions of public transport or fare reduction measures to reduce private transport use and to encourage new developments in conjunction with rail-based systems investments (Nosal and Solecka, 2014). More details of Park and Ride schemes are discussed in

Section 3.3.3. Another option is a bike share scheme, also called a public bicycle system or bicycle-sharing system, which provides bicycles for shared use in order to encourage the use of bikes as a travel mode for short distances (Cervero *et al.*, 2013). Bike share schemes allow people to borrow a bike from point A and return it at point B. For instance, in Denmark and the Netherlands, bike-and-ride schemes represent a quarter or more of access trips to regional rail stops (Rietveld, 2000; Martens, 2007; Pucher and Buehler, 2008). Also, in the capital cities of these two countries, Copenhagen and Amsterdam, one-third or more of all access trips to rail stops are by bicycle, even on rainy days (Cervero, 2003; Martens, 2004). In the UK, there is a rural bus service - 'Wigglybus' - in areas where population is sparse (Potter and Skinner, 2000). People need to cycle to catch the bus, so spaces for bikes are provided on the buses. Private transport users are able to transfer to public transport for part of their trips by using these facilities, such as Park and Ride schemes and Bike Share schemes. Hence, it is clear that public transport infrastructures such as MRT, LRT, and BRT should be integrated with bus networks and cycle facilities in order to encourage commuters to use public transport modes and to achieve seamless travel (Khaw, 2002).

3.3.2 Price reduction measures

Extensive literature has pointed out that external factors such as financial incentives and changing the physical environment, accompanied by internal factors such as background and attitudes, are essential for reducing the motivation to use a car (Stern, 2000; Gärling *et al.*, 2002a). Subsidized public transport fares are one of the most important variables to encourage the use of public transport (Nurdden *et al.*, 2007). This is because individuals make travel mode choices and choose an alternative based on cost-effectiveness regarding money, effort, and social approval (Gifford and Nilsson, 2014). Price reduction measures are a common technique which utilizes an economic approach to changing personal material incentives (Bamberg and Schmidt, 2003; Gärling and Fujii, 2009). For example, a monthly free bus ticket is a common marketing tool, and is an easy promotion approach to encourage people unfamiliar with bus travel to try it (Fujii and Kitamura, 2003). One study has indicated that initiatives such as fare reductions (subsidisation) are effective at encouraging the public to use public transport, because their travel demand is focused on fare changes (Bresson *et al.*, 2003). Fare subsidies become

most effective in high fare areas, reflected in the greatest increase in demand as people take up the opportunity to utilize cheaper fares than the norm.

Another study demonstrated that fare increases or decreases are related to the demand of patronage: when fares increase, passenger numbers decrease; when fares decrease, more passengers are likely to take public transport (Balcombe *et al.*, 2004). A free travel card for a month is sufficient to encourage car users to change their travel mode habits and use public transport (Litman, 2004). It was found that a free ticket for public transport is effective at interrupting habitual car use (Matthies *et al.*, 2006). A later study reported on a free ticket for group travel which was implemented in West Yorkshire, UK, for infrequent bus users (Beale and Bonsall, 2007). The findings of the study showed that the free bus ticket directly affected people who did not use buses, but that the effect was short term. A further study indicated that the Copenhagen government used a month's free travel card to attract car users to try public transport (Thøgersen, 2009b; Richter *et al.*, 2011). This incentive was effective, and led to a significant increase of public transport trips: from 5% of commuter trips to 10% in the short term and 7% after it finished in the longer term. When the promotion expired, the effect became weaker after five months. This means that the travel card was effective in attracting people to use buses in the short term, but after its expiration, passenger trips gradually declined.

Others have argued that a decrease in the cost of public transport is not effective in changing travel modes. Only 1% of car users wanted public transport to be made cheaper as an incentive to use it (Mackett, 2001). Public transport fare reductions and more frequent services have led to an insignificant increase in off-peak use in cities (O'Fallon *et al.*, 2004). Furthermore, in most studies commuting by public transport declined to its initial rate after the promotion period, so the experience of using public transport does not effectively encourage car users to change their baseline evaluation of public transport (Møller and Thøgersen, 2008). The majority of car users choose modes of transport based on their habits, and their final choice is consistent with their preferences. When public transport fares have to be paid for, the car users retain their preference for commuting by car. Likewise, it was found that people have such a strong wish to use a car that it is unlikely to be changed by pull initiatives (Richter *et al.*, 2009). It is clear that price reduction is more effective

in the short than long term. Many return to other modes of transport, and while users may be convinced that public transport was a viable option for them, the effects on behaviour are small. The researcher agrees with the point that public transport fares change public travel behaviour in the short term, but only affect a small part of the population in the long term.

As part of its current transport policy, the New Taipei City Government has provided a financial incentive to generate the habit of using buses before converting users to the MRT after its construction, so for people who use Easycard for taking the MRT Pilot buses during rush hour (6-7am and 5-6pm) it is free of charge. The details of this scheme will be fully discussed in Chapter 6.

3.3.3 Park-and-ride scheme

Park-and-ride (P&R) schemes integrate private and public transport modes through providing parking facilities in cities, combined with a public transport connection such as an MRT station (Liu et al., 2009; Santos et al., 2010). The purposes for implementing P&R are to distribute traffic away from city centres, and to encourage private users to transfer from private vehicles to public transport when entering central areas, thus reducing congestion and air pollution (Marshall and Banister, 2000; Parkhurst, 2000; Turnbull *et al.*, 2004). Many different modes of public transport have been integrated into P&R facilities such as light and heavy rail, existing bus networks, and MRT. P&R sites are usually run by the local government, so the parking fees are considerably less expensive than parking in the city centre. P&R schemes are an effective measure for solving traffic congestion problems in highly developed urban settlements (Wang et al., 2004). For example, a study in the UK showed that P&R into the centre of Bristol may have reduced the number of car trips per day by more than 500 (Marshall and Banister, 2000). More than half of the P&R users would otherwise have used private cars to reach the city centre. P&R enables a decline in the number of the private vehicles entering cities, which achieves the targets and benefits of sustainable transport (Hamsa et al., 2014).

However, it was found that car use dependency is in contrast to the public transport system's success for encouraging mode shift (Mees, 2010). For example, Melbourne's rail system has nearly 40,000 P&R spaces, and provided a 400-space

bus P&R station in 2003 as part of a freeway extension. Yet a later survey found that 98% of those using the P&R bus network had previously walked to their local stop and taken buses for the whole trip. That is to say the P&R scheme had increased the number of car trips, rather than reducing them. It is probable that P&R is a supplementary access mode with the main focus on feeder services, but it does not provide a real alternative to the car.

In Taiwan, TRTC has provided parking spaces near some metro stations in order to provide seamless transfers at the connections between transit systems. The following provision is offered: 3,801 car parking spaces, 10,194 motorbike parking spaces, and 12,685 bike parking spaces (Juan, 2011). The nearest MRT station to the case study area is Nanshaijiao MRT Station, which provides 340 car parking spaces, with car parking fees and discounts. This research will examine the effectiveness of the Park-and-ride scheme in switching car users'/motorcyclists' travel behaviour (the details will be fully discussed in Chapter 7).

3.3.4 Campaigns for alterative transport modes

The initiative of campaigns for alternative transport modes (mass advertising campaigns) is a tool for reducing car use faster, more cheaply and more easily. This initiative is aimed at increasing individuals' awareness of problems caused by car use (Beatley, 2000; Rose and Ampt, 2001; Cairns et al., 2008; Friman et al., 2013), and is designed to encourage private transport users to switch to more sustainable travel modes on a voluntary basis (Cairns *et al.*, 2008). It is trying to affect individuals' decision making by persuasion and change their awareness and motivation, instead of using force and restrictive initiatives. It is an important strategy in many cities to encourage more sustainable behaviours and practices. The British government has been encouraging people to reduce car use by raising awareness of the problems of car use, and their objectives were to make people aware of the necessity for car use reduction (Rose and Ampt, 2001). In the first stage, the government demonstrated the environmental problems and pollution caused by transport through advertising campaigns using a set of brochures, posters, bumper stickers, and logos. They also promoted alternative travel modes such as car sharing or pooling, public transport, and trip chains. The latter stage involved transport planners making a more targeted effort with 'walk to school week' or 'ride

to work' campaigns (Rose and Ampt, 2001: 97), as well as facilitating discussions with community groups to clarify the issues. On average, the number of commuter trips made by employees using public transport, cycling or walking has doubled since before the campaign in the UK (Cairns et al., 2008).

It is evident that many countries such as Australia and the UK have successfully implemented car use reduction strategies and increased use of more sustainable travel modes with initiatives based around transport information. Public transport companies and evaluations have confirmed the changes in public transport use as being a stable modal shift one to two years after the initial implementation. These results suggest that public transport information has made a significant contribution to changing people's travel mode choices.

In Taiwan, the New Taipei City Government has used various methods such as internet information, campaigns, and television to make the public aware of environmental issues, and reduce the negative impacts of transport use. This research will explore commuters' awareness of climate change in order to find out whether it influences their travel behaviour. This will be discussed in Chapter 7.

To be comprehensive the research has listed the literature for all eight options but the empirical research has focused on the first four of these, as modal shifting policies which may help to change travel behaviour in New Taipei City. The advantages of public transport improvements, price reduction measures, and park-and-ride schemes for changing people's travel mode are clear, e.g. cheaper travel costs or improved accessibility through public transport systems. In addition, campaigns for alternative transport modes can use environmental campaigns or education to influence public travel mode choices.

3.4 Acceptability and the effectiveness of shift transport policies

This section discusses the acceptability and the effectiveness of transport initiatives in order to explore how effective the policies typically used within the global south cities are compared to other policies within the ASI framework.

3.4.1 The acceptability of transport initiatives to change travel behaviour

There is a wealth of empirical studies showing that the attributes of the initiatives play an important role in public acceptance (Jakobsson *et al.*, 2000; Vlek, 2007). A previous study examined the acceptability of two different policy packages in 2004 and 2006 (see Table 3.4.1) (Söderholm, 2010). In the SHARP programme, the acceptability of different types of transport initiatives was examined by a survey, namely psychological pull measures, including a general information campaign and personalized information about local public transport; structural pull initiatives, including improved accessibility for cyclists and pedestrians, improved public transport, and subsidies for renewable fuel; push initiatives, including an extended car-free centre in the municipality and raised taxes on fossil fuels.

The findings showed that three structural pull initiatives had the largest acceptability percentage of the four packages of initiatives: improved local public transport (77%), improved facilities for cyclists and pedestrians (74%), and subsidies for renewable fuel (69%). Also, around half of the respondents (45%) were found to accept the information measures, such as personalized information about public transport. Regarding the package of structural push and pull initiatives, 34% of respondents supported the package where a tax increase was used to subsidize renewable fuel, while 23% did so when it was used to improve public transport. In terms of push initiatives, an extended car-free centre in the municipality was supported by 34%, which is around half of that achieved for structural pull initiatives. Clearly, the structural pull initiatives were more acceptable for the public, although push initiatives are necessary to reduce car use. This finding is in line with previous studies which noted that pull initiatives were more acceptable for most car users, while push initiatives such as raised taxes on fossil fuel were generally perceived to be less acceptable (Eriksson *et al.*, 2006; Steg and Schuitema, 2007; Eriksson *et al.*, 2008a).

Accordingly, empirical findings have shown that push initiatives such as transport pricing policies or a congestion charge are not easily implemented because they are much less acceptable to the public (Schade and Schlag, 2000; Schade and Schlag, 2003; Steg, 2003; Schuitema and Steg, 2005; Schuitema and Steg, 2008). It is

probable that people do not want to pay extra costs, so they usually reject push initiatives (Dieplinger and Fürst, 2014). Also, people feel their freedom of mode choices is seriously affected by push initiatives so they do not easily accept them (Jakobsson *et al.*, 2000; Steg and Schuitema, 2007).

Table 3.4.1: Acceptability percentages for different transport initiatives in the SHARP questionnaire 2004 and 2006

	SHARP questionnaire 2004	SHARP questionnaire 2006
Psychological pull initiatives		
General information campaign	27%	-
Personalized information about local public transport	-	45%
Structural pull initiatives		
Improved facilities for cyclists and pedestrians	-	74%
Improved local public transport	68%	77%
Subsidy for renewable fuel	-	69%
Push initiatives		
Extended car free centre in municipality	-	34%
Raised tax on fossil fuel	12%	12%
Structural push and pull initiatives	-	
Raised tax on fossil fuel and improved local public transport	-	23%
Raised tax on fossil fuel and subsidy for renewable fuel		34%

Source: Adapted from Table 10.3, (Söderholm, 2010).

Pull initiatives are more acceptable than push initiatives, but several places such as Singapore and London have effectively implemented push initiatives, such as congestion charges. In Singapore, the government implemented the Singapore area licence scheme (a congestion charge) on the most common route. In London, the congestion charge prompted changes to bus use (and taxis), which were more popular than route changes (Santos, 2004a). Notably, in these two places, the quality of public transport was improved at the same time, and alternative modes of transport were made available to the public. A combination of improved transport infrastructure and high road congestion charges is important for transport pricing to be more effective. By contrast, if the charges are relatively low, this may be less effective (Tretvik, 2003; Santos, 2004b).

Interestingly, it was found that acceptability is related to environmental concerns. To some degree this may be true. If people are strongly concerned about the environmental problems caused by car use, they will accept increases to private transport costs (Schade and Schlag, 2000; Steg and Schuitema, 2007). If people feel responsible for solving these problems, their acceptance is higher than those who are not concerned about the negative impacts of car use. In addition, transport pricing will be effective at reducing car use (Jaensirisak *et al.*, 2003; Schade and Schlag, 2003), benefitting individuals and society as a whole. For example, in Saas-Fee, Switzerland, the acceptability of road pricing was high (57% supported this policy), because people were aware of the problems caused by cars (Frey, 2003). They thought road pricing would be likely to reduce these problems. Therefore, the success of this policy can be explained by the fact that push and pull initiatives act in mutual support, and increase the acceptability of measures for implementing initiative packages such as these. The potential is there for synergy between the strategies (Vieira *et al.*, 2007; Banister, 2008).

Clearly, public acceptance of the policies does not directly influence their effectiveness. Academics have been interested in the acceptability of different measures, perhaps assuming that acceptability would result in changed behaviours, but this has not often been the case. Some pull initiatives are easily accepted but may not result in higher take up of services. By contrast, public acceptance of push initiatives is relatively lower than pull initiatives, because people feel that their freedom of mode choice is seriously affected by push initiatives. Also, they do not want to pay extra costs. Nevertheless, some push initiatives may be more effective than pull initiatives, because they do change behaviour.

The New Taipei City Government has mainly used pull initiatives to increase the relative attractiveness of sustainable travel modes, for example improving cycleways; they are less focused on using push initiatives. This is probably because of their political infeasibility as well as lack of public acceptance. But these pull initiatives may not be enough to change travel behaviour. In light of the discussion above, it is suggested that the government not only provides high quality public transport as an alternative, but also uses increased costs such as a congestion charge. By doing both, it could successfully increase the acceptability of measures.

3.4.2 The perceived effectiveness of transport initiatives to change travel behaviour

In the last few years, there has been a growing focus on transport initiatives that move towards reducing car use (Möser and Bamberg, 2008). A considerable number of studies have indicated that pull initiatives are perceived as more effective than push initiatives (Schade and Schlag, 2003; Steg, 2003). For example, in London, the perceived most effective solution to reducing London's traffic levels is better quality public transport (33% of respondents), followed by cheaper public transport (18%) (see Table 3.4.2) (Turton *et al.*, 2000). The measure of banning car access to Central London was supported by about 8%, and P&R schemes by 7%. Clearly, pull measures are perceived as much more effective.

Table 3.4.2: The most perceived effective initiatives for reducing London's traffic

Variables	Perceived effectiveness percentage
Better quality public transport	33%
Cheaper public transport	18%
Banning cars in Central London	8%
Park and ride schemes	7%
Car sharing	5%
Road user charge – £5 in Central London	5%
Stricter enforcement of parking regulations	5%
More bus lanes	4%
Improved cycle and walking facilities	3%
Safe routes to school	3%
Workplace parking charging, such as £100/ month	2%
Doubling parking costs all over London	2%
Increased petrol taxation	1%

Source: Adapted from Table 1, (Turton *et al.*, 2000).

In general, push initiatives on car traffic, such as restrictive measures, are often seen in a very critical way by citizens. Nevertheless, they can be more effective than pull initiatives, leading to a larger reduction in car use, e.g. increasing cost of car use is effective in reducing the level of car use (TfL, 2004). Push initiatives such as a congestion charge have been successfully implemented in some countries such as the UK, Singapore, and Sweden. In London the congestion charge reduced by 16% the total number of vehicles entering the city centre from 2002 to 2006 (Santos, 2004a; TfL, 2007). Similarly, in Stockholm, congestion charges led to a

22% decrease in overall traffic between January and August 2006 (Hugosson et al., 2006). This implies that the actual effectiveness of measures is not well revealed by people's perception of these measures' effectiveness. And that some less attractive measures have proven to be much more effective than people's perception of them.

There is a wealth of documented evidence that individual transport initiatives are insufficient to address car use and environmental problems caused by transport, so a combination of mutually strengthening measures is necessary (Marshall and Banister, 2000; O'Fallon *et al.*, 2004; Vieira *et al.*, 2007; Vlek, 2007; Cairns *et al.*, 2008; Eriksson *et al.*, 2008b). The combination of raised taxes (a push measure) and improved public transport (a pull measure) were found to encourage reduced car use, because these have different advantages and functions within a transport policy compared to individual measures (Marshall and Banister, 2000; O'Fallon *et al.*, 2004). This is because push initiatives tend to try to 'tax' the user, so that effectively the user pays the climate costs of car use (and this can be used to defray costs) while pull initiatives give users more attractive alternatives. There are potential synergies between different initiatives, so simultaneously implementing two policies may lead to a larger effect compared to the two measures implemented separately (Vieira et al., 2007). Furthermore, a previous study in the Netherlands and USA reported that the implementation of push and pull initiatives, such as parking management and bus subsidies, resulted in a reduction of car use by 20-25% for work travel (Cairns et al., 2008). By contrast, if such measures were separately implemented, the resulting car reduction was only 5-15%. Based on this finding, a behavioural policy package of both push and pull initiatives is thus more effective than the separate implementation of two individual initiatives.

Another study used an experimental between-subject design to examine the effect of a push measure such as increasing tax on fossil fuel, and a pull measure such as improving public transport, alongside a combination of the two measures. Groups of car users evaluated how they would adjust their travel behaviour both in a weekly car diary and on an annual basis (Eriksson et al., 2008a). The findings demonstrated that the combined measures resulted in a larger expectation of car use reduction compared to increased tax and improved public services being implemented separately. Another study assessed individual packages combining one push

measure such as increasing tax on fossil fuel and one pull measure such as improving public transport or a subsidy on renewable fuel (Eriksson et al., 2008a). Each individual transport policy measure was found likely to decrease the relative attractiveness of car use, with pull and push initiatives having different impacts on different target groups, and thus proving variously effective at changing travel behavior (Richter *et al.*, 2009). Both not only strengthen the motivation of car users to reduce their car use, but also contribute to the physical travel context by encouraging sustainable travel behaviour (Gärling et al., 2002b; Eriksson et al., 2010).

It is evident that a combination of push and push initiatives can mitigate some of the drawbacks of individual strategies (Vlek, 2007; Eriksson *et al.*, 2008a; Richter *et al.*, 2009). Pull initiatives alone cannot significantly decrease the attractiveness of car use (Vlek, 2007), but do so if combined with push transport initiatives, which would likely be enforced (Gärling and Schuitema, 2007). This is because the public is encouraged to change modes of transport, and need an alternative mode which is convenient to use. Also, if combined with pull initiatives such as improving the quality of alternative modes, push initiatives such as transport pricing are likely to be more acceptable, and thus more effective (Stopher, 2004; Cairns *et al.*, 2008).

From the discussion above, the public have a perception about the effectiveness of different measures – they tended to favour pull factors as being more effective than push factors. Taking London as an example, only 5% of those asked perceived congestion charging to be effective, and only 8% perceived closing London to cars would be. Yet when congestion charging was introduced between 2002-2006, it demonstrated a 16% reduction in cars entering the centre, which could be argued to be a highly effective measure. So public perception of the effectiveness of initiatives is a questionable measure.

Other studies have looked at individual initiatives and more integrated approaches. It was found that pull and push initiatives are different in their effectiveness. Previous studies have concluded that both pull and push initiatives strengthen the motivation of private transport users to reduce car/motorbike use, and that this may lead to a larger effect when combined than when implementing them separately. The researcher thinks

that if the New Taipei City Government solely uses pull initiatives to attract private transport users to public transport, they cannot effectively reduce car/motorbike use. Therefore, the importance of this research is that it discusses the extension of shift transport policies to include both pull and push initiatives.

3.5 Environmental concerns and travel behaviour

In recent decades, environmental preservation has become one of the most significant issues of our time, so it is necessary to reduce negative effects on the environment from human behaviour as much as possible (Lehman and Geller, 2004; Steg and Vlek, 2009).

3.5.1 Environmental education for promoting environmental issues

Environmental education plays a crucial role in helping individuals to understand their interaction with the natural world and promoting the knowledge, attitudes, and behaviour necessary to improve and protect the environment (Palmer, 2002; Duvall and Zint, 2007). It is often combined with other strategies, focusing on positive environmental effects by increasing environmentally friendly behaviour (Lehman and Geller, 2004). Combined long term strategies are more effective at changing behaviour than one off events/short campaigns, by offering advanced and beneficial technology, changing economic incentives, and altering attitudes and beliefs by using environmental education and information (Steg et al., 2005). Environmental education is classified into two types: formal environmental education, and informal environmental education. Formal environmental education provides the younger generation with information, at primary, secondary and tertiary education level. Informal environmental education provides adults who have left school with information on environmental issues using mass media such as social media accounts, the internet, blogs, television/films (Sudarmadi *et al.*, 2001).

Environmental education in schools is an important strategy for raising environmental awareness, because people's attitudes towards the environment are developed in childhood (Loughland et al., 2002). Education on environmental issues is critical in teaching the next generation about climate change and influencing their ideas, while their thinking is still being formed. Students should be educated about environmental problems so that they have clear knowledge from an early age (Pojani et al., 2013).

Hence, teachers and students in many cities of the world are involved in environmental education, and many students actively participate in local environmental projects (Ballantyne et al., 2001). For instance, a useful way of promoting environmental education would be to explore the student's own experience of the environment and then challenge it (Loughland et al., 2003). In addition, it was found that environmental awareness in schools potentially influences family attitudes and behaviour because children are more likely to engage in discussions with their parents (Ballantyne et al., 2001). People are devoted to providing an ecologically sustainable future for their children and the next generation (Ballantyne et al., 2006).

Up to now, environmental education has not been effective at changing travel behavior on a large scale, because the majority of people still lack environmental knowledge (Kollmuss and Agyeman, 2002; Ogilvie et al., 2004; Ogilvie et al., 2007). They do not clearly understand environmental issues, leading them not to act in an environmentally responsible way (Whitmarsh, 2005; Lorenzoni et al., 2007). The deficit model of public knowledge refers to members of the public who are knowledge-deficient and misguided, which may lead their decision making in the wrong direction (Wynne, 1991). Several factors affect the information deficit model of environmental behaviour, such as a lack of awareness, concern or intelligence, societal values, personal experience, and other contextual factors (Irwin and Wynne, 1996; Macnaghten and Urry, 1998; Sturgis and Allum, 2004). If the public commonly do not understand environmental issues, especially global warming and the concept of sustainable development, it is necessary to concentrate on the provision of reliable scientific information to educate the public, change behaviour and gain their support for policy (Eden, 1996). Environmental agencies play an important role in influencing public environmental knowledge, because policymakers use key strategies to encourage individual environmental responsibility. This is a process of knowledge transfer from top down (expert to the public) to influence their attitudes and behaviours towards the environment (Macnaghten and Urry, 1998).

A report by Harris setting out the findings for the 'Going for Green' initiative in the UK concluded that *people had good intentions, but more support and information were required to encourage action; that people as individuals felt powerless […], and looked to the government and councils to set leading examples; and that the main barriers to*

action were time/inconvenience and lack of information' (Green, 1995: 2-4). This finding showed that the public are eager for more environmental information to support them to act in a more environmental friendly way. Policymakers can thus use some key strategies to encourage individual environmental responsibility, based on providing information. This assumes that people will trust such information as credible, because environmental concerns as well as actions are presumed to be limited by information. If the public lack basic knowledge about causes, impacts and solutions to climate change it may result in a sense of uncertainty about climate change (Lorenzoni et al., 2007). It is important for them to have environmental education and knowledge from professional experts, particularly in relation to participation in environmental behaviour (Yearley, 2000; Petts and Brooks, 2006).

3.5.2 Environmental attitudes influencing travel behaviour

Environmental education and marketing campaigns are aimed at helping the public to make informed decisions about their environmental behaviour, and generating preparedness to act in more environmentally sustainable ways (Jurin and Fortner, 2002; Jacobson et al., 2006; Damerell, 2009; Boyes and Stanisstreet, 2012). It is important to provide basic information to overcome lack of environmental knowledge in the public, in order to reduce the negative effects on the environment from human behaviour as much as possible (Lehman and Geller, 2004; Steg and Vlek, 2009). Environmental education is recognized as a tool to provide people with new information, which is an important determinant of people's willingness to resolve environmental problems, and to accept climate change initiatives (Nilsson et al., 2004). It is an attempt to change behaviour by increasing awareness and knowledge about issues through education and communication-based approaches.

There is a wealth of literature suggesting that environmental education and marketing campaigns are one of the most effective strategies in switching or adopting simple behaviours that require little confidence or skill, especially when environmental behaviour is more convenient and requires little expenditure of money, time, or effort (Lehman and Geller, 2004; Abrahamse et al., 2005; Heimlich and Ardoin, 2008). The ABC framework explains peoples' attitude, behaviour, and choice; `A' stands for attitude, `B' for behaviour, and `C' for choice (Shove, 2010). It is the dominant model for environmental policy, which positions governments and agencies as enablers. Their

purposes are to induce people to make pro-environmental decisions, and to make them act in environmentally friendly ways. As an academic with expertise in sustainable issues, Shove pointed out that 'The popularity of the ABC framework is an indication of the extent to which responsibility for responding to climate change is thought to lie with individuals whose behavioural choices will make the difference' (Shove, 2010: 1274).

If people's environmental knowledge and attitude is high, they are more likely to try to solve environmental problems by promoting environmental activities, and to adopt more environmentally friendly behaviour (Sudarmadi *et al.*, 2001). Even without external constraints on behaviour it is possible to persuade people to change their attitudes, strengthen their altruistic and ecological values, and make them devote themselves to being more environmentally friendly (Gärling and Schuitema, 2007). A necessary task for policymakers is to increase knowledge and awareness of environmental concerns through education and communication-based approaches, and to promote appropriate behaviour to reduce environmental issues (Whitmarsh, 2005). Increasing the public's understanding of the effects and consequences of ongoing environmental problems is the key determinant of behavioural intentions (Bord et al., 2000). This is a chance to increase environmental sensitivity through providing environmental knowledge and raising awareness of the associated problems.

Furthermore, governments have emphasized information on environmental issues using the education system and awareness campaigns with the public to stress their responsibility for relevant problems, and to indicate what they could do to alleviate them (Steg and Groot, 2010; Pojani et al., 2013). This should be combined with letting them clearly understand the environmental impact of their travel behaviour, and its advantages and disadvantages, because increased environmental knowledge may lead to willingness to act in an environmentally friendly manner, then influence travel mode choices. Therefore, people need to be continually educated in the environmental field, adapting to rapidly changing circumstances, and encouraged to take appropriate action. Environmental education is not only about raising the sense of responsibility for environmental issues, but also about strengthening the moral obligation to take environmental action (Macnaghten and Urry, 1998; De Groot and Steg, 2009).

However, an extensive literature review has pointed out that environmental campaigns,

and other interventions have generally been very ineffective at changing travel behaviour (Kollmuss and Agyeman, 2002; Ogilvie et al., 2004; Ogilvie et al., 2007). When environmental education is concentrated on abstract or impersonal issues, these are not effective at generating greater social and environmental responsibility and do not resolve problems related to the usage of private vehicles. The public pay little attention to environmental concerns, because some of them do not feel that their own behaviour influences climate change. They are not willing to change their travel behaviour. For example, in 2004 just over half of the British population believed that changing their own behaviour would have an impact on climate change (BBC, 2004). In addition, people think climate change is a social issue, so it does not make them feel a prominent personal threat (Lorenzoni and Pidgeon, 2006). They do not see the urgency of addressing the problems of climate change so they are less likely to behave in an environmentally friendly way (Lorenzoni and Pidgeon, 2006; Lorenzoni *et al.*, 2007).

Studies indicate that most people who conserve energy do it because of financial and health reasons rather than environmental issues (Defra, 2002). Global social risks such as poverty, AIDS and debt tend to be grouped together as more serious negative issues than personal concerns, so their personal damage is seen as insignificant (Nilsson and Küller, 2000). In other words, people usually tend to have more concern for other issues such as personal health, security, and financial concerns, whereas environmental issues and sustainable development are considered as a separate concern from them (Bord et al., 2000; Poortinga and Pidgeon, 2003; Norton and Leaman, 2004). Besides, people think their needs in daily life are more important than environmental concerns, and cannot see the environmental costs of daily life, so it is not effective to try and persuade them to consume or waste less by changing their behaviour (Uzzell, 2008). If the targets of achieving sustainability cannot be realized by changing individuals' behaviour, they may be better reached through government-led interventions (Darnton, 2004).

This is the same situation in Taiwan, where the government has made efforts to promote public environmental knowledge to influence behaviour through internet information, campaigns, and television. Nevertheless, environmental policies, and moral and educational approaches are not effective at changing behaviour. It is probable that people's self-interest (transport is free/cheap and convenient) determines the motivation

for using cars/motorbikes (see Chapter 2's discussions). Even if environmental knowledge is important, their travel behaviour is less likely to be changed by environmental concerns. This implies that a package of policies is needed to mode shift away from private vehicles.

3.6 Avoid/Reduce and Improve elements

Figure 1.2.1 lists the ASI framework, and the Avoid/ Reduce and Improve elements will be considered here. A brief discussion of suggested A&I policies is included here to illustrate that shift policies are not the only way to reduce GHGs produced through transport.

3.6.1 Avoid: Reduce the need to travel

Many city governments have been implementing a wide range of different initiatives to reduce the adverse effects of car use, and change private transport users' travel behaviour (Fujii and Gärling, 2003; Bamberg, 2006; Gärling and Schuitema, 2007; Söderholm, 2010). Transport planning experts in Europe, Australia, and Japan have recognized the importance of altering private transport users' travel behaviour from motor vehicles to public transport, e.g. buses or trains, and aim to decrease automobile dependency and increase the demand for public transport (Fujii and Taniguchi, 2006). Reducing individuals' travel needs requires fewer trips being made but does not necessarily mean teleworking or no more trips being made (Banister, 2008).

3.6.2 Reduce: Land-use initiatives – urban form and structure

In the ASI framework, in connection with the 'avoid' element, 'reduce' focuses on reducing trips through changing the urban form (e.g. mixed land-use developments, including employment, retailing, services, and business opportunities). Extensive literature has recognized that urban form and infrastructure play an important role in achieving sustainable transport use (Priemus *et al.*, 2001; Thakuriah, 2001; Frumkin *et al.*, 2004; Wegener and Fürst, 2004; Bertolini *et al.*, 2005). Urban form characteristics (such as settlement size, mixed land-use, accessibility, and local street layout) have been closely connected to travel patterns, and travel behaviour. It was found that transport patterns are outcomes of urban form, and the connection

must be made by decision-makers, i.e. policymakers, between land-use and transport (Mees, 2010; Aditjandra *et al.*, 2012). For example, urban form can influence location and designs such as housing, infrastructure, services and facilities to support local services, because it not only reduces the residents' travel distances to work, school, and shops, but also increases public transport use (Mees, 2010).

In addition, high densities such as city centre areas provide a high degree of access to opportunity locations such as workplaces, which reduces the overall distance and travel demand, and affects the use of travel modes (Santos *et al.*, 2010). For these high levels of access to destinations, people tend to have a shorter trip, which could be expected to contribute to lower transport energy consumption (Næss, 2012). Therefore, in order to reduce car use and the need for travel, it is necessary to integrate urban form and layouts to reduce the amount of travel and distance, to make public transport effective (Giuliano, 1995; Newman and Kenworthy, 1996; Williams, 2005; Banister, 2008; Næss, 2012).

In the US, Canada, Australia, and many European countries, transport systems have been highly developed, and operated for more than fifty years, and they are being improved to achieve sustainable mobility (Hensher, 1998; Zhang, 2004). This is not only because decision-makers have adapted public transport to the existing urban form, but also because they have built convenient transport systems with good quality of service to the public (Williams *et al.*, 2000; Mees, 2010; Wang *et al.*, 2014). For instance, cities such as Toronto, Ottawa and Vancouver have used buses, extending them to trunk rail. Also, busway networks have linked into dispersed suburbs, and the suburbs have been linked to one another. Furthermore, Zurich, which is the biggest city in Switzerland, provides an excellent public transit network (Mees, 2010). The quality of its services is good with high frequencies and reliable services on all corridors, cross-city and radial. Also, it provides multi-modal fares and excellent facilities to reduce transfers between routes. Passengers can get anywhere at any time of day. However, it is worth noting that the high speeds and improved access of the public transport system may encourage long-distance commuting, because people can travel further to find jobs outside of local

areas. The increases in travel distances result in a decline in self-containment[8] (Mees, 2010).

Similarly, in some developing countries, integrated land use and transport policies have been successful in cities such as Curitiba of Brazil, Hong Kong, and Singapore (Gwilliam, 2003). According to Wright and Fulton, 'most developing-nation cities still possess the basis for a more sustainable future' (Wright and Fulton, 2005: 691). Compared to developed countries, zero-carbon modes of transport are still common, such as walking and cycling. In Curitiba, the government established a transport network with low capital expenditure (Santos et al., 2010). They also took some simple, relatively cost-effective measures, such as establishing bus priority lanes. Also, integrating public transport with other transport infrastructures, such as cycling paths, is an important determinant for developing sustainable urban mobility. The success of the public transport system in Curitiba is due to policymakers not only constructing busway infrastructures, but also providing integrated network planning (Mees, 2010).

Hong Kong is another successful example in a global south country, in which land-use characteristics are integrated with a public transport system to reduce car use. For example, from 1981 to 1991, public transport use rose by 104 trips per capita (Newman and Kenworthy, 1996). The city has been successfully planned because a high density of mixed-use development in this city is served by electric rail and buses, and there are also high levels of walking and cycling. Newman and Kenworthy concluded that 'central to the success of this model is high-density urban development that is closely integrated around the transit system' (Newman and Kenworthy, 1996: 13).

Another example, Singapore is a small city-state island country, and has one of the most efficient transport systems in the world (Midgley and World Bank. Asia Technical, 1994; Sim *et al.*, 2001). The important determinant is to incorporate a transit-oriented planning concept into land use and transport planning as well as demand management measures. Newman and Kenworthy stated that 'Singapore is

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[8] Self-containment refers to achieving a built form that allows many to live, work, shop and recreate within a community or defined geographical area. Burby, R.J. and Weiss, S.F. (1976) *New communities USA*. Lexington Books..

a good example of a handful of places which have simultaneously introduced severe economic restrictions on car ownership and use, while dramatically improving public transport…' (Newman and Kenworthy, 1996: 7). In 1971, the Singapore government developed residential blocks, and incorporated roads, expressways, and MRT lines to decentralize the population away from the Central Business District (CBD) (LTA, 1996).

In 1991, transport planners developed local areas and sub-regional centres located around MRT stations to decentralize commercial and economic activities in Singapore. The developments in land use increased the public's travel demands between commercial centres, shopping centres and residential areas. This led to higher use of the MRT network. Furthermore, the public housing authority emphasized a fair degree of self-containment with neighbourhood centres providing for basic needs for goods and services (Ooi, 2008). High density residential areas that have main transport hubs within walking distance increase the demand for services around the local areas. As such, Singapore's land use and transport planning have been successful in providing more sustainable alternatives to the use of private modes of transport, including a well-organised public bus and MRT system. Also, they have reduced the number and distance of trips made by the public, another move towards sustainable transport.

Many rapidly motorizing cities such as Bangkok, Manila, and Jakarta in Global South countries have increased car ownership, and they take Hong Kong or Singapore as a model for public transport systems in order to reduce traffic and environmental problems (Newman and Kenworthy, 1996). The cities of Global South countries benefit from high density mixed-use development, and accessible public transport as well as walking and cycling. Yet, these cities face the challenge that is transport system improvements to maintain the market share of low carbon emission modes (Wright and Fulton, 2005). It is clear that successful cities either in developed countries or Global South countries did not attempt to rebuild urban form as completely different places; instead, they have adapted convenient public transport networks to the existing urban form.

Given the focus of this research, urban form was not the main topic that was explored. But the researcher is interested in how urban form influences people's travel behaviour.

The New Taipei City Government put the MRT Three Rings and Three Lines Construction in place to improve public transport infrastructures in the Taipei metropolitan area, so the MRT system is being fitted to existing buildings, rather than building transport infrastructure and then having new buildings fit around that.

3.6.3 Improve: Technological innovation – increase efficiency

Returning to the ASI framework, this section reviews the literature focused on the improve element. Transport technologies directly affect the efficiency of operating vehicles and reduce noise and exhaust emissions at source; these include engine design, alternative fuels, and the use of renewable energy sources (Banister, 2008). For example, 'electric bikes are a transitional mode between human-powered bikes and full-blown automobile ownership' (Cherry and Cervero, 2007: 247). In the UK, around a third of local authorities are researching low carbon vehicle technologies, such as new power-trains, advanced electronics and materials as well as structures (Britain, 2003). They have also implemented a hybrid policy measure to permit vehicles that are likely to be environmentally cleaner, such as fuel-cell buses, and electric and hybrid vehicles, to access certain parts of the city which are restricted from other vehicles. In addition, in Britain the Foresight vehicle programme involved over 400 companies and organizations in a range of projects (Banister, 2005). It was found that more than 30 per cent of the costs of any new vehicle are associated with technology, especially engine management systems, the new generation of route guidance systems, and diagnostics for maintenance, and these costs will increase in the future. In Taiwan, the government subsidized electric bike use, and provided clean alternative gas-powered scooters in the 1990s (Taiwan, 1998; Chiu and Tzeng, 1999).

In Taiwan, the New Taipei City Government has made an effort to replace traditional buses with low chassis buses, because the latter are, when hybrid electric, more environmental friendly modes of buses. In addition, the government provides NTD 100 million (around £2 million) every year to subsidise the bus companies' upgrade of their traditional buses to low chassis versions and/or hybrid electric plus low chassis buses. More details are fully discussed in Section 5.4.2.

3.7 Summary

This chapter introduces the ASI framework, and its objectives. It mostly explores transport policies within the Shift element to find out their effectiveness in switching travel behaviour and reducing private vehicle use. As reducing private vehicle use is becoming increasingly important in the development and implementation of transport policy in all countries, so policymakers have implemented transport initiatives to encourage people to commute more sustainably by improving travel options.

In terms of shifting policies, which are the main focus of this research, their purpose is to reduce levels of private vehicle use and encourage private transport users to use sustainable modes. These policies are subdivided into pull initiatives, and push initiatives. Many global south cities tend to be reliant on infrastructure-led approaches (pull initiatives) such as MRT, LRT and BRT systems to reduce GHG emissions from private vehicles, and enhance the attractiveness of alternative modes (Hayashi et al., 2004; Hossain, 2006; Deng and Nelson, 2011). Yet, this infrastructure-led approach alone is not sufficient to get people to switch from car/motorbikes to public transport. Both pull and push initiatives are likely to decrease the attractiveness of car use, and have different impacts on changing travel behaviour with different target groups. In addition, packages of transport initiatives have been found to influence travel behaviour to a larger extent compared to individual initiatives, as individual initiatives have strong characteristics but also some limitations. Besides, there are potential synergies between different initiatives so that simultaneously implementing two initiatives, with pull intitiatives supporting push initiatives, may lead to a larger effect compared to the two initiatives implemented separately (Vieira et al., 2007). Most importantly, modal shift policies are only one element within the broader ASI framework; avoid and improve elements must be considered as well.

