DOCTORAL DISSERTATION
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A STUDY IN INTEGRATING PARATRANSIT AS A FEEDER INTO MASS TRANSIT SYSTEMS IN DEVELOPING COUNTRIES: A STUDY IN BANGKOK

途上国における都市鉄道のフィーダーシステムとしてのパラトランジットに関する研究
－バンコクを対象として－

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by

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ABSTRACT

In many megacities of developing countries, at present, several plans of mass transit network expansion linking with suburban areas are under process; however, to provide excessive network is financially infeasible. This has resulted in difficulty of accessing mass transit stations – one of mass transit planning issues – especially in short to intermediate distances from the stations. To solve this problem, it might not be effective to directly apply approaches experienced by developed countries because of differences in characteristics of cities between the developing countries and the developed countries especially urban structures and people preferences. Poor road network and land use development in urban areas of developing cities caused difficulties in providing adequate public transport services. Moreover, transitional economies and development of megacities of developing countries inevitably differ greatly in economic, demographic characteristics and income that have induced varieties of people. These variations brought about various needs of commuting and perceptions and attitudes towards transport modes. According to the growth of motorization and public transit deficiency, people in urban areas are discouraged to use public transport. Private vehicles - car and motorcycle - have become preferable modes to those who can afford, notwithstanding the fact that mass transits have been implemented. It is because private car offers convenience and door-to-door function which have been considered much advantageous over mass transit and public transport. Currently, paratransit emerges as one of transportation modes and gradually becomes an outperforming mode in connecting people between their residences and public transport specifically in areas left by public transport. Paratransit continues its dominant function as a feeder in several megacities of the developing countries due to their services satisfying captive riders in terms of mobility and door-to-door services. It is because of the advantages of vehicle size and unrestrained operation that make paratransit response to fluctuating demand. In addition, a combination of paratransit as a feeder and public transports becomes one of typical travel choices for commuters and this will continue into the future.

In recent years, studies regarding paratransit in developing countries have become popular. Most studies mainly concerned with paratransit itself such as service characteristics and position in transportation hierarchy (Cervero, 1998; Cervero, 2000; Regidor, 1999; Shimazaki and Rahman, 1996); and market structures, regulations and impacts of paratransit on transportation system (Cervero and Golub, 2007; Diaz and Cal, 2005; Leopairojna and Hanaoka, 2005). Paratransit's feeder potential and performance in urban transportation have gradually been examined (Loo, 2007; Okada et al., 2003; Satiennam et al., 2006). Public perception was recognized as an important tool in evaluating paratransit operation and its future (Joewono and Kubota, 2006). The previous researches could provide valuable information, insight of paratransit performance and the ability for integrating paratransit as a feeder into mass transit system, with anticipation, to improve the performance of the existing transport modes that seem more financially and economically feasible for the developing countries. Paratransit, nevertheless, often experiences malignity because its informal services lead to traffic congestion, safety threats and pessimistic images. Consequently, it has been ignored by transportation planners and policy makers and study regarding this integration has not been performed. Therefore, this research aims to render and provide one of the important steps to achieve the policy for enhancing public transport performance and urban transportation in developing countries through the idea of integrating paratransit as a feeder into mass

transit system. As the distances connecting between mass transit station and commuter's origins and destinations are too short to offset total travel delays and paratransit services in developing countries are considered informal, this research, therefore, focuses mainly on commuter perceptions of paratransit services and trips accessing mass transit stations that will be important keys for future development of integrating paratransit as a feeder. Since access is the starting point of the mass transit and public transport trips, it is, therefore, vital to understand influences of paratransit service on commuters' perception and attitudes to their trips accessing mass transit station and willingness to use paratransit and mass transits in order to promote paratransit as a feeder. Besides, assuming simplicity of people's homogeneity in developing countries, typically applied in most transportation studies, might obtain misleading outcome due to large divergences of commuters' statuses and needs. Thus, this research proposed to provide basic framework and a beginning step of managing the existing paratransit and future planning of access development around mass transit stations. In addition, this research aims to investigate several influences of commuters' perceptions and attitudes to paratransit services on the trip accessing mass transit stations and willingness to use mass transit and paratransit as feeder mode, and to emphasize the importance of considering effects of commuter heterogeneity in the transportation planning of the developing countries.