Environmental education is recognized as a tool to change behaviour by increasing environmental knowledge, and correcting public understanding of the effects and consequences of ongoing environmental problems, then raising their sense of responsibility for environmental issues (Bord *et al.*, 2000; De Groot and Steg, 2009). If people's environmental knowledge is high, they are more likely to try to solve environmental problems by promoting environmental activities, and to adopt more environmentally friendly behaviour (Sudarmadi *et al.*, 2001). However, some people

think climate change is a social issue, so it does not make them feel a prominent personal threat (Lorenzoni and Pidgeon, 2006). They usually tend to be more concerned with other issues such as personal health, security, and finance (Bord et al., 2000; Poortinga and Pidgeon, 2003; Norton and Leaman, 2004). In addition, various other factors also affect peoples' travel mode choices, such as the feel good factor, social norms, individual benefits, ease and so on (Defra, 2008). As such, educational approaches are not likely to be effective at changing peoples' travel behaviour, so policymakers have to use other policies such as push initiatives to shift private transport users' travel mode choices.

In Taiwan, the New Taipei City Government is primarily focused on the shift element within the ASI framework, but does use other relevant policies, such as land use policies, to address other elements of the ASI. As New Taipei City had already been built, the New Taipei City Government has now invested huge funding into fitting the MRT Three Rings and Three Lines Construction into the existing urban form in order to achieve the goal of 50% public transport use for all trips. This research has mainly focused on those transport initiatives which tend to deliver more highly on the shift element of ASI (more details in Chapter 6), but also discussed the relationships between urban form and the MRT Three Rings and Three Lines Construction as well as case study area (see as Chapter 5).

The next chapter presents an overview and justification of the methodology utilized to achieve the research aim, describing the case study selection, empirical data collection, interviews design and survey design.

Chapter 4
Research design and methodology

4.1 Introduction

Chapter Four discusses the methodology utilised to achieve the research objectives. The purpose of this chapter is to describe how this research was designed to answer the research aims and objectives, with particular reference to evaluating transport policies to increase public transport use, and exploring commuters' mode of travel choices for commuter trips. The chapter briefly reviews the aims of the research, then discusses the research strategy and framework, empirical data collection, the interview design, and the survey approach and design. It summarizes the sampling, data collection and method of analysis. The research aim and case study selection are discussed in 4.2. The interview design, sample collection and interview analysis are presented in Section 4.3. Section 4.4 covers piloting the questionnaire, survey design, the survey sample collection and survey analysis. The ethical issues of the data collection are given in 4.5, and the limitations of this research are presented in Section 4.6.

4.2 Methodological approach

The overall research aim is to explore the potential for changing commuters' travel behaviour to more environmentally-friendly modes of transport by critically evaluating transport policy attempts to increase public transport use, and by evaluating commuters' travel behaviour to discover their intentions. This research used a single-case research method, which is a common and appropriate approach (Denzin, 2005; Soy, 2015). This is because a case study has the advantage of effectively observing and analyzing phenomena that are usually inaccessible by scientific investigation (Abelson, 2001). The chosen case was New Taipei City of Taiwan, as the basis to explain and conduct a sub-unit of case study to investigate commuter travel mode choices, and their rationales for these choices. It not only reflects commuter travel behaviour and their opinions toward transport initiatives in depth, but also leads to an understanding of the case, which answers the research objectives.

In Taiwan, the New Taipei City Government is primarily focused on pull initiatives of

modal shifting policies to reduce motorized vehicle use, e.g. the MRT Three Rings and Three Lines Construction, and the MRT Pilot Bus. This research adopts the shift element within the ASI framework to critically evaluate the effectiveness of New Taipei City transport initiatives in increasing public transport use. Hence, this research used a mixed-method approach, including reviewing transport policies relating to the locality; using questionnaires for commuters (quantitative approach); using policymakers' and experts' interviews (qualitative approach) for exploring three transport initiatives, namely the MRT Three Rings and Three Lines Construction, and the MRT Pilot Bus.

The quantitative approach revealed a deeper picture of the commuters' mode of travel choices, travel behaviour, their service satisfaction with public transport (the metro and bus) and their thoughts on current transport policies and facilities. The qualitative approach was implemented through policymaker and expert interviews (with university academics, environmental activists, and experts from identified transport consultancies), to understand their opinions of these three transport initiatives. These four groups were targeted to gain a multidimensional perspective regarding transport transport policies in New Taipei City. By including both quantitative and qualitative data, the research helps explain both the process and outcomes of commuters' travel behaviour and a critical evaluation of New Taipei City's transport initiatives through complete analysis of the case under investigation.

4.2.1 Case study selection: New Taipei City

Many Global South countries have experienced rapid economic growth for over ten years, which has led to high levels of motorcycle use in countries such as Vietnam, Indonesia, and Thailand, particularly in city areas (Hossain, 2006; LUbis, 2009). Likewise, New Taipei City is a fast-growing city, which has rapidly increasing levels of motor vehicle ownership and use. Also, it was upgraded to a municipality in 2010, which has driven the development of the surrounding satellite towns, and narrowed the gap between urban and rural areas. The New Taipei City Government carried out restructuring to simplify the administrative hierarchy, enhancing local administrative efficiency, and allocating budgets and resources for the authorities at all levels. In addition, they have implemented land development planning, and try to ensure that the restructuring of administrative resources between each district of New Taipei City is fairly balanced.

A complete MRT system was constructed in Taipei city of Taiwan, but in 2010 the New Taipei City Government designed lines making up a single MRT network with New Taipei City at their centre to emphasize the networks' primary importance for New Taipei City. Zhonghe district is a transportation hub, and is located in the south-west of New Taipei City, which is one of the satellite towns of Taipei City. Its total population is 415,055, with 157,474 households, and a total area of 20.294 km^2 (Department of Civil Affairs, 2014). The geographical position of Zhonghe district is located to the west of the Yonghe district, the north of Xindian district, and the east of Banqiao district. Figure 4.2.1 shows that New Taipei City consists of 29 districts, which includes this research's case district of Zhonghe, as the second most populous.

Four reasons which led to the selection of this case study are outlined below. Firstly, Global South countries are experiencing explosive growth, and implementing public transport services at the moment. They tend to rely on infrastructure-led approaches such as MRT, LRT, and BRT, especially in Taiwan (Hayashi et al., 2004; Hossain, 2006; Deng and Nelson, 2011). In 2010, the Transportation Department of New Taipei City's government invested a great deal of money in the MRT Three Rings and Three Lines Construction to switch private transport users from using cars and motorbikes to public transport. Hence, the research seeks to address the possibility that the MRT Three Rings and Three Lines might be a substantial incentive to change behaviour.

Secondly, Zhonghe district is the district of New Taipei City where the researcher grew up, so she has a good understanding of transport infrastructures, and population characteristics and particularities. Thirdly, New Taipei City's transport system is currently overwhelmed by travel demands on its existing five MRT lines, 34 stations, and 42.3 km of track. All of these operate in the Taipei metropolitan area[9]. Furthermore, the average width of roads is around 10.9 m in New Taipei City, which is considered too narrow to accommodate a large fleet of motor vehicles (Transportation Department, 2015). The pre-existing transport infrastructure of New Taipei City was not enough to accommodate the daily trips generated by the 3.9 million people who live in New Taipei City.

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[9]The Taipei metropolitan area is comprised of Taipei City, New Taipei City, and Taoyuan City.

Finally, motorbike use has become a crucial issue to be addressed in Taiwan, because of social pressure and cultural challenges. There is a constant high volume of motorbike traffic in Taiwan, as the average household owns more than one motorbike as well as a car (MOTC, 2014). The population of Taiwan is around 23 million, 8,286,260 households, and the total numbers of registered motorbikes and cars in 2013 were 14,195,123, and 7,367,522 respectively. In addition, the Ministry of Transportation and Communication's published statistical data show that in 2013 up to 75.2% of Taiwanese used private transport to commute and for school trips, and, out of these, 50% used motorbikes and 24% used cars (MOTC, 2013). This demonstrates the importance of motorbikes as a mode of transport in Taiwan.

Regarding the MRT Three Rings and Three Lines, the case study area is located in the first stage of the Zhonghe Line, which forms part of the Three Lines along with Zonghe-Xinlu Line, and Wanda and Sulin Line (First phase construction). The MRT Xioulang Bridge Station (the nearest MRT station for the He Ping Shin Jiun community) will be constructed in the first phase of the Zhonghe district Ring Line, which is estimated to be completed in December 2018. More details of the transport system in the case study area are shown in Chapter 5.

Policymakers have invested a huge amount of money in the MRT Three Rings and Three Lines Construction to provide a new travel option to the public. Therefore, the research adopted New Taipei City as a typical example of global south cities, aiming to find out whether commuters' travel behaviour are likely to be changed by this investment. It aims at examining whether infrastructure-led approach is sufficient to persuade people to switch from car/motorbikes to public transport, and evaluating the effectiveness of New Taipei City's transport initiatives regarding two aspects of their transport policy, namely the MRT Three Rings and Three Lines Construction, and the MRT Pilot bus in New Taipei City.
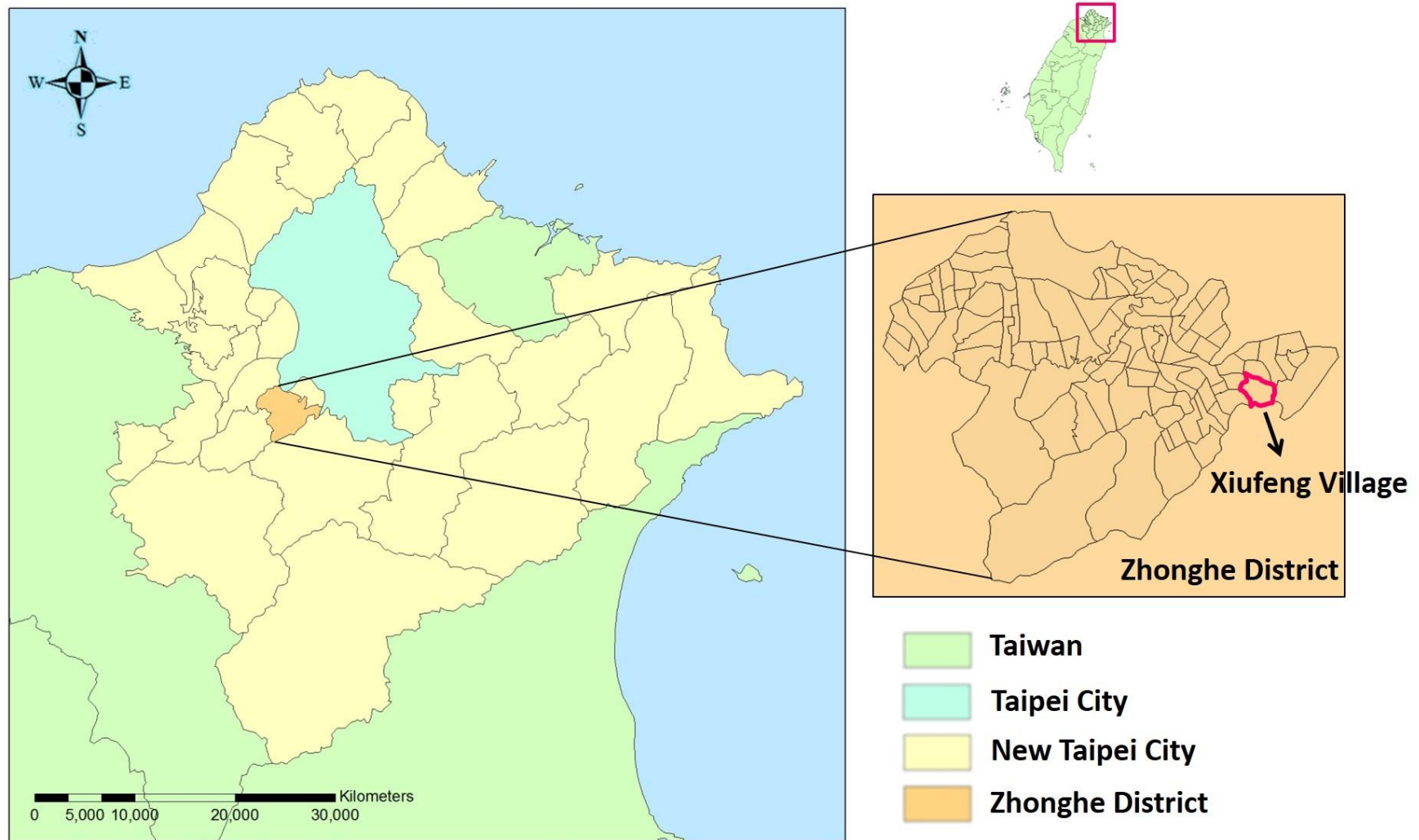
Figure 4.2.1: The north of Taiwan

Source: This map is modified from data provided in 2010 by the Department of Architecture and Urban Design, Chinese Culture University in Taipei, Taiwan.

4.2.2 Sub-unit of case study selection: The He Ping Shin Jiun community

The case study focus is an embedded unit of analysis – the He Ping Shin Jiun community, which is located in Xiufeng village of the Zhonghe district, New Taipei city, Taiwan. '*Case study with embedded units of analysis is to look at sub-units that are situated within a larger case, the data can be analyzed within the subunits separately (within case analysis) […].* (Yin, 2003: 550).'

This community was chosen because in 2008 Xiufeng Village was awarded the title of No.1 cleanest village in Taiwan. More than 200 environmental volunteers implement environmental protection measures in Xiufeng Village, such as recycling flyers wherever they see them. Also, they go around the streets and parks to pick up flyers and litter every day. This would imply that the residents who live in the case study area may have a clearer understanding of environmental issues and a greater environmental knowledge than other residents in other districts, and perhaps a stronger sense of environmental responsibility, which may positively influence their travel behaviour and make them more likely to shift modes of transport. In the research, the embedded unit of case study analysis is focused on the empirical evidence of commuters' travel behaviour, which reflects and combines their opinions/travel needs, and their thoughts on transport initiatives. Use of a single case with embedded units enables the researcher to explore the case in depth while considering how commuters' travel behaviour is affected by public transport improvements, as well as related transport initiatives of New Taipei City. Given the interest of this study, this was an important factor in choosing this sub-unit.

4.2.3 Justification of the targeted group: Commuters

Zhonghe is a crucial transport hub and plays an important role between Taipei City and New Taipei City. The study selected residents living in Xiufeng village, which is a typically environmentally conscious community in Zhonghe. According to New Taipei City population statistics, Xiufeng comprises 47 neighbourhoods and 1,833 households, with a total population of 4,562 (46.0% males, 54.0% females)(Department of Civil Affairs, 2018). In the community of He Ping Shin Jiun, there are 2,010 males and 2,250 females, for a total population of 4,260 (see Figure 4.2.2). In the research, individual

commuters were the targeted objects for the data collection survey, because they have to complete more trip-chains for non-work activities (e.g. shopping, picking up children, and visiting friends) in addition to their commute. Furthermore, because commuter trips tend to be longer distance than other trips such as household provisioning, recreational, and social trips, commuters are less likely to use other alternative modes for commuter trips (Hess, 2001). These trip-chains invisibly encourage commuters to use private vehicles more, and so their travel mode choices are more difficult to shift. In particular, private vehicles are free from the restrictions of service hours and network coverage, which increases their use for commuter trip chains as it offers an ever-present door-to-door service at any time of the day without waiting (Susilo and Kitamura, 2008). While commuting trips form only a small percentage of total car use, commuters are particularly unsusceptible to making a mode shift (Curtis and Headicar, 1997; Eriksson, 2011). Most car commuters are highly reliant on using cars. Besides, the policy measure of the MRT Pilot bus is free of charge in rush hours (am 6:00-7:00, pm 5:00-6:00), which particularly targets commuter users, so that became another reason for focusing on commuters in the research. Therefore, this research has chosen to focus on commuters as a less researched group.

While changing commuters' travel behaviour is difficult, it is likely to be possible where the MRT Three Rings and Three Lines is being put in place, as a whole new travel option is being provided. Given its research interests, this thesis aims to use the ASI framework to critically examine the effectiveness of significant financial investment in the MRT Three Rings and Three Lines Construction. The survey was designed to collect information on the targeted groups based on the following criteria:

- Commuters i.e. both males and females 18 years old and above and in full-time work, excluding people walking and cycling;
- Drivers of private vehicles (including motorbikes and cars) <u>or</u>
- Commuters who travel to work using the metro and bus.

The research focuses on four modes of transport used by commuters: motorbikes, cars, buses and the metro. This is because they are ranked as the top four travel modes for commuter trips in Taiwan and New Taipei City. In New Taipei City, private transport represented 61.2% of all means of transport for commuter trips. 43.9% used motorbikes as the dominant mode of transport, followed by 16.7% for cars (MOTC, 2013).

Regarding public transport for commuter trips in New Taipei City, the city bus and metro comprised 15.2% and 13.8%, respectively, of all modes of transport for commuter trips.
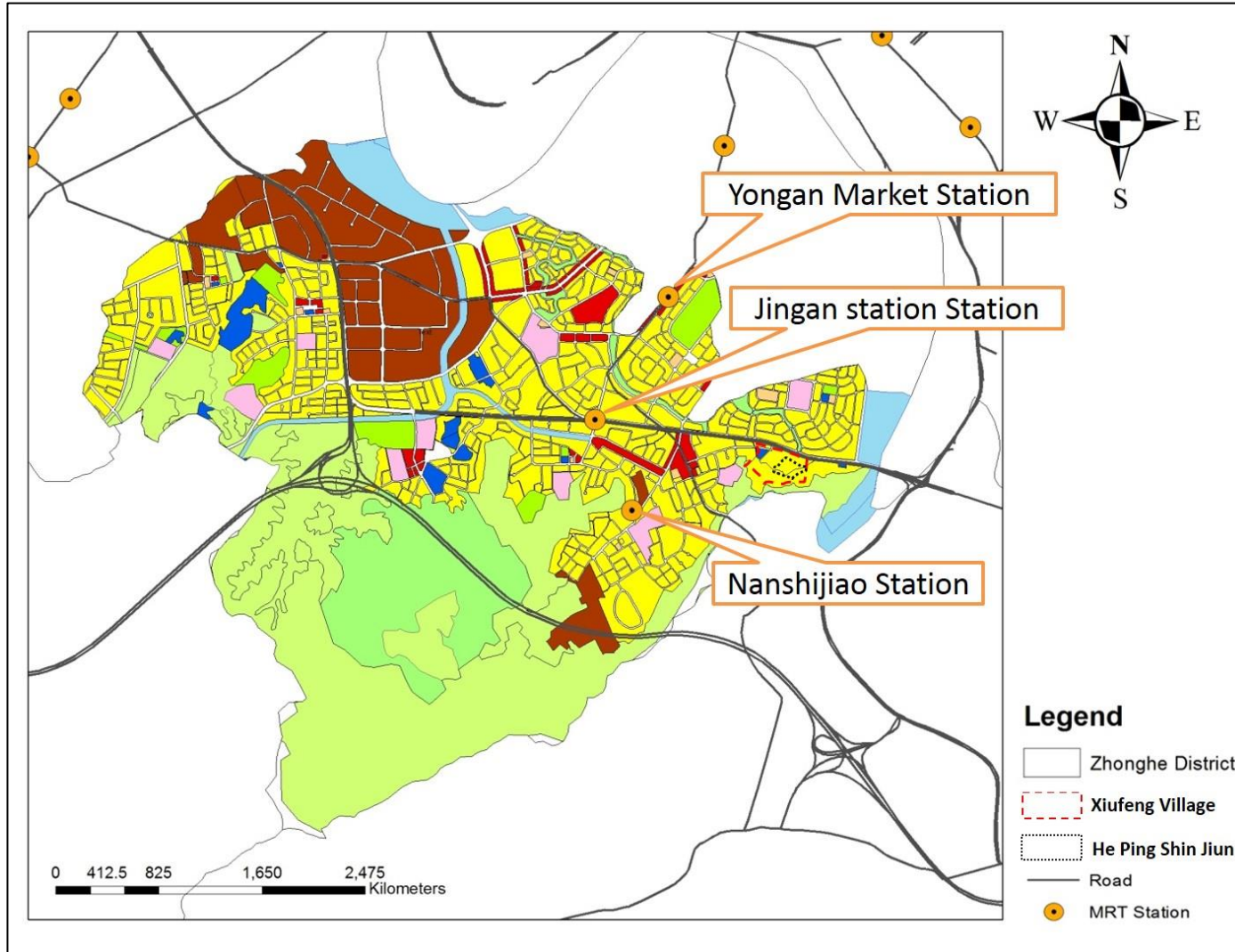
Figure 4.2.2: Case study area

Source: This map is modified from the data provided in 2010 by the Department of Architecture and Urban Design, Chinese Culture University in Taipei, Taiwan.

4.2.4 Justification of the selected approach

Over the past forty years, both quantitative and qualitative viewpoints have been found to be useful in dealing with research objectives (Johnson *et al.*, 2007). 'Mixed methods research's central premise is that the use of quantitative and qualitative approaches, in combination, provides a better understanding of research problems than either research approach alone' (Clark and Creswell, 2011: 5). In this research, quantitative questionnaires and qualitative semi-structured interviews constituted the primary methods of data collection, which led towards the selection of a mixed approach as the appropriate method. The quantitative method is helpful for exploring the reasons for and scope of travel mode usage for commuter trips, and it provides insights into the sources of travel behaviour as well as motivation. The quantitative method was used instead of a qualitative approach, because it is useful for gathering a large number of respondents' information without limitations (Decrop, 1999), as the qualitative method is less credible and dependable for understanding the whole picture of the commuters' travel behaviour and their opinions on transport initiatives.

Nevertheless, the qualitative method will help achieve a better understanding, explanation and interpretation regarding policymakers' and experts' insights into the current transport policy measures. These points of view should help form a critical evaluation through combining an understanding of the attitudes and preferences of those in the survey with expert views regarding the two strands of transport policy, namely the MRT Three Rings and Three Lines Construction, and the MRT Pilot bus. Due to the semi-structured interview questions being open-ended and not limiting the respondents' choice of answers, the interviewer can make use of cues and prompts to direct the interviewee to the research topic area and thus gather a more in-depth data

set (McCracken, 1988; Patton, 1990; Gubrium and Holstein, 2002; Creswell, 2013). Furthermore, semi-structured interviews make up for any deficiency in the review of policy documents. Both quantitative and qualitative methods can be corroborated to maintain the reliability of collected data. Two schemes of interview were designed for the policymakers and experts (details presented in Section 4.3.2). There is no doubt that the role of mixed methods research utilizes the strength of the two methods and minimizes their individual weaknesses (Feilzer, 2010). Its flexibility enables it to solve complex issues so that researchers have the freedom to use suitable approaches, techniques and procedures that combine to answer the research objectives. This involves statistical and text analysis so that the interpretation and understanding of the data is not limited to one form (Easterby-Smith *et al.*, 2008). It can be said that mixed methods research is the best method for this research.

4.3 Interviews

The qualitative method is used as an independent research strategy to explore and understand a diversity of social and public policy issues (Huberman and Miles, 2002). In the research, the qualitative data were mainly obtained through policymaker and expert interviews, including university academics, environmental activists, and experts from identified transport consultancies, to gain a multidimensional perspective for developing a critical evaluation of New Taipei City transport policy. For the government dimension, policymakers were interviewed to understand their rationales for implementing three transport initiatives, namely the MRT Three Rings and Three Lines Construction, and the MRT Pilot Bus in more detail. Regarding the academic dimension, the university academics selected were specialists in transport planning and transport policy. Because some of them had worked in the related Transportation Department of the government, they had clear ideas of Taipei City and New Taipei

City's initiatives e.g. roads, the MRT, buses, and YouBike paths. They were able to give an insightful critique of what has been happening in relation to those three measures, and commuters' travel behaviour. Furthermore, these university academics can comment on the issues more as commentators than just participants, so they are suitable as observing experts in the research. In terms of the business dimension, the researcher targeted experts from identified transport consultancies, because they are voices from practice, who know from their day to day interactions with the issues, policies and initiatives what is going on, how and why, and can reflect on these from their various practice experiences. They not only cooperate with the government on transport-related projects (e.g. the MRT networks, and road maintenance), but also focus on the planning and operation of transport infrastructure as well as the training of staff. Regarding the environmental dimension, environmental activists were chosen to give advice on the environmental aspects of the transport initiatives. In addition, these experts (university academics, environmental activists, and consultancy staff) can represent the users' perspective by pointing out the problems of using the public transport system from their own experience.

4.3.1 Interview design

In the research, the interviews were classified into two types: policymakers' and experts' interviews. Regarding the policymakers' interview design, the interview questions consisted of two themes: Network and Stations; the MRT Pilot Bus (see Appendix A). The first was Improved Network and Stations, and it began with some general questions by asking the policymakers about the current situation of the MRT Three Rings and Three Lines Construction, and why they had invested significant funding in it regarding the transport dimension, economic development dimension, and environmental dimension. Then, the policymakers were asked

questions about commuter needs and wants for the MRT Three Rings and Three Lines Construction. For the other theme, the MRT Pilot Bus, the interview questions started with the current situation of implementing the MRT Pilot Bus, the main rationale for its investment, and the relationship between the MRT Pilot Bus and wider city transport schemes or other relevant schemes.

In terms of the interview questions for experts, two similar types were followed, namely the MRT Three Rings and Three Lines Construction, and the MRT Pilot Bus (see Appendix B). The questions on each transport policy moved from general to specific, so they began with asking the interviewees what they thought about transport policy measures. In terms of the first policy, MRT Three Rings and Three Lines Construction, the researcher wanted to understand the interviewees' opinions regarding the New Taipei government promoting a switch from private transport to using the MRT Three Rings and Three Lines system. If they did not support this measure, they were asked to provide alternative measures instead, and explain their reasoning. Then, the questions were more in depth, asking them if they thought the New Taipei government could fulfil its long term target – 50% of public transport usage by all trips in 2030. This question was helpful to understand whether the government's target was realistic using the MRT Three Rings and Three Lines Construction. The final question was asked to understand the interviewees' points of view on the issues raised in the survey, in order to understand the respondents' opinions on commuters' motivations for using private vehicles.

The second part was aimed at understanding the interviewees' opinions on the MRT Pilot bus, so the main point was to understand their thoughts on the New Taipei City Government's use of financial incentives in operating it. It particularly sought

to understand whether it was only effective in attracting people to go by bus in the short term or if it was possible that bus trip-takers would convert to the MRT Three Rings and Three Lines system once it was complete. If the former, it is necessary to understand what a more effective measure for increasing private transport users' willingness to use buses and trains could be. A copy of the policymakers' and experts' interview designs is inserted in Appendices A and B, respectively.

4.3.2 The interview data collection

4.3.2.1 The policymakers' interview

The case study area is located in New Taipei City, and the Transportation Department of the New Taipei government is the main authority responsible for the design, planning, and implementation of all transport policies in New Taipei City, e.g. public transport provision, bus networks planning, and the facilities of road transport. The interview was used to collect qualitative data through direct verbal interaction with individuals in the surveyed organizations, which is one of the most common qualitative methodologies (Denscombe, 2003). The structure of the research interviews with the policymakers were semi-structured interviews, which allow interviewees the space to say what they wish to say, while giving the interviewer space to explore some of the interesting avenues of enquiry that emerge and maintain a focus on the main objective of the interviews. The qualitative procedures provide insight into the underlying transport policy implications and issues arising from individuals' modes of transport choice behaviour.

All the policymakers' interviews were conducted from December 2013 to March 2014, and the policymakers were interviewed for approximately 40 minutes to an hour each. In addition, before doing the interviews, the researcher sent the interview

questions to the assistant of each interviewee, so they had time to prepare and think about the opinions that they wanted to give and could elaborate more fully during the interviews. Meanwhile, the researcher had time to write notes in order to record the key points of interviews.

In Taiwan, the Mayor of New Taipei City decided to implement the MRT Three Rings and Three Lines projects, and assigned the Transportation Department of New Taipei City the task of making a master plan, including the overall budget demand. The Commissioner of the Transportation Department commands its subordinate units in a top-down way. Hence, the divisions of the Transportation Department, such as the Comprehensive Planning and Transportation Management Divisions, were given a budget for routine business and they initiated the project of the MRT Three Rings and Three Lines. They continue in their routine business for the project as long as they have enough money for its annual budget. More details of the transport organization in New Taipei City are discussed in Chapter 5. To understand the implications behind the transport policies, from the practice aspects of the Division Manager (the bottom) to the operation aspects of the Commissioner (the top), officers who worked in different positions were interviewed. The selection of interviewees who worked in transport-related organizations were: the Commissioner of Transportation Department, the Division Manager of the Planning and Development Division, the Division Manager of the Transportation Management Division, the Deputy Commissioner of the Urban and Rural Development Department, the Deputy Commissioner Engineer of the Department of Rapid Transit Systems in the New Taipei City Government and the Team Leader of the Institute of Transportation in MOTC (see Table 4.3.1 for the list of interviewed policymakers; Figure 4.3.1 shows the organizational diagram of

interviewees (red color)).

The interview questions were focused on two types of transport policy, namely improved network and stations and the MRT Pilot Bus, and the policymakers developed their ideas and spoke more widely on these transport issues. To begin with, the researcher introduced herself and her research background, motivations, and the aim and objectives of the interviews, to warm up the interviews. Then, she asked the interviewees about their responsibilities, and let the interviewees know that all the information from interviews was confidential and used solely for research purposes so that they could feel free to talk on each type of transport policy. The interviewees had participated in planning transport policies for more than ten years, so they were clear about the rationale for implementing the transport policy measures. By doing the interviews, the researcher obtained more insights into transport policies and the implications of transport policy. The data obtained through the interviews helped clarify the existing transport policy and provision implications and how transport infrastructure might be improved to change commuters' travel behaviour from private transport.

It should be mentioned that the interview with the Commissioner was particularly helpful for the interview data collection, because he gave the researcher an overview of the transport initiatives, including MRT Three Rings and Three Lines Construction and the MRT Pilot Bus. He also explained why and how they were being implemented, which enabled the researcher to understand the whole picture of these transport initiatives in depth. More details of the transport initiatives are discussed in Chapter 6. Also, the Commissioner spoke to five other policymakers who worked in related departments, such as the Deputy Commissioner of the Urban and Rural Development Department of New Taipei City, so that made the policymakers' interview data

collection easier.

Table 4.3.1: The list of interviewed policymakers

No.	Interview Respondents	Position Held	Organization	Code
1	Governmental official	The Commissioner	Transportation Department, the New Taipei City Government	GO1
2	Governmental official	The Deputy Commissioner	Urban and Rural Development Department, New Taipei City	GO2
3	Governmental official	Division Manager	Planning and Development Division, Transportation Department, the New Taipei City Government	GO3
4	Governmental official	Team Leader	Institute of Transportation, the Ministry of Transportation and Communications (MOTC)	GO4
5	Governmental official	Division Manager	Transportation Management Division, Transportation Department, the New Taipei City Government	GO5
6	Governmental official	Deputy Commissioner Engineer	Department of Rapid Transit Systems, the New Taipei City Government	GO6
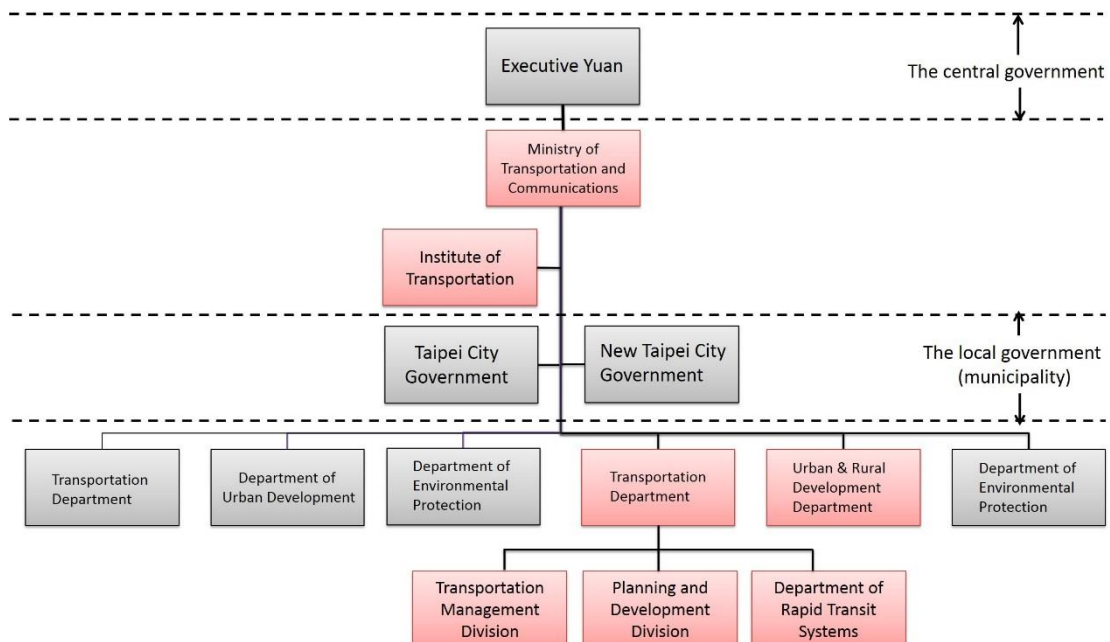
Figure 4.3.1: The organization of interviewees

4.3.2.2 The experts' interviews

The experts' interviews were comprised of university academics, environmental activists, and experts from identified transport consultancies. These were conducted for two months from October 2015 to December 2015. The researcher searched the internet to find potential interviewees who worked in departments related to transport management in Taiwan. This included ten universities that appeared to have relevant research interests. Then, she reviewed the lecturers' or professors' on-line research profiles, and sent the interview invitation to those whose expertise was on transport planning, transport system analysis, traveller behaviour, and transport networks analysis. She used electronic communication devices such as Skype and Google hangouts as the main tools for doing the interviews. On average, each interview took approximately 40 minutes to an hour. As with policymakers, before doing the interviews, the researcher sent the interview questions to each interviewee so that they could elaborate their points of view in more detail when the interviews were undertaken. Skype interviews and telephone interviews have appeared as a feasible research method over three decades within the literature, as a useful supplement to or replacement for face-to-face interviews. Also, online interviewing encourages interviewees who have time and place limitations to participate in research, and its flexibility helps the researcher reach key informants and increase participation (Weinmann *et al.*, 2012; Deakin and Wakefield, 2014; Janghorban *et al.*, 2014). The use of Skype technology was time efficient and cost effective for the researcher.

All the interviews were completed smoothly, without the technical issues that the researcher had envisaged, and she used the snow ball technique whereby each interviewee introduced the researcher to another relevant person willing to be

interviewed. Where some interviewees would not accept an interview, they were often prepared to forward the invitation to other potential interviewees. In total, 12 university academics, 3 environmental activists, and 3 experts from identified transport consultancies chose to be interviewed (see Table 4.3.2). Of the 12 university academics who agreed to participate, they were from the fields of Transportation and Communication Management Science or Civil Engineering. Due to these academics' expertise in transport-related fields, some of whom had worked in the public sector for many years, they knew transport transport policies well. Their opinions were helpful for analyzing transport transport policies from different perspectives. In addition, there were three environmental activists working in non-governmental organizations and non-profit organizations (Anti-Tam Bei Road Federation, Taiwan Watch, and Environmental Jurists' Association) whose specialties were sustainable development, green transport, environmental protection, transport policy, and energy policy. The three interviewees from consultancy companies specialized in transport planning, transport engineering, urban rural planning, and transport management, and worked for THI Consultants lnc, Mega Trans International Corp, and Sinotech Engineering Consultants, Ltd.

Table 4.3.2: The list of interviewed experts

No.	Interview Respondents	Organization	Position Held	Expertise	Code
1	Academic	National Taiwan University	Professor[10]	Public Transport; Transport Economy	A01
2	Academic	National Taiwan University	Assistant Professor	Transport Planning; Transport System Analysis; Traveller behaviour; Transport Networks Analysis	A02

[10]Professor is equivalent to the position of UK Professor; Associate Professor equivalent to the position of UK Senior Lecturer; Assistant Professor equivalent to the position of UK lecturer.

3	Academic	National Cheng Kung University	Associate Professor	Transport Safety; Transport Needs	A03
4	Academic	National Chiao Tung University	Associate Professor	Transport Planning	A04
5	Academic	National Chiao Tung University	Professor	Transport Economy; Transport Engineering	A05
6	Academic	National Taiwan Ocean University	Assistant Professor	Transport Planning	A06
7	Academic	Tamkang University	Associate Professor	Public Transport Operation Management; GIS	A07
8	Academic	Tamkang University	Associate Professor	Transport Planning	A08
9	Academic	Feng Chia University	Assistant Professor	Transport Planning; Transport Policy	A09
10	Academic	Kainan University	Professor	Urban Transport Management	A10
11	Academic	Kainan University	Assistant Professor	Transport Planning; Transport System Analysis	A11
12	Academic	Kainan University	Assistant Professor	Transport Engineering; Public Transport Planning	A12
13	Environmental activists	Anti TamBei Road Federation	Chairman	Sustainable development, green transport, and environmental protection	E01
14	Environmental activists	Taiwan Watch	Commissioner Strategy Officer	Climate change	E02
15	Environmental activists	Environmental Jurists Association	Executive Councillor	Transport Policy; Energy Policy; Business Pollution	E03
16	Experts from identified transport consultancies	THI Consultants lnc.	Assistant Vice President	Transport Planning; Transport Engineering; Urban and Rural planning	I01
17	Experts from identified transport consultancies	Mega Trans International Corp	Chairman	Transport Planning consultancy	I02
18	Experts from identified transport consultancies	Sinotech Engineering Consultants, Ltd.	Consultant	Transport Planning; Transport Engineering; Transport Management	I03

The researcher aimed to interview nine environmental activists who worked in the main environmental organizations of Taiwan. Unfortunately, she only interviewed three environmental activists, as six of them were not willing to accept the interviews (see Table 4.3.3). These six targeted environmental activists' areas of expertise were climate change, environmental policy and legislation promotion, education campaigns and concept promotion, global warming, sustainable development, and green transport, which are relevant to the researcher's interests. However, they rejected interviews because they were busy with their work at the end of the year. The researcher thus focused on the interviews with university academics.

Table 4.3.3: The list of environmental activists who rejected interviews

No.	Interview Respondents	Organization	Expertise
1	Environmental activists	Taiwan Environmental Protection Union	Climate change; Environmental policy and legislation promotion; Education campaign and concept promotion
2	Environmental activists	Taiwan Environmental Information Centre	Global warming; Sustainable development; Green transport
3	Environmental activists	Green Citizens' Action Alliance	Environmental policy
4	Environmental activists	Wild Heart Legal Defence Association, Taiwan	Climate change; Green transport
5	Environmental activists	Taiwan Information Association	Global warming; Sustainable development; Green transport
6	Environmental activists	Citizen of the Earth, Taiwan	Climate change; Green transport

4.3.3 Analysis of interview data

As outlined earlier in Section 4.3, the research study used a semi-structured interview as one of its primary data collection methods and to complete part of the mixed methods approach. The most appropriate method for analysing the interview data was content analysis, which involves a large amount of text data, so it is a flexible method of analysis (Hsieh and Shannon, 2005). Six steps were applied to analyse the data from policymakers' and experts' interviews (as shown in Figure 4.3.2).
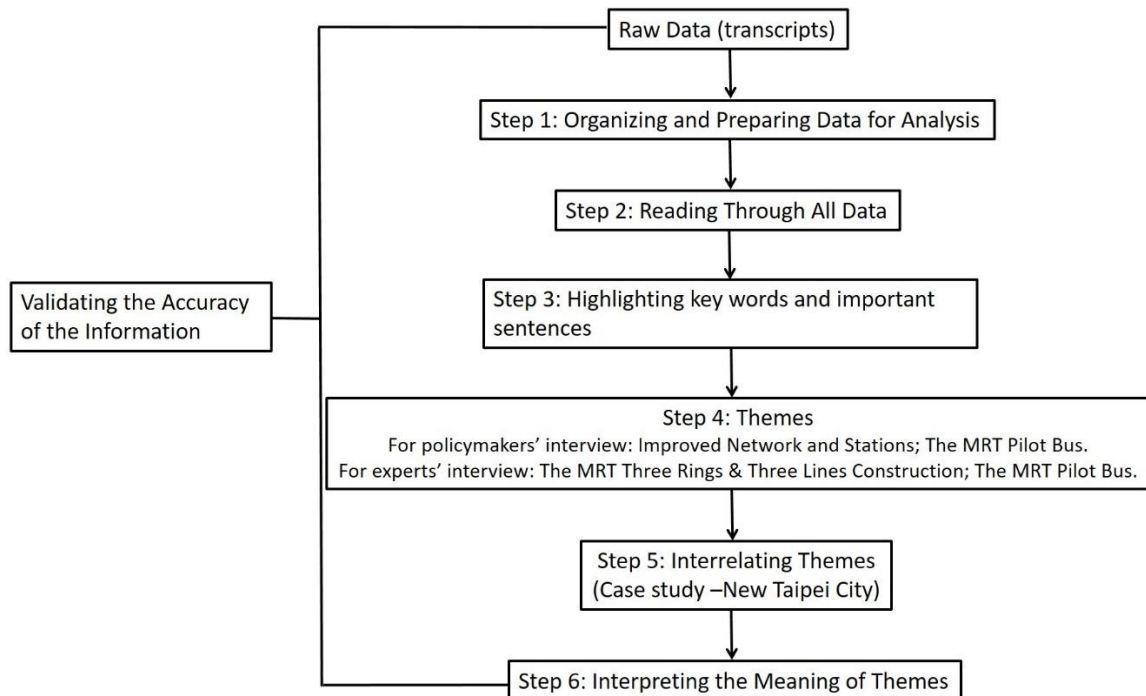
Figure 4.3.2: The progress of interview data analysis

Source: Revised from (Creswell, 2013) Figure 9.1.

Step 1: Organize and prepare the data for analysis. The interviews were transcribed and responses coded to bring together concepts and types. Appropriate divisions of the interview transcripts were then flagged in accordance with the concepts they corresponded to (Creswell, 2013). The semi-structured interview required tools that could transform and analyse a large amount of narrative data into meaningful

conclusions and credible data in order to answer the research objectives. It was also necessary to sort and arrange the data into different types depending on the sources of information.

Step 2: Read through all the data. This step was to perceive the overall meaning of interview data, and acquire a general sense of the information. The researcher listened to all the recordings several times and became familiar with these, and the types and variables of key messages were found. The text data were derived after she translated and transcribed the audio-recorded interview. She wrote notes as key words and important sentences to emphasise respondents' insights and thoughts at this stage.

Step 3 was to use the highlighted key words and important sentences to generate a small number of categories based on the two main themes, namely the MRT Three Rings and Three Lines Construction, and The MRT Pilot Bus. These were used to create headings in the findings section (see Chapter 6). Step 4 generated text data from interview data, segmenting sentences and paragraphs into categories, and labelling these categories with a term such as pull and push initiatives. By doing this, the researcher was able to clearly develop and elaborate on the arguments regarding the issues in each section. Step 5, interrelating themes, was completed to explain the policymakers' and experts' thoughts and insights regarding multiple related transport policies for the case study - New Taipei City. Step 6, the final step in the data analysis, involved making an interpretation of the data. The researcher interpreted the interview data, and made arguments from them.

4.4 Questionnaires

In the research, the main aim of the quantitative approach was to discover the commuters' mode of travel choices, travel behaviour, their service satisfaction with public transport (the metro and bus) and their thoughts on current transport initiatives. A commuter survey was used to gain an understanding of a considerable number of respondents' travel behaviour as well as their opinions on transport initiatives. Quantitative research methodology typically answers where, what, who and when questions (Crabtree and Miller, 1999; Silverman, 2000). Because surveys provide a numerical form of information, the information can be manipulated in precise, structured and reproducible ways. Furthermore, the quantitative method involves the measurement of variables with predetermined data collection instruments and produces statistical results that are descriptions, relationships, comparisons and predictions (Fink, 2003; Creswell, 2013).

In the past, transport planners have largely relied on the ''Travel Diary'' as their main instrument to measure traveller behaviour. It is a survey instrument designed to record all movements during the course of one or more days, and their relevant details–the details of the journey include parking type, location and costs or major roads used (Axhausen, 1996). This approach is a complex way to elicit individuals' travel perceptions and provides many reasons for them, for example, people often travel to work by car because of habit. Nevertheless, the researcher decided to use a questionnaire for the quantitative approach rather than travel diaries. It was thought that travel diaries were not a good way of capturing respondents' opinions on transport initiatives, one of the intentions of the survey, and that travel diaries were too detailed for this research, as they provide detail on individuals' daily and weekly travel movements which are not deemed necessary for this research. Hence, it was decided

that travel diaries were not a suitable method for data collection in the research.

Instead, a self-completion questionnaire was employed as an appropriate way of collecting quantitative data. It was important to make the survey easy for respondents to understand, to gain the desired information. Also, it was helpful for the researcher to rethink questionnaire design, and whether or not the results of the survey could explain the reasons behind commuters' travel mode choices and travel behaviour, and their rationales for using certain modes of transport. The research undertook two pilot studies to check how easily the questions were comprehended, and to improve on their design where they were misunderstood. One of these pilot studies was a focus group session; another was the pilot survey.

4.4.1 Piloting the questionnaire

In the research, the purpose of doing the focus group session and the pilot survey was mainly to pilot the questionnaire to make sure the questions were understandable, and that they generated the types of responses the researcher was hoping to gain from the full questionnaire. However, it also provided some valuable early insights into commuters' travel choices and the motivations behind these. A focus group is a group discussion organized to explore a specific set of issues, and is ideal for testing the phrasing of questions and useful in exploring survey results (O'Brien, 1993; Kitzinger, 1994; Kitzinger, 1995).

To gain access to the community, the researcher visited the village leader and asked him for help to find six to eight potential target respondents for the focus group session. Published research suggests that a manageable size of focus group is between six and ten participants (Krueger et al., 2000; Rabiee, 2004), as it is small enough for everyone to have a chance to provide their insight, but large enough to obtain a variety of

perceptions. The leader of the village had a better understanding of the demographic composition in the community and a clearer picture of what activities were taking place; it was also a relatively quick and easy way to find participants who lived in the community not known personally by the researcher. In addition, he is a gate keeper to the wider community, so if he is happy that the researcher is doing the survey, then the likelihood is that other research activities relating to the survey are likely to be made possible. Therefore, the focus group was conducted with eight people; participants were selected for two commuters of each mode of transport (car commuters, motorbike commuters, metro commuters, and bus commuters). The focus group lasted approximately 1-2 hours.

In order to enable the respondents to understand clearly the issues of the research, the researcher gave the questionnaires to participants to fill in at the beginning of the focus group sessions. Then after 10-20 minutes she started running the focus group, because this gave the participants some time to develop their ideas about the topic. Furthermore, the questions designed for the focus group session were more general at the beginning, and then as the group continued the questions became more specific. This was because as the participants participated in the process of the focus group session they could understand the issues of the survey better. They also affected each other through responding to the ideas and comments of others.

The second pilot study work was the pilot survey, which was carried out over three days. This approach involved a respondent going through the questionnaire with the researcher present, responding to the questions and talking through the responses that the questionnaire raised. This allowed the researcher to see how the questionnaire worked as a data gathering tool, where misunderstandings occurred, and what responses

the questionnaire raised. The researcher asked friends who had a job and travelled by the four modes of transport (car, motorbike, the metro and bus) to fill in the survey. It was essential to understand respondents' thoughts and feelings on using these four modes of transport. This helped ensure there were no significant gaps in responses to indicate that questions were unclear to respondents or that respondents were skipping a particular question. While they completed the survey, the researcher discussed with them one to one to check any difficulties and faults with the questions in the survey.

4.4.2 Design of the Zhonghe district survey

The questionnaire was structured in a close-ended format, and the questions within the survey are mainly comprised of the respondents' transport information, travel behaviour, their service satisfaction with public transport, and their socio-economic factors e.g. gender, age, education level and so on. Their thoughts on transport initiatives were also collected. There were six parts to the Zhonghe survey (see Appendix C): part I is related to commuters' mode of transport choice behaviour for commuter trips (6 questions), such as car and motorbike licence, house and work location, and modes of transport used. This part is to identify the main mode of transport that commuters use in commuter trips. Part II is related to commuters' service satisfaction with public transport (11 questions), because their satisfaction influences their intentions to use public transport. If they were not satisfied with the service of the metro and buses, they might use private transport as their main mode of travel. Part III is related to the reasons why commuters do not take public transport (13 questions). This part is to understand the reasons why commuters might be put off using public transport, especially the private transport users, as their rationales may be the key factors affecting their travel mode choices.

Both Part II and III were measured using a five-point Likert scale to assess each item e.g. in Part II respondents were asked to indicate how satisfied they were with the safety of getting on and off the metro and bus, and to respond with 'not very satisfied', 'not satisfied',' neutral', 'satisfied', or 'very satisfied'. The Likert scale format is considered one of the most popular formats to measure attitudes in questionnaire design ranging from very positive to very negative (Bryman and Bell, 2007). The respondents are able to express the intensity of their feeling or attitudes relating to the question asked. Part IV is related to commuters' attitudes towards climate change (4 questions). This is to understand the extent of commuters' environmental knowledge, because it was thought that their environmental knowledge might influences their attitude toward travel mode choices due to their concern for the environment.

Part V is related to commuters' understanding of transport policies (12 questions), which includes a set of four policies, namely Parking Provision at Metro Stations, Discounted Travel Permits, Improvements to Bus Vehicles, and the MRT Three Rings and Three Lines Construction. Policies 1, 2 and 4 are a park and ride scheme between cars/motorbikes and the metro; price reduction for the metro and bus transfer; and public transport improvements for MRT Three Rings and Three Lines Construction. Policy 3 seeks to increase the efficiency of buses by replacing traditional buses with more environmentally friendly ones. Among these four policies, policies 1, 2 and 4 are shift element, while policy 3 comes under the improve element of ASI framework. This part is mainly to understand the effectiveness and usefulness of these initiatives for changing people's travel behaviour.

Part VI is related to general information on respondents (5 questions), including gender, age, education level, occupation and income. Based on the literature review, these

variables strongly influence individuals' travel behaviour and travel patterns, and they are helpful for explaining commuters' travel behaviour for commuter trips. The questionnaire was designed in English because it was easier for the researcher to discuss the survey design with university academics whose mother tongue is English, but translated into Mandarin, because that is the first language of Taiwan. The general public can easily understand it without translation.

4.4.3 The survey sample collection

The extensive community survey of He Ping Shin Jiun, Xiufeng village in the Zhonghe district, was conducted in January 2013. Of the 500 questionnaires delivered, which were face-to-face surveys, 169 were returned (33.8%), excluding some questionnaires with missing answers to many survey questions (item nonresponse); this was undertaken by the researcher and a team (five people in total). She asked the leader of Xiufeng village, her family, and friends, to help deliver the questionnaires to local residents. Before delivering the survey, the researcher had a meeting with these assistants to train them. The training included practice guidance, such as the purpose of the study, issues relating to specific questions and guidance on how to fill in the questionnaires, and avoiding saying or doing anything that might make commuters feel compelled to participate in the survey. The questions were clarified for these assistants, so if the respondents did not understand the meaning of any question, the assistants were able to interpret the questions in the same way. The data collection relied on the local residents living in the community, and questionnaires were filled in using paper and pen.

In order to increase the response rate from both private and public transport users, the researcher and team stood in the streets, including Lane 103, 119, and 127 of Xiufeng,

and passed out the questionnaires. They were then available to assist the local residents in filling in the questionnaires, if they had any questions. Because these are the main streets around the community, many people passed by. Before the respondents filled in the survey, the researchers asked them whether they commute to work by foot or bike, because walking and cycling commuters are not the targeted groups in this research. In addition, the researcher asked the participants to return their survey to the leader of the local village, if they could not complete it in time to hand back to a researcher directly. The researcher then collected these questionnaires from the leader of the village a few days after the survey was delivered.

The survey was carried out from 5pm to 9pm on weekdays over two weeks. This was the best time to deliver the survey, because in the morning, people were in a rush to get to work, while they could be more patient and relaxed after work in the evening. However, it was hard to deliver the survey at the beginning, even though the researcher stated that if respondents completed the survey, they would receive a gift, which was a pack of red envelopes. This was done to encourage respondents to complete the survey, and in the hope of increasing questionnaire return rates. In order to gain a sufficiently high response rate from the questionnaire, the sample was split into population segments, and five hundred questionnaires from the survey were delivered. Due to the assistance from the village leader, who gave the research a level of legitimacy, people were encouraged to complete the survey and a satisfactory response rate of 33.8% was returned.

4.4.3 Analysis of survey data

There were six data sets in the survey data analysis (see Appendix C), and most of them were measured using descriptive statistical analysis. Part I, part IV, part V, and part VI

were nominal[11] scale; part II and part III were interval scale. In addition, part I was assessed as a distribution frequency and percentage to help the researcher describe commuters' mode of travel choices in terms of variables such as car and motorbike licence, house and work location, and mode of transport usage. Part II and part III were assessed by distribution (mean, standard deviation) to analyze commuters' service satisfaction about public transport, and the reasons why commuters do not take public transport; distribution frequency and percentage were used to assess the reasons why public transport users choose to use metro/bus. In the survey, these two parts used a five-point Likert scale to assess each item; for instance, in part II, the respondents were asked how satisfied they were with the punctuality of the metro and bus, and their choice of answers ranged from 'Not very satisfied' = scale 1, 'Not satisfied' = 2, 'Neutral' = 3, 'Satisfied' = 4 and 'Very satisfied' = 5. It is easier for the researcher to deal with these kinds of questions using Likert scales with coded numbers, and to analyse the data with statistical analysis techniques.

Regarding the survey analysis of part IV and part V, these were assessed by distribution frequency and percentage to measure commuters' attitudes towards climate change and their understanding of specified transport policies Part VI was assessed using Chi-Square Test of Independence to measure the relationship between respondents' general information such as gender, age, education level, occupation and income. Chapter 7

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[11] The nominal scale is known as descriptive data or categorical data that cannot be ranked in order; ordinal scale is a scale on which data is shown simply in order of magnitude since there is no standard measurement of differences; the interval scale is a scale of measurement of data according to which the differences between values can be quantified in absolute but not in relative terms and for which any zero is merely arbitrary. Both the nominal and ordinal scales are recognized as categorical data. Bryman, A. and Bell, E. (2007) 'Business research strategies', Business research methods, Saunders, M., Lewis, P. and Thornhill, A. (2009) Research Methods for Business Students. Pearson Education.

will present the statistical analysis techniques used for the quantitative data by using the SPSS statistical package.

4.5 Ethical issues

When conducting research, ethical issues must be carefully considered. The ethical issues concerned in this research are informed anonymity and confidentiality. Participants were fully briefed about the purpose of the research, and how the research was being conducted, in particular during the survey and interviews. In addition, participants were assured of confidentiality and were asked for permission to use their data; they agreed that they were happy to be recorded during the interview, and that their anonymized responses would be included in the research. Importantly, the interviewees were informed that they could withdraw at any time during the interviewing or in the research process.

4.6   The limitations of this research

All research has its limitations; however the limitations of one research project provide potential opportunities for further study. The main perspective of this thesis aimed to use the ASI framework to critically examine the effectiveness of significant financial investment in the MRT Three Rings and Three Lines Construction. It used a mixed-method approach. In accordance with the results obtained in the research, other possible studies can be suggested to develop and expand this study's findings. Several limitations have been identified, both in operationalizing the research and in the conceptual framework itself. These are discussed below and suggestions are made for further study which could improve the study design. The three limitations of this research are, firstly, the length of the questionnaire employed in the commuter survey. Some respondents indicated that

when they filled in the eight-page survey they felt it was too long, and the questions were not easy to answer without consideration. In addition, a few questions were not relevant to the study, such as size of vehicle or motorbike's engine, and car and motorbike parking fees per month. Without these questions, the survey could have been reduced to shorten the completion time. At the same time, the omission of this dimension from the research would have simplified and shortened the questionnaire and facilitated greater focus on the questions related to commuters' opinions on the current transport initiatives.

Secondly, in this case study, the sample size is considered to be neither too large nor too small; it is the characteristics of the sample which should be of concern rather than the sample size. However, the size of the sample was restricted. Due to the research not being funded by any local authority, it lacked funding resources. If this research had been funded, the scope could have included many sub-cities, or even a city-wide level, such as all New Taipei City rather than the small community of Zhonghe district.

Thirdly, time and costs constrained the quantity of face-to-face surveys. The survey was conducted from 5-9pm on the weekdays for two weeks, because it was inconvenient to speak to commuters during rush hour in the morning. This limited the available time in which to complete questionnaires, so the process of doing the commuter survey took longer than the general survey. Also, the hard copies of the survey and the gifts for respondents were costly, although they did increase the willingness to complete the survey.

4.7 Summary

This chapter describes how this research was designed to answer the research aims and objectives with particular reference to those suitable for evaluating transport policies to increase public transport use, and exploring commuters' mode of travel choices for commuter trips. In order to achieve these aims, it was decided to carry out the case study in the Zhonghe district of New Taipei City, Taiwan. The research methodologies thus gathered data from the commuters' questionnaires, and policymakers' and experts' interviews, to facilitate the interpretation of each data set. A total of 169 questionnaires were collected to obtain data on commuters' mode of transport behaviour for commuter trips, as well as their opinions on transport policies and climate change. Regarding the interview data collection, six policymakers were interviewed who worked in related transport organizations of the New Taipei City Government . In order to strengthen the context of transport policy evaluation, and gain critical opinions in addition to the policymakers' opinions, experts' interviews were undertaken with 12 university academics, 3 environmental activists, and 3 experts from identified transport consultancies. The interview questions were mainly to gain the views of the policymakers on the findings of the survey and to understand the implications of transport transport policieson the MRT Three Rings and Three Lines Construction, and the MRT Pilot Bus. The interpretation brought data sets together from a multidimensional perspective, and produced the conclusions of this thesis.

The next chapter provides background on public transport in Taiwan, including transport organization, the introduction of the metro and bus in New Taipei City, and people's service satisfaction with the metro and bus according to governmental statistics.

Chapter 5

The public transport system in Taiwan

5.1   Introduction

This chapter provides the general background to the transport organizations, transport policy, and public transport system (metro/bus) in New Taipei City. The purpose of this chapter is contextual, to set up the policy maker and expert views in Chapter 6, and the analysis of the commuter survey in Chapter 7. The organization and responsibilities of the Transportation Department in New Taipei City are introduced in Section 5.2. Then transport policy in New Taipei City is introduced in Section 5.3. Section 5.4 illustrates the transport system in New Taipei City, including the background, operations, and routes of the MRT and buses. Section 5.5 presents how The MRT Three Rings and Three Lines Construction fits into the urban form of both cities of Taipei and New Taipei, and discusses the urban form of the case study area.

5.2 Transport organization in New Taipei City

As transport projects involve the fields of transport, urban development and environment, cross-sectional coordination within a city government is common and constant among departments in these fields in both Taipei and New Taipei Cities (see Figure 5.2.1). The Transportation Departments in both cities are responsible for transport policy, planning, operation and safety in their respective cities. Because of the close connection between the two cities with regards to economic, social and transport aspects, coordination and cooperation across governments of the two cities are frequent. Surrounding the capital Taipei City, New Taipei City is densely covered with various

local, national and inter-city transport systems which are managed by different authorities. Local systems, such as city roads, are mainly constructed, maintained, operated and managed by the Transportation Department of New Taipei City government.

National systems, including the (traditional) railway and High Speed Rail which have a main joint station located in the busiest traffic area of New Taipei City, Ban-Chiao Distrct, as well as two national highways and several expressways, are built, operated and supervised by corresponding affiliated organisations of Ministry of Transportation and Communications (MOTC). MOTC is the highest administration authority within the central government of Taiwan (Executive Yuan) and is responsible for the policies, regulation and supervision of national transport systems.

Inter-city systems between Taipei City and New Taipei City, such as Taipei MRT and Taipei Joint Bus System, are mainly operated by private companies and managed under the cooperation of Taipei City government and New Taipei City government. With regard to a new MRT construction proposal specifically, if a transport project spans Taipei City and New Taipei City, such as the MRT Three Rings and Three Lines Construction, the governments of these cities will have a project agreement in advance. The city which proposes the project is in charge of coordination with the other city on project details, such as budget allocation and location of stations. Then the proposing city government submits a comprehensive proposal to Executive Yuan. The feasibility of the operation and finance plan of the proposal will be seriously assessed by the MOTC. Environmental impact and land use plans are also examined by relevant authorities in central government. A commission organized by Executive Yuan will suggest the priority of this proposal compared with other relevant projects based on the

assessment results from the MOTC and relevant authorities. Executive Yuan will then make a decision on approval of the project. Partial, usually over 50%, financial support from Executive Yuan is available for the construction expenses of the approved projects depending on the assessment results. The financial support is paid to the city government on an annual basis according to the approved project. Despite financial support from central government, the City government still need to adapt their own annual budget to meet the rest of the financial demand. Regarding operation of the MRT, fare rate and concession subsidy policy are consistent across the whole Taipei MRT network. Taipei City Government and New Taipei City Government coordinate with each other about sharing operation and maintenance costs and subsidy costs for concessions. Some costs are shared based on the length of MRT lines (km) or total passenger travel distances in the jurisdictions; however, it mainly depends on the negotiation results between the two cities. It should be noted that the Taipei metropolitan area is just a spatial and social concept. So far, there is no administrative organization which manages the three cities (Taipei City, New Taipei City, and Taoyuan City) together.

Furthermore, and most relevant to this research, the MRT is operated by the government-owned Taipei Rapid Transit Corporation (TRTC), which is owned by MOTC, New Taipei City government, banks and mainly by Taipei City government. The Department of Rapid Transit Systems of Taipei City is responsible for commissioning the construction of the metro system and supervising the operation of the MRT.
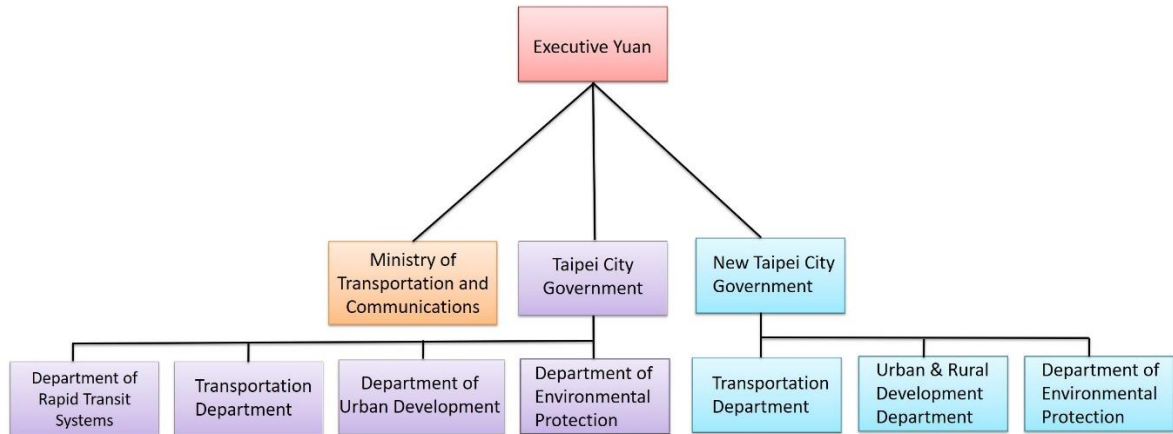
Figure 5.2.1: The transport organizations of Taiwan

5.2.1 Transportation Department of the New Taipei City Government

The Transportation Department is responsible for public transport planning, road construction and parking management in the whole area of New Taipei City, which consists of 29 districts, including Zhonghe district. The Commissioner of the Transportation Department commands subordinate units in a top-down way. Then, the divisions of the Transportation Department, such as the Planning and Development Division, and the Transportation Management Division, are given a budget for routine business, which in this case allowed them to initiate the project of the MRT Three Rings and Three Lines.

Furthermore, the Transportation Department is composed of six business (external) units and four administrative (internal) units. The business units are responsible for planning and implementation of transport policy and other related transport services. They contain Planning and Development Division, Transportation Management Division, Traffic Control and Engineering Division, Parking Management Division, Parking Operate Division and Traffic Safety Division. The administrative units are responsible for the general administrative matters inside the Department of Transportation that is composed of Secretariat, Accounting Office, Personnel Office

and Civil Service Ethnical Office. The organization of the Transportation Department in New Taipei City's government is shown in Figure 5.2.2.
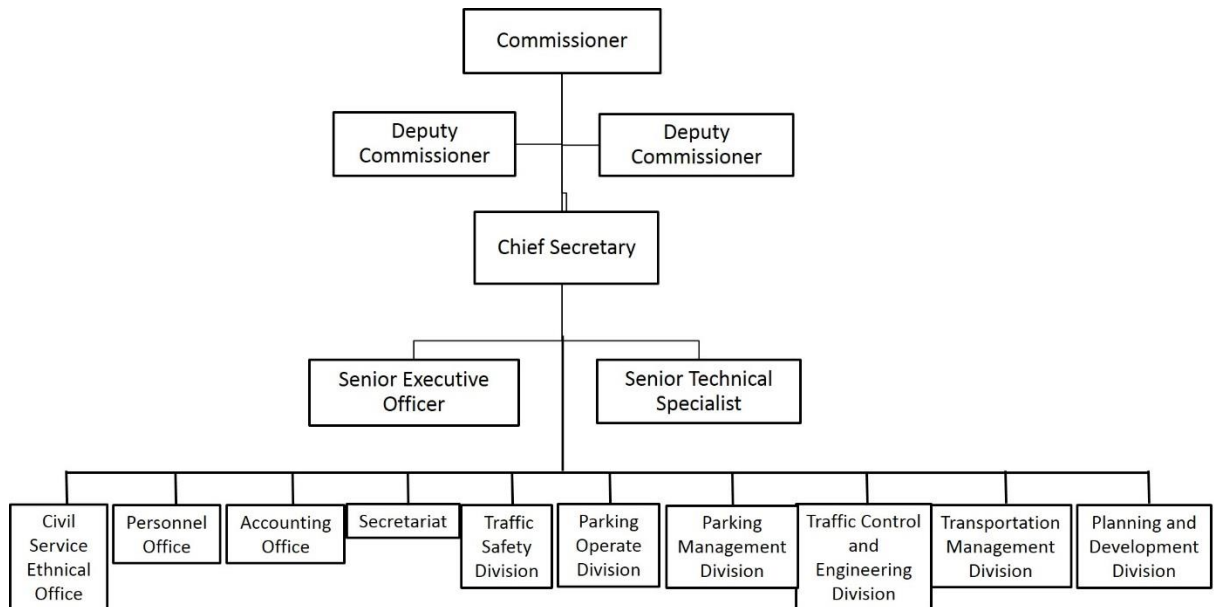
Figure 5.2.2: The organization of the Transportation Department in New Taipei City's government

Source: Adapted from (New Taipei City Government, 2017)

Since the case study area, Zhonghe district, is located in New Taipei City, all the key public transport initiatives this research is interested in, that is the MRT Three Rings and Three Lines Construction, the MRT pilot bus and the green transport initiative, are implemented and maintained by the Transportation Department of the New Taipei City Government. Among the sections of the Transportation Department, it is the Planning and Development Division and the Transportation Management Division that are responsible for the planning and construction of bus transport. The Planning and Development Division is responsible for transport policy development, transport systems integration planning, the regional road traffic improvement plan, the planning and supervision of rail transport, and so on. The Transportation Management Division is responsible for bus network planning, bus route evaluation, bus subsidies, and bus auditing, and matters related to taxis (see Table 5.2.1). Hence, this study interviewed

two policymakers who worked in the Planning and Development Division and the Transportation Management Division.

Table 5.2.1: The divisions of the Transportation Department

Division	Responsibility
Planning and Development Division	- Transport policy development, and promotion - Transport systems integration planning - Transport data collection and analysis - The development and integration of intelligent transport - Site development traffic impact assessment review - The regional road traffic improvement plan and new road planning review - Rail transport planning and supervision - Rail construction development fund management and use
Transportation Management Division	- Bus network planning, bus route evaluation, bus subsidies, and bus auditing - In this research, research objective c is to explore whether the MRT Pilot Bus may be an effective policy measure in shifting car users/motorcyclists into MRT trip-takers. This division can provide some statistical data on the MRT pilot buses, such as passenger trips, which is helpful for the researcher to understand the outcomes of all the MRT Pilot Bus lines - Taxi companies, personal taxi companies, taxi cooperatives, radio taxis, taxi passenger services, wireless taxi fleets, taxi rates approval, taxi drivers service centre, taxi stand planning and management, and taxi hub management - Disabled people bus management, urban and highway transport management, public transport stations, and waiting facilities construction engineering
Traffic Control Engineering Division	- Planning and designing traffic facilities (traffic signs, markings, signals and road safety facilities) - Managing and maintaining traffic control engineering facilities - Planning, designing, implementing, controlling and maintaining computer traffic signal system and advanced traffic management systems - Improving traffic conditions and road sections that are prone to traffic accident occurrences - Planning traffic facilities; - Coordinating sign facilities and conduit movement - Conducting traffic control facilities, damage repair and

	breakdown emergency repairs
Parking Management Division	• Stipulating parking policies. Drafting and executing parking improvement schemes • Planning, designing, building, managing, and supervising public off-street parking facilities • Planning, managing and utilizing parking lot operation funds • Application information for motor carrier industry parking lot, temporary street parking lot and impound lot • Stipulating parking fee rates • Parking lot registration certificate issuance information • Ratifying public off-street parking facility management regulations
Parking Operation Division	• Planning roadside parking spaces, installing and collecting fees and managing related affairs • Roadside parking fee rate adjustment • Roadside parking related appeals processing • Public off-street parking facility parking ticket issuance • Street parking information update
Traffic Safety Division	• Operating and executing New Taipei City traffic safety affairs • Reviewing and supervising traffic maintenance during the construction of major traffic projects in New Taipei City • Promoting and educating road safety, devising traffic accident prevention and control strategy. Investigating and adjudicating traffic accidents • Integrating and promoting New Taipei City traffic safety project

Source: Adapted from (New Taipei City Government, 2017).

As this research's objective is to assess whether reaching the target of 50% public transport usage for all trips in New Taipei City by completing the rail transport system in 2030 is realistic, it is necessary to have a clear understanding of the background and benefits of implementing the MRT Three Rings and Three Lines Construction. This research found the transport data collection and analysis sector of the Planning and Development Division particularly useful because it provided source material relating to the various transport initiatives including the MRT Three Rings and Three Lines Construction.

5.3 Transport policy in New Taipei City

Taipei City is the capital and has prosperous business activities and many job opportunities; surrounding it is New Taipei City. Many New Taipei City citizens travel to work or school from New Taipei City to Taipei City using public transport or private transport daily. The service quality of the public transport system e.g. ticket/fare rate, frequency, comfort, walking distance, as well as customer service, is important for the public, because their travel demands are affected by these attributes of public transport services in the two cities (Prioni and Hensher, 2000).

However, the existing transport system was not satisfactory. The New Taipei City Government has thus made an effort to construct a complete public transport system to improve the service quality in order to match the services in Taipei City since New Taipei City was upgraded to a municipality in 2010. Districts in New Taipei City are distinctive, with different characteristics (e.g. population, industries, geography, economy, and so on). The New Taipei City Government has to plan a suitable transport system for each district based on their local characteristics. Their purpose is to create a local transport system which can meet the demands of people for work, leisure and other basic living activities, so the transport system needs to be convenient, safe, comfortable, multi-informational, and low-pollution (New Taipei City Government, 2014). It is useful for transport and industry to combine to enhance the competitiveness of New Taipei City. Furthermore, the traffic concept of the New Taipei City Government is to provide comfortable, convenient, beautiful, and safe walking spaces, as well as more accessible spaces for disabled people.

The New Taipei City Government aims to reduce motorized vehicle use, and

achieve a rate of 50% of all trips using any public travel mode (including the transfer of some modes to another) (New Taipei City Government, 2010). Among the three elements of the ASI framework, the government is primarily focused on policies of pull initiatives within the Shift element e.g. the metro, New Taipei City Bus, cycling paths, and road maintenance as well as environmental knowledge raising (see Table 5.3.1).

Regarding the improve element, the New Taipei City Government replaced traditional buses with low-chassis ones, because hybrid electric buses consume less energy and emit lower exhaust emissions. The transport initiatives of New Taipei City centre on those using private vehicles, focusing on both non-commuters and commuters, except for the policy measure of the MRT Pilot bus. This research has focused on the shift element of the ASI framework, including shift transport policies of pull initiatives. Also, it looks at all initiatives focusing on commuters as a difficult group to shift away from private transport, partly due to their tendency to tack additional trips onto their commuter trip, creating trip chains.

Table 5.3.1: Main transport initiatives in New Taipei City

		The ASI Framework
The metro	The MRT Three Rings and Three Lines Construction	S
New Taipei City Bus	Rapid Bus	SI
	The MRT Shuttle Bus	SI
	Free Bus	SI
	The MRT Pilot Bus	SI
Cycling Path	YouBike routes	S
Road Maintenance	Maintaining existing road surface quality, and drainage	S

Environmental knowledge raising	Environmental education	S

5.3.1 The road initiatives in New Taipei City

The New Taipei City Government is not only devoted to implementing the MRT Three Rings and Three Lines, but also spends a huge amount on road maintenance projects every year. Road maintenance is an important transport policy measure, because not all traffic problems, such as car accidents, can be solved by constructing the MRT. In addition, several modes of transport (buses, cars, motorbikes, and taxis) use the roads so it is necessary to maintain road surfacing to provide a good service quality on existing infrastructures. The budget for road-smoothing engineering was NTD 454,058,000 (around £9 million) in 2016 (Government, 2016). Inevitably, this will detract from the New Taipei City Government's efforts to get people to change their mode of transport, as improved roads will attract people to continue to make the trips they already do, and may encourage others onto the network.

In Taiwan, the central government imposes fuel taxes[12] and licence taxes on private transport use, so private transport users must pay annually for their cars/motorbikes. For example, for 501-600cc and below private cars, fuel taxes for petrol are NTD 1440 (around £28), and licence taxes are NTD 1620 (around £32) per private car per year (Directorate General of Highways, 2016). Furthermore, the cost of using cars/motorbikes in terms of petrol and parking fees is relatively cheaper than in other countries. The price of a motorbike of 125cc is around £1000-1200 each, and

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[12] The current Motor Vehicle Fuel Tax and Licence Tax are levied according to the vehicle's engine size. It is the same price no matter how much the vehicle is driven.

one litre of petrol is around £0.50. On average, the general public's income is around £720 per month (Directorate General of Budget, 2014- 2015), so the cost of using private vehicles is affordable.

Moreover, it is notable that, unlike in European countries, the Taiwanese government does not internalize the external costs of private transport use (e.g. environmental taxes, the costs of infrastructure, congestion costs, and accident costs), so private transport users do not pay the actual price of using cars/motorbikes. They only consider personal costs and private transport operational costs (e.g. vehicle purchasing costs, registration, fuel, insurance costs, repair and maintenance, wear and tear and energy costs of vehicle use, own time costs, transport taxes and charges), because these are out of pocket costs, and are directly paid by the transport user. It is worth noting at this point that the central government does not have any policies seeking to increase fuel taxes and the New Taipei City Government has not increased parking fees. Besides, the New Taipei City Government has not implemented push initiatives, because these may be unpopular as well as politically unfeasible.

5.4 Transport system in New Taipei City

74.1% of work and school trips in Taiwan are by private transport (MOTC, 2011), so the central and local government has made an effort to improve the public transport system to attract more people to more sustainable modes. In New Taipei City, the government is attempting to provide a convenient public transport system for the public, so they are building the MRT Three Rings and Three Lines Construction, and introducing eco-friendly buses alongside encouraging more people to use them to try to maximize the eco-friendly gains. Taipei metro, which

is operated by TRTC, serves citizens in the Taipei metropolitan area. Their reason for operating the system, besides being a profitable organization, is to reduce traffic congestion, improve public road safety, and boost both the cities and the development of the surrounding satellite towns.

TRTC is a regular operation agency, invested in by local governments and private companies such as the Ministry of Transportation and Communications, the Taipei City Government, the New Taipei City Government , Tang Eng Iron Works Co., Ltd., Mega International Commercial Bank Co., Ltd., Taiwan Cooperative Bank Co., Ltd., and Taipei Fubon Commercial Bank Co., Ltd. As can be seen from Figure 5.4.1, the Taipei City Government is the largest stockholder, accounting for 73.75% of shares, followed by the Ministry of Transportation and Communications at 17.14% (TRTC, 2012). The New Taipei City Government comprises 8.75%, and the remaining 0.36% represents private companies and banks. However, TRTC is only responsible for the operations of MRT routes and stations, maintenance, and management (e.g. providing staff and rolling stock/vehicles). The construction and planning of MRT routes is the main responsibility of the Department of Rapid Transit Systems of the New Taipei City Government .
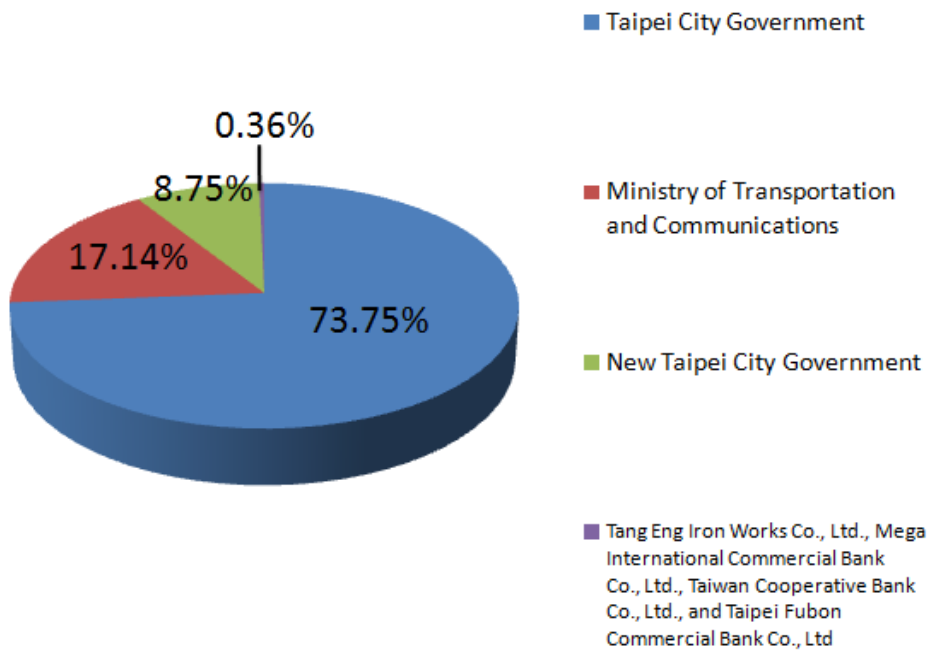
Figure 5.4.1: TRTC organization

Source: Adapted from (TRTC, 2012: 23).

In 2014, there were five MRT Taipei metro network lines between Taipei City and New Taipei City: Wenhu, Tamsui-Xinyi, Songshan-Xindian, Zhonghe-Xinlu, and Banqiao (see Table 5.4.1 and Figure 5.4.2). To date (2017), the total length of the MRT routes is 129.2 km, and there are 119 metro stations before new construction, including six main transfer stations: Taipei Main Station, ZhongxiaoFuxing, Minquan W. Rd, ZhongxiaoXinsheng, Taipei Nangang Exhibition Centre, and Daan.

Table 5.4.1: The MRT routes, stations and route length

Code	The MRT routes	The MRT stations	Route length (Km)
BR	Wenhu Line	From Taipei Zoo Station to Taipei Nangang Exhibition Centre Station (24 MRT stations)	25.2
R	Tamsui-XinyiLine	From Tamsui Station to Xiangshan Station (28 MRT stations, including Xinbeitou Station)	29.3

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G	Songshan-Xindian Line	From Xindian Station to Songshan Station (including the route of Xiaobitan Station)	20.7
O	Zhonghe-XInlu Line	From Nanshijiao Station to Huilong Station, Luzhou Station	29.3
BL	Banqiao Line	From to Taipei Nangang Exhibition Centre Station to Yonging (22 MRT station)	24.7

Source: Adapted from (Metro, 2017).

Figure 5.4.2: Taipei MRT routes

Source: Adapted from (Metro, 2017).

The costs for passengers using the metro are based on distance. A full price metro ticket for 0-5 km is NTD 20 (around 40 pence), 5-8 km is NTD 25 (around 50 pence), 8-11 km is NTD 30 (around 60 pence) etc.; as the distance increases 3 km, the fare increases NTD 5 (around 10 pence) (as shown in Table 5.4.2). There are 5 MRT routes on the Taipei metro networks. People use different types of Easy Card[13] which provide discounts for the metro ticket. If people use an Easy Card, such as a Student or General card, they can gain a 20% discount for each metro ticket. For example, students travelling by metro within 0-5 km only need to pay NTD 16 (around 32 pence) for this trip; adults using an Easy Card such as the General Card to travel by metro for 11-14 km pay NTD 28 (around 56 pence). Also, those eligible to use a Senior, Charity or Escort Card to travel on the metro can gain a 60% discount.

Table 5.4.2: Metro ticket fares (May 2016)

Distance (km)	0-5	5-8	8-11	11-14	14-17	17-20	20-23	23-27	27-31	31-
Full-price metro ticket (NTD)	20	25	30	35	40	45	50	55	60	65
Easy Card (NTD) (Student Card/ General Card)	16	20	24	28	32	36	40	44	48	52
Easy Card (NTD) (Senior/Charity/ Escort Card)	8	10	12	14	16	18	20	22	24	26

Source: Adapted from (Metro, 2017).

Based on statistics from TRTC in 2012, we can see both total passenger trips and

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[13] EasyCard is a 'touch-and-go' IC ticketing system for the Taipei Metro and bus services. From Easy Card Corporation website: http://www.easycard.com.tw/english/easycard/index.asp

the average daily passenger trips of the metro on both the high[14] and medium-capacity systems from 1996 to 2012 (as shown in Figure 5.4.3) (TRTC, 2012). In 2012, total passenger trips were around 6 hundred million, which was the highest number of recorded trips for the past 17 years. This compares to total metro passenger trips at 5.6 hundred million in 2011, and gives the growth rate as 6.03%. In addition, there were 1.6 million average daily passenger trips in 2012, which increased by 9.3 thousand trips compared to 2011 (see Figure 5.4.4).

Figure 5.4.3: Total Passenger trips from 1996 to 2012
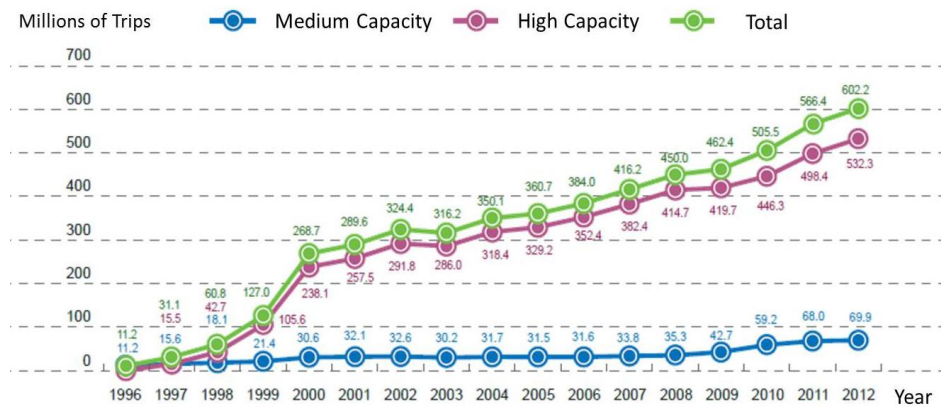
Source: Adapted from (TRTC, 2012).

Figure 5.4.4: Average Daily Passenger trips from 1996 to 2012

Source: Adapted from (TRTC, 2012).

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[14]The high-capacity system carries more than 20,000 passengers/per hour/one-way; the medium-capacity system carries around 5,000-20,000 passengers/per hour/one-way Chang, C.-J. (1999) *Urban Metro: Planning and Design* (2 vols). Taipei City, Taiwan: San Min Book co.,Ltd.

The majority of MRT lines are operated as high-capacity systems, including the Tamsui (opened 1997), Zhonghe (opened 1998), Xindian (opened 1998), Nangang (opened 1999), Banqiao (opened 1999), Xiaonanmen (opened 2000), Tucheng (opened 2006), Luzhou (opened 2010) and Xinzhuang (opened 2012). Total passenger trips and average daily passenger trips on the high-capacity system dramatically increased between 1996 and 2012; on the high-capacity system, the total number of passenger trips was 5.3 hundred million in 2012, with a daily average of 1.4 million. The increase was primarily because of new MRT lines opening. Conversely, the MRT Wenhu Line (opened 2009) is the only one using a medium-capacity system, and its total passenger trips and average daily passenger trips slightly increased; total passenger trips were around 69 million in 2012, with an average daily passenger rate of 190,000. In 2010, the MRT Luzhou Line opened, and thereafter the Xinzhuang Line. Daqiaotou Station was extended to Fu Jen University Station, and Dongmen Station in 2012. In 2013, Huilong Station was extended from Fu Jen University Station. Clearly, as passenger trips have increased, the New Taipei City Government has focused on high-capacity systems when continuing the construction of new MRT lines.

Due to the continuous construction of new MRT lines, the MRT's capacity and its passenger numbers have slowly increased. As the New Taipei City Government is devoted to providing a complete public transport system, including the MRT Three Rings and Three Lines Construction, the MRT Pilot Bus, and YouBike paths, it is possible that after the MRT Three Rings and Three Lines begin operation, the MRT will be a more convenient travel tool in the Taipei metropolitan area, thus more people will travel by the MRT.

5.4.1 The MRT Three Rings and Three Lines Construction

In 2010, with the New Taipei City mayoral election, the Mayor of New Taipei City, Li-Lun Zhu announced that the:

'MRT Three Rings and Three Lines is the main direction of transport policy in New Taipei City; when it is constructed in 2030, it will bring more convenient life to the Taipei metropolitan area.'

The New Taipei City Government is primarily focusing on the MRT Three Rings and Three Lines to achieve 50% of all trips by public transport modes; currently, public transport use is 32.2% in New Taipei City (MOTC, 2013). Owing to the MRT Three Rings and Three Lines strengthening the role of New Taipei City in the Taipei metropolitan area, it has become the most important investment in the public transport system within the last ten years. However, the pre-existing MRT lines were mainly from the outskirts of the city going inward towards the city centre, so this design was not convenient for citizens who live in New Taipei City (Yih-Shun, 2011). If citizens who live in New Taipei City need to travel to another district within New Taipei City, they have to transfer via one of the MRT stations in Taipei City, which means travelling into the centre and out again. The government took the broader perspective of integrating the existing MRT lines of Taipei City with those of New Taipei City to shorten New Taipei City travel distances and reduce journey times. In 2010, they designed MRT networks with New Taipei City at their centre, emphasizing the networks' primary importance for New Taipei City. They thus extended all the MRT lines outward, and connected them to the existing MRT lines, such as the Tamsui, Xinyi, Xindian, Songshang, and Banqiao in Taipei City and New Taipei City. Also, the Tucheng line was extended from the Banqiao line, and the Wenhu line (brown line on map) was extended (see Page 128; Figure 5.4.5). The Zhonghe line (Ring Line Phase 1; yellow line on map) was originally

constructed around the area of Taipei main station to the Xinzhuang line (orange line on map), which was extended to the Luzhou line (Ring Line Phase 2; yellow line on map). These MRT lines form the 'Three Rings' and 'Three Lines,' comprised of the northern, western, and southern (Tamsui district, Xizhi District, and Ankeng area) areas of New Taipei City.

Figure 5.4.5: The MRT Three Rings and Three Lines network

Source: Revised from (Transportation Department, 2015).

Most new metro stations will be constructed in New Taipei City; 12 new metro stations will be constructed in Tamsui District, 11 in Xindian District, 8 in Xinzhuang District, 6 each in Tucheng District and Shulin District respectively, 4 each in Sanxia, Luzhou and Yingge Districts, 2 in Banqiao, Taishan and Wugu Districts, one in Linkou District, 9 in Sanchong District, 7 in Zhonghe District, 3 in Yhonghe District, and 5 in Xizhi District. The MRT routes, timeline and current situation of MRT Three Rings and Three Lines Construction are presented in Table 5.4.3 (MRT routes are shaded to correspond with the lines' colour depiction on the map). The construction of the MRT Ring line is classified into two stages. Regarding the case study area, the Zhonghe District is located in the first stage of the Zhonghe Line (yellow line on map), which is along with Zonghe-Newlu Line (orange line on map), and the Wanda and Sulin Line (first phase) (light green line on map). The MRT Xioulang Bridge Station (i.e. the nearest MRT station of the He Ping Shin Jiun community) will be constructed in the first phase of the Zhonghe district Ring Line, which is estimated to be completed in December 2018.

The researcher thinks that if the shift of the remaining 17.8% (the gap between 32.8% in 2015 and the target of 50%) of public transport use from cars and motorbikes onto the metro and the bus service occurs, these two modes may be completely integrated. In addition, even if public transport use shifts from non-motorized modes such as cycling or walking then these are acceptable potential sources to fill the 17.8% gap. This would be welcomed despite CO_2 emissions not actually declining from private vehicle use, as it corresponds with national and international ambitions to reduce CO_2 emissions.

The New Taipei City Government is the competent authority[15] for MRT routes which are located fully within New Taipei City, such as the trams of Dahi, Ankeng, Wugu Taishan, Shenkeng, and Bali. However, according to the Mass Rapid Transit Act, regulations stipulate that the two city governments have to negotiate with each other on authority if the MRT route crosses cities. After negotiations, it was agreed that the Taipei City government would be the competent authority for the MRT Three Rings and Three Lines except the airport line, which crosses three cities and is led by the Bureau of High Speed Rail, MOTC.

Table 5.4.3: The Progress of the MRT Three Rings and Three Lines Construction

MRT Three Rings and Three Lines Construction	MRT Line	Authority	Timeline	
The First Ring	**Wenhu Line**	**Taipei City**	**4th July 2009 in operation**	
	Ring Line	Taipei City	The first phase estimated completion date is December 2018	The first phase is in construction The second phase is at the feasibility stage
The Second Ring	**Zhonghe-Newlu Line**	**Taipei City**	**29th June 2013 in operation**	
	Wanda and Sulin Line the first phase construction	Taipei City	The first phase of construction is estimated to be completed at the end of 2018	In construction
	Wanda and Sulin Line the second phase construction	Taipei City	The first and second phases of construction are targeted for completion in 2018	The Executive Yuan has approved the route of the second phase construction Land development effectiveness and financial plan amendments are in process

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[15]According to Article 4 of the Mass Rapid Transit Act, the 'Competent Authority' for the massive rapid transit system was the Ministry of Transport and Communications at the central government level, municipal governments at the municipal level, and county (city) governments at the county (city) level. The municipal and county (city) governments are entitled to negotiate with each other to generate the competent authority, when the network spans two or more administrative regions.

The Third Ring	**Airport Line**	**Central government**	**2nd March 2017 in operation**	
	Bannan Line	**Taipei City**	**31th May 2006 in operation**	
	Dingpu Section of the Tucheng Line extension	**Taipei City**	**5th July 2015 in operation**	
	Sanyin Line	New Taipei City	Target completion in 2021	In construction
Three Lines	1st Line: Dahi tram	New Taipei City	The first line is estimated to be completed by the end of 2018 and all lines are targeted for completion in 2025	In construction
	2nd Line: Ankeng tram	New Taipei City	Target completion in 2021	In construction
	3rd Line: Minsheng Xizhi Line	Taipei City	Target completion in 2021	The Executive Yuan approved the feasibility study on 19th December, 2011 In the process of the Comprehensive Planning Project

Source: Adapted from (Transportation Department, 2015).

Note:

i.   Colour relates to the colour the line is depicted on Figure 5.4.5.

ii.   Bold text depicts lines already existing and in operation; Non-bold text depicts lines proposed, in construction at date of write-up (2017).

5.4.2 New Taipei City Bus

The New Taipei City Government has adjusted the bus network, and replaced traditional buses with low-chassis ones, some of which are equipped with a hybrid electric system. These low-chassis buses are easy, convenient, and accessible for the elderly, disabled, and children; the environmentally friendly hybrid electric system consumes less energy and emits lower exhaust emissions. In 2014, 2,263 buses served the citizens of New Taipei City, including 853 low-chassis buses (two electric buses, 79 hybrid electric plus low-chassis buses (Low Carbon Sustainable Information System, 2014). The government provides NTD 100 million (around £2 million) in subsidies every year to the bus companies to upgrade traditional buses to low-chassis buses and/or hybrid electric plus low-chassis buses. The subsidy for each low chassis bus is around NTD 900,000 to 1,000,000 (around £18,000 to £20,000), and for an electric bus this is up to NTD five million (around £100,000). The improvement of the bus fleet to include low-chassis buses and hybrid electric systems is helpful for attracting passengers from private vehicles to buses, resulting in a reduction of CO_2 emissions reduction as well.

The New Taipei City Government is the competent authority for New Taipei City buses and is responsible for regulating the bus service provided by 13 privately owned limited companies. The 13 bus companies include Zhongxing Bus Company, Ltd., Zhinan Bus Company, Ltd., Keelung Bus Company, Ltd., Tamshui Bus Company, Ltd., Kuang-Hua Bus Company, Ltd., and New Taipei Bus Company, Ltd. that are run by Zhongxing Bus Company, Ltd.; Capital Bus Company, Ltd., Taipei Bus Company, Ltd., and Metropolitan Transport Corporation that are subsidiary companies of Capital Bus Company, Ltd; Danan Bus Company, Ltd. and Shin-Shin Bus Company, Ltd. that are run by Veterans Affairs Council, R.O.C. Furthermore, San Chung Bus Company, Ltd., and Kuo-Kuang Motor Transport Company Ltd. are independent bus companies.

The ticket and fare systems are the same and each bus company runs different bus routes (some routes are run by two companies). However, the internal organization of each bus company, its assets (including operating buses), legal rights, and the operation of buses remain mostly independent. The Taipei City Bus Joint Operation Management Centre is responsible for establishing bus stops and coding the bus

lines system, as well as designing the unified ticketing and charging systems for all the bus companies in Taipei City as well as New Taipei City. There are three special types of bus service in New Taipei City, namely the Rapid bus, the MRT Shuttle Bus, and the Free Bus. In addition, the MRT Pilot bus has also been introduced, as discussed below.

5.4.2.1 Rapid Bus

The rapid bus refers to the commuter bus which passes through the provincial Freeway and the Expressway. It travels rapidly from peripheral locations in different cities to the centre or key destinations, such as universities and transfer points of the MRT Stations (see as Table 5.4.4). Three rapid bus services pass Zhonghe district: 908 Sanxia－MRT Jingan Station, 921 Sanxia－MRT Jingan Station and 933 Sanchong District－MRT Taipei Zoo Station. For example, in Zhonghe district, 908 Sanxia－MRT Jingan Station starts in Sanxia district and passes by Taipei University, and En Chu Kong Hospital; the destination connects to MRT Jingan Station. 921 Sanxia－MRT Jingan Station starts in Sanxia district and passes by Taipei University, and the destination is MRT Jingan Station. In terms of fares, those of the rapid bus are the same as general city buses. Due to rapid buses driving on the Freeway, they reach the city centre quickly and are more convenient for people in outskirts areas because they reduce the travel time of all trips.

Table 5.4.4: Rapid Bus routes

Rapid Bus	Bus stops	Departure time	Interval
908 Sanxia－MRT Jingan Station	13	5:30 am - 22:00 pm	Weekday: 8-12 minutes at peak; 15-20 minutes off peak. Weekend: 20-30 minutes
921 Sanxia－MRT Jingan Station	23	6:00 am - 22:20 pm	Weekday: 7-10 minutes at peak, and 15-20 minutes off peak. Weekend: 15 - 30 minutes
933 Sanchong District－MRT Taipei Zoo Station	41	5:30 am - 22:30 pm	Weekday: 10-12 minutes at peak, and 15-20 minutes off peak. Weekend: 20-30 minutes

Sources: Adapted from (Government, 2016).

5.4.2.2 MRT Shuttle Bus

The MRT Shuttle Bus connects the MRT stations of different MRT routes. It was introduced to help passengers identify the different MRT routes as the MRT Shuttle Bus provides an alternative means of transport while the MRT line is under construction. Buses are named with the colour of the MRT line that they replicate. In Zhonghe district, three lines of MRT Shuttle buses pass by the MRT Orange Line (Zhonghe Newlu Line), and connect to MRT stations (see Table 5.4.5): Orange 1 and Orange 5 of the MRT Shuttle Buses connect to MRT Jingan Station; MRT Shuttle Bus Orange 2 connects to MRT Yongan Market Station and MRT Jingan Station. The fares of the shuttle bus are the same as general city buses, but if people use an Easy Card they can transfer from metro to bus within an hour, and vice versa; they also pay a discount fare for a bus ticket.

Table 5.4.5: MRT Shuttle Bus routes

MRT Shuttle Bus	Bus stops	Departure time	Interval
Orange 1	35	5:30 am - 23:30 pm	Weekday: 15 minutes at peak; 20-30 minutes off peak. Weekend: 30 minutes
Orange 2	22	5:50 am - 23:00 pm	Weekday: 8-12 minutes at peak; 15-20 minutes off peak. Weekend: 15-20 minutes
Orange 5	28	5:40 am – 23:10 pm	Weekday: 8-12 minutes at peak; 15-20 minutes off peak. Weekend: 15-20 minutes

Sources: Adapted from (Government, 2016).

5.4.2.3 Free Bus

New Taipei City Bus is a free, regional bus, which connects small towns and MRT stations. In Zhonghe district, free buses serve the local citizens, and these include F511, F512, and F513 (see Table 5.4.6). For example, F513 operates in Zhonghe district, and passes by MRT Jingan Station, and MRT Yongan Market Station. This bus could effectively attract people who want to reduce transport fees for all trips.

Table 5.4.6: Free Bus routes

Free Bus	Bus stops	Departure time	Interval
F511	9	6:30 am - 20:30 pm	Weekday: 25- 30 minutes. Weekend: 30 minutes
F512	57	6:30 am - 20:00 pm	Everyday: 1 hr
F513	32	6:30 am - 20:00 pm	Everyday: 1 hr

Sources: Adapted from (Government, 2016).

5.4.2.4 The MRT Pilot Bus

Significant to this research, given the initiative's intention to capture the commuter market, the MRT Pilot Bus operates during the construction period of the MRT Three Rings and Three Lines and runs through or near the future MRT routes, to encourage commuters to take buses, rather than resorting to private modes of transport such as the car. The passengers can use an Easycard to take the MRT Pilot Bus free of charge in rush hours (6:00-7:00am, 5:00-6:00pm). Currently, four lines of the MRT Pilot bus are in operation, 981 Sanyin MRT Pilot Bus, 982 Ring MRT Pilot Bus, 983 Danhei MRT Pilot Bus, 985 Wanda Sulin MRT Pilot Bus, and 986 Airport MRT Pilot Bus (see as Table 5.4.7). Also, Ankeng MRT Pilot Bus, and Xizhi MRT Pilot Bus will be in operation in the near future.

Table 5.4.7: The MRT Pilot Bus routes

The MRT Pilot Bus	Bus stops	Departure time	Interval
981 Sanyin MRT Pilot Bus	43	6:00 am - 22:00 pm	Weekday: 25 minutes. Weekend: 40 minutes – 1hour
982 Ring MRT Pilot Bus	49	5:30 am - 22:30 pm	Weekday: 6 -10 minutes at peak; 20 – 30 minutes off peak. Weekend: 20 – 30 minutes
983 Danhei MRT Pilot Bus	32	6:00 am - 23:00 pm	Everyday: 15 - 20 minutes at peak; 30 – 40 minutes off peak
985 Wanda Sulin MRT Pilot Bus	62	5:30 am - 22:30 pm	Weekday: 20 minutes at peak; 30 – 40 minutes off peak. Weekend: 30 minutes
986 Airport	42	6:00 am -	Weekday: 15 -20 minutes; weekend: 30

MRT Pilot Bus		22:00 pm	minutes – 1 hour.

Sources: Adapted from (Government, 2016).

5.4.2.5 Fares

Currently, a bus ticket or an Easy Card is required by passengers. If passengers pay cash, they must have the exact fare ready as the bus driver does not give change. The bus charges vary according to the number of sections that the passenger takes. The fare of each section differs from adults to students and concessions (under 12 or over 65) but not based on time (see Table 5.4.8). In addition, different bus lines have different fare demarcations based on the travelling distance, and when the bus runs over the demarcation, the passengers pay for an extra section ticket. The full price of an adult bus ticket (one section bus ticket) is NTD 15 in cash (around 30 pence), a student ticket is NTD 12 (around 24 pence), and concession ticket is NTD 8 (around 16 pence).

In addition, TRTC has an incentive measure to offer a discount to passengers transferring either from the MRT to buses or from buses to the MRT within an hour when using an Easy Card. Adults using a General Card only need to pay NTD 8 (around 16 pence), and students using a Student Card pay NTD 6 (around 12 pence) for a bus trip. Passengers using a Charity Card, Escort Card, or Senior Card pay NTD 4 (around 8 pence) per trip. However, if passengers need to pay for a two zone bus ticket or three zone bus ticket by transfer bus, they can only have one bus ticket discount.

Table 5.4.8: Discounts for bus tickets using an Easy Card

Bus ticket	Full-price (NTD /Trip)	Type of Easy Card	Discounted fare for the metro/ bus transaction (NTD /Trip)
Adult ticket	15	General Card	8
Student ticket	12	Student Card	6
Senior[16] ticket/ Disabled people/ Children ticket	8	Charity Card	4

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[16] Elderly people are classed as over 65 years old, with an identification card.

	Escort Card	4
	Senior Card	4

Note:
i. The full price is for a zone 1 bus ticket; if passengers get off buses over the demarcation, they have to pay for an extra section ticket.
ii. Someone who accompanies a disabled person can use an Escort Card. If they do not accompany a disabled person, they have to pay NTD 8 rather than NTD 4.

5.4.3 Transport system of case study: the He Ping Shin Jiun community

The transportation system provides access for the local residents who live in Zhonghe District to the Taipei metropolitan area. They have a variety of modes of transport choices to other places e.g. the MRT, buses, cars, motorbikes, and bikes. In terms of the MRT system, the Zhonghe Metro Line was established in Zhonghe District in 1998, with three metro stations: Yongan Market station, Jingan station, and Nanshijiao station (see Figure 5.4.6).
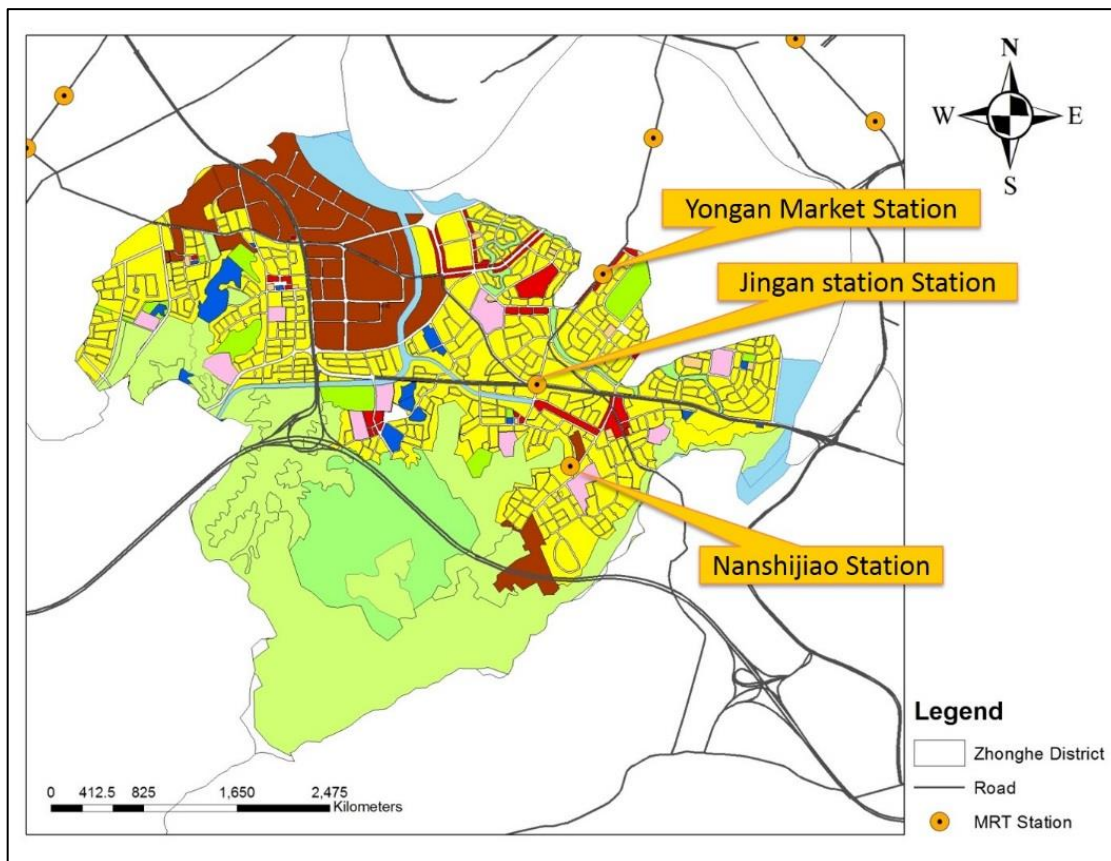
Figure 5.4.6: The metro in Zhonghe District

Source: This map is modified from data provided in 2010 by the Department of Architecture and Urban Design, Chinese Culture University in Taipei, Taiwan.

Buses are also available and accessible to local residents of Zhonghe District; there are more than 30 bus lines, including the 10, 241, 254, 625, 672 and Green 2. The bus service is quite extensive, with a bus every 10 minutes. Bus stops are situated along the main roads in Zhonghe District. In addition, local residents can also choose to use the intercity buses (coaches), which are mainly divided into two routes, one going to other counties and cities around Taiwan and the other solely accessing northern Taipei.

According to the statistics (MOTC, 2011), private modes of transport are most often chosen as the primary modes of transport. Among all transport modes, 72.6% of trips are made by private vehicles, consisting of motorbikes, the largest proportion, at 48.5% and cars, the second largest, at 24.1%. Only 6.7% of trips are made by walking, while those using the city bus and the MRT accounted for 5.8% and 3.9% respectively, and just 1.5% of trips are made by the intercity buses.

Road system

When people travel around, they generally need to rely on the road system. In Taiwan, national and city investment in roads remains high. The road system is classified as the National Freeway (UK equivalent: motorway), Provincial Highway (UK equivalent: dual carriageway), County Road (B road or C road) (see Table 5.4.9 and Figure 5.4.7). Also, in Zhonghe District, four main roads (UK equivalent: trunk road) play an important role in local residents' transport routes: JingPing Road, ChungCheng Road, and ChingHsin Street (see Table 5.4.10).

Table 5.4.9: Road system of Zhonghe District

Type of road	Name of road system
National Freeway[17]	No.3 National Freeway, and Zhonghe interchange
Provincial Highway	No. 64 is identified as Expressway, which is a provincial highway that connects two Freeways.
County Road	106 County Road, 106 Chia County Road, 111 County Road

Table 5.4.10: Main Roads of Zhonghe District

Main Road	Function of the road

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[17] National Freeway, and Provincial Freeway only permit cars, and motorbikes are restricted.

JingPing Road	Road is constructed throughout the whole Zhonghe District, is connected to No. 64 Taiwan Provincial Freeway, and leads to Xindian District and Taipei City. Therefore, it is the most important and busiest road in Zhonghe District. In the future, the Circle Line of the Taipei MRT will be constructed along this road in an elevated form.
ChungCheng Road	One of ways to reach Banqiao District, so traffic is busy there, i.e. a single lane in each direction.
ChungShan Road	The main road which connects Banqiao District and Yonghe District. In addition, the road and 106 County Road have the same route.
ChingHsin Street	The road is one of the ways to reach the Ankeng area of Xindian District, which is connected to 111 County Road.
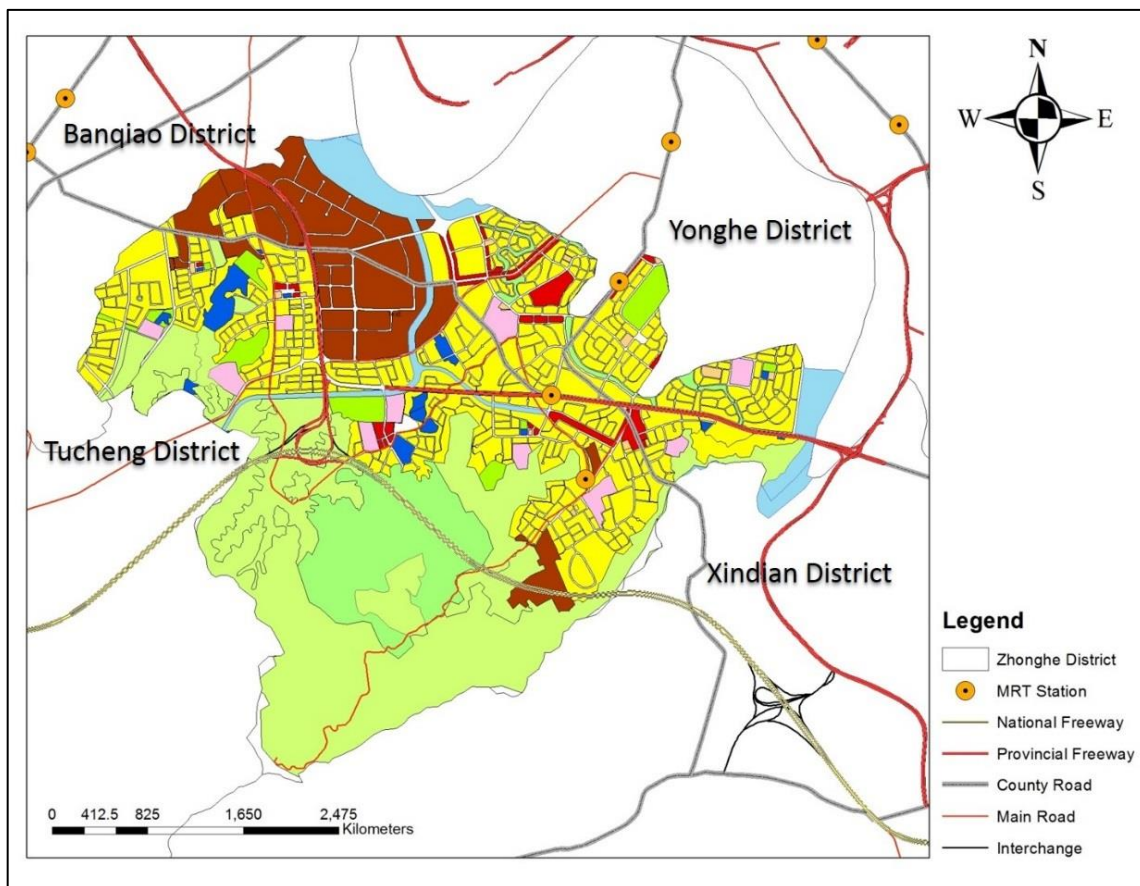
Figure 5.4.7: The transport system of Zhonghe District

Source: This map is modified from data provided in 2010 by the Department of Architecture and Urban Design, Chinese Culture University in Taipei, Taiwan

5.5   Urban form of The MRT Three Rings and Three Lines Construction

Taiwan has a total area of 36,193 million square kilometers and a total population of 23

million. Taipei City is its capital city, which has rapidly developed since 1990. Its population is around 2.6 million (Department of Civil Affairs, 2017b). The total area is 272 km^2, which is encircled by New Taipei City. Regarding New Taipei City, the population is around 3.9 million (Department of Civil Affairs, 2017a), and the total area is 2,053 km^2. More than 80% of New Taipei City's residents live in ten of the 29 total districts, which are Banqiao, Zhonghe, Xinzhuang, Sanchong, Xindian, Tucheng, Yonghe, Luzhou, Xizhi, and Shulin district. Both of the city centre areas in Taipei and New Taipei are mixed land use, combining commercial areas and mid-to-high density residential areas (Tu and Lin, 2008). The initial MRT network primarily covered Taipei City, but some parts did reach New Taipei City, such as the MRT Danshui and Xindian Line (Lee, 2007). It consisted of six lines, and the first stage of the MRT network was approved by the Executive Yuan in May, 1986. There were the south-north Danshui-Xindian Line, the east-west Ban-Nan Line, and Muzha Line. Hence, the most completed MRT lines were constructed in Taipei City, with its pre-existing urban form.

However, in 2010 New Taipei City was upgraded to a municipality, and the New Taipei City Government introduced a whole new extension to the existing Taipei rapid transit system, which is the MRT Three Rings and Three Lines Construction, in order to achieve 50% public transport use for all trips made (Transportation Department, 2015). The MRT lines of the MRT Three Rings and Three Lines Construction were extended from the pre-existing MRT lines of Taipei City, and they will cover the northern, western, and southern areas (the Tamsui district, Xizhi District, and Ankeng area) of New Taipei City. Regarding the urban form of the MRT lines of the MRT Three Rings and Three Lines, the first Ring is comprised of Wenhu Line (in brown), Ring Line Phase 1 (where the case study community is located), and 2 (in yellow) (see as Page 128, Figure 5.4.5). Wenhu Line was constructed in Taipei City, and was fitted into the pre-existing urban form. Also, Ring Line Phase 1 and 2 will mainly serve New Taipei City, so will be fitted into the existing urban form.

The second Ring includes Zhonghe-Newlu Line (in orange), and Xindian Line (in green) which were mainly constructed in New Taipei City, and fitted into the existing urban form. Wanda - Sulin Line (in light green) will be mainly constructed in New Taipei City, and will be fitted into the existing urban form. The third Ring is comprised of Airport Line (in purple), Bannan Line (in Navy blue), Dingpu Section of the Tucheng Line

extension (in Navy blue), and Sanyin Line (in blue). Airport Line was constructed from New Taipei City to Taoyuan City, and was fitted into the existing urban form. Bannan Line was half constructed in Taipei City, and half in New Taipei City, so it was fitted into the two existing urban forms. Dingpu Section of the Tucheng Line extension, and Sanyin Line are mainly being constructed in New Taipei City, so they fit into the existing urban form. In addition, within the Three Lines, Dahi tram (in indigo), and Ankeng tram (in beige) will be constructed in New Taipei City, and will fit into the existing urban form. Also, Minsheng Xizhi Line (in khaki) will be mainly constructed in Taipei City, and partly extended to New Taipei City. It will be fitted into the existing urban forms separately.

5.5.1 Urban form of the He Ping Shin Jiun community

Regarding urban form and structure in the He Ping Shin Jiun community, it has a grid block system (as shown in Figure 5.5.1). There are 4-10 storey residential blocks, and mixed-use buildings (first floor are mostly commercial, and upper floors are residential). In the local area, there are no green spaces.

- Shops and small businesses provide local goods and services;
- Single lane roads;
- On street/ on pavement motorcycle parking;
- Parking includes three types: private parking areas, on street parking without charges or restrictions, and some buildings with underground parking spaces.

It is clear that the local residents have several choices to park their own cars/motorcycles without charge, which inadvertently encourages them to use private vehicles for travelling even though public transport provision is convenient there.
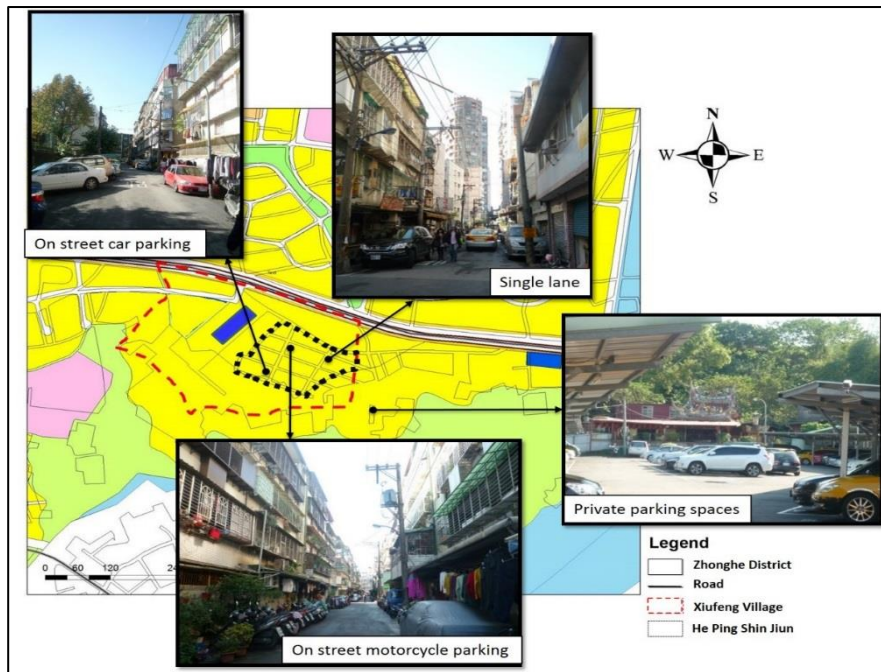
Figure 5.5.1: Parking spaces of Xiufeng Village

Source: This map is modified from data provided in 2010 by the Department of Architecture and Urban Design, Chinese Culture University in Taipei, Taiwan.

Services and facilities in Xiufeng Village include the Xiufeng Village Office, Coast Guard Administration Executive Yuan, Temple, and a small chain store (see as Figure 5.5.2). The Xiufeng Village Office plays an important role in this village, because the leader of the village is responsible for coordinating local residents' disputes, reflecting residents' opinions, promoting village recreational activities, and assisting residents with social affairs and social welfare, for example applying for a living allowance. Also, before doing the survey in the community, permission was sought from the leader of the village.
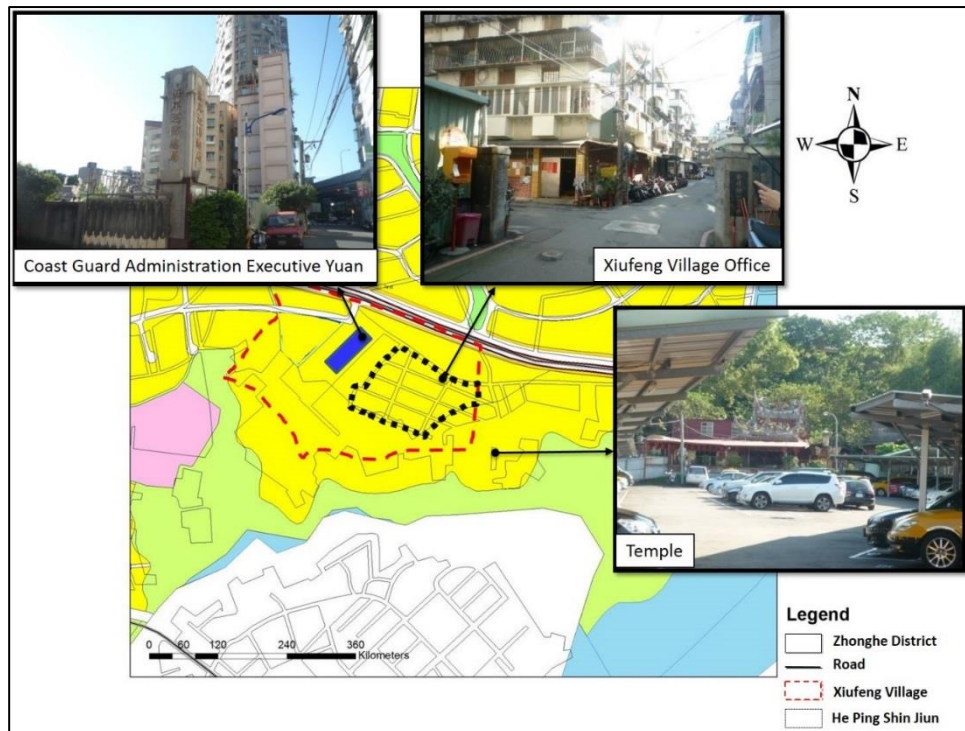
Figure 5.5.2: Infrastructure of Xiufeng Village

Source: This map is modified from data provided in 2010 by the Department of Architecture and Urban Design, Chinese Culture University in Taipei, Taiwan.

5.6 Summary

This chapter provides the general background of the transport organizations, transport policy, and transport system (the metro/bus) in New Taipei City. The Transportation Department of the New Taipei City Government is responsible for public transport planning, e.g. the MRT Three Rings and Three Lines Construction, the MRT pilot bus, road construction, and parking management in whole area of New Taipei City. Among the divisions of the Transportation Department, the Planning and Development Division, and Transportation Management Division are more relevant to this research, because they can provide useful secondary sources on transport initiatives such as the MRT Three Rings and Three Lines Construction, and the MRT pilot buses. In addition, regarding the urban form of The MRT Three Rings and Three Lines Construction, and the case study area, the nearest MRT station - Xioulang Bridge Station - will be constructed in the first phase of Zhonghe district Ring Line, which will be fitted into the existing urban form of New Taipei City.

The New Taipei City Government is investing heavily in positive measures both in relation to road provision and in relation to a range of Public Transit provision. Their

emphasis has been on transport improvement – which effectively is a pull initiative for whichever mode of transport it is related to. Unfortunately, in relation to the target of 50% public transport usage, road improvement work means that considerable amounts of money are being spent attracting people to continue to use their car or motorbike. The New Taipei City Government have not really engaged with push initiatives. So far they are seeking to shift people's modes of transport just by heavily investing in a range of public transport initiatives discussed above.

The next chapter investigates more fully the intentions behind policymakers' initiatives and experts' points of views on New Taipei City transport initiatives in order to critically evaluate them.

Chapter 6

Analysis of interview data from policymakers and experts

6.1 Introduction

In this chapter, the interviews with the policymakers and experts are analysed in relation to the three research objectives originally set in this thesis. The three objectives in the analysis of the interviews are as follows:

a. to assess whether the target of 50% public transport usage for all trips by completing the rail transport system in 2030 is realistic;

b. to examine whether a rail transport system is the right transport policy priority for the public, and if not, why not;

c. to explore whether the MRT Pilot Bus may be an effective policy measure in shifting car users/motorcyclists into MRT trip-takers.

The following discussion of the interview data is in connection with research objectives a-c. The New Taipei City Government aims to reduce motorized vehicle use, and achieve 50% of all trips being made by public transport, since public transport use is currently 32.2% in New Taipei City (MOTC, 2013). They are primarily focusing on the MRT Three Rings and Three Lines to achieve this target, and have also used the MRT Pilot bus to encourage people to use public transport. In order to address these research objectives, Section 6.2 discusses how the MRT Three Rings and Three Lines might be judged effective in achieving the target of public transport use. From this, the right priorities for transport policy are identified. Section 6.3 assesses how the MRT Pilot Bus could be effective in attracting some people to the MRT.

6.2 The MRT Three Rings and Three Lines Construction

6.2.1 Filling the target of public transport use

The first research objective assesses how policymakers can achieve the long-term target of public transport use (50%) through completing the MRT Three Rings and Three Lines Construction in 2030. This section discusses different points of view reported by respondents regarding fulfilling the aim of 50% public transport use in New Taipei City. In this research, the shift policies of pull initiatives, including the MRT Three Rings and Three Lines Construction and the MRT Pilot Bus, have been examined within the shift element of the ASI framework, as these are the primary means of achieving a change.

In Taiwan, people have been found to use private transport for commuter trips at a rate of 75.2%, including motorbikes and cars, which accounted for 49.8% and 24.2%, respectively, among all modes of transport (MOTC, 2011). In New Taipei City, the use of private transport represented 61.2% of all commuter trips. Among these, the motorbike was the dominant mode of transport, making up 43.9% of all modes, followed by car use at 16.7% for commuter trips. The figure for the use of private transport in New Taipei City is less than the overall Taiwanese figure. More people take trips on public transport in New Taipei City, where better public transport is provided, as it is more frequent and more reliable than services provided elsewhere in Taiwan. In order to increase public transport use and reduce private vehicle use, the central and the New Taipei City Government are going to provide a complete public transport system for the public. Ultimately, the New Taipei City Government aims to achieve a rate of 50% of all trips using any public travel mode (New Taipei City Government, 2010). They are primarily focusing on the MRT Three Rings and Three Lines to achieve this target. Hence, it has become the main direction of transport policy in recent years. The government official interviewed in this research, GO3, was positive about the initiative of the MRT Three Rings and Three Lines, and claimed that they could achieve 50% public transport use after this new initiative had been operating for a few years.

'[…]. Currently the use of public transport is around 25% in New Taipei City. Constructing the public transport system is to solve the problems of traffic. The target of the MRT Three Rings and Three Lines is to increase public transport use to over 50%.'(GO3).

In the past, the most complete MRT network was constructed in Taipei City, but after the MRT Three Rings and Three Lines has been finished in 2030, the MRT network will be more complete and convenient for the whole of the Taipei metropolitan area and not just Taipei City. The New Taipei City Government expects that once the MRT Three Rings and Three Lines is in operation it will bring benefits to those who live in the Taipei metropolitan area in three dimensions, namely transport, economic development, and the environment (Transportation Department, 2015).

Regarding the transport dimension, the MRT Three Rings and Three Lines will serve more than six million citizens who live in Taipei City, and New Taipei City, and it will make travel easier between these two cities and the districts of New Taipei City. Existing metro commuters may also have shorter journeys because of new links or a better MRT service. The Taipei metropolitan commuters not currently using the metro, and who could potentially shift to it, may do so if journey times are shorter and easier. Thus, a considerable number of commuters could effectively shorten their travel time and easily manage their daily commuting time using the MRT. In terms of economic development dimensions, due to New Taipei City being well-developed in relation to sightseeing opportunities, history, culture, and technology, since it was upgraded to a Municipality in 2010, a considerable number of working, business, tourism and shopping trips have been made into New Taipei City from Taipei city and other neighbouring cities, such as Taoyuan City, Keelung City, and even Xinchu City (50km away). The MRT Three Rings and Three Lines has become indispensable in serving the residents of Taipei City, New Taipei City and Taoyuan City, and local economic and industrial development and investment will keep increasing in these cities. Several MRT lines on the MRT Three Rings and Three Lines are partially in use, namely the Wenhu, Zhonghe-Newlu, and Bannan lines. More details on this are given in Section 5.4.1. Already, it is effectively enhancing local development and boosting urban and rural prosperity (Yih-Shun, 2011).

Regarding the environmental dimension, the capacity of the MRT carriages is larger than that of cars/motorbikes, therefore the MRT can carry a large number of people at one time. It is also more efficient than private vehicles. In addition, the MRT

system is a low carbon railway transport, which runs on electricity [18], so it contributes less to air and noise pollution than private vehicles. The MRT system facilitates traffic flow, because the models of the MRT system construction are either underground or elevated (Department of Rapid Transit Systems, 2016). There is no doubt that the MRT Three Rings and Three Lines needs to be built to reduce environmental and traffic problems and for this reason it has become the New Taipei City Government 's main transport policy.

Before assessing how policymakers will achieve 50% public transport, push and pull initiatives were defined during the researcher's interviews with respondents, who included university academics specializing in transport issues, experts from identified transport consultancies, and environmental activists reflecting on transport policy in Taipei City and New Taipei City. For these respondents, push initiatives were defined as measures seeking to manage the use of private vehicles, through increasing parking fees and fuel taxes, to better reflect the actual costs of using private vehicles; effectively, this means internalizing the external pollution costs into the expense of owning and using a car or motorbike. Pull initiatives were defined as connecting with other means of public transport such as bus lines, taxis, BRT, and YouBike paths, or offering financial incentives to use the MRT and buses. In this case, the New Taipei City Government's intention is to focus on the MRT Three Rings and Three Lines to achieve this target. It has used the MRT Pilot Bus to encourage people to use public transport.

However, academic interviewees A06 and A10 highlighted that the New Taipei City Government should not solely focus on constructing the MRT Three Rings and Three Lines, but should integrate this with measures involving other modes of public transport such as increasing bus lines, and connecting with YouBike paths, to provide a more complete public transport system. Although the MRT lines are being constructed along the main transport corridors, it is not a door-to-door service (Chien-Tung, 2011). Therefore, if private transport users do not feel that using public transport is convenient across the Taipei metropolitan area, they will be more likely to keep using cars and motorbikes. The interviewees shared this view as

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[18] The electricity of the MRT system is supplied by Taiwan Power Company, which is generated from large nuclear power plants, hydro power plants, and thermal power plants to serve the population.

follows:

'[…]. New Taipei City has a vast territory; if the New Taipei government does not provide complete services for connecting the bus and the MRT, it is impossible that they will fulfil the long-term target – 50% of public transport use.' (A06).

'[…]. The key to success is to fulfil this target using coordinated sets of measures such as removing the parking spaces, providing YouBike paths, and improving the pavement facilities.' (A10).

From the discussion above, the New Taipei City Government implemented the MRT Three Rings and Three Lines predominantly to contribute to three main dimensions, namely transport, economic development, and the environment. Furthermore, in Taiwan, economic development is a significant issue related to living standards as well as the national aspect, so the political dimension is important for policymakers. Policymakers attempt to boost the economy to win public support and gain political benefit. The government has invested a great deal of funding and other resources on the large transport infrastructure project that is the MRT Three Rings and Three Lines, because it could effectively boost economic development in the Taipei metropolitan area. However, due to the political context, policymakers are less willing to implement push initiatives because these may be unpopular as well as politically unfeasible. As such, the researcher agrees that the dimensions of transport, economic development, and the environment are significant reasons to initiate the initiative of the MRT Three Rings and Three Lines, and, behind this, the political dimension also plays an important role. That said, political issues are not discussed further in this research.

Despite the disadvantages mentioned, two of the respondents, A07, and I02, indicated that push policies are more effective than pull policies. So if the New Taipei government improves public provision (a pull factor) and increases taxes on private vehicle use (a push factor) at the same time, car users/ motorcyclists are likely to feel that using private vehicles is more expensive and less convenient than public transport. Based on cost-effectiveness, they will consider using public transport. The two interviewees said:

'[…]. It is more effective to use push policies such as increasing fuel fees and parking fees than using pull policies.' (A07).

'[…]. However, push policies are more effective than pull policies. […]. The New Taipei City Government is not effectively switching private transport users to public transport, so if they increase the costs of using private vehicles that could push the private transport users to use public transport.' (I02).

Clearly, private vehicles are affordable for the general public in Taiwan. If the government does not use push policies such as internalizing the external pollution costs into private vehicle use and/or increasing parking fees, they will not be successful in reducing the use of private transport. This is supported by previous findings that increasing the cost of car use is more effective in reducing the level of car use than pull policies (TfL, 2004). However, push policies on car traffic, such as restrictive measures, are often seen in a very critical way by citizens. This view was also given by interviewees A07 and I02. They thought push policies would be more effective than pull policies in achieving 50% public transport use in New Taipei City. In this research, the push policies of the shift element, such as internalizing the external pollution costs into private vehicle use and increasing parking fees, are the second means of effecting change.

Both the MRT Three Rings and Three Lines and the maintenance of roads are important transport policy measures. The New Taipei City Government has constructed transport infrastructures while also maintaining road surfacing and drainage. Nevertheless, one of the interviewees from an environmental group argued that this indirectly encourages private transport users to use cars/motorbikes because using private vehicles on roads is convenient. This view was given by one interviewee, E01, also from an environmental group:

'[…]. So far they (the New Taipei government) have not used push policies, so they keep building roads as well as bridges. It seems to hint that people are encouraged to use cars/motorbikes, […]. Instead, they should make the public feel using private vehicles is inconvenient; then they will switch to using buses. […].' (E01).

Road maintenance is an important transport initiative, and the New Taipei City Government must do it every year. Even though policymakers are focusing on constructing the MRT Three Rings and Three Lines, they have not cut the funding on the road maintenance project. Due to it inadvertently encouraging private transport users to use cars/motorbikes, road maintenance may actually pull people onto roads (discourage changes in the mode of travel). Hence, it is necessary to integrate push/pull initiatives.

Moreover, it is argued that it is not possible to achieve 50% public transport use for all trips[19] in any city of Taiwan. The most complete public transport system is in Taipei City, which is the largest of all cities in Taiwan, and public transport use is 41.8% for all trips. The figure is still not more than half. New Taipei City has the third largest public transport use of all cities in Taiwan at 32.2% for commuter trips, and private transport use for commuting is 61.2% (MOTC, 2013). Interviewees A04 and E03 suggested that even with the current development of the public transport system it will be hard to achieve 50% public transport use for all trips in New Taipei City and other cities of Taiwan. These two interviewees spoke about achieving the target of public transport use in New Taipei City, as follows:

'The networks of the MRT are more complete in Taipei City, but the use of public transport does not achieve 50%. Even if the New Taipei City Government makes connections between the MRT and bus networks, I do not think they can achieve 50% of public transport use in New Taipei City.' (A04).

'I cannot estimate whether the New Taipei government can fulfil 50% of public transport use, but, taking Taipei City as an example, I do not think the passenger trips of New Taipei City will be higher than Taipei City.' (E03).

The New Taipei City Government has not yet finished constructing the MRT Three Rings and Three Lines, so they have not provided a comprehensive integrated public transport network to the public by combining the MRT with other modes of public transport such as bus lines, and YouBike Paths. It appears that interviewees A04 and E03 are not positive about achieving 50% public transport use in New Taipei City, or other cities in Taiwan.

However, two of the interviewees, A01, and A03, felt that the New Taipei City Government may achieve 50% public transport use if they use push policies to control private vehicle use strictly (e.g. increasing parking fees, and internalizing the external pollution costs into private transport use), and pull policies (e.g. the MRT Three Rings and Three Lines, and improving bus lines) at the same time, because push policies are aimed at discouraging the usage of cars/motorbikes, while pull policies are aiming at encouraging use of other modes of transport by making

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[19] The purpose of trips is classified into school trips, business trips, leisure trips, commuter trips, family and personal trips, business visit trips, and shopping trips.

them more attractive. By doing this, it is probable that a completed public transport network can meet the travel needs of private transport users who have switched from cars/motorbikes. A01 and A03 gave their opinions on this, as below:

'[…]. Firstly, the New Taipei City Government does not manage cars and motorbikes in the way that they should. In the cities of the world, they have successfully increased public transport use via both push and pull policies. The use of private vehicles is managed, and private transport users should pay the price of using private vehicles. […].' (A01).

'The New Taipei government must use pull and push policies. […]. In Taiwan, the cost of using cars/motorbikes and parking fees is relatively cheap. […]. They have to increase parking and fuel fees, and internalize the external pollution into the costs.' (A03).

Furthermore, this stance was supported by another interviewee from a transport consultancy, and one of the environmental activists, I03 and E02:

'It is possible to achieve 50% of public transport use after the MRT Three Rings and Three Lines is constructed, but the New Taipei government has to use coordinated sets of measures such as increasing parking fees, and improving bus services and YouBike.' (I03).

'[…]. The government should increase the YouBike docks, the operations, and the use of YouBike. Besides, they also have to increase the costs of using private vehicles, and parking fees, to make private transport users switch from using private vehicles to public transport.' (E02).

These interviewees, A01, A03, I03 and E02, revealed that if the New Taipei City Government integrates the MRT Three Rings and Three Lines with other modes of public transport, such as bus lines and YouBike paths, it will provide a more complete public transport network with better access to goods and services for the public. On the other hand, the government should use push policies, e.g. internalizing the external pollution costs into private transport use, and increasing parking fees, to inconvenience private transport users. This finding is supported by previous studies, in which it was found that using both push and pull policies not only strengthens the motivation of car users to reduce their car use, but also contributes to the physical travel context by encouraging sustainable travel behaviour (Gärling *et al.*, 2002b; Eriksson *et al.*, 2010). Also, a combination of push and pull policies into packages is better able to cope with some of the drawbacks of individual transport policies (Vlek, 2007; Eriksson *et al.*, 2008a).

When car users/motorcyclists feel that using private vehicles is more expensive than using public transport, they will gradually switch to public transport. In addition, transport policies could be targeted at commuters; for example, cheap fares to travel at commuter times to encourage people taking public transport (pull initiative), and expensive parking/ restrictive parking until 9:00am to discourage people taking the car/ motorbike (push initiative).

In summary, policymakers have claimed that after the MRT Three Rings and Three Lines has been completely constructed in 2030, they can achieve 50% public transport use for all trips. However, it was argued by other interviewees that if they do not provide a comprehensive integrated public transport network to the public, and strictly control private vehicle use at the same time, e.g. by increasing parking fees and charging congestion fees, they cannot achieve this target. Nevertheless, the New Taipei City Government relies on using pull policies such as the MRT Three Rings and Three Lines at this time, because the political circumstances of Taiwan are not conducive to implementing push policies.

6.2.2 The MRT Three Rings and Three Lines Construction as a priority for transport policy

The second objective of the research was to examine whether the MRT Three Rings and Three Lines Construction is the right transport policy priority for the public, and if not, why not. It is helpful to assess this, and to consider if it could be replaced by other measures which may be more likely to achieve the goal of 50% public transport usage for all trips.

After the networks of the MRT Three Rings and Three Lines have been completed in 2030, the MRT network will be more complete and convenient for travelling by MRT in the Taipei metropolitan area. It not only shortens the travel distance in all the districts of New Taipei City, but also saves travel time. For example, people originally took around 40-50 minutes to travel from Furen University to the Taipei Main Station by bus. Since the MRT Xinzhuang line started operation in 2012, this has been reduced by one third, as it has been shortened to 26 minutes (Transportation Department, 2015). Hence, a number of commuters significantly shorten their travel time for commuter trips to work. Two academic interviewees,

A03 and A04, suggested that the MRT Three Rings and Three Lines is the right priority for transport policy because it makes travel more convenient, as follows:

'The New Taipei City Government's implementation of the MRT Three Rings and Three Lines is correct, because MRT is effective at converting private transport users from cars/motorbikes to public transport. Also, it reduces the traffic congestion on the main roads and improves safety on the roads.' (A03).

'I think that the MRT Three Rings and Three Lines is the right priority for transport policy, because the new residents' travel needs can rely on it. The MRT Three Rings and Three Lines is an essential policy measure for the future in New Taipei City.' (A04).

Further to this, one environmental activist respondent, E03, highlighted that the MRT Three Rings and Three Lines is a sustainable travel mode, which runs on electricity and emits less CO_2 than private vehicles. Their view was given as below:

'I think that the MRT Three Rings and Three Lines is the right priority for transport policy, because the traffic will become more convenient. Also, it will reduce the problems of car parking, pollution, and carbon emissions.' (E03).

Moreover, using the MRT system is more efficient than private vehicles. MRT carriages can carry a considerable number of passengers at one time, but emit less pollution than cars/motorbikes. While four passengers can be carried in private vehicles or two on passenger motorbikes, these contribute to excessive CO_2 emissions. Hence, interviewees A03, A04, and E03 supported the view that, regarding transport and environmental aspects, the MRT Three Rings and Three Lines is the right priority for the transport policy in New Taipei City.

In contrast to the above view, some respondents argued that the MRT Three Rings and Three Lines should not be the priority for transport policy because it has cost a vast amount of money, and will take a long time to complete (2030). Further to this, two respondents, A12, and E01, explained that the MRT system will take more than ten years to finish from beginning to end, and so it will take longer to construct than other means of public transport. Also, transport and environmental problems are getting worse; the MRT system is too time-consuming and cannot resolve these problems in time. Therefore, it is important to use other coordinated sets of measures such as combining land use and transport policy, adjusting bus lines, and controlling parking spaces. This view was shared as follows:

'I do not think that the MRT Three Rings and Three Lines is the right priority for transport policy because from planning, construction, and operation of the MRT projects, it will take more than 10 years to finish.' (A12).

'[…]. The New Taipei City Government should invest in other modes of public transport system such as BRT or trams. They should focus on strengthening the modes between the MRT and buses such as a BRT […].' (E01).

In addition, two respondents, I02 and I03, argued that the cost of the MRT Three Rings and Three Lines is around £556 billion, which is a heavy burden for the central government's finances, and the government does not have a great deal of money to complete it. The two interviewees (I02, and I03) stated their opinion on the right priority for the transport policy, as below:

'Considering the financial difficulties in Taiwan, I do not think that the New Taipei government spending vast sums on the MRT Three Rings and Three Lines is the right priority. […].' (I02).

'I think that the MRT Three Rings and Three Lines is just a political view, which cannot be realized because the funding is not enough. […].' (I03).

Given the interest of the study, it solely focuses on assessing the effectiveness of transport policy measures, so the issue of the government's financial distribution on transport policy is not discussed.

Consequently, the majority of interviewees do agree that the current approach focusing on the MRT Three Rings and Three Lines is appropriate and correct, though it was suggested that it is necessary to combine it with a coordinated set of measures for the transport policy options as suggested by two academic interviewees, A01 and A06:

'[…]. Besides, when the government is constructing the MRT, they have to use coordinated sets of measures such as car management, improving the efficiency of bus operations, and using BRT. […]. It is more affordable to attract the public to use it.' (A01).

'[…]. The New Taipei government should take the entire Taipei metropolitan area as the whole picture for doing public transport planning […]. They should construct a complete bus network, and strengthen bus facilities with low-chassis buses, electronic boards, and chairs in bus shelters as a priority for the transport policy […].' (A06).

This suggests that by focusing on these other initiatives, national and local

government could provide a more coordinated and wider ranging set of measures, and in so doing they could save a vast amount of funding, time, and labour for construction, while also being more effective in their intentions to encourage people to change their mode of transport. It should be noted, that these academics included some push factors e.g. 'car management' as well as the usual pull factors in their suggestions of adopting a more coordinated approach.

Based on the cost-effectiveness of implementing transport infrastructure, the various initiatives of public transport e.g. bus lines, YouBike paths, Tram or BRT, would take fewer than ten years to complete, and cost less than the MRT system. However, the current plan was supported by the overwhelming majority of respondents, notably A03, A04, and E03, as presented earlier in this section. They agreed that the MRT Three Rings and Three Lines is the right priority for transport policy.

6.3 The MRT Pilot Bus

The MRT Pilot Bus started operating in 2011 and was aimed at reducing the inconvenience of road traffic caused by the MRT Three Rings and Three Lines Construction. It was also intended that it would generate the habit of using buses before converting users to the MRT after its construction. Indeed, the MRT Pilot Bus follows the route of the MRT Three Rings and Three Lines Construction. Due to the MRT taking at least ten years to be constructed, it is inconvenient to road traffic users because of reduced carriageways. The New Taipei City Government has thus provided a financial incentive to attract people onto the MRT Pilot Bus, with a free Easycard for the MRT Pilot buses for use during the rush hour (6-7am and 5-6pm). The MRT Pilot Bus is an initiative that specifically target commuters as well as being available to other users. In addition, this free bus service may attract the public to use the MRT Pilot buses habitually during the construction period. It is helpful to develop potential users of the MRT Three Rings and Three Lines by gradually inducing the habit of using public transport. If people more commonly take buses, they will become more familiar with travelling by bus and see them as a major means of commuting rather than cars or motorbikes.

In 2014, four lines of the MRT Pilot Bus began operating in New Taipei City, including

the Sanyin Line MRT Pilot Bus, the Ring Line MRT Pilot Bus, the Danhei Line MRT Pilot Bus, and the Wanda and Sulin Line MRT Pilot Bus (Transportation Department, 2014). In the near future, it is planned that the Ankeng line MRT Pilot Bus and the Minsheng Xizhi line MRT Pilot Bus will also operate.

6.3.1 The effectiveness of the MRT Pilot Bus

The third research objective was to explore the effectiveness of the MRT Pilot Bus as a policy measure for shifting car users/motorcyclists into MRT trip-takers. IThe following discussions are divided into two groups: all trip-takers, and commuters.

For trip-takers, interviewees A10 and E02 indicated that the New Taipei City Government has taken financial incentives as the main technique to encourage use of the MRT Pilot buses. The majority of people are interested in financial incentives, as they want to save money on commuting, and are more likely to take advantage of this. According to the statistics provided by the Transportation Department of New Taipei City Government (Transportation Department, 2014), by February, 2014, five MRT Pilot Bus lines were operating and passenger trips had significantly increased on the Sanyin Line MRT Pilot Bus, Ring Line MRT Pilot Bus, Danhei Line MRT Pilot Bus, Wanda and Sulin Line MRT Pilot Bus, and Airport Line MRT Pilot Bus. This finding confirms that of previous studies, that price reduction measures effectively attract people to public transport in the short term, because their public transport demand is focused on fare changes (Beale and Bonsall, 2007; Thøgersen, 2009a; Richter *et al.*, 2011). This opinion was shared by the two interviewees, A10 and E02, as below:

'The financial incentives must be used. The concepts are like when people get tasters before they buy goodies, so they can easily use it. The public is interested in using MRT Pilot buses because of the financial incentives. It will be helpful for the passenger trips of MRT Three Rings and Three Lines Construction in the future.' (A10).'

'It is effective to use financial incentives to encourage people to use the MRT Pilot Bus in the short term because it generates public travel behaviour towards using buses. It is thus easy to be successful to attract the private transport users to use the MRT Pilot buses.' (E02).

For commuters, interviewees A06 and A07 noted that if commuters use the MRT Pilot buses, they are likely to use the MRT when the MRT Pilot buses stop. This is not only because they will have to pay to use buses, but also because they will have higher

service satisfaction with the MRT than with buses. This view was presented as follows:

'After the MRT Pilot buses stop operating, bus users will have to pay for buses. They will convert from using buses to using the MRT because they have travel purposes using the MRT.' (A06).

'[…]. The services of the MRT are better than buses. In addition, there is a discount for transferring between the MRT and the bus, and the fares for the MRT are not too expensive. […].' (A07).

The New Taipei City Government uses financial incentives as the main tool for attracting people to the MRT Pilot buses, and increasing passenger trips, especially targeting commuters through its free at peak time service. There are two potential groups using them. One is commuters who were originally bus users. It is probable that because the MRT Pilot bus is free of charge, they will take advantage of using it. Also, the bus stops may be close to their work location. After the MRT Pilot bus stops operating, they may keep using the buses, and while this does not help increase passenger bus trips or public transport use, it may retain them. Another potential commuter group is car users/motorcyclists who may be attracted to use the MRT Pilot buses because they are free. After the MRT Pilot bus stops, if they feel using the bus is convenient, they may convert to the MRT.

Interestingly, interviewees A05 and A09 indicated that the MRT Pilot bus provides a good chance to encourage people who have never used buses to do so, and if they have a good experience they are likely to use the MRT Three Rings and Three Lines. This then has transferable benefits to the bus service, as people will travel on buses when they previously had not, as well as the metro. They gave this opinion as below:

'[…]. However, if people do not have a good impression about using the bus, but after they have used it they feel travelling by them is convenient, they will probably keep using buses in the future. […].' (A05).

'In the first two years, most bus users will convert into MRT trip-takers after the MRT Three Rings and Three Lines is completely constructed. However, from the fourth year to the fifth, passenger trips on the MRT will be significantly increased, while passenger bus trips will be reduced. […].' (A09).

Effectively, then, the New Taipei City Government predominantly uses financial incentives to attract more commuters to the MRT Pilot buses, as an alternative mode of public transport, and to improve users' knowledge of possible transport options which

may encourage them to change travel modes. Some car users or motorcyclists may never have used buses or MRT before, so if they feel, after using it, that the MRT Pilot bus is convenient, they may use the buses again. These persons could be potential users of the MRT Three Rings and Three Lines after its construction. This view is supported by previous studies in that a free bus ticket is an easy promotional approach to encourage both infrequent and frequent public-transport users onto public transport (Fujii and Kitamura, 2003). It is a strategy to give the public a positive impression of using public transport by changing the price structure (Litman, 2004).

In contrast to the above view, two interviewees, A04 and A06, argued that the financial incentives of the MRT Pilot Bus only effectively encourage bus use in the short term, and that passenger trips will be reduced after it has stopped. The financial incentives for the MRT Pilot Bus are a key factor affecting travel mode choices, but other factors such as the characteristics of travel modes are also important for commuters. Hence, the financial incentives for the MRT Pilot Bus maybe not effective in switching their travel behaviour in the long term. This view was given as follows:

'The financial incentives are attractive for commuters because it is free at peak times. However, after the MRT Pilot buses stop operating, if the New Taipei City Government only provides financial incentives to the public, the attractiveness is not strong enough to switch private transport users onto buses.' (A04).

'The policy measure of the MRT Pilot bus encourages private transport users onto buses, and to become familiar with the bus lines. However, this is far from changing their travel behaviour.' (A06).

The policy measure of the MRT Pilot Bus is a transformation policy, meaning it will stop operating once the MRT Three Rings and Three Lines Construction is in operation. At the beginning, the majority of bus users may convert into MRT trip-takers because they feel that using the new MRT lines is convenient for their work location. However, some commuters may be using the MRT Pilot bus just because of the financial incentive, so they may return to their previous travel mode after the MRT Pilot bus stops. The financial incentive is effective at attracting all people to go by bus, but because it is temporary, it may not be strong enough to influence their travel behaviour for a long period of time. This effectively raises the issue that financial incentives may not be enough, so that at the point when the MRT Pilot bus stops, people will re-evaluate their decisions, and may make different travel mode choices. This finding is consistent with

a previous study in which a free bus ticket had only a short-term direct impact on bus use (Beale and Bonsall, 2007). This is because people also take other factors into account when making travel mode choices.

Interestingly, interviewees E03 and GO3 raised the issue that the bus and the MRT are very different modes of public transport with different characteristics, so trip-takers of these two modes generally belong to two different groups, within which users have different travel distances, walking distances, time values and budgets. It is possible that after the MRT Three Rings and Three Lines is constructed, some bus users will continue using the bus and not convert to the MRT. This view was shared as follows:

'I think that the use between the MRT Three Rings and Three Lines and the MRT Pilot bus is not linked. The public uses the MRT Pilot buses due to convenience. Even if their travel habits for using public transport are generated from using the MRT Pilot bus, they are unlikely to convert to the MRT.' (E03).

'[…]. However, in future, the bus routes will not be the same as the MRT, so the issue will be raised of whether it achieves the targeted passenger trips of the MRT. If passenger bus trips are not high enough, it may cause the problem of converting to the MRT in the future.' (GO3).

In this case, some bus users may ask the New Taipei City Government to keep running the MRT Pilot buses because they are used to them. The bus and MRT are very different transport modes with different characteristics. This implies that the important element of the MRT Pilot bus is convenience and route, so the government may have to keep providing it after the MRT Three Rings and Three Lines has been constructed. By doing this, it may be helpful in changing travel behaviour and increasing public transport use.

In summary, the New Taipei City Government has provided financial incentives for the MRT Pilot bus to the public during the rush hour to attract more commuters onto buses while the MRT Three Rings and Three Lines Construction is being constructed. This has helped to generate a habit of using public transport, and to develop potential users of the MRT Three Rings and Three Lines. If taking the bus becomes more common, people will be more familiar with it and use it as a major transport tool for commuting rather than a car or motorbike. However, it is argued that the financial incentives are not strong enough to change travel behaviour in the long term. The fare is only one factor affecting travel mode choices, and it has a short impact. Furthermore, buses and the MRT are very different modes of public transport with different characteristics, so

the users of these two modes generally belong to two different groups in which users travel and walk different distances, with different budgets. It is possible that after the MRT Three Rings and Three Lines is constructed, some bus users will still use the buses while others may convert to the MRT. This suggests that the New Taipei City Government should find a permanent solution to keep regular passenger trips on public transport in the long run, using the Pilot buses to complement the deficits of the MRT.

6.4 Summary

This chapter has discussed the three research objectives set for this research in relation to the interview data collected from policymakers, and experts such as university academics specializing in transport issues, environmental activists, and experts from identified transport consultancies. This is in regard to the two types of transport initiatives, namely the MRT Three Rings and Three Lines Construction, and the MRT Pilot Bus. The New Taipei City Government aims to reduce motorized vehicle usage, and achieve 50% of public transport usage on all trips by all public transport means (New Taipei City Government, 2010). They are primarily focusing on the MRT Three Rings and Three Lines to achieve this target, and they designed the system to connect with existing MRT lines. After it has been constructed, the MRT network will become more comprehensive and be able to serve more than six million citizens in both Taipei City and New Taipei City.

Policymakers claimed that after the MRT Three Rings and Three Lines is completely constructed in 2030, they can achieve 50% of public transport use. It will certainly help, providing a new positive option not previously available, and is likely to be one of the main pull initiatives encouraging people to use public transport rather than private transport options. However, without other measures it is debatable whether this 50% target is achievable, as the government has not integrated the MRT network with other modes of public transport; this includes improving the efficiency of bus operations, and YouBike paths. While the New Taipei City Government are focusing on constructing the MRT Three Rings and Three Lines, they keep maintaining road surfacing to provide a good service quality on existing infrastructure, inadvertently encouraging private transport users onto roads. Most importantly, so far New Taipei City Government has not used any push policies e.g. parking fees, to force private transport users to stop using cars/motorbikes. While these are unpopular, they may prove necessary because

pull policies are a more egoistic-orientated strategy adopted to make people change their travel mode choices out of self-interest (transport is free/cheap, and convenient). Where real costs are applied in relation to fuel taxes and so on, self-interest still determines the motivation for using cars/motorbikes, and so push policies make using private vehicles less attractive.

Regarding the policy measure of the MRT Pilot bus, the New Taipei City Government provides financial incentives for using it during the rush hour to attract more people to use the MRT Three Rings and Three Lines Construction once constructed. Private transport users who had no experience of using public transport have also had the chance to try the MRT Pilot bus. If these users feel that using the MRT Pilot bus is convenient for travel in the Taipei metropolitan area, they may use it more often. It may then be possible to switch some bus and private transport users from using the MRT Pilot buses or private vehicles to using the MRT. However, it is argued that the financial incentives are not enough to change commuters' travel behaviour in the long term, and passenger trips may decline after the MRT Pilot bus stops operating. Furthermore, buses and the MRT are very different modes with different characteristics, so it is suggested that the MRT Pilot bus should keep operating after the MRT Three Rings and Three Lines has been completely constructed to effectively stop users from going back to private transport, because the bus service network can complement the drawbacks of the MRT.

It is suggested that the New Taipei City Government should integrate the MRT networks and bus lines to provide a more comprehensive public transit network to the public. In addition, they should internalize the external costs of private vehicle use, such as increasing parking fees to discourage private vehicle use. In this sense, it is concluded that if the government could adopt pull and push policies together, the likelihood of achieving success in relation to shifting people from private transport to public transport would be greater, and fulfilling the target of 50% public transport use more feasible. Most importantly, it is suggested that the government should strongly connect all the initiatives within each element of the ASI framework, to have more robust transport policies and a more synergistic framework for achieving sustainable development of transport either in New Taipei City or the Taipei metropolitan area.

The next chapter investigates commuters' mode of travel choices, travel behaviour

for commuter trips, their service satisfaction with public transport (the metro/bus), and their thoughts on the provision of transport initiatives.

Chapter 7
Analysis of the commuter survey data

7.1 Introduction

Chapter Seven presents the commuters' survey data analysis. The three objectives in the analysis of the interviews are as follows:

a. to investigate commuters' mode of transport choices for commuter trips, and why these choices were made;
b. to examine the relationship between socio-economic factors and commuters' travel mode choices, and to attempt to understand why these factors have a significant effect on their travel behaviour;
c. to understand commuters' environmental knowledge, and their thoughts on transport initiatives.

By answering these three objectives, we can understand commuters' mode of travel choices, travel behaviour, their service satisfaction with public transport (the metro/bus) and their thoughts on transport initiatives. This is helpful for exploring the potential to change commuters' travel behaviour through policymakers' and experts' interviews (Chapter 6). The type of analysis in this chapter is mostly quantitative, focusing on survey results from a sample of 169 commuters in the community of He Ping Shin Jiun.

Section 7.2 describes the data set of the commuters' profiles, their socio-economic factors, and examines how these factors affect their travel distances. It then compares the characteristics of the sample with governmental statistics to demonstrate the extent to which this case study is a representative case for Zhonghe district. Section 7.3 examines commuter service satisfaction with the metro/bus, why they do not use these modes, and how their (dis)satisfaction with public transport services influences their travel mode choices. Section 7.4 explores commuter attitudes towards climate change. Section 7.5 investigates commuters' understanding of transport initiatives, namely Parking Provision at Metro Stations,

Discounted Travel Permits, Improvements to Bus Vehicles, and Improved Network and Stations.

7.2   Commuters' profile

The collected information shows the four modes of transport, car, motorbike, metro, and bus (excluding commuters using non-motorised transport) mainly used by residents in the He Ping Shin Jiun community for commuter trips. It is evident that there are variations in the modes of transport use patterns, depending on the users' socio-economic (income, educational levels, and occupation) and demographic (gender and age) characteristics, and the attributes of the modes of transport. In the survey, 500 questionnaires were delivered and 169 were returned (33.8%); 36 of the respondents used a car, 58 used a motorbike, 43 used the bus, and 32 used the metro. Evidently, private transport use (55.6%) was more than that of public transport (44.3%). The most popular mode of transport for travelling to work (34.32% of the sample) was the motorbike. The lower purchase and maintenance costs of motorbikes play a significant role in this. For example, each 125cc motorbike costs around NTD 50,000 - 60,000 (£1,000 - 1,200), which makes this option affordable for many more people than cars.

The other modal shares of interest for the whole sample are 25.44% for bus, 21.3% for car, and 18.94% for metro. The statistics of the modes of transport within the survey are shown in Table 7.2.1.

Table 7.2.1: Travel mode statistics from the He Ping Shin Jiun survey

(N = 169)

	Number returned	Male	Female	Percentage
Travel by car	36	22	14	21.3%
Travel by motorbike	58	25	33	34.3%
Travel by metro	32	14	18	18.9%
Travel by bus	43	19	24	25.4%
Total	169	80	89	99.9%

Note: Totals of percentages are not 100 for every characteristic because of rounding.
It is notable that the level of motorbike use is a common traffic situation in Asian and some European cities. Motorbike ownership and use in Asia is affected by situational factors (e.g. the weather, the economy, the population density and the cultural background) which are different from Western countries (Hsu et al., 2003).

Travel times and travel distance between house and work

Table 7.2.2 shows that 28.4% of respondents had a distance between house and work of 2-5 km, 26.6% reported less than 1 km, and 22.5% were in the 6-10 km range. 14.2% and 8.3% of respondents reported that their house and work location was 11-20 km or over 21 km, respectively. The findings show that around a quarter of commuters effectively work locally within Zhonghe district, so their travel distance between house and work location was less than 1 km. These residents are self-contained, but once the MRT Three Rings and Three Lines Construction has been built they may choose to work beyond these local areas.

In addition, more than a quarter of commuters' commuting distance was 2-5 km, suggesting they probably work in a nearby district such as Yonghe district, Xindian district, or Zhongzheng district of Taipei City. For example, the journey to Xindian district is 3.1km by car, and takes around 10-12 minutes, as measured by Google Maps. By comparison, it takes around 20 minutes by the metro, and 40-50 minutes by bus. Around one-fifth of commuters' travel distance between house and work location was 6-10 km, so they were less self-contained. It is probable that they work in the centre of Taipei City, such as Zhongzheng District, Xinyi District or the centre of New Taipei City – Banqiao District. For instance, commuting distance to Taipei City Hall is around 9.2 km by car, and takes 16 minutes. The commute to the New Taipei City Government is around 10 km by car, and takes 17 minutes. This implies that even with the new transport system it is still quicker to travel by car at commuter travelling times. It is therefore unlikely that car users would be willing to change their mode of transport.

Regarding the distance between house and bus stops, 66.4% of respondents had a distance between house and bus stop of 100m, followed by 16% of respondents with a distance of 101-300m. This is because of a high frequency of bus stops, as well as a high number of bus routes serving Zhonghe district. Also, 4 storey apartment blocks are usually located relatively close to stops in the community. These findings are in line with the literature that integrated urban form and transport system makes public transport networks more accessible (Newman and Kenworthy, 1996; Williams, 2005; Banister, 2008; Næss, 2012).

Table 7.2.2: Travel times and travel distance between house, and work

Category		Frequency	Percentage
The distance between house and work location	Under 1 km	45	26.6%
	2-5 km	48	28.4%
	6-10 km	38	22.5%
	11-20 km	24	14.2%
	Over 21 km	14	8.3%
The distance between house and bus stop	Under 100 m	112	66.4%
	101-300 m	27	16.0%
	301-500 m	1	0.6%
	Over 501 m	1	0.6%
	Non-responses	28	16.6%

Note: Totals of percentages are not 100 for every characteristic because of rounding.

7.2.1 Commuters' travel mode choices

To understand the main reasons commuters use particular modes of transport to work, this research investigated the reasons why they used the modes of transport they did at the time of the survey. They were allowed to choose more than one response each time, but their main mode of transport for the purpose of analysis was determined based on use times. Different points of view emerged from the private transport users (car and motor bike users) and from the public transport users, as shown in Table 7.2.3 and Table 7.2.4. The main reason car users gave for using the car was convenience in getting to and from work (29.3%), but also convenience in relation to having the car available for trips before and after work (27.3%) to take children to/from school, and to do other trips, e.g. go to the supermarket. From this, three main reasons influenced car users' travel mode choices for commuter trips. Firstly, car users use cars for all trips, because they feel using cars is convenient. They neither need to spend time for waiting for the metro/bus to come, nor bear travelling with crowded commuters in carriages/buses; using the car provides door-to-door transport between home and workplace. This finding is in line with a previous study that found people prefer to use cars for reasons such as flexibility and control (Gatersleben and Uzzell, 2007). Secondly, some car users may have to drive a car because of their job responsibilities and position, which include activities such as visiting clients, and carrying goods. For example, those in sales have to visit their clients every day, so they have to drive their car as well as carry products; couriers have to pick up and deliver parcels, so

they must use cars for their job. Thirdly, after work, car use meets users' personal needs such as shopping and picking up children. If they were to go by metro or bus, they could not easily and conveniently do these two things within the same journey. The findings are in line with expectations and previous studies that daily activities such as shopping and child care have a significant influence on the choice of travel mode, as many trip chains make it difficult to use public transport to accomplish these activities (Mackett and Ahern, 2000).

For motorcyclists, 36.5% thought that the 'motorbike is convenient to travel to the work place', followed by 25.0% who thought that the 'motorbike is needed before or after work'. 24.2% of motorcyclists thought that the 'motorbike is used without time limit', and 12.1% thought that the 'motorbike is needed to drop off/pick up others'. Over one-third of motorcyclists using their motorbikes to commute did so because they felt riding them was convenient for commuting. Motorbikes are convenient and provide door-to-door access, so motorcyclists get used to riding them for commuter trips as well as for any short trips (e.g. shopping, and visiting friends). Motorbikes are not limited by time or space, and are particularly suited to weaving through queues in congested areas, and short distance travel. For example, they can be parked on the street without spending time looking for a parking space, because motorbike parking spaces can easily be found. Most importantly, the price of a motorbike is affordable for the general public, and petrol is not expensive; each 125cc motorbike costs around £1000-1200 each, and 1 litre of petrol is around £0.50. It is clear that many advantages exist for using motorbikes, including the weather conditions of Taiwan being suitable for riding motorbikes, even in the winter; the characteristics of motorbike use e.g. flexibility, convenience, high mobility, and versatility; and the costs of motorbike being affordable for the public.

It appears that private transport users' main reasons for their travel mode choices for commuter trips are comprised of their dependency on using private vehicles without considering other means, and work-related purposes (e.g. job responsibilities, and position). Nevertheless, due to the unpopularity of imposing push initiatives such as parking restrictions, the New Taipei City Government has chosen not to impose these sorts of measures.

Table 7.2.3: The reasons why car users/motorcyclists use a car/motorbike to commute

	Car users		Motorcyclists	
	Frequency	Percentage	Frequency	Percentage
Car/motorbike is convenient to work place	29	29.3%	48	36.5%
Car/motorbike is needed before or after work	27	27.3%	33	25.0%
Car/motorbike is needed to drop off/pick up others	17	17.2%	16	12.1%
Car/motorbike is used without time limit	18	18.2%	32	24.2%
Other	8	8.1%	3	2.3%
Total	99	100.0%	132	100.0%

Note: Totals of percentages are not 100 for every characteristic because of rounding.

As shown in Table 7.2.4, both metro and bus users said that their most significant reason for taking public transport to work was the proximity of the metro/bus station to their work location. Over one-third of the metro users (35.2%) thought that 'the metro/bus goes close enough to where I go', and 23.9% thought 'the metro/bus fare is cheap'.

For bus users, 30.9% thought that 'the metro/bus goes close enough to where I go', and 26.6% thought that 'the metro/bus is eco-friendly'. The New Taipei City Government has replaced traditional buses with low-chassis buses, which may be attractive for bus users who travel on it for eco-friendly reasons. The low-chassis bus is an eco-friendly mode of public transport, which saves energy, so it is more efficient than private vehicles. Notably, the importance of the bus/metro being eco-friendly is very impressive to the researcher, and this seems more important to users than frequency. One fifth to a quarter of all metro and bus commuters said the reason they used this form of transport was because it was eco-friendly.

Table 7.2.4: The reasons why public transport users travel by public transport for commuter trips

	Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage
The metro/bus goes close enough to where I go	25	35.2%	29	30.9%
The metro/bus is frequent enough	14	19.7%	20	21.3%
The metro/bus is eco-friendly	15	21.1%	25	26.6%
The metro/bus fare is cheap	17	23.9%	20	21.3%

Total	71	100.0%	94	100.0%

Note: Totals of percentages are not 100 for every characteristic because of rounding.

7.2.2 Socio-economic factors of the sample

Based on the literature review (Section 2.2), six socio-economic variables were selected in this section of the survey design. Questions related to gender, age, education level (the highest education qualifications), occupation, income (total personal income per month), and vehicle licence (car/motorbike licence). These details are presented in the following sections.

7.2.2.1 Gender distribution

With regards to gender difference in mode of transport use, the respondents by gender were 80 males (47.3%) and 89 females (52.7%). Females preferred to take public transport and ride a motorbike to work, while relatively more males travel by car.

7.2.2.2 Age group distribution

The sample population was divided into six age bands: under 20 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years and more than 60 years. It can be seen from Table 7.2.5 that 43 respondents were 50-59 years (25.4%), 39 respondents were 20-29 years (23.1%), 32 respondents were 40-49 years (18.9%), and 22 respondents were 30-39 years (13%). There were ten respondents (5.9%) in each of the age groups 'under 20 years' and 'more than 60 years'. 13 respondents (7.7%) did not provide their age information as they thought that age was a private matter.

7.2.2.3 Education level distribution

As can be seen from Table 7.2.5, a significant proportion of the respondents (46.8%) were educated to undergraduate education level, followed by 33.1% at senior high school education level. Respondents educated to postgraduate level and above accounted for 10.1%, while 5.3% of respondents were educated to junior high school education level. Only 4.7% of respondents were educated to only primary school education level. It is apparent that most respondents had a senior high school qualification or undergraduate degree, so they were well-educated.

7.2.2.4 Occupation distribution

Of the occupation categories, the 169 respondents were split as follows: 44 (26.0%) were in supervisory clerical and junior managerial, administrative or professional roles, 34 (20.1%) were skilled manual workers, 32 (18.9%) were in intermediate managerial, administrative or professional positions, 21 (12.4%) were semi and unskilled manual workers and two were in the category of state pensioners, casual or lowest grade workers (only 1.2% of the sample) (as shown in Table 7.2.5). In addition, 14 respondents were in high managerial, administrative, or professional occupations (8.3%) and 22 respondents (13.0%) were in the 'other' category, identifying their occupations as teaching and sales.

7.2.2.5 Monthly income distribution

Personal income was covered in seven separate income bands, measured in terms of net monthly income from employment, benefits, and other sources. Regarding the income bands for the 169 respondents, 35 respondents earned between NTD 19,000 and NTD 29,000 (20.7%) (as shown in Table 7.2.5). Owing to the economic recession in Taiwan at the time of the survey (2012), people's average income (per month) was not more than NTD 29,000. In addition, 31 respondents had an income under NTD 19,000 (18.3%), 29 between NTD 29,001 and NTD 39,000 (17.2%), 19 between NTD 49,001 and NTD 59,000 (11.2%),18 over NTD 69,000 (10.7%), 12 between NTD 39,001 and NTD 49,000 (7.1%), four between NTD 59,001 and NTD 69,000 (2.4%). 21 respondents (12.4%) objected to providing income details.

7.2.2.6 Vehicle licence distribution

It was discussed in Chapter 2 that owning a driving licence is key to being able to use this form of transport. In the survey sample, slightly more people had a driving licence (56.8%) than a motorbike licence (50.9%). Around one quarter of respondents (24.3%) had both a car and motorbike licence, but 18.9% of respondents had neither (see Table 7.2.5). They had to use public transport or walk/cycle for commuter trips. In Taiwan, people over 18 years old can take a car/motorbike driving licence test. Notably, people with a car licence can ride 50 cc scooters without a motorbike licence.

Table 7.2.5: Demographic characteristics of the He Ping Shin Jiun survey sample

(N = 169)

Characteristic	Frequency	Percentage
Age group		
Under 20 years	10	5.9%
20-29 years	39	23.1%
30-39 years	22	13.0%
40-49 years	32	18.9%
50-59 years	43	25.4%
Education level		
Educated to primary school level	8	4.7%
Educated to junior high school level	9	5.3%
Educated to senior high school level	56	33.1%
Educated to undergraduate level	79	46.8%
Educated to postgraduate level and above	17	10.1%
Occupation		
High managerial, administrative or professional	14	8.3%
Intermediate managerial, administrative or professional	32	18.9%
Supervisory, clerical and junior managerial, administrative or professional	44	26.0%
Skilled manual workers	34	20.1%
Semi and unskilled manual workers	21	12.4%
Stated pensioners, casual or lowest grade workers, unemployed with stated benefits only	2	1.2%
Other	22	13.0%
Monthly income (NTD)		
Under 19,000	31	18.3%
19,000-29,000	35	20.7%
29,001-39,000	29	17.2%
39,001-49,000	12	7.1%
49,001-59,000	19	11.2%
59,001-69,000	4	2.4%
Over 69,000	18	10.7%
Non-responses	21	12.4%
Vehicle licence		
Respondents have both car and motorbike licence	41	24.3%
Respondents do not have car/motorbike licence	54	32%
Respondents have car licence but not motorbike licence	42	24.9%

Respondents have motorbike licence but not car licence	32	18.9%

Note: Totals of percentages are not 100 for every characteristic because of rounding.

7.2.3 The relationship between socio-economic factors and travel distance

The second objective was to examine the relationship between socio-economic factors and commuters' travel mode choices, and to attempt to understand why these factors have a significant effect on their travel behaviour. Based on the literature review, it was found that socio-economic factors are significantly related to individuals' travel behaviour and travel patterns (see as Section 2.2). To answer this objective, the researcher performed Chi-Square Test of Independence for the variables between six main socio-demographic characteristics (e.g. gender, age, education level, occupation, income, car/motorbike licence), and commuters' travel distances and mode of transport (car, motorbike, metro, and bus). This test helps to understand if two categorical variables are related or associated (i.e. dependent). If there is no relationship between the two categorical variables, this is quite clear. By contrast, if there is a relationship between the two categorical variables, it is difficult to identify the relationship between their impacts. The findings showed that only seven sets of variables had a significant interaction.

7.2.3.1 The relationship between income and car users' travel distance

It can be seen from Table 7.2.6 that among socio-demographic characteristics income has a significant effect on car travel distances ($p < 0.05$). Twenty commuters who earned over NTD 49,001 per month had car travel distances of 6-20 km; 8 of them travelled under 5 km by car. Two commuters earned NTD 29,001-49,000 monthly, and their car travel distances were 6-20 km; two travelled by car over 21 km. It is clear that car users had higher incomes and travelled further than lower income people. The higher income people were more likely to work in the centre of Taipei City, because more job opportunities are provided there. Also, it is where people's average income is the highest in Taiwan[20] (Directorate General of Budget, 2013). A

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[20] On average, Taipei City citizens have the highest income at NTD 76, 204 per month than people in other cities. Directorate General of Budget, A.a.S., Executive Yuan, R. O. C (2013) *Family Income and Expenditure Investigation Report*. Taipei City, Taiwan. [Online]. Available at:

possible explanation is that commuters who have higher incomes are less self-contained, because they travel further. It is probable that their income cannot afford a house in the central areas, even for the highest earners, so they choose to live far away from the city centre. The findings are consistent with previous research suggesting that having a higher income affects both commuting distance and modes of transport used for commuting (Cervero, 1996).

Table 7.2.6 The relationship between income and car user travel distance

(N = 36)

		Income (monthly)			Total
		Under NTD 29,000	NTD 29,001-49,000	Over NTD 49,001	
Car travel distances	Under 5 km	3	0	8	11
	6-20 km	0	2	20	22
	Over 21 km	0	2	0	2
Total		3	4	28	35

Note: Chi-Square Test value is 23.636, P value is under 0.000.

7.2.3.2 The relationship between age and car user travel distance

Table 7.2.7 shows that age has a significant effect on car travel distances ($p < 0.05$). Fourteen car users were aged over 50 years old, and their travel distances between their house and work location were 6-20 km; the remaining six car users over 50 years old commuted under 5 km. Also, nine car users were aged 30-49, and their most common travel distance for commuter trips was 6-20 km, with four others in this group travelling distances of under 5 km.

In addition, commuters aged 30-49 and over 50 years old whose travel distances were 6-20 km for commuter trips might have worked in Taipei City, as their income was higher than people who worked outside Taipei City. The findings are consistent with a previous study which found that, on average, people aged between 30 and 39 tend to travel more than most other age groups, and hence they contribute to transport energy consumption and GHG emissions at a high rate (Stead, 2001).

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http://win.dgbas.gov.tw/fies/.. New Taipei City citizens have the second highest income of NTD 53,790 monthly, and Taoyuan City citizens have NTD 55,430 per month.

Table 7.2.7: The relationship between age and car user travel distance

<div align="right">(N = 36)</div>

		Age			Total
		Under 29 years	30-49 years	Over 50 years	
Car travel distances	Under 5 km	1	4	6	11
	6-20 km	0	9	14	23
	Over 21 km	1	1	0	2
Total		2	14	20	36

Note: Chi-Square Test value is 9.948, P value is under 0.041.

7.2.3.3 The relationship between occupation and car user travel distance

It can be seen from Table 7.2.8 that occupation has a significant effect on car users' travel distances ($p < 0.05$). Seventeen of the car users work in high managerial, intermediate managerial, supervisory, clerical and junior managerial, administrative or professional occupations, and used their car to travel distances for commuter trips of 6-20 km. This finding is a reflection of where Zhonghe district is and the fact that there are many high status jobs in Taipei city, so this is effectively the daily commute to the capital city of Taipei from the periphery. The skilled, unskilled, and manual workers seem to travel further: two car users travelled over 21 km by car, but it may be that their jobs are more delivery or service style jobs, so that they have to travel to their clientele to complete key tasks.

Table 7.2.8: The relationship between occupation and car user travel distance

<div align="right">(N = 36)</div>

		Occupation			Total
		High managerial, Intermediate managerial, Supervisory, clerical and junior managerial, administrative or professional	Semi, Skilled unskilled manual workers	State pensioners, casual or lowest grade workers, unemployed with state benefits only	
Car travel distances	Under 5 km	6	2	3	11
	6-20 km	17	3	3	23
	Over 21 km	0	2	0	2
Total		23	7	6	36

Note: Chi-Square Test value is 10.215, P value is under 0.037.

7.2.3.4 The relationship between motorbike licence and car user travel distance

As can be seen from Table 7.2.9, motorbike licence has a significant effect on car travel distances ($p < 0.05$). All car users who also had a motorbike licence travelled distances of 6-20 km, while eleven car users with no motorbike licence travelled under 5 km. If car users had no motorbike licence, they travelled by car even for short trips. If they had a motorbike licence, they still used the car for 6-20 km, but may have relied on something else for short and long trips.

Table 7.2.9: The relationship between motorbike licence and car user travel distance

($N = 36$)

		Motorbike licence		Total
		No	Yes	
Car travel distances	Under 5 km	11	0	11
	6-20 km	7	16	23
	Over 21 km	2	0	2
Total		20	16	36

Note: Chi-Square Test value is 16.278, P value is under .000.

7.2.3.5 The relationship between education level and bus user travel distance

It can be seen from Table 7.2.10 that education level has a significant effect on bus travel distances ($p < 0.05$). Eleven bus commuters with an undergraduate degree travelled under 5 km, eight travelled 6-20 km, and the remaining two travelled over 21 km. However, three bus users with a master's degree or above travelled over 21 km for commuter trips, while only one travelled under 5 km by bus. Bus users with a master's degree or above travelled further than those with an undergraduate degree or below. For example, lecturers' travel distances were further than those with lower educational attainment levels, such as labourers. It is probable that they were university lecturers, and so had to go into Taipei City. By contrast, labourers have a lower educational level, and their job is probably close to their house location.

Table 7.2.10: The relationship between education level and bus user travel distance

(N = 43)

		Occupation					Total
		Primary school level	Junior high school level	Senior high school level	Undergraduate level	Postgraduate level and above	
Bus travel distances	Under 5 km	3	1	9	11	1	25
	6-20 km	1	1	2	8	0	12
	Over 21 km	0	0	1	2	3	6
Total		4	2	12	21	4	43

Note: Chi-Square Test value is 16.570, P value is under 0.035.

7.2.3.6 The relationship between car licence and bus user travel distance

It can be seen from Table 7.2.11 that car licence has a significant effect on bus travel distance ($p < 0.05$). Over half of bus commuters did not have a car licence, and had travel distances less than 5 km, while five of the bus commuters with a car licence travelled 6-20 km. It appears that bus users with a car licence travelled further than those who did not.

Table 7.2.11: The relationship between car licence and bus user travel distance

(N = 43)

		Car licence		Total
		No	Yes	
Bus travel distances	Under 5 km	22	3	25
	6-20 km	7	5	12
	Over 21 km	2	4	6
Total		31	12	43

Note: Chi-Square Test value is 8.754, P value is under .013.

7.2.3.7 The relationship between motorbike licence and bus user travel distance

As can be seen from Table 7.2.12, motorbike licence has a significant effect on bus travel distances ($p < 0.05$). More than half of bus users had no motorbike licence, and their travel distances were less than 5 km. However, five bus users had a

motorbike licence and had travel distances of 6-20 km, four travelled distances under 5 km and four travelled over 21 km. Most bus users had no motorbike licence, so they solely relied on using buses to commute. By contrast, bus users with a motorbike licence travelled further by motorbike than those without, because they may travel by motorbike occasionally during work, e.g. for visiting clients.

Table 7.2.12: The relationship between motorbike licence and bus user travel distance

(N = 43)

		Motorbike licence		Total
		No	Yes	
Bus travel distances	Under 5 km	21	4	25
	6-20 km	7	5	12
	Over 21 km	2	4	6
Total		30	13	43

Note: Chi-Square Test value is 6.921, P value is under .031.

7.2.4 Comparison of the sample characteristics and governmental statistics

This section compares and contrasts the findings of the survey and the governmental statistics of New Taipei City to demonstrate why this case study is representative of Zhonghe district. Also, it helps to understand how the New Taipei City Government has attempted to achieve its goal of 50% public transport use for all trips.

7.2.4.1 The modes of transport use

The Ministry of Transportation and Communication publishes an annual statistical data report titled 'The Investigation of People's Use of Modes of Transport in Daily Life'. It covers people over 15 years old using public transport and private transport for daily commuter trips, including school trips, and the reasons why the public do not use public transport, as well as their satisfaction with public transport (MOTC, 2013). As can be seen from Table 7.2.13, in 2013, people used private transport for commuter trips at a rate of 75.2%, including motorbikes and cars, which accounted for 49.8% and 24.2% respectively among all modes of transport in Taiwan. People who took the city bus and the metro in their daily life comprised 7.3% and 5.5% respectively. However, 3.5% of people walked, and 3.6% cycled. It is obvious that,

in Taiwan, the majority of people prefer to use motorbikes or cars to commute, because they are convenient as well as low-cost.

In New Taipei City, commuting trips by private transport represented 61.2%. Among these, the motorbike is the dominant mode of transport, making up 43.9% of all modes, followed by car use at 16.7%. People who use the city bus and the metro to commute comprise 15.2% and 13.8% respectively. 4.9% of people walked, while just 1.8% cycled. Not surprisingly, private transport use was the largest among all modes of transport in Taiwan and in New Taipei City. Nevertheless, the use of public transport in New Taipei City was nearly double that of Taiwan, which implies that New Taipei City citizens are more likely to use public transport, particularly city buses and the metro, for commuting trips. However, the New Taipei City Government still feels it necessary to achieve a rate of 50% of public transport for all trips in New Taipei City.

Regarding the survey findings of the current study, these also showed that the majority of people travelled to work by private transport: 36 respondents used a car, 58 used a motorbike, 43 used the bus, and 32 used the metro. Private transport use represented 55.62% of commuting trips, compared to 44.38% on public transport. In particular, the dominant means of travel to work (34.32% of the sample) was a motorbike, as shown in Section 7.2, Table 7.2.1. There is no doubt that the findings of the survey are in line with the government statistics on the modes of transport use, as private transport use was significantly higher than public transport use, especially motorbikes.

Table 7.2.13: The modes of transport use

Unit: %

The transport modes use	Public transport use										Non-motorized transport use			The private transport use		
		City bus	The metro	Transport vehicle	Train	Road passenger transport	Taxi	National highway passenger transport	Other		Walking	Cycling		Motorbike	Car	Other
Taiwan	17.7	7.3	5.5	2.3	1.5	0.5	0.3	0.2	0.2	7.1	3.5	3.6	75.2	49.8	24.2	1.2
New Taipei City	32.2	15.2	13.8	1.2	1.2	0.4	0.3	0.1	0.1	6.6	4.9	1.8	61.2	43.9	16.7	0.6

7.2.4.2 Public transport use by gender

In 2013, 36.7% and 20.0% of trips made by adult females and males respectively were on public transport, each of which was almost twice the countrywide average, 18.6% and 11.7% respectively. In terms of the findings on public transport use by gender in this survey, 24.9% of females used public transport compared to 19.5% of males. The proportion of men using public transport in He Ping Shin Jiun was similar to the proportion of males using public transport in New Taipei City.

Table 7.2.14: Public transport use by gender between New Taipei City and the survey sample

Unit: %

Gender City	Male	Female
Taiwan	11.7%	18.6%
New Taipei City	20.0%	36.7%
The sample of He Ping Shin Jiun	19.5%	24.9%

Source: classified by the author.

7.2.4.3 Public transport use by education level

According to New Taipei City Population Statistics in 2014 (Department of Civil Affairs, 2014), over one-third of New Taipei City citizens (37.3%) were educated to undergraduate level, followed by 30.3% at senior high school level, among all educational levels (see Table 7.2.15). Citizens educated to junior and primary school level accounted for 14.9% and 10.7%, respectively. Regarding the residents in Zhonghe District, 40.2% and 30.4% of Zhonghe District residents had an undergraduate and senior high school qualification, respectively. The residents educated to junior and primary school level accounted for 12.3% and 9.8%, respectively. In terms of the findings of the survey, 46.8% of commuters in He Ping Shin Jiun had an undergraduate education level, followed by 33.1% with a senior high school education level (see Section 7.2, Table 7.2.5). Respondents educated to postgraduate level and above accounted for 10.1%. Also, 5.3% and 4.7% of respondents were of junior high school education level, and primary school education level, respectively.

It is evident that the findings of the He Ping Shin Jiun survey are consistent with the education level of citizens in Zhonghe District and New Taipei City, although

levels of higher education in this survey were higher than those in the general statistics. Most residents had at least an undergraduate degree, so they were well-educated people. This could be because this study targeted only commuters, and people with more education are more likely to be employed/commuting. It is evident that the case study selection of Xiufeng Village can represent the whole population who live in Zhonghe District. Also, the rate of education implies that most Zhonghe District residents may have a clear understanding of environmental issues and a reasonable environmental knowledge.

Table 7.2.15: Education level of the population in New Taipei City and Zhonghe District

	New Taipei City education level of population percentage	Zhonghe District education level of population percentage
Illiterate	1.3%	1%
Educated to primary school level	10.7%	9.8%
Educated to junior high school level	14.9%	12.3%
Educated to senior high school level	30.3%	30.4%
Educated to undergraduate level	37.3%	40.2%
Educated to postgraduate level and above	5.5%	6.4%
Total	100.0%	100.0%

Source: Classified from (Department of Civil Affairs, 2014).

7.2.5 Summary

In order to achieve the target of 50% public transport usage, policymakers are constructing the MRT Three Rings and Three Lines for the public, however, the primary findings of the survey show that car users' and motorcyclists' main reasons for using private vehicles on commuter trips were convenience (flexibility and control) for work, and for trip-chains after work (e.g. picking up children). Clearly, it is not easy to change the habits of private transport users who use cars/motorbikes out of necessity; however, it is possible to shift others whose behaviour is partly formulated by their preferences.

Seven socio-economic factors were found to have a significant effect on travel distances. It was found that income, age and occupation have a significant effect on car users' travel distance, with car users under 29 years old evenly distributed between travelling distances of less than 5 km and over 21 km. A possible explanation is that some of their work is highly mobile, and they may have different work locations.

Furthermore, car users' occupations were mainly high managerial, intermediate managerial (aged 30-49 and over 50 years old), and these groups all travelled distances of 6-20 km for commuter trips. These car users tended to be high income groups, with jobs in the centre of Taipei City as well as New Taipei City. This finding was a reflection of where Zhonghe district is and that there are many high status jobs in Taipei city, so these respondents represent the daily commute to the centre of the Taipei from the periphery.

Regarding the relationship between education level and bus user travel distance, bus users with a master's degree or above travelled further than those with an undergraduate level degree or below. In terms of the relationship between car/motorbike licence and bus user travel distance, bus users with a car or motorbike licence travelled further than those without, because they were flexible about doing more things before work or after work.

It is evident that commuters' dependency on using private vehicles, convenience, and the necessity of using the private vehicles after work as well as their socio-economic factors (e.g. age, income, and occupation) are the key determinants for influencing their travel behaviour. However, the private transport users' socio-economic factors are difficult to challenge and change, so it is suggested that the New Taipei City Government may need to use push initiatives, e.g. internalizing the external pollution costs into private vehicle use and/or increasing parking fees. The high income group in particular should pay more fees for using private vehicles. In addition, when the range of choices is altered through a much improved public transport service in the MRT Three Rings and Three Lines, then this may change their preference. Alternatively, if the government could implement a policy aimed at making companies develop a more efficient route map for those employees who must travel by car or motorbike during their work, this could reduce travel time, increase work efficiency and may reduce emissions from private vehicles.

7.3 Perceived values

This section explores users' perceptions of the metro/bus service, drawing on Chapter 2's discussion of key service characteristics, e.g. punctuality, comfort, cleanliness, safety, the stability of service, information, the quality of staff

behaviour, fare, availability, and route characteristics which affect transport users' choices. This section is to understand public transport users' service satisfaction with the metro/bus, and why private transport users do not take the metro/bus.

7.3.1 Commuters' service satisfaction with the metro/bus

In terms of the private and public transport users' service satisfaction with the metro and bus, all the car users (100%) were satisfied with the metro on the variable 'The cleanliness of the metro' (see Table 7.3.1). Passengers are not allowed to eat food in the metro station. If they violate this rule, they are fined NTD 1500-7500 (around £30-£150). In addition, the TRTC cleaners maintain the cleanliness very well in all metro station areas such as the toilets, seats and floors, and in each carriage of the metro. This suggests that this metro-service determined policy is working to ensure a clean service, which is perceived as such by those who do not usually use it; that is, car-users are not put off using the metro due to a lack of cleanliness.

The second largest percentage of metro service satisfaction was 84% of car users on three variables: 'Safety of getting on and off the metro', 'The clarity of the information service in the metro' and 'The metro station staff are well-dressed,' respectively. Car users thought that it is safe to get on and off the metro, because the gap between the platform and each carriage is not too wide. When the passengers get off the metro, the announcements from TRTC remind them to mind the gap. Furthermore, the information provided by the metro, such as the metro route maps inside of the metro stations, is clear for all age groups. When passengers are waiting for the metro to come, the arrival time is clearly shown on the information board in the metro station. If the metro is delayed, they can see this on the information board. Besides, car users are impressed by the TRTC service image, because the metro station staff wear a uniform that is clean and tidy. On the other hand, 8% of car users were not satisfied with the metro service on the variable 'The clarity of the information service in the metro'. It is possible that they were not familiar with this information service because they do not commute using the metro very often. In addition, many MRT lines are currently being constructed, so when car users who are not familiar with the usual service transfer from one metro line to another, particularly in a large station (such as Taipei Main Station, and Zhongxiao Fuxing Station), they may be confused. There are many direction signs

which can be hard to interpret.

For motorcyclists, 72.5% were satisfied with the metro on the variable 'Punctuality of the metro'. Motorcyclists thought that the metro usually comes on time. Sometimes, if the metro is delayed, they find out the actual arrival time of the metro from the information board, and they can do other things before the metro arrives. 72.4% of motorcyclists were satisfied with the metro on the variable 'Safety when you are waiting in the metro station'. In general, taking the metro is safer than riding a motorbike. Metro users are protected when the carriages operate, so they do not have a high degree of exposure to risk. Also, metro staff working in the stations can help passengers.

For metro users, 87.5% were satisfied with the 'Safety of getting on and off the metro'. They felt the same as the car users here. In addition, 84.4% were satisfied with the three variables of 'Punctuality of the metro', 'The cleanliness of the metro' and 'Stability when the metro is moving', respectively. This is because the metro usually arrives on time, as the information board shows. Also, the surroundings of the metro station and each carriage are quite clean. The metro runs at a stable speed, so users were keen to use it as their mode of transport for commuter trips. However, 6.4% of the metro users were dissatisfied with the punctuality of the metro. This was because unexpected events sometimes occur (e.g. suicides or passengers' goods on the rail), resulting in delays. This may make passengers late to work. Also, metro and track maintenance means carriages may be in the wrong place for the next journey. If there is a problem with the track or with a carriage, then there may be delays while it is repaired. Given that the systems are closed, a delay happening in relation to one metro has repercussions for other metros.

For bus users, 81.4% were satisfied with the service attribute of the metro 'Stability when the metro is moving', followed by 79% for 'Punctuality of the metro'. It is probable that when the metro is moving it is more stable than the bus because sometimes bus drivers brake suddenly, causing standing passengers to fall. Passengers may feel unsafe especially if they have a long journey for work trips. In addition, the MRT system is a rail system, so traffic jams and car accidents tend not to affect this mode of transport. This may reduce unexpected accidents, so bus users feel that travelling by the metro (79%) is more punctual than by bus (39.6%). By

contrast, 9.3% of bus users were dissatisfied with 'Comfort of the seat in the metro,' because the seats in the metro are hard compared to the buses, which have a soft pad. Bus users get used to soft seats, so the seats of the metro are less comfortable for them.

The TRTC covers every aspect of the facilities of the metro stations, and the efficiency of the metro, to provide a better service to the passengers. It appears that the majority of private transport users and public transport users are satisfied with the aspects of the metro regarding its cleanliness, safety, and punctuality. In particular, motorcyclists, metro users, and bus users were satisfied with the punctuality of the metro. The metro is rarely delayed, but even if it is delayed this is clearly shown on the information board in advance. The passengers can think about whether it is necessary to switch to other modes, if they are likely to be late for work.

Table 7.3.1: Commuters' service satisfaction with the metro

	Car users			Motorcyclists			Metro users			Bus users		
	Satisfied/Neutral/Not satisfied			Satisfied/Neutral/Not satisfied			Satisfied/Neutral/Not satisfied			Satisfied/Neutral/Not satisfied		
Punctuality of the metro	72%	28%	-	72.5%	17.2%	3.4%	84.4%	9.4%	6.4%	79%	11.6%	2.3%
Comfort of the seat in the metro	60%	40%	-	58.6%	31%	3.4%	68.8%	28.1%	3.1%	58.1%	25.6%	9.3%
Cleanliness of the metro	100%	-	-	70.7%	19%	3.4%	84.4%	15.6%	-	74.4%	16.4%	2.3%
Safety of getting on and off the metro	84%	16%	-	69%	22.4%	1.7%	87.5%	12.5%	-	69.7%	20.9%	2.3%
Safety– when you are waiting in the metro station	80%	20%	-	72.4%	19%	1.7%	78.1%	21.9%	-	67.4%	23.3%	2.3%
Stability – when the metro is moving	80%	20%	-	67.2%	24.1%	1.7%	84.4%	12.5%	3.1%	81.4%	7%	4.7%
The clarity of the information service in the metro	84%	8%	8%	62.1%	27.6%	3.4%	71.9%	28.1%	-	76.7%	9.3%	7%

The metro station staff's attitude is good	68%	32%	-	51.7%	37.9%	3.4%	75%	25%	-	67.5%	23.3%	2.3%
The metro station staff are well-dressed	84%	16%	-	48.3%	41.4%	3.4%	81.3%	18.8%	-	76.8%	11.6%	4.7%

Commuters' service satisfaction for buses

In terms of the commuters' service satisfaction with buses, of the 36 respondents who were car users, 26 did not fill in the questions on service satisfaction with the bus. It is possible that only ten of the car users surveyed had experience of using the bus to travel to work or for other trips. This would imply that most car users are not familiar with the bus service, and would not choose to travel by bus, though they might travel by metro. Among those who did answer, 16.7% of car users were satisfied with 'The clarity of the information service' (see Table 7.3.2). 44.2% of the bus users were also satisfied with this variable in relation to the bus service. There is an electronic marquee inside the bus, which shows the information for each bus stop. When the passengers need to get off the bus, they can easily see this. Also, some bus drivers are willing to announce each bus stop to remind the passengers to get off.

Furthermore, 11.1% of car users are satisfied with the 'Cleanliness of the bus', 'Safety when you stay at the bus stop', 'The bus drivers' attitude is good' and 'The bus driver is well-dressed'. One rule on the bus is that the passengers are not allowed to eat food, to reduce mess and dirt, so the buses are quite clean. In addition, when the passengers are not clear about which bus stop they need, the bus drivers give them directions. This finding is in line with a previous study that for bus and trolley bus operators, one of the most important satisfaction characteristics is vehicle cleanliness (Tyrinopoulos and Antoniou, 2008).

Conversely, 5.6% of car users were dissatisfied with each of 'Cleanliness of the bus' and 'Safety when you stay at a bus stop'. A minority of commuters were dissatisfied with the stability of the bus movement: 28.2% of the metro users, 16.4% of bus users, 13.8% of the motorcyclists and 5.6% of car users. In addition, 16.4% of bus users and 13.8% of the motorcyclists were dissatisfied with 'Safety of getting on

and off the bus'. For stability concerns, it is probable that sometimes the bus drivers suddenly drive faster or slower, because unexpected incidents may happen on the roads (e.g. car accidents or dogs or cats suddenly running onto the road). Other safety concerns include bus drivers sometimes stopping the bus before the bus stop for the passengers to get off, which could cause risks for motorcyclists. Notably, none of the car users had concerns about safety at all (perhaps through inexperience of using the metro/bus).

Regarding the motorcyclists' service satisfaction with buses, 38% were satisfied with the 'Comfort of the seat on the bus'. Also, 46.6% of the bus users were satisfied with this variable because the seats have a seat pad; it is comfortable, especially for elderly people and children. Compared to the plastic seats on the metro, the motorcyclists felt that the bus seats were more comfortable. In addition, 37.9% of the motorcyclists were satisfied with the cleanliness of the bus. They had the same opinion as the car users. In terms of the metro users, 34.4% were satisfied with the variable of 'The bus driver is well-dressed'. 31.3% were satisfied that 'The bus driver's attitude is good'. It is probable that the bus drivers wear a uniform for their work, and their attitude is generally kind. If the passengers have any problems, such as not being sure which bus stop they need, the bus drivers help them.

It is evident that most commuters were not satisfied with the stability of buses, among other attributes of bus services. In general, the bus drivers drive at a regular speed, but sometimes they suddenly stop, depending on the traffic. This is dangerous for standing passengers, especially when the bus is crowded in rush hour. In addition, motorcyclists and bus users were dissatisfied with the safety of getting on and off the bus, as motorcyclists were a hazard. The bus drivers should be aware of speed, and pay more attention to passengers' safety, for example by stopping at the bus stop and making sure that the passengers have safely alighted; this is all down to the bus drivers' positioning of the bus. The service features linked to the safety and security of public transport were evaluated by considering safety and security on board and at bus stops, and showed commuters' concerns in this area (Eboli and Mazzulla, 2011). This could mean that the bus companies should provide more training for bus drivers to improve the stability of running buses, and the safety of the passengers. This could increase the users' service satisfaction with

buses, and bus use.

Table 7.3.2: Commuters' service satisfaction for bus

	Car users			Motorcyclists			Metro users			Bus users		
	Satisfied	Neutral	Not satisfied	Satisfied	Neutral	Not satisfied	Satisfied	Neutral	Not satisfied	Satisfied	Neutral	Not satisfied
Punctuality of bus	-	27.8%	-	29.3%	46.6%	12%	25%	43.8%	15.6%	39.6%	44.2%	9.3%
Comfort of the seat on bus	5.6%	22.2%	-	38%	41.4%	8.6%	25%	53.1%	6.4%	46.6%	39.5%	7%
Cleanliness of the bus	11.1%	11.1%	5.6%	37.9%	44.8%	6.9%	18.8%	50%	15.6%	37.2%	44.2%	11.6%
Safety of getting on and off bus	5.6%	22.2%	-	32.7%	43.1%	13.8%	31.3%	37.5%	15.6%	39.6%	37.2%	16.4%
Safety – when you stay at the bus stop	11.1%	11.1%	5.6%	29.3%	48.3%	12%	25%	53.1%	6.3%	41.9%	41.9%	9.3%
Stability - when bus is moving	5.6%	16.7%	5.6%	25.8%	50%	13.8%	25%	31.3%	28.2%	37.2%	39.5%	16.4%
The clarity of the information service on bus	16.7%	11.1%	-	36.3%	48.3%	5.2%	21.9%	50%	12.6%	44.2%	37.2%	11.7%
The bus driver's attitude is good	11.1%	16.7%	-	31%	55.2%	3.4%	31.3%	46.9%	6.4%	41.9%	37.2%	14%
The bus driver is well-dressed	11.1%	16.7%	-	25.8%	58.6%	5.2%	34.4%	46.9%	3.1%	51.1%	34.9%	7%

7.3.2 The reasons why commuters do not take the metro/bus

As shown in Table 7.3.3, 41.7% of car users and 43.1% of motorcyclists agreed they did not take the metro/bus because 'I have problems parking near the bus stop/metro station'. Although metro stations such as Nanshijiao Station in Zhonghe district have car parking spaces, these commuters are not likely to use them. It is probable that parking cars/motorbikes near the bus stop/metro station before using public transport is time-consuming. Also, they may have to visit clients in different places during the day, so travelling by car is necessary for their job. 25% of car users agreed that 'The metro/bus is often late'. Probably, some had experience of using buses, but they felt it was difficult to control commuting times. Car users have the advantage of deciding to take an alternative route while bus drivers have to stay on their designated route when problems of congestion occur.

For the metro users, 18.8% agreed that why they do not use the metro/bus because 'The seat of the metro/bus is uncomfortable', and 'It is unsafe when getting on and off the metro/bus'. The comfort of the seat on the metro/bus is one factor that influences peoples' mode of travel choices. If the seats of the metro/bus are

uncomfortable, people are not likely to use it. In addition, when the metro users get on and off buses, some motorbikes may suddenly pass close to them so they do not feel safe getting off. By contrast, 50.1% of the metro users disagreed with the statement that commuters do not take the metro/bus because the 'Cost of the bus/metro tickets is too high'. The cost of public transport is affordable for the general public, so this is not the reason why commuters do not travel on public transport. In addition, 37.5% of the metro users did not have any comments on the costs of the bus/metro tickets. For bus users, 28% agreed that 'The metro/bus is often late.' That is, the buses are easily affected by traffic congestion. Travelling by bus makes punctuality harder than when using the metro. However, 41.9% bus users, and 39.7% of motorcyclists, did not think the metro/bus was unclean. Both the metro/bus are quite clean because eating is not allowed in the metro station, carriages, or buses. It is not a factor which influences their travel mode choices.

It should be noted that the fares and the cleanliness of the metro/bus, and the metro station staff/bus drivers' uniform, are not the reasons that determine why commuters do not take public transport. This is because public transport users only pay for a ticket when they go by the metro/bus, whereas private users must pay fuel, insurance costs, and repair and maintenance. The cost of using the metro/bus is cheaper than using cars/motorbikes. Also, the metro stations/carriages are quite clean because the passengers are not allowed to eat food. The metro station staff/bus drivers wear a uniform, so the passengers have a good impression of them.

Table 7.3.3: The reason why commuters do not take the metro/bus

	Car users			Motorcyclists			Metro users			Bus users		
	Agree	Neutral	Disagree	Agree	Neutral	Disagree	Agree	Neutral	Disagree	Agree	Neutral	Disagree
The metro/bus is often late	25%	11.1%	25%	13.8%	56.9%	27.5%	6.3%	56.4%	37.6%	28%	41.9%	30.2%
The seat of the metro/bus is uncomfortable	19.5%	19.4%	22.2%	17.2%	51.7%	29.3%	18.8%	53.1%	28.2%	16.4%	44.2%	39.5%
It is unclean on the metro/bus	5.6%	22.2%	33.3%	6.9%	51.7%	39.7%	15.6%	50%	34.4%	9.3%	48.8%	41.9%
It is unsafe when getting on and off the metro/bus	13.9%	13.9%	33.3%	24.1%	39.7%	34.5%	18.8%	46.9%	34.4%	16.4%	53.5%	30.2%
It is unsafe when you stay at the metro station/bus stop	19.4%	5.6%	36.2%	15.5%	50%	32.7%	6.3%	56.4%	37.5%	7%	58.1%	34.9%

It is unstable when the metro/bus moves	13.9%	11.1%	36.2%	13.8%	53.4%	31%	6.3%	65.6%	28.2%	14%	60.5%	25.6%
The information service of the metro/bus is unclear	16.7%	11.1%	33.3%	10.3%	56.9%	31%	12.5%	56.4%	31.3%	11.6%	53.5%	34.9%
The metro station staff's attitude/bus drivers' attitude is not good	5.6%	16.7%	38.9%	13.7%	56.9%	27.6%	6.3%	46.9%	46.9%	11.7%	55.8%	32.6%
The metro station staff/bus driver is not well-dressed	2.8%	16.7%	41.6%	10.3%	46.6%	41.4%	3.1%	50%	46.9%	7%	58.1%	34.9%
Cost of the bus/metro tickets is too high	5.6%	25%	30.6%	12%	56.9%	27.6%	12.5%	37.5%	50.1%	14%	46.6%	39.5%
I have problems parking near the bus stop/metro station	41.7%	8.3%	11.1%	43.1%	37.6%	27.6%	15.7%	40.6%	43.8%	18.6%	48.8%	32.5%
The bus stop/metro station is too far from my home	5.6%	13.9%	41.7%	27.6%	29.3%	39.7%	9.4%	34.4%	53.1%	16.4%	44.2%	39.6%

7.3.3 Summary

The clear majority of all the commuters were satisfied with aspects of the metro regarding cleanness, safety, and punctuality. These factors are clearly positive in terms of meeting people's expectations of the service, and do not discourage people from using the service; it also potentially causes a problem in that these factors cannot be improved upon, so people will not be encouraged to use the service because of improvements in these areas. However, some metro users, bus users, and motorcyclists are not satisfied with the comfort of the seats on the metro. Perhaps, the seats are hard compared to the bus seats, which have soft pads. Bus users and other modes of transport users prefer to have soft seats, so this factor influences their travel mode choices. Hence, if TRTC could improve the comfort of the seats on the metro, it could increase users' service satisfaction and more people might be likely to use it.

In addition, many commuters are not satisfied with the stability of buses, and safety

when getting on and off. Training for bus drivers to improve the stability of running buses, and the safety of the passengers, could increase the users' service satisfaction, and bus use. Interestingly, the findings of the survey showed that some car users did not have experience of using buses, so they would not choose to travel by bus though they might travel by metro. In this sense, the New Taipei City Government has found it necessary to use financial incentives to encourage more people to use buses, because some private transport users strongly rely on using cars/motorbikes for all trips. They may not have used buses before, so they could take advantage of this opportunity to use buses. If they have a good experience using them, they will be more likely to use buses again.

7.4 Attitudinal factors

The last objective of this research was to understand commuters' environmental knowledge, and their thoughts on transport initiatives. This section discusses commuters' awareness of climate change, and their thoughts on transport initiatives are explored in Section 7.5.

7.4.1 Commuters' attitude towards climate change

As shown in Table 7.4.1, 100% of car users and 84.5% of motorcyclists had heard about climate change, but 15.5% of motorcyclists were not aware of it as an issue. Indeed, on the basis of this research, car users were more aware than those using arguably more environmentally friendly transport options. In terms of public transport users, 81.3% of the metro users had heard about climate change, while 18.8% had not. Similarly, 83.7% of bus users had heard about climate change, whereas 16.4% had not. Clearly, the majority of commuters had some awareness of the issue of climate change, and were conscious of environmental issues.

Table 7.4.1: Commuters awareness of climate change

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	36	100.0%	49	84.5%	26	81.3%	36	83.7%
No	-	-	9	15.5%	6	18.8%	7	16.4%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

Commuters' opinions on climate change

As can be seen from Table 7.4.2, 66.7% of car users thought that climate change is caused by both human activities and nature, 13.9% thought that climate change is purely a natural occurrence, 11.1% thought that climate change is not happening, and only 8.3% of car users thought that climate change is caused purely by human activities. For motorcyclists' opinions regarding climate change, 60.3% thought that climate change is caused by both human activities and nature, 24.1% thought that climate change is caused purely by human activities, 13.8% of motorcyclists thought that climate change is purely a natural occurrence, and 1.7% did not believe that climate change has happened. Clearly most private transport users are aware of climate change, but they may feel that human activity in terms of manufacturing or farming contributes to climate change, so it is not necessary to change their own transport behaviour.

With regard to public transport users' opinion on climate change, 78.1% of the metro users thought that climate change is caused by both human activities and nature, 9.4% thought that climate change is caused purely by human activities, 6.4% thought that climate change is purely a natural occurrence, and 6.4% did not believe that climate change has happened. For bus users' opinions regarding climate change, 74.4% thought that climate change is caused by both human activities and nature, 16.4% thought that climate change is caused purely by human activities, 7% thought that climate change is purely a natural occurrence, and 2.3% did not believe that climate change has happened. Over half of private and public transport users thought that it is caused by both human activities and well as nature.

Table 7.4.2: Commuters' opinions on climate change

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Climate change is caused purely by human activities	3	8.3%	14	24.1%	3	9.4%	7	16.4%
Climate change is purely a natural occurrence	5	13.9%	8	13.8%	2	6.4%	3	7.0%
I think climate change is caused by both of them	24	66.7%	35	60.3%	25	78.1%	32	74.4%
I do not believe that climate change has happened	4	11.1%	1	1.7%	2	6.4%	1	2.3%

| Total | 36 | 100.0% | 58 | 100.0% | 32 | 100.0% | 43 | 100.0% |

Commuters' opinions toward the government reducing climate change

As shown in Table 7.4.3, a clear majority of the private transport users and public transport users agreed that the government should introduce policies to help mitigate the impact of transport emissions on climate change. Clearly, environmental issues have become a significant issue worldwide, and most commuters thought that the government should be responsible for addressing the negative impacts of climate change. Furthermore, the residents who live in Xiufeng Village may have a clear understanding of environmental issues and be more concerned with the global issue of climate change.

Table 7.4.3: Commuters' opinions toward the government reducing climate change

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	36	100.0%	54	93.1%	28	87.5%	40	93.0%
No	-	-	4	6.9%	4	12.5%	3	7.0%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

Commuters' opinions on whether travelling by car or motorbike influences climate change

It can be seen from Table 7.4.4 that 91.7% of car users and 77.6% of motorcyclists did not think that travelling by car/motorbike influences climate change more than public transport. It is possible that the private transport users choose to use private vehicles due to their work purposes or personal needs, although they are clear that climate change is affected by both nature and human activities. They put their needs as the first priority rather than environmental concerns.

For the metro and bus users, 90.6% of metro and 93.0% of bus users thought that private transport use affects climate change more than that of public transport use. This supports the findings presented in Table 7.2.4 of Section 7.2.1; 26.6% of bus and 21.1% of metro users thought that 'the metro/bus is eco-friendly'. Both bus and metro users had a clearer environmental consciousness than private transport users.

Table 7.4.4: Commuters' opinions on whether travelling by car/motorbike influences climate change more than public transport

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	3	8.3%	13	22.4%	29	90.6%	40	93.0%
No	33	91.7%	45	77.6%	3	9.4%	3	7.0%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

7.4.2 Summary

The majority of commuters have an awareness of climate change, so they are aware of environmental issues. Over half of private and public transport users thought that climate change is predominantly caused by both human activities and nature. Also, they thought that the government should take action to address the negative impacts of climate change caused by human activities. In addition, public transport users appear to have a clearer understanding of environmental issues than private transport users. This finding is in line with the survey response that one quarter of bus users and one-fifth of metro users use these modes due to the fact that 'the metro/bus is eco-friendly'. Ninety percent of the metro and bus users thought that travelling by car/motorbike influences climate change more than by public transport; however, more than ninety percent of car users and around seventy percent of motorcyclists thought that travelling by private transport does not influence climate change more than that of public transport.

For many people who use private vehicles, this usage has contributed more to environmental pollution than they expect. In addition, when people make travel mode choices, they intuitively take their own work needs and personal purposes into account as the priority. Their own interests are more important than the environment or society. People tend to be more concerned with other issues such as personal health, security, and financial concerns, so they do not see the urgency of solving the impacts of climate change. Even if they have a clear understanding of climate change issues, these do not strongly influence their travel behaviour, as people's travel mode choices are affected by complex factors such as social norms, individual benefits, and interpersonal influences. As educational approaches have generally been very ineffective at changing travel behaviour, it is necessary to use other policies to reduce private vehicle use such as increasing parking fees, and road charging.

In this study, it is surprising that the residents who live in Xiufeng Village are not as environmentally aware as might have been expected, especially when it comes to their travel behaviour, meaning they may not easily shift modes of transport. The researcher thinks that private transport users choose not to be aware of climate change, and rely on their own travel needs when making travel mode choices. In this sense, the New Taipei City Government should implement some push initiatives to reduce the negative impacts of private vehicle use on the environment such as internalizing the environmental costs into private transport use, which would make it possible to influence private transport users' travel behaviour.

7.5 Commuters' understanding of transport initiatives

The last objective of this survey was to understand commuters' environmental knowledge (discussed in Section 7.4), and their thoughts on transport initiatives. The New Taipei City Government is committed to raising public transport use and has adopted a number of initiatives to facilitate this. There are four types of transport initiatives and policies: 1: Parking Provision at Metro Stations, 2: Discounted Travel Permits, 3: Improved Bus Vehicles, and 4: Improved Network and Stations. These four initiatives are the main incentives connected with public transport infrastructures (the metro and bus) in the Taipei metropolitan area.

Policies 1, 2 and 4 are pull initiatives within the Shift element of the ASI framework, while policy 3, which seeks to replace traditional buses with more efficient, environmentally friendly ones, is a pull measure in the Improve element of the ASI framework. This section explores respondents' perceptions and take-up of these initiatives to understand their effectiveness and outcomes.

7.5.1 Policy 1: Parking Provision at Metro Stations

To provide seamless transfers at the connections between transit systems, TRTC has provided parking spaces near some metro stations. By May of 2011, this provision offered: 3,801 car parking spaces, 10,194 motorbike parking spaces, and 12,685 bike parking spaces (Juan, 2011). At Nanshaijiao MRT Station, 340 car parking spaces have been provided, with car parking fees as follows:
Weekdays: 06:00 – 24:00, NTD 30 (around 60 pence)/hour
Holiday: 06:00 – 24:00, NTD 40 (around 80 pence)/hour

Night: 01:00 – 06:00, NTD 10 (around 20 pence)/hour

There are several discounts available for car parking fees. Firstly, if you use an Easy Card travelling one way on the metro, then you can have NTD 5 (around 10 pence) discount an hour on car parking fees. Secondly, the TRTC provides 145 monthly permits which cost NTD 3500 (around £70); 100 bi-monthly permits are provided which cost NTD 7000 (around £140); 15 limited time monthly permits are provided, which cost NTD 2000 (around £40).

Commuters' awareness of parking discounts

It can be seen from Table 7.5.1 that the majority of private transport and public transport users were not aware of the parking fee discounts. 58.3% of car users and 58.6% of motorcyclists were not aware of the parking discounts. For public transport users, 62.5% of the metro users and 69.8% of bus users were not aware of the parking discounts. It is clear that neither private transport nor public transport users were fully aware of the parking discounts, so the TRTC should increase advertising and campaigns to raise awareness. Then, it might be possible to attract more private transport users to park their cars/motorbikes at stations.

Table 7.5.1: Commuters' awareness of parking discounts

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	15	41.7%	24	41.4%	12	37.5%	13	30.2%
No	21	58.3%	34	58.6%	20	62.5%	30	69.8%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

Commuters' intention to use parking spaces

As shown in Table 7.5.2, 52.8% of car users would be likely to park their car/motorbikes in the parking spaces and then use the metro for commuter trips, while 47.2% would not. Around half of car users would not be likely to change their travel mode, though some of them would like to.

For motorcyclists within the survey, 58.6% would like to park in the parking spaces and then use the metro, whilst 41.4% would not. As Section 7.3.2 demonstrates, 41.7% of car users and 43.1% of motorcyclists did not take the metro/bus because 'I have problems parking near the bus stop/metro station' (see as Table 7.3.3). For

the metro users, 59.4% would be likely to park their car or motorbike and then use the metro to commute, while 40.6% would not. For bus users, 60.5% would be likely to park and then use the metro, whilst 39.5% would not use the parking spaces. It is unsurprising that public transport users are more likely to use the parking than private users, probably because their main travel modes are the metro/bus, and so if they have to use cars/motorbikes to work occasionally, they intend to have more environmentally friendly behaviour to reduce CO_2 emissions.

It is clear that over half of the private transport users would like to use the parking at Nanshijiao MRT Station, but more than half of them were not aware of the parking discounts. If private transport users were made aware of it, some would like to use the parking and then take the metro to commute to work. This implies that if the government clearly let the public know the provisions of parking discounts at Nanshijiao MRT Station, perhaps more private transport users would use the parking spaces. This would make it possible to get people to shift from using cars/motorbikes to the metro. In this sense, the transport initiative of Parking Provision at Metro Stations could be partly effective in influencing private transport users' travel behaviour, and increasing public transport use.

Table 7.5.2: Commuters' intention to use the parking spaces at Nanshijiao

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	19	52.8%	34	58.6%	19	59.4%	26	60.5%
No	17	47.2%	24	41.4%	13	40.6%	17	39.5%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

Commuters' intention to use parking discounts

As shown in Table 7.5.3, around 64% of car users would like to use the parking discounts if they parked their cars in Nanshaijiao MRT Station. For motorcyclists, 67.2% would. As more than half of private transport users were willing to use the parking discounts, if the TRTC strengthen advertising about the parking discounts for local residents in Zhonghe district, it is possible they might attract more private transport users to use the parking spaces at Nanshaijiao MRT Station.

Table 7.5.3: Commuters' intention to use the parking discounts

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	23	63.9%	39	67.2%	18	56.4%	28	65.1%
No	13	36.2%	19	32.8%	14	43.7%	15	34.9%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

7.5.2 Policy 2: Discounted Travel Permits

The TRTC Easy Card provides a discount for passengers travelling one way and changing their mode of transport (between bus and metro). It is valid for an hour from when it is first activated. For example, if you are an adult and you take the metro then transfer to the bus, you need only pay the reduced price of NTD 8 (around 16 pence) for the bus ticket and the metro ticket.

Commuters' awareness of the TRTC Easy Card

As shown in Table 7.5.4, 100% of car users and 93.1% of motorcyclists were aware of the Easy card. For the metro users and bus users, 93.8% and 93.0% were aware, respectively. This shows that most commuters were aware of the TRTC Easy Card, so if they travel by public transport, they are likely to take advantage of it.

Table 7.5.4: Commuters' awareness of the TRTC Easy Card

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	36	100.0%	54	93.1%	30	93.8%	40	93.0%
No	-	-	4	6.9%	2	6.4%	3	7.0%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

Commuters' awareness of discounts when travelling on the metro and bus

As can be seen from Table 7.5.5, 100% of car users and 77.6% of motorcyclists had heard about the discounts for travelling one way on the metro and bus. For public transport users, 93.8% of the metro users and 86% of bus users had heard of it, whereas 6.4% of the metro users and 14% of the bus users had not heard about it. Clearly, the majority of commuters had heard about the discounts for travelling one way on the metro and bus, so when private transport users need to use public transport, they probably take advantage of it.

Table 7.5.5: Commuters' awareness of the discounts for travelling one way on the metro and

bus

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	36	100.0%	45	77.6%	30	93.8%	37	86.0%
No	-	-	13	22.4%	2	6.4%	6	14.0%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

Commuters' motivation to use public transport because of travel discounts on the metro/bus

It can be seen from Table 7.5.6, that 8.4% of car users and 8.7% of motorcyclists would use the travel discount on the metro/bus for commute trips, ie. would use both metro and bus in one journey. 22.2% of car users and 24.1% of motorcyclists may consider using the travel discount on the metro/bus for work trips. However, 69.4% of car users and 67.2% of motorcyclists would not, possibly because they have to use private vehicles for work needs (e.g. sales visits to clients every day, carrying products), or for personal purposes such as picking up children, or shopping after work. In addition, using the metro and bus is quite time-consuming, even if cheaper. In the findings of Section 7.2.1, 29.3% of car users and 36.5% of motorcyclists used private vehicles as the main travel mode because the 'Car/motorbike is convenient to go to the workplace'. Also, 27.3% of car users and 25.0% of motorcyclists thought that the 'Car/motorbike is needed before or after work'.

For public transport users, it is no surprise that almost all public transport users were likely to use the travel discount on the metro/bus for work trips. It appears that public transport users fully use these discounts when commuting.

It is clear that most of the private transport users would not be encouraged to use public transport just because of the discounts for transferring between the metro/bus, although one-third would or might. It is probable that travelling on the bus and metro consecutively is quite time-consuming, so the travel discount is not important enough to private transport users. Thus, the transport initiative of Discounted Travel Permits is not effective in encouraging private transport users to use public transport, because this incentive is not enough to influence their travel behaviour.

Table 7.5.6: Commuters' motivation to use public transport because of travel discounts on the metro/bus

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	3	8.4%	5	8.7%	32	100.0%	40	93.0%
No	25	69.4%	39	67.2%	-	-	1	2.3%
Maybe	8	22.2%	14	24.1%	-	-	2	4.7%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

7.5.3 Policy 3: Improved Buses

To increase the accessibility of vehicles to passengers, the Taipei Passenger Transport Company is introducing new buses in Zhonghe District. These are low-chassis buses, touch activated, with wider doors for accessibility for all ages. They alsohave lower CO_2 emissions compared with traditional petrol or diesel-driven buses. These vehicle upgrades have already occurred on the Orange 2 and Orange 5 routes.

Commuters' awareness that buses are being improved

As can be seen from Table 7.5.7, more than half of the private transport users were not aware of the new low-chassis buses; 61.1% of car users and 62.1% of motorcyclists were not aware. As most of the car users/motorcyclists rely on private vehicles for work trips and rarely use buses, it is unlikely that they would be aware of the bus models. For public transport users, 87.5% of the metro users were aware of improvements, but 12.5% were not. For bus users, 93% were aware. It is unsurprising that over eighty per cent of public transport users were aware of the traditional buses being replaced, because their main travel mode is the metro/bus. They are clearly more aware of the information and facilities of the public transport system than private transport users.

Table 7.5.7: Commuters' awareness of bus improvements

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	14	38.9%	22	37.9%	28	87.5%	40	93.0%
No	22	61.1%	36	62.1%	4	12.5%	3	7.0%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

Commuters' use of low-chassis buses

It can be seen from Table 7.5.8 that 63.9% of car users and 82.8% of motorcyclists had used the low-chassis buses before, while 36.2% of car users and 17.2% of motorcyclists did not. For public transport users, 87.5% of the metro users and 93% of bus users used them, whereas 12.5% of the metro users and 7% of bus users did not.

Every year, the government provides £2 million funding to the bus companies to upgrade their traditional buses, the majority of which are being replaced, so most commuters have experienced the low-chassis buses.

Table 7.5.8: Commuters' use of the low-chassis bus

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	23	63.9%	48	82.8%	28	87.5%	40	93.0%
No	13	36.2%	10	17.2%	4	12.5%	3	7.0%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

Commuters' attitudes toward using the low-chassis bus

As shown in Table 7.5.9, 41.7% of car users thought that the low-chassis bus was more convenient than the traditional bus, but 22.2% did not think so. For motorcyclists, 62.1% thought that the low chassis bus was more convenient, while 20.7% did not think so. For public transport users, 59.4% of the metro users thought that the low-chassis bus was more convenient, but 28.1% did not think so. 72.1% of bus users thought that the low-chassis bus was better, whereas 20.9% did not think so.

Most commuters thought that the low-chassis buses were easy, convenient, and accessible for passengers, in particular the elderly, disabled, and children. The findings are in line with a previous study that low-chassis buses are easier to access than traditional modes of buses for these users (Balcombe et al., 2004). It is worth noting that around one-third of car users did not answer the question, because they may have thought there was no significant difference in using the low-chassis buses. This could mean that the transport initiative of Improvements to Bus Vehicles is not effective in encouraging the private transport users to use these buses.

Table 7.5.9: Commuters' attitudes toward whether to using low-chassis buses

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	15	41.7%	36	62.1%	19	59.4%	31	72.1%
No	8	22.2%	12	20.7%	9	28.1%	9	20.9%
No response	13	36.2%	10	17.2%	4	12.5%	3	7.0%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

7.5.4 Policy 4: Improved Network and Stations

The New Taipei City Government is constructing the Mass Rapid Transit (MRT) Three Rings and Three Lines because currently the city's satellite towns do not have an interlinked MRT network. The first Loop Line of the MRT system (the first stage) is being built and is expected to be completed by 2030. The nearest metro station on this new route for local residents who live in Xiufeng village is Xioulang Bridge station. After it is constructed, it will provide more a convenient and easier MRT network for local people.

Commuters' awareness of the MRT Three Rings and Three Lines

As shown in Table 7.5.10, 80.6% of car users and 74.1% of motorcyclists were aware of the MRT Three Rings and Three Lines Construction, but 19.4% of car users and 25.9% of motorcyclists were not aware. For public transport users, 68.8% of metro users and 55.8% of bus users were aware, whereas 31.2% of metro users and 44.2% of bus users were not. Surprisingly, around one-third of public transport users were not aware of the MRT Three Rings and Three Lines Construction, as it is probable that at the time of the survey it was in the very early stages.

Table 7.5.10: Commuters' awareness of the MRT Three Rings and Three Lines

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	29	80.6%	43	74.1%	22	68.8%	24	55.8%
No	7	19.4%	15	25.9%	10	31.2%	19	44.2%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

Commuters' intention to use the MRT Three Rings and Three Lines

As shown in Table 7.5.11, 44.5% of car users said they would use the MRT Three Rings and Three Lines to commute after it has been completed, but 36.2% would not. For motorcyclists, 55.2% would travel by the improved MRT network, while 20.7% would not. Also, 19.4% of car users and 24.1% of motorcyclists would consider using the network in the future.

For public transport, 87.5% of the metro users would keep commuting by metro, but 3.1% would not. For the bus users, 69.8% would use the MRT Three Rings and Three Lines for work trips, but 6.9% would not. However, 9.4% of metro users and 23.3 % of bus users may consider use it when commuting in the future. It is probable that the improved MRT network is more convenient to their work location, so they could save time from their current commute. Most public transport users will thus convert to the MRT Three Rings and Three Lines for commuter trips, although some will continue using old lines if these go closer to their workplace.

Due to the government not yet having provided a complete network of public transport to the public, it is not easy to encourage private transport users to use public transport. However, according to the survey more than sixty percent of the private transport users would consider using the MRT Three Rings and Three Lines for work trips after it has been completed in 2030. The findings are promising for the policymakers' concerns about take-up. Nevertheless, the new provisions may not be adequate to shift most private transport users away from using cars/motorbikes to the metro, so it is necessary for the government to use push initiatives at the same time. This finding is supported by a wide range of literature which finds that implementing push initiatives that change the relative attractiveness of travel modes can make pull initiatives more effective at motivating private transport users to switch to other travel modes (Gärling *et al.*, 2009; Bamberg *et al.*, 2011). This implies that transport initiatives of the MRT Three Rings and Three Lines will only be partially effective at encouraging private transport users to use the metro in the near future.

Table 7.5.11: Commuters' intention to use the MRT Three Rings and Three Lines

	Car users		Motorcyclists		Metro users		Bus users	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	16	44.5%	32	55.2%	28	87.5%	30	69.8%
No	13	36.2%	12	20.7%	1	3.1%	3	6.9%
Maybe	7	19.4%	14	24.1%	3	9.4%	10	23.3%
Total	36	100.0%	58	100.0%	32	100.0%	43	100.0%

7.5.5 Summary

The New Taipei City Government is committed to increasing the use of public transport and has adopted four main initiatives to facilitate this. Regarding the first, Parking Provision at Metro Stations, the findings showed that over half of private transport users would like to use the parking spaces at Nanshijiao MRT Station, and then take the metro to work. They had not used it before because they were not aware of either the parking for cars/motorbikes at Nanshaijiao MRT Station, or the discounts. This implies that if the government or the TRTC informed the public more clearly about the parking spaces/discounts, more private transport users would be likely to use the parking spaces. This provides the potential to get people to shift from using cars/motorbikes to the metro.

In terms of the second initiative, Discounted Travel Permits, the findings revealed that most private transport users are not encouraged to use public transport by the discount on journeys which include both metro and bus. It is probable that using the metro or bus individually, not both, is the easiest way to complete their journey. Also, it is possible that they have to use private vehicles for visiting clients, or carrying goods. The findings are in line with Section 7.2.1, which showed that the main reason for car users and motorcyclists using private transport on work trips is because 'Car/motorbike is convenient to travel to the workplace ', and 'Car is needed before or after work'. Clearly, the transport initiative of Discounted Travel Permits for metro/bus transfers is not a strong enough incentive to influence private transport users' travel behaviour.

Regarding Improvements to Bus Vehicles, the third initiative, the findings showed that most commuters thought that the low-chassis buses are easy, convenient, and accessible for passengers, in particular the elderly, disabled, and children. However,

around one-third of car users did not answer this question, so they may think that there is no significant difference in using the low-chassis buses. Other factors such as personal travel needs, were more important to commuters' travel mode choices. Apparently, the transport initiative of Improvements to Bus Vehicles is not effective in encouraging private transport users to use buses. Nevertheless, improving the quality of the buses, and making them more eco-friendly, does improve this mode of transport's credentials as an eco-friendly transport alternative.

Finally, in terms of Improved Network and Stations, the findings showed that around half of the private transport users would consider using the MRT Three Rings and Three Lines for commuter trips after it has been constructed in 2030. This implies that the transport initiative of the MRT Three Rings the Three Lines may be partly effective in causing private transport users to switch from private vehicles to the metro in the future.

It is evident that the initiatives of Discounted Travel Permits and Improvements to Bus Vehicles are not effectively attracting private transport users to use public transport. However, the initiatives of Parking Provision at Metro Stations, and the MRT Three Rings and Three Lines Construction may be partially effective at switching private transport users from using cars/motorbikes to using the metro in the future. So, if these policies could be better implemented, there is potential to increase opportunities for shifting private transport users' travel behaviour. However, it may not be enough to use only pull initiatives, so most importantly, the New Taipei City Government should use push initiatives such as increasing city-centre parking fees at the same time.

7.6 Concluding Remarks

This chapter has discussed the findings of the data analysis process in terms of four types of commuters' (car users, motorcyclists, metro users and bus users) travel behaviour for commuter trips, six socio-economic factors (gender, age, education level, occupation, income, car/motorbike license) that affect travel mode choices, and the commuters' awareness of environmental issues, as well as their thoughts on four current transport initiatives.

In Taiwan, MRT Three Rings and Three Lines, despite not being finished yet, would seem to be a good metro system for the public as it is likely to benefit the citizens who live in the Taipei metropolitan area, e.g. facilitating the convenience of traffic, promoting economic development and sightseeing for locals, and reducing CO_2 emissions. Nevertheless, the primary findings of the survey show that car users' and motorcyclists' rationales for using private vehicles on commuter trips were mainly comprised of convenience, flexibility and control, and the necessity of using those vehicles before or after work to complete various trip chains. This makes their travel behaviour more difficult to change; however, it is possible to shift those who rely on private vehicles by preference only.

Furthermore, it was found in the study that the residents who live in Xiufeng Village are not as environmentally aware as might have been expected, especially when it comes to their travel behaviour, so they are unlikely to readily shift modes of transport. This is because, when people make travel mode choices, they intuitively prioritise their own travel needs and purposesover the environment or society. In this sense, if the government could use push initiatives such as internalizing the external pollution costs into private vehicle taxes and/or increasing parking fees, especially forcing high income people to pay higher fees for using private vehicles, this would make it possible to alter more private transport users' travel behaviour.

In New Taipei City, discounted travel permits and improvements to buses are not effectively attracting private transport users to use public transport. On the other hand, parking provision at metro stations and the MRT Three Rings and Three Lines Construction may be partially effective at switching private transport users to using the metro in the future, if they are completely implemented. However, it may not be adequate to use pull initiatives to change most private transport users' travel mode choices, so the New Taipei City Government should use push initiatives at the same time.

The next chapter presents the conclusions of this thesis. The intention is to provide an overview of the key findings identified in the foregoing chapters and to outline the implications of these findings, alongside presenting the contribution of the thesis and making suggestions for future research.

Chapter 8

Conclusion: Changing people's travel behaviour through public transport infrastructures is possible but difficult

8.1　Introduction

This chapter draws the study together by outlining its significance and providing implications for the future direction of both policy and study. Environmental problems such as CO_2 emissions and climate change exist mainly because of increasing levels of traffic in cities. In order to address these problems, many governments, consistent with some narrower elements of the Avoid/Reduce-Shift-Improve (A-S-I) framework but not with the broader framework, have aimed at promoting alternative mobility solutions and developing sustainable transport systems (Banister, 2008; Bos and Temme, 2014). In addition, many global south cities tend to be reliant on using the shift element within the ASI framework, and most of them have focused on using pull initiatives related to public transport infrastructures such as MRT, BRT, and LRT (Hayashi et al., 2004; Hossain, 2006; Deng and Nelson, 2011), but these infrastructure-led approaches are likely to be too narrow to adequately increase public transport use.

Taiwan is no exception. The New Taipei City Government is focused on shift policies of pull initiatives within the Shift element of the ASI framework. They have aimed to reduce motorized vehicle use, and achieve 50% public transport use on all trips (including transfer from one public transport mode to another) (New Taipei City Government, 2010). Primarily pull initiatives have been used to achieve this target in the form of the MRT Three Rings and Three Lines, and the MRT Pilot Buses. These pull initiatives not only assist in reducing private transport users' trips, but also provide improved alternatives, for instance the MRT Three Rings and Three Lines enables private transport users to travel to the metro stop and then take the train, which shortens their car/motorbike trip. Many people with a nearby new metro station can avoid commuting by private vehicle altogether.

The aims of this research were to explore the potential for changing commuters' travel behaviour to more environmental-friendly modes of transport by critically

evaluating transport policy attempts to increase public transport use, and by evaluating commuters' travel behaviour to discover their intentions. The case study is New Taipei City, Taiwan, within which the government is providing major investment in pull initiatives to persuade people to shift to public transport. Adopting a mixed method approach, quantitative questionnaires and qualitative semi-structured interviews were conducted with commuters, transport officials, experts from identified transport consultancies, environmental activists, and university academics specializing in transport issues and policy documentation. New Taipei City's transport proposals and policies, notably the MRT Three Rings and Three Lines Construction and the MRT Pilot Bus, were evaluated. The commuter surveys were focused on the sub-unit of case study - the He Ping Shin Jiun community - to obtain data on commuter travel model choices, travel behaviour, service satisfaction with public transport (the metro/bus), and commuters' thoughts on transport initiatives. Therefore, this chapter will recap the implications of the study's investigation into commuter travel behaviour, key actors and critical observers of the policies implemented, including the initiatives of the MRT Three Rings and Three Lines Construction and the MRT Pilot Bus.

8.2   Key findings and implications

The emphasis on new infrastructure in transport policy represented the starting point to this research. As outlined in Chapter Five and Chapter Six, the New Taipei City Government has offered primarily public transport provision and incentives to encourage commuters, business travellers and other travellers to change their private transport to public transport. It has yet to be seen whether these transport policies will be effective in increasing the use of public transport.

The conclusions of this research are organized around four research objectives. The first objective was concerned with commuters' mode of transport choices, and why these choices were made. The second focused on whether the MRT Pilot Bus may be an effective policy measure in shifting car users/motorcyclists into MRT trip-takers. The third objective looked at how environmental attitudes influence commuters' travel behaviour. The last objective looked at how policymakers seek to achieve 50% public transport usage for all trips by completing the MRT Three

Rings and Three Lines Construction in 2030.

8.2.1 Discussion of commuter travel behaviour

In order to explore the potential to make commuter travel behaviour more environmentally friendly, the importance of their travel mode choice and rationale for using modes of transport needed to be investigated and analyzed. The first objective for this research was to investigate commuters' mode of transport choices for commuter trips, and why these choices were made.

The most significant reason for car users and motorcyclists using private transport for commuter trips was convenience in the workplace and before or after work. From this, three main reasons influenced car users' travel mode choices for commuter trips. Firstly, car users prefer to use cars over other modes of transport for reasons such as flexibility and control. They think it is more convenient to travel to work by car than using public transport. Also, they neither need to spend additional time awaiting the arrival of the metro/bus, nor bear crowded commuting conditions in carriages/on buses.

Secondly, some car users have to drive a car because of their job responsibilities and position, which includes activities such as visiting clients and carrying goods. For example, those in sales have to visit their clients every day, so they have to drive their car as well as carry products. Thirdly, after work, the car meets their personal needs for shopping and child care. If they were to go by metro or bus, they could not easily and conveniently do these things. These findings are consistent with previous studies which found that daily activities have a influence on the choice of travel mode, and time pressures also play a role, so it is difficult to use public transport for all trips (Mackett and Ahern, 2000).

For motorcyclists, over one third thought that a 'motorbike is convenient for travel to workplace', while one quarter thought that a 'motorbike is needed before or after work'. Around one quarter of motorcyclists thought that a 'motorbike is used without time limit'. Due to motorbikes being the most popular mode of transport, there is a high volume of motorbike traffic in Taiwan. Taiwan is a densely populated sub-tropical area, so people can easily ride motorbikes everywhere without weather constraints, even in the winter. Furthermore, the advantages of motorbike use are flexibility, convenience,

high mobility, versatility, cheapness, small size, and ease of parking. They are not significantly limited by time or space availability, and are particularly suited to weaving through queues in congested areas, especially over short distances.

For example, motorcyclists are able to park their motorbike on the street without spending time looking for a parking space, because these are easily found. In addition to convenience and providing door-to-door access, motorcyclists are used to riding motorbikes for commuter trips and any short trips (e.g. shopping, and visiting friends). Moreover, the price of a motorbike is affordable, and petrol is not expensive; a 125cc motorbike is around £1000-1200, and one litre of petrol is around £0.50. It is evident that, in Taiwan, they are the majority of people's travel mode of choice because of their many advantages, including the characteristics of motorbikes, the costs, and situational factors (e.g. the weather, the economy, the population density and the cultural background).

Regarding travel distances, socio-economic factors have a significant effect. In chapter 7, the findings showed that age, education level, occupation, income, and car/motorbike licence had a significant effect on commuters' travel distances, especially for car users. For example, car users were usually in high or intermediate managerial jobs, earning over NTD 49,001 per month, and were aged 30-49 or over 50 years old, with a travel distance of 6-20 km for commuter trips. They had longer travel distances for work trips, so they were less self-contained. It is probable that even some high income workers may not be able to afford central district housing prices, so they choose to live far away and commute there. Some have long travel distances because of work location, e.g. a lecturer whose university is located in Taipei City.

However, an issue may be raised that after the MRT Three Rings and Three Lines Construction has been completed, the improved access of the MRT network will encourage long-distance commuting, so the public may travel further to find a job in other cities of the Taipei metropolitan area. The rising of travel distances leads to a decline in self-containment, and may increase CO_2 emissions even if people travel by public transport systems. Yet, this was not policymakers' intentions; New Taipei City was upgraded to a municipality in 2010, but its pre-existing transport infrastructures were not sufficient to accommodate the daily trips generated by the 3.9 million people who live in New Taipei City. In this sense, this implies that the transport initiative of

The MRT Three Rings and Three Lines is not likely to mitigate long distance commuting in Taipei City, or New Taipei City.

It is argued in this study that the majority of car users and motorcyclists travel by private vehicles on commuter trips mainly because of their dependency on private vehicles, and the necessity of using private vehicles before or after work, as well as due to socio-economic factors. For example, having a number of trip chains before or after work daily (e.g. shopping, picking up children, and visiting friends). It would not be easy to encourage public transport use in such cases, as these trip-chains invisibly encourage them to use private vehicles more.

On the other hand, it is possible to shift others who rely on using private vehicles, although their travel behaviour is entrenched. These choices are partly formulated by their preferences, so if one can alter their range of choices through a much improved alternative service such as the MRT Three Rings and Three Lines, then this may alter their preference. Alternatively, if one can alter their choices by internalizing the external pollution costs into private vehicle use and/or increasing city-centre parking fees, perhaps forcing high income people to pay higher fees for using private vehicles, this may alter some private transport users' travel behaviour.

8.2.2 Discussion on the MRT Pilot Bus: a transitional transport policy measure

The discussion will now consider whether it is necessary to stop operating the MRT Pilot Bus after the MRT Three Rings and Three Lines is completely constructed. The second objective of this research was to understand whether the MRT Pilot Bus could be an effective policy measure in shifting car users/motorcyclists into MRT trip-takers.

The policy measure of the MRT Pilot Bus aims at reducing private vehicle usage prior to the completion of the MRT Three Rings and Three Lines Construction, and generating in private transport users the habit of using it during the period in which the MRT Three Rings and Three Lines is being constructed. Policymakers provided an attractive financial incentive to the public: travelling free on the MRT Pilot Buses during rush hour. This is helpful for encouraging potential users of the MRT Three Rings and Three Lines to gradually form the habit of using public transport.

It was found that passenger trips on the pilot buses for the Sanyin Line MRT, Ring Line MRT, Danhei Line MRT, Wanda and Sulin Line MRT, and Airport Line have all significantly increased compared to previous buses on similar lines (Transportation Department, 2014). Some people use the MRT Pilot bus because it is free, e.g. some car users without experience of using public transport may have taken advantage of using the MRT Pilot buses.

These findings are consistent with previous studies in which a free month travel card was sufficient to attract car users to use public transport and change their travel mode habits (Thøgersen, 2009b; Richter *et al.*, 2011). It is probable that changing the price structure has had a positive effect on numbers travelling by public transport (Litman, 2004). Also, a free ticket for the bus effectively interrupts habitual car use as a personal norm by reducing the personal commitment to it (Matthies et al., 2006). It is possible that the MRT Pilot Bus is effective at attracting private transport users in the short term.

Nevertheless, it could be argued that the financial incentives are not enough to change long-term travel behaviour, as passenger trips may be reduced after the free travel promotion ends or after the MRT Three Rings and Three Lines has operated for a few years. This finding is in line with a previous study in which a free bus ticket had a direct impact on reducing car use in favour of buses, but the effect was short lived (Beale and Bonsall, 2007). Commuting by public transport declined to the initial level after the promotion period, so the experience of using public transport did not encourage car users to change their evaluation of public transport and stop using cars (Møller and Thøgersen, 2008). Furthermore, buses and the MRT are different modes of public transport with different characteristics, so the users of these two modes generally belong to two different groups. The users travel and walk different distances, and can afford to spend different amounts on travel. After the MRT Three Rings and Three Lines is in operation, some people may keep using buses, as it is unlikely that all of those who used the MRT Pilot buses will convert to using the MRT Three Rings and Three Lines.Therefore, this suggests that the New Taipei City Government should use a prolonged MRT Pilot bus service to effectively attract more people to use the MRT Three Rings and Three Lines in the long term. This not only keeps people's options open, but it is also better to keep operating the MRT Pilot Buses as the bus network

can complement any insufficiency of the MRT. As such, it could effectively shift private transport users' trips into public transport trips in the long term.

8.2.3 Discussion on how environmental attitudes influence travel behavior

In order to shift public travel mode choices, apart from transport policies, it is necessary to find out whether environmental attitude influences public travel behaviour or not, which is the third objective of this research.

The findings of the survey showed that most commuters were aware of climate change, and they were conscious of environmental issues (as shown in Chapter 7). Nevertheless, more than ninety percent of car users and over seventy percent of motorcyclists did not think that travelling by car/motorbike influences climate change more than public transport. They have a clear understanding that climate change is affected by both nature and human activities, but their travel mode choices strongly rely on their work purposes or personal needs. The key findings showed that the residents of Xiufeng Village are not as environmentally aware as might have been expected, especially when it comes to their travel behaviour, and they put their own work or personal travel needs first; environmental issues are less important for them. Even if commuters are aware of climate change, they are less concerned with environmental issues. Therefore, they are less likely to choose sustainable transport modes as their main travel modes for commuter trips. The findings are consistent with previous studies that environmental knowledge does not directly affect people's travel mode choices, but it potentially slightly influences their behaviour (Kollmuss and Agyeman, 2002; Ogilvie et al., 2004; Ogilvie et al., 2007). Because people did not feel a prominent personal threat of the adverse impacts of climate change (Lorenzoni and Pidgeon, 2006; Lorenzoni *et al.*, 2007), they tended to be more concerned with other issues such as personal health, security, and finances (Defra, 2002). It is obvious that environmental attitude is not likely to affect commuters' travel behaviour. Even if the residents have high environmental knowledge, it does not influence their travel behaviour and make them more likely to shift modes of transport.

In view of that, it is suggested that a key priority for the government should be to think

about how to effectively raise the public environmental knowledge and shift their behaviour to become more environmentally friendly. Perhaps they should clearly let people know how big their carbon footprint is due to commuting and shopping trips. If people feel that environmental awareness matters to them, they may thus try to reduce their carbon footprint. In addition, campaigns could use the negative impacts of air pollution such as smog as an example of harm to people's health. People have first-hand experience of smog, so their environmental awareness could be easily raised. If they see the urgency of dealing with the problems of disasters such as global warming and rising sea levels, they are more likely to behave in an environmentally friendly way. This may be more effective at positively persuading the public to become more environmentally aware, and to modify their behaviour to be more environmentally friendly.

8.2.4 Discussion on the potential to achieve the target of 50% of all trips on public transport

The last objective of this research was to assess whether it is possible for policymakers to achieve 50% public transport usage for all trips by completing the MRT Three Rings and Three Lines Construction in 2030. Government officials thought this could primarily be achieved through the completion of the MRT Three Rings and Three Lines Construction. They have claimed that after the MRT Three Rings and Three Lines is completely constructed in 2030, they can achieve 50% of all trips in the New Taipei metropolitan district using public transport (Chapter 6). They believe it is the right transport policy priority for the public, because, firstly, the MRT Three Rings and Three Lines serves more than six million citizens who live in Taipei City, and New Taipei City, and it will make it easier for them to travel between these two cities and between the districts of New Taipei City. Existing metro commuters may benefit from shorter journeys because of new links or a better MRT service. Moreover, some Taipei metropolitan commuters not currently using the metro could potentially shift to it if journey times become shorter and easier. Thus, a considerable number of commuters could effectively shorten their travel time and easily manage their daily commute using the MRT.

Secondly, the MRT Three Rings and Three Lines will be essential in serving the residents of Taipei City, New Taipei City and Taoyuan City, and local economic and

industrial development and investment will keep increasing in these cities. It also effectively enhances all local development and boosts the prosperity of urban as well as rural areas (Yih-Shun, 2011). Thirdly, the MRT system is a low carbon railway transport system which runs on electricity, so it contributes less to air and noise pollution than private vehicles. Also, the MRT system alleviates the likelihood of traffic flow problems because the tracks of the MRT are either underground or elevated. After the MRT Three Rings and Three Lines are constructed, the MRT network will be more complete, and people may feel it is more convenient for travel in the Taipei metropolitan area. As chapter 6 concluded, the MRT Three Rings and Three Lines Construction may be partially effective at switching private transport users away from using cars/motorbikes to using the metro in the future.

Nevertheless, it could be argued that the New Taipei City Government is not likely to achieve the 50% target using only the MRT Three Rings and Three Lines Construction, because they have not provided a complete public transport system to the public that connects with bus lines and YouBike paths. Based on current transport policy directions, the public may not feel that travel by public transport is more convenient than using private vehicles.

Furthermore, other transport initiatives could be better implemented to complement the MRT Three Rings and Three Lines. The findings of Section 7.5 showed that over half of private transport users would like to use the parking at Nanshijiao MRT Station, but more than half of them were not aware of the parking discounts. If private transport users were made aware of it, some would be likely to use the parking and then take the metro to commute to work. Most importantly, it may not be adequate to use pull measures in order to change most private transport users' travel behaviour, so push measures such as increasing city-centre parking fees should be implemented at the same time. There is potential there to increase opportunities for shifting the private transport users' travel behaviour.

There is a wealth of documented evidence that a combined push-pull package is able to cope with some of the drawbacks of individual initiatives (Vlek, 2007; Eriksson *et al.*, 2008a; Richter *et al.*, 2009). Pull initiatives here are improvement of the MRT network, and the efficiency of bus operations, while push initiatives

could increase parking fees and charge congestion fees to force private transport users from cars/and motorbikes. Pull initiatives are likely to be more effective if they are integrated, reflect each other, and are developed in line with each other, so the metro without the bus connections undermines the effectiveness of both initiatives. Furthermore, push initiatives e.g. increasing city-centre parking fees and charging congestion fees, are necessary to force people to rethink their travel mode choices. Using both not only strengthens the motivation of car users to reduce their car use, but also contributes to the physical travel context by encouraging sustainable travel behaviour (Gärling *et al.*, 2002b; Eriksson *et al.*, 2010). Notably, the government's legitimate policy to improve the municipality's road network and maintain the existing road system arguably further subsidizes car and motorbike use, by invisibly encouraging private transport users to continue to use their cars and motorbikes, rather than challenging that choice.

It is clear that the MRT Three Rings and Three Lines is the right priority for the public, and also an indispensable measure for New Taipei City, because it services the residents who live in the Taipei metropolitan area, and boosts local economic and industrial development. Nevertheless, it is suggested that the New Taipei City Government should integrate public transport systems, such as linking the MRT Three Rings and Three Lines with bus services or YouBike paths, because the bus lines and YouBike paths cover wider areas while the MRT is only at certain points. The government needs to enhance access and connectivity of the MRT and integrate bus networks to encourage commuters to use public transport modes. Furthermore, if the government clearly let the public know about the provisions of parking discounts at MRT Stations, more private transport users are likely to use the parking spaces. This will result in an increased likelihood of getting people to shift from using cars/motorbikes onto the metro.

The majority of Global South countries tend to be reliant on the shift element within the ASI framework, and most of them have focused on using pull initiatives to increase public transport use; this research demonstrated that in New Taipei City, policymakers primarily focus on using the MRT system (pull initiative) over other public transport investments to achieve the target of public transport use, but they have not implemented any policies to discourage private transport use. This is not adequate to change people's

travel behaviour, and reduce private transport use. Push initiatives including internalizing the external costs of private transport use (e.g. environmental taxes, the costs of infrastructure, congestion costs, and accident costs), and parking fees are necessary to force people to rethink their travel mode choices. Even if this tends to be politically unfeasible and lacks public acceptance at this moment in New Taipei City, it reflects a more realistic cost of provision. In this case, it is suggested that policymakers should broaden use of their budgets to spend on integration of public transport systems.

The ASI framework would be helpful for the New Taipei City Government to evaluate transport initiatives critically, and identify those possibilities that are likely to reduce the negative environmental impacts of transport in the city. Also, it is a useful analytical tool for the government to reflect on the effectiveness of these transport initiatives, even when not used in its entirety. This could make them more likely to achieve success in relation to shifting a significant number of private transport users onto public transport and achieving a more sustainable transport system in New Taipei City. Given New Taipei City as an example, it is suggested that other similar types of global south cities need to consider the wider ASI framework when designing transport policies to tackle the effects of transport on climate change, and achieve sustainable transport development.

8.3 Discussion of the contribution to knowledge

This research has analyzed commuter travel behaviour, and policymakers' and experts' opinions on transport initiatives in Taiwan. In this way, it is original in having analyzed the topic from a multidimensional perspective, including views from university academics specializing in transport issues, environmental activists, and experts from identified transport consultancies. These groups were asked to comment on transport initiatives, namely the MRT Three Rings and Three Lines Construction, the MRT Pilot Bus, and the promotion of commuter environmental knowledge. It is suggested that the findings are applied to transport policies in New Taipei City, as they show a clear understanding of commuters' travel purposes and needs, as well as how transport initiatives can be improved to change travel behaviour. Thus, the contributions of the research mainly fall into four areas as follows:

Firstly, there is limited academic research and related governmental publications discussing the transport initiatives of the MRT Three Rings and Three Lines Construction, and the MRT Pilot Bus, because they are recent public transport provisions beginning in the last ten years. The central and New Taipei City Governments have invested vast funding and other resources in this significant transport infrastructure project. For this reason, it is necessary to evaluate how effective these transport initiatives have been, and will be, at reducing motorized vehicle use, and at achieving a rate of 50% of all trips using any public travel mode (New Taipei City Government, 2010). This research looks at the provision side, and demand side. The provision side was to gather thoughts and opinions from experts in different fields (e.g. experts from identified transport consultancies, environmental activists, and university academics specializing in transport issues) regarding the transport initiatives of the MRT Three Rings and Three Lines Construction, and the MRT Pilot Bus, in addition to policymakers' perspectives on implementing these initiatives. Furthermore, university academics specializing in transport issues, who know Taipei and New Taipei City initiatives very well, were able to give an insightful critique of what was happening in relation to the research objectives relating to transport, the environment, and commuter travel behaviour, being aware of the literature as well as the locality and initiatives. Also, environmental activists and experts from identified transport consultancies gave alternative practice-related perspectives on what the government officers were arguing for, and implementing. By interviewing these policymakers and experts in transport and environmental fields, a multidimensional perspective was gained from which to develop a critique and evaluation of the policy. It was the academic experts who offered a different and original dimension to the research. This is helpful for policymakers, and instructive to academics, as an example of how considerable funding sums can be spent.

The demand side used the commuter surveys to reveal a deeper picture of their travel behaviour, and their thoughts on transport initiatives and climate change issues. The primary findings of the survey showed that car and motorbike users' main reasons for using private vehicles comprised of their dependency on using said private vehicles, work-related purposes (e.g. job responsibilities and position), and socio-economic factors (Chapter 7). Furthermore, the survey findings showed that over ninety percent of car commuters and over seventy percent of motorcyclists did not think that travelling by private transport (car/motorcycle) affected climate change

more than public transport (metro/bus). However, it is possible that they are clear that climate change is affected by both nature and human activities, but they put their needs first over environmental concerns. This finding is consistent with previous studies that people tend to focus on other issues such as personal health, security and financial concerns, and they do not see the urgency of addressing the problems of climate change (Bord et al., 2000; Poortinga and Pidgeon, 2003; Norton and Leaman, 2004). They are less likely to act in an environmentally friendly way (Lorenzoni and Pidgeon, 2006; Lorenzoni *et al.*, 2007).

Clearly, the findings and discussion presented in this research have highlighted the practical implications of commuter transport choices, and their opinions regarding transport initiatives and climate change issues. It would be helpful for the New Taipei City Government to understand commuter travel behaviour in more detail so that they can adjust their initiatives based on these results, to increase public transport use effectively.

Secondly, changing commuters' travel behaviour is difficult, because they have a number of fixed trips, as well as more trip chains for non-work activities. This research used a rapidly expanding city - New Taipei City - as a typical example of global south cities, to examine whether the money invested by the central and New Taipei City Governments in the MRT Three Rings and Three Lines Construction will be sufficient to get commuters to switch from car/motorbikes to public transport or not. The findings showed that shift policies of pull initiatives are not effective in increasing public transport use and switching travel behaviour without integrating push initiatives. These findings are in line with previous studies which found that pull and push initiatives have different impacts on different target groups, and are variously effective at changing travel behaviour (Richter *et al.*, 2009). Both not only strengthen the motivation of car users to get rid of using cars, but also encourage their use of sustainable transport modes (Gärling *et al.*, 2002b; Eriksson *et al.*, 2010). Thus, the research demonstrated that the initiative of the MRT Three Rings and Three Lines is costly but not very effective at changing travel behaviour without using push policies.

Thirdly, a practical contribution of the research is also to use the shift element of the ASI framework to critically evaluate transport initiatives implemented in unison.

The findings of the study showed that pull initiatives like the MRT Three Rings and Three Lines Construction and the MRT Pilot Bus are partially effective at changing behaviour. In addition, it is argued that push initiatives are unpopular but they are likely to prove necessary. The government should simultaneously implement these to control private transport use in New Taipei City, e.g. increase parking fees, and in so doing push car and motorbike users onto the MRT system. Using a combination of pull and push initiatives may be a more balanced approach to changing behaviour in relation to trip choice, which must be practised to implement sustainable transport interventions. Furthermore, the ASI framework could provide some guiding principles for such changes, which is a useful analytical tool for the New Taipei City Government, not only to be able to review transport initiatives regarding pull (incentive), and push (disincentive) initiatives in New Taipei City, but also to be able to reflect their effectiveness in increasing public transport use. As such, it provides a guide to help them identify possibilities for transport initiatives which are likely to reduce the negative environmental impacts of transport in the Taipei metropolitan area, and can provide some guiding principles for such changes. Also, the ASI framework could become a critical policy framework that could guide the sustainable development of transport either in one city or country or across a range of countries, and could assist policymakers to make better decisions.

Finally, but perhaps most importantly, an academic contribution of the research is that the broader ASI framework can be helpful for modal shifting to achieve more sustainable transport, even when applied to very different cases. This research set up a useful example to identify the possibilities that are likely to reduce the negative environmental impacts of transport. It has deeply reflected on the effectiveness of transport initiatives (including pull, and push policies) within the shift element of the ASI framework in New Taipei City (Chapter 6) by gaining multidimensional viewpoints from academics and experts in transport and environmental related fields.

8.4   Suggestions for future research

A number of tasks can be identified with respect to future study. At the top level, it would be useful to carry out a study of a representative sample to test/substantiate the study framework developed and establish the degree to which the findings outlined above are applicable to other private transport users (car users and motorcyclists) and public transport users (metro and bus users). This could take the form of a questionnaire, focusing on the key findings noted above. This section provides four suggestions for further study, primarily to develop the findings presented in this chapter, but also to counteract some of the study's limitations.

This research could have explored in more detail the infrastructure-led approach, which aims to encourage switching behaviour away from private transport. Whilst this research has been insightful in critically evaluating this policy, there are areas which could have been explored in more detail. We need to understand commuter preferences better through deeper qualitative work, such as travel diaries for other trips in New Taipei City or other similar global south cities. A travel diary is a common approach used in exploring travel behaviour in urban case studies, because it is able to efficiently collect rich data on travel behaviour, including relevant details of a person or household, such as non-home activity and trip purposes by all travel modes in one or more days (Barnard, 1986; Axhausen, 1994). It is thus an appropriate approach to explore travel behaviour in depth at a city-wide level. It is suggested that future research could be focused on using travel diaries to explore private transport commuters' travel behaviour in more detail, including travel purposes and trip chains in leisure trips, in order to understand their mobility or immobility for leisure trips further as a social practice.

In addition, further study is needed to investigate other urban areas, either similar (to compare and justify results) or dissimilar (to contrast findings) in nature to New Taipei City. This could include further population samples in New Taipei City, modelled from the He Ping Shin Jiun community survey data set, in order to make comparisons against other population segments in New Taipei City and other global south cities, particularly those with similar demographics, fast growing, with high levels of motorcycle use.

Thirdly, further research could focus on different research objectives, including various travel mode choices for other trips, because the focus of this research on commuter travel behaviour using private transport (cars and motorbikes) and public transport (the metro and buses) (Chapter 7) may have been too narrow. Non-motorized transport must also be considered. Hence, it is recommended that a future study could be extended to cover a wider travel mode choice context, such as cycling, other trips like non-commuting trips (shopping, and business trips) or off-peak times, in order to clearly understand private transport users' travel behaviour. This would be helpful for policymakers to understand the complete situation of private vehicle use, and find effective ways to reduce it.

As the MRT Three Rings and Three Lines Construction has not been completed, a future study could assess whether policymakers have achieved the long term target of public transport usage (50%), specifically whether take-up of the MRT Three Rings and Three Lines Construction has been successful at switching private transport users to public transport. In this sense, further research is also needed to examine what happens when the MRT Pilot Bus stops operating, to consider whether bus trip-takers have been converted into MRT trip-takers or not. Therefore, it is suggested that a further study could focus on discussing public and expert opinions regarding transport policies on a more widespread basis for the crucial evaluation of the related transport infrastructures/ policies, at a time when the full impact of the Three Rings and Three Lines Construction can be seen.

Finally, so far most studies have generally described the ASI framework as having the potential to reduce the negative impacts of motorized vehicle use in many countries (Dalkmann and Huizenga, 2010; Enkhbayar, 2011; Zuidgeest et al., 2012; Hanaoka, 2013; Bakker et al., 2014), but they have not provided an in-depth discussion of how the ASI framework could be implemented. Many global south cities tend to rely on infrastructure-led approaches, but these substantial incentives are not sufficient to increase public transport use as well as get people to switch from private vehicles to public transport. Because few governments have carried out an analysis of transport initiatives using such an analytical framework, or even using an individual element within this framework (Huizenga and Leather, 2012), it is suggested that future research could use the broader ASI approach, because it

brings about more synergistic and integrated policies to increase public transport use in global south and European countries.

To sum up, although there is still much work to be done to improve transport initiatives, e.g. pull and push initiatives, to achieve success in shifting private users to public transport, the research detailed in this thesis has contributed to this work, by analyzing commuter travel mode choices, and by utilizing academic as well as expert insights regarding transport policy implications and the issues arising from them. In this sense, it represents an interesting critical evaluation of New Taipei City's transport initiatives, with the stated goal of increasing public transport use.

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Appendices

Appendix A: Policymakers' interview design

Policymakers' interview

(Warm up: Introduce myself first then ask the interviewees about their responsibilities.)

The purpose of the interview is:

- to understand the existing transport policy/provision, and how these policies are effective in switching commuters' travel behaviour from using private transport to using public transport;
- to find out policymakers' understanding and reaction to commuters' environmental knowledge as well as travel behaviour, and how this understanding influenced policy;
- to discuss the difference between commuters' needs for transport initiatives and the directions of the existing transport policy.

In order to reach the aims of interview, the interview design is thus classified into the three types of transport policy, namely Improved Network and Stations, MRT pilot buses, and Sustainable Transport.

All the information of interviews will be kept confidential and used solely for research purposes.

Type	Issues
Improved Network and Stations	In 2010 Mayor election, the Mayer of New Taipei City – Mr. Zhu claimed 'Mass Rapid Transit (MRT) Three Rings and Three Lines Construction' will be finished construction in 2030 and that will reach the demand of Taipei metropolitan transport, reduce travel time in trips, balance regional development and implement sustainable transport development. - What is happening on 'MRT Three Rings and Three Lines construction'? - What is the main rationale for this project of investment (e.g. economic aspect, social aspect, environmental aspect)? - How does it fit into wider city transport schemes/ other relevant schemes? - Have the government assessed commuter needs/ want before constructing' MRT Three Rings and Three Lines construction'? - If yes, what were the main points that came out of that consultation? Can you please provide the publication to me? - If no, how do you know about commuter needs/ want when it will be constructed? However, the study shows that some commuters think that the government should spend funding on the road maintenance and consider the surroundings of local conditions (e.g. the width of lane) as a first priority, and the improvements of facilities and services of public transport are the second priority. The respondents think that everyone can benefit from the road maintenance, while if the government focus on improving the facilities and services of public transport, only public transport users can benefit from that. - Do you feel this scheme is matching the priority of commuters? Why or why not?
The MRT Pilot Bus	Before the completed construction of MRT Three Rings and Three Lines, the New Taipei City Government is promoting the provision of 'MRT pilot buses' in order to change the travel habits of passengers. MRT pilot buses are the mode of electric buses, low chassis buses and hybrid electric plus low chassis buses. What is happening on the measure of " MRT pilot buses"? Are there any statistics or official publications? Can you please provide these?

	• What is the main rationale for this project of investment (e.g. economic aspect, social aspect, environmental aspect)? • How does it fit into wider city transport schemes/ other relevant schemes? • Does the New Taipei City Government plan to upgrade current buses to become electric buses, low-chassis buses and hybrid electric plus low-chassis buses?
Green Transport	The aim of the New Taipei City Government is to build a low-carbon city, so they actively promote four strategies, namely 'Energy saving', 'Green transport', 'Source recycling' and 'Low-carbon life'. In terms of the strategy of "Green transport", the government has four action schemes, including increasing the usage of public transport, the push car-pool system, encouraging people to cycle, walking and low- pollution transport modes. • What is happening on the measure of 'Green transport'? Are there any statistics or official publications? Can you please provide these? • What is the main rationale for this project of investment (e.g. economic aspect, social aspect, environmental aspect)? However, the findings of the study show that 91.7% of car commuters and 77.6% of motorcyclists do not think that travelling by the private transport (car/motorcycle) affects climate change more than public transport (metro/bus), while 90.6% of the metro users and 93% of bus users think that the usage of private transport affects climate change more than the usage of public transport. • How do you attempt to change commuters' misconception that travelling by private transport affects climate change more than public transport? • How does the government make sure that people correctly acquire the concepts from them in the future?

Overall, do you have anything else to say?

Are there any suggestions for this interview? Can you suggest other people for me to interview?

Appendix B: Experts' interview design

Experts' interview

(Warm up: Introduce myself first then talk about the purpose of the interview.)
The purpose of the interview is:

- to understand the expert insights into why New Taipei government implemented the MRT Three Rings and Three Lines construction, and switching private transport users from using cars/motorcycles to using public transport, and to achieve the long term target of transport;
- to understand expert thoughts on how the government can effectively raise public environmental knowledge to increase public transport usage.
- to understand expert opinions on how bus transport policiescould effectively attract private transport users to go by bus.

In order to reach the aims of the interview, the interview design is classified into the three types of transport policy, namely the MRT Three Rings and Three Lines construction, the measure of the bus, and raising commuters' environmental knowledge.

All the information from the interviews is confidential and used solely for research purposes.

Type	Issues

The MRT Three Rings and Three Lines Construction	According to government statistics from 2013, public transport usage was 32%, while private transport usage was 61% in New Taipei City. The long term target is to achieve 50% of public transport usage in 2030, so the New Taipei City Government implemented the measure of the MRT Three Rings and Three Lines construction which is aimed at encouraging the public to travel by public transport and decreasing the usage of private transport in Taipei City and New Taipei City. It was designed to connect with the existing MRT lines in Taipei City, which strengthens the role of New Taipei City in the Taipei metropolitan.
	    ● Are you aware of the MRT Three Rings and Three Lines construction? What do you think about it?
	    ● What is your point of view about New Taipei government switching private transport usage to public transport though completing the MRT Three Rings and Three Lines construction? Why?
	    ● If the MRT Three Rings and Three Lines system is constructed, do you think the New Taipei government can fulfill the long term target – 50% of public transport usage? Why?
	    ● If the MRT Three Rings and Three Lines construction is not constructed, what do you think the public travel mode choices will be? Why?
	    ● Do you think the MRT Three Rings and Three Lines construction is the right priority for transport policy? Why?
	My survey findings showed that it is difficult to switch private transport users to using public transport because of their personal purposes as well as work needs, which are the main motivations for using private vehicles.
	    ● What do you think about it? Why?

The MRT Pilot Bus	The MRT Pilot Bus which started operating in 2011 aimed at shifting the private transport users from car/ motorcycle towards using buses from before the MRT Three Rings and Three Lines was completely constructed. In order to generate a public habit for using buses, and to convince them that the MRT Three Rings and Three Lines will effectively attract more people go by MRT, the New Taipei City Government implemented it, i.e. the MRT Pilot Bus following the route of the MRT Three Rings and Three Lines construction. They provide a free bus service

	to the public at rush hour (am 6:00-7:00, pm 5:00-6:00), which is a financial incentive to encourage people to take the MRT Pilot Bus. According to the statistics provided by the Transportation Department of the New Taipei City Government , the number of passenger trips of the Sanyin Line MRT Pilot Bus, the Ring Line MRT Pilot Bus, the Danhei Line MRT Pilot Bus, the Wanda and Sulin Line MRT Pilot Bus and Airport Line MRT Pilot Bus were all significantly increased. For example, Wanda and Sulin Line MRT Pilot Bus started operation on 31st, December 2013. There were around 72,585 passengers per month in 2014, compared to the initial operation it has increased by 155%. Airport Line MRT Pilot Bus started operation on 24th, October 2014. There were around 49,114 passengers per month in 2014. ● Are you aware of the MRT Pilot bus? What do you think about it? ● Do you think the financial incentive is effective to encourage people to use the MRT Pilot Bus? ● When the MRT Pilot buses stop operating, do you think bus trip-takers will keep using buses? Why? ● Do you think car users/ motorcyclists will shift into MRT trip-takers after the MRT Three Rings and Three Lines construction is completely constructed? Why? ● What do you think about an effective measure for attracting private transport users to use buses? Why?
Promoting the public's environmental knowledge	New Taipei City Government is focus on promoting environmental knowledge to the public by using social media accounts, internet propaganda, blogs, and television/ movie advertisements, campaigns, environmental education, and activities in order to make them aware of environmental issues. However, in my study, the survey findings showed that 91.7% of car commuters and 77.6% of motorcyclists do not think that travelling by the private transport (car/motorcycle) affects climate change more than public transport (metro/bus), while 90.6% of the metro users and 93% of bus users think that the usage of private transport affects climate change more than the usage of public transport. ● Do you think environmental knowledge influences travel behaviour? Why? ● What is your point of view about whether people who are environmentally aware will stop using private vehicles? Why?

Overall, do you have anything else to say?

Are there any suggestions for this interview? Can you suggest to me other people to interview?

Questionnaire

No. _____

> Dear residents,
>
> This purpose of this survey is to investigate commuters' mode of travel choices behaviour in commuter trips as well as their thought of shifting from using cars/motorcycles to the public transportation in the future. Please note that there are no right or wrong answers in this survey. All the information will be kept confidential and used solely for research purposes. If you have any questions for this survey, you are welcome to e-mail to *y.c.lin@newcastle.ac.uk.* Thank you for your help.
>
> Name of Organization: University of Newcastle, UK
>
> Name of investigator: Yi-Chun Lin

Part I: Commuters' mode of transport choice behaviour for work trips

Q1. Do you have a car / motorcycle licence?
   1. Car licence：□ Yes□ No 2. Motorcycle licence：□ Yes□ No

Q2. The distance between **your house and work location**:
   1. □Under 1 Km 2. □2~5 Km 3. □6~10 Km 4. □11~20 Km 5. □ Over 21 Km

Q3. How many days a week, do you travel to work by the following modes of transport?
The modes of transport：□ Car, how many days a week? □1 □2 □3 □4 □5 □6□7
   □ Motorcycle, how many days a week? □1 □2 □3 □4 □5 □6 □7
   □ The metro, how many days a week?   □1 □2 □3 □4 □5 □6 □7
   □ Bus, how many days a week? □1 □2 □3 □4 □5 □6 □7
   □Other_____, how many days a week? □1 □2 □3 □4 □5 □6 □7
   □Work at home

Q4. Can you commute by car/ motorcycle?
*If you never travel to work by car/motorcycle, you can skip this question.

	Car	**Motorcycle**
How long does it / would it take you travel to work? (Walking to a car park is included.)	_____ Minutes	_____ Minutes
What is the size of your vehicle/ motorcycle's engine	_____ c.c.	_____ c.c.

What is your car/motorcycle parking fee per month? **(If you do not need to pay for it, please fill in 0.)**	_____ NTD/month	_____ NTD/month

Q5.If you travel at all to work by car/motorcycle, why do you travel to work by car/motorcycle? **(Multiple responses allowed)**

□ Never travel to work by car/motorcycle– Go on to **Q6**

    1. □ Car/ motorcycle is convenient to work place

    2. □ Car/ motorcycle is needed before or after work

    3. □ Car/ motorcycle is needed to drop off/pick up others

    4. □ Car/ motorcycle is used without time limitation

    5. □ Other (please specify)_____

Q6. Please answer the questions about the metro/bus that you can travel to work as below **(Train is not considered in this question)**:
  *If you never take the metro/bus to work place, you can go to Part II.

	Bus stop	**The metro station**
The nearest distance between **public transport** and **your house**	1.□Under 100 metres 2.□101~300 metres 3.□301~500 metres 4.□Over 501 metres	1.□ Under 500 metres 2.□501~1000 metres 3.□1001~2000 metres 4.□Over 2001 metres
The nearest distance between **public transport** and **your work location**	1.□ Under 100 metres 2.□101~300 metres 3.□301~500 metres 4.□Over 501 metres	1.□ Under 500 metres 2.□501~1000 metres 3.□1001~2000 metres 4.□ Over 2001 metres

Part II: Commuters' service satisfaction with public transport

The aim of this part is to understand your satisfaction with the metro/bus. If you are very satisfied with the service, you can circle 5 point; if you are not very satisfied with the service, you can circle 1 point.
*Please fill in this part even if you have only experiences travel by the metro/bus occasionally. If not, you can go to part III.

How satisfied are you with the following?	The metro					Bus				
	Very satisfied	Satisfied	Neutral	Not satisfied	Not very satisfied	Very satisfied	Satisfied	Neutral	Not satisfied	Not very satisfied
Punctuality	5	4	3	2	1	5	4	3	2	1
Comfort of the seat in the metro/bus.	5	4	3	2	1	5	4	3	2	1
The cleanliness of the metro/ bus.	5	4	3	2	1	5	4	3	2	1
Safety of getting on and off the metro / bus.	5	4	3	2	1	5	4	3	2	1
Safety – when you are waiting in the metro station / bus stop.	5	4	3	2	1	5	4	3	2	1
Stability – when the metro/ bus is moving.	5	4	3	2	1	5	4	3	2	1
The clarity of the information service in the metro/bus.	5	4	3	2	1	5	4	3	2	1
The metro station staff's attitude/ bus drivers' attitude Is good.	5	4	3	2	1	5	4	3	2	1
The metro station staff/ bus driver is well-dressed.	5	4	3	2	1	5	4	3	2	1
Other_____	5	4	3	2	1	5	4	3	2	1

Q7. If you travel at all to work by metro/bus, why do you travel to work by the metro/ bus? **(Multiple responses allowed)**

□ Never travel to work by metro/bus – Go on to **Part III**

    1. □ The metro/bus goes where I go close enough

    2. □The metro/bus is frequent enough

    3. □The metro/bus is eco-friendly

    4. □The metro/bus fare is cheap

    5. □Other (please specify)_____

Part III: The reason why commuters do not take public transport

The aim of this part is to understand the reasons why you might be put off using public transport. If you strongly agree with the reason why you might be put off using public transport, you can circle 5 points; if you strongly disagree with the reason, you can circle 1 point.

*Please fill in this part even if you only have experience of travel by the metro/bus. If you travel by the metro/bus currently, please fill in this part. If you do not have any experience of travelling by the metro/bus, please go on to Part IV.

How do you think about the following in your choice to take car/ motorcycle to work?					
Points \ Rationale	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. The metro/bus is often late.	5	4	3	2	1
2. The seat of the metro / bus is uncomfortable.	5	4	3	2	1
3. It is unclean of the metro/ bus.	5	4	3	2	1
4. It is unsafe when getting on and off the metro / bus.	5	4	3	2	1
5. It is unsafe when you wait in the metro station / bus stop.	5	4	3	2	1
6. It is unstable when the metro/ bus moves.	5	4	3	2	1
7. The information service of the metro/ bus is unclear.	5	4	3	2	1
8. The metro station staff's attitude/ bus drivers' attitude is not good.	5	4	3	2	1
9. The metro station staff/ bus driver is not well-dressed.	5	4	3	2	1
10. Costs of the bus/metro tickets are too high	5	4	3	2	1
11. I have problems parking near the bus stop / metro station	5	4	3	2	1
12. The bus stop / metro station is too far from my home	5	4	3	2	1
13. Other_____	5	4	3	2	1

Part IV: Commuters' attitude towards climate change

Q8. Have you heard about climate change?
1.□ Yes 2. □ No

Q9. Which of the following best indicates your opinion regarding climate change?
1. □ I believe, I think it is caused purely by human activities.
2. □ I believe, I think it is purely a natural occurrence.
3. □I believe, I think it is caused by both of them.
4. □I do not believe that climate change has happened.

Q10. Should the government introduce policies to try to reduce our impact on climate change?
1.□ Yes 2. □ No, please specify the reason _____

Q11. Do you feel that travelling by car/motorcycle instead of by metro/bus affects climate change?
1.□ Yes 2. □ No, please specify the reason _____

Part V: Commuters' understanding of transport policies

Taipei City Government is committed to raising the public transit usage and has adopted a number of policies/initiatives to facilitate this. This section explores your awareness and take-up of these initiatives.

Policy 1: Parking Provision at Metro Stations

To provide seamless transfers at the connections between transit systems, TRTC has provided parking spaces near some metro stations. By May of 2011, this provision offered: 3,801 car parking spaces, 10,194 motorcycle parking spaces, and 12,685 bike parking spaces. At MRT Nanshaijiao Station, 340 car parking spaces have been provided, with car parking fees and discounts as follows:
Weekdays: 6:00 – 24:00, NTD 30 / hour
Holiday: 6:00 – 24:00, NTD 40 / hour
Night: 1:00 –6:00 pm, NTD 10 / hour

In addition, there are several discounts for car parking fees. Firstly, if you use an Easy Card travelling one way on the metro then you can have NTD 5 discount an hour for car parking fees. Secondly, TRTC provides 145 monthly permits, which cost NTD 3500; 100 bi-monthly permits are provided, which cost NTD 7000; 15 limited time monthly permits are provided, which cost NTD 2000.

Q12. If you travel to work by car then Metro, do you use these spaces?

1.□ Yes

2. □ No, please specify the reason _____

Q13. The parking becomes cheaper if you park for longer (to encourage commuter parking).
Were you aware of this discount?
1. □ Yes, if yes How did you know?
    □Sign in car park 2. □Friends3. □Email 4. □Newspaper 5. □Other(please specify) _____

2. □ No, please specify the reason _____

Q14. If you park in the metro station when you commute to work do you use this discount?
1. □ Yes 2. □ No , please specify the reason _____

Q15. Would improving the parking provision near the metro stations encourage you to use the metro more to travel to work?
1. □ Yes, please specify the reason_____
2. □ No, why not? Please specify _____
3. □ Maybe, please specify the reason _____

Policy 2: Discounted Travel Permits

The TRTC Easy Card provides a discount for passengers travelling one way and changing their mode of transport (between bus and metro). It is valid for an hour from when it is first activated. For example, if you are an adult, you take the metro then transfer to the bus. You only need to pay the reduced price of NTD 8 bus ticket + the metro ticket.

Q16. Were you aware of this card?

1. □ Yes, if yes how did you know about it?
    1.□ Sign in the metro station 2. □Friends3. □Email 4. □ Newspaper 5.

□Other(please specify) _____
    2. □No

Q17. Have you heard about the discount travelling one way between the metro and bus?

1. □ Yes, if yes do you use this discount when you travel to work?

    1. □ Yes 2. □ No , please specify the reason _____

2. □ No, if no, do the discounted travel permits encourage you to travel to work more on the bus and/or metro?

    1. □ Yes, please specify the reason _____

    2. □ No, why not? Please specify _____

    3. □ Maybe, please specify the reason _____

Policy 3: Improvements to Bus Vehicles (Buses and Metro rolling stock)
To increase the accessibility of vehicles to passengers, the Taipei Passenger Transport Company are introducing new buses in Zhonghe District. These are low-chassis buses, touch activated, with wider doors to make the buses more accessible for all ages. These vehicle up-grades have already occurred on the Orange 2 and Orange 5 routes.

Q18. Were you aware that the buses were being improved?

1. □ Yes, if yes how did you know about it?
    1.□ The metro station 2. □Friends3. □Email 4. □ Newspaper 5. □Other (please specify) _____
    2.□ No

Q19. Have you used one of these buses?
1.□ Yes, if yes do you think the low-chassis bus is more convenient than traditional bus?
    1. □ Yes 2. □ No , please specify the reason _____
    2.□ No, please specify the reason _____

Q20. If the government improves the facilities of bus in the future, please list your priority as the following options. The most important is 1; the least important is 3.

( ) All buses will be improved into low-chassis buses

( ) The discount of travelling one way for bus-to-bus transfer

( ) To increase the frequency of buses

Policy 4: Improved Network and Stations
New Taipei City Government is actively building 'The Mass Rapid Transit (MRT) Three Rings and Three Lines Network', because the satellite towns do not have an inter-linked MRT network. The first Loop Line of MRT system (the first stage) is being built and is expected to be completed in December 31, 2015. The nearest metro station on this new route for local residents who live in Xiufeng village is Xioulang Bridge station. In the future, it will provide more convenient and easier transport systems for local people.

Q21. Were you aware of this information?

1. □ Yes, if yes how did you know about it?

1.□The metro station 2. □Friends 3. □Email 4. □ Newspaper 5. □Other (please specify) ____

    2. □No

2. □ No

Q22. Will having this new network make you more likely to take the metro in the future to travel to work?

1. □ Yes, please specify the reason _____

2. □ No, why not? Please specify _____

3. □ Maybe, please specify the reason _____

Q23. If you had a chance to give advice to the transportation department, the New Taipei City Government , what advice would you give?

_____

_____

Part VI: General Information

Q24. Gender: 1. □ Male 2.□ Female

Q25. Age: 1. □Under 20 years   2. □ 20~29years   3. □30~39years
4.□ 40~49years   5. □ 50~59years   6. □More than 60 years

Q26. Education level (The highest education qualifications):
1. □ Educated to primary school level
2. □ Educated to junior high school level
3. □ Educated to senior high school level
4. □ Educated to undergraduate level
5. □ Educated to postgraduate level and above

Q27. Occupation:
1. □ High managerial, administrative, or professional
2. □ Intermediate managerial, administrative, or professional
3. □ Supervisory, clerical and junior managerial, administrative, or professional
4. □ Skilled manual workers
5. □ Semi and unskilled manual workers
6. □ State pensioners, casual or lowest grade workers, unemployed with state benefits only
7. □ Other (please specify) _____

Q28. Income (Total personal income per month)**:**
1. □ Under NTD19,000   2. □ NTD19,000~29,000   3. □ NTD29,001~39,000
4. □ NTD39,001~49,000   5. □ NTD49,001~59,000   6. □ NTD59,001~69,000
7. □ Over NTD69,000

Thank you for taking the time to complete this questionnaire!

*If you complete the questionnaire, please hand in it to the leader of village, and

I will collect it from him within three days.