This research was carried out using study areas along mass transit corridors in Bangkok, Thailand, where large income differences were appearing, vehicle ownership was increasing, several plans of mass transit were arranging, and varieties of paratransit were functioning as a feeder. Demand-based paratransit, motorcycle-taxi, and route-based paratransit, Songtaew, were selected to be investigated. Though pessimistic attitudes to inconvenience and difficulties of using a travel choice of combination between paratransit and public transport, especially risks in terms of safety and security, dissatisfied and discouraged commuters to use this travel alternative, paratransit services were still taken into consideration by the commuters. Flexible and door-to-door services offered by the motorcycle-taxi and safety and security of paratransit operation showed positive influence on satisfaction of trip accessing mass transit stations that encouraged commuters to use mass transit and paratransit in the future. In addition, inevitable outcome was found while heterogeneity of people was considered. Low income commuters assessed their satisfaction of access trips mainly on out-of-pocket expenses while commuters in higher status mainly awarded on access time. Motorcycle-taxi positively influenced the high income; however, its safety and security posed negative impacts to all commuters. Songtaew, in contrast, was a favorable mode of the low income, because it offered cheaper and safer services; nevertheless, commuters suffered its unreliable waiting and travel time. Both demand-based and route-based paratransit had their own service areas, potential users, and different influences on various types of commuters. These findings would provide effective ways of planning of integrating paratransit as a feeder into mass transit systems. Based on these attempts, this research highlights advantages and future potential of paratransit in urban transportation, and emphasizes seriousness of heterogeneity of commuters for enhancing effectiveness of transportation planning and development in developing countries.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Many metropolitans of developing countries have implemented Mass Rapid Transit (MRT) or mass transit systems to relieve traffic congestion in the past decades such as Bus Rapid Transit (BRT) in Jakarta, Seoul, and Curitiba as well as rail-based systems, Light Rail Transit (LRT)/ Heavy Rail Transit (HRT)/ Subway in Bangkok, Delhi, and Manila. Though several MRT network expansion projects are planned to handle with outward growth of urban areas, the excessive networks of MRT are financially infeasible to be implemented in most of megacities of developing countries according to the limited investment. Thus, only few lines or small networks have been inaugurated, at present, and they have to deal with huge travel demands. Generally, most of mass transits implemented are located along the high-density and the long been developed urban areas with anticipation to reduce number of car usages and obtain adequate ridership from those areas. Unfortunately, some of mass transits implemented can not well achieve their expected targets. The obstructions are not only an increase in motorization, poor planning on land use, and disadvantages of higher fare, but also a poor connectivity with other existing transport modes and access difficulty. The difficulties in accessing mass transits and public transports are mostly caused by inefficient land use plans, low service coverage, and inadequate feeder systems. In the high-density urban areas of developing countries, the land developments have long been settled with ineffective growth control that create large areas of mixed land use of residences and business activities. This has resulted in a vernacular growth of road network that caused malfunctions of many narrow alleys off the main streets and poor connectivity of roads in such areas. In addition, the discrepancy of climate and people behavior between developing countries and developed countries has compelled some obvious different images and perceptions of traveling by mass transit in terms of expense, comfort and convenience, particularly walking distance. The pessimistic mindset dissatisfy commuters and leads to low system performance and level of patronage as occurred in two rail systems of Bangkok, and MRT3 of Manila. Even though mass transit systems offer high speed service as well as private car does or sometimes even faster, car users still have not transferred to ride mass transits. Besides, greater income level and traffic congestion increase car use and hinder public transport patronage especially bus, the main land-based urban public transport mode of developing megacities. These trends will continue into the future of the developing countries. This is because automobile can satisfy commuters’ needs of door-to-door service that present mass transit systems in developing countries cannot offer. When given the choice and the opportunity, most individuals will prefer using a car. Moreover, access is the starting point of public transport trips. If commuters face difficulties at the beginning, they will easily shift to private vehicle especially when they can afford. Therefore, the effective feeder system along the mass transit corridors will be an important key and urgently required in order to fade away the weakness of mass transit systems. This feeder system would provide more convenient in travelling by mass transits not only for the car users but for other commuters as well.

Currently, a new methodology to deal with problems and enhance mass transit performance is developed as called Transit-Oriented-Development (TOD). The solutions such as bus feeder service and compact city have shown their capabilities in coping with problems of access to mass transit stations in several cities of developed countries. The potential of solving access difficulty and increasing role of public transport through the strategy of compact city should be high, in theory, for high-density cities with mixed land use. However, the results of previous study suggested that high density does not necessarily guarantee success for public transport and encourage non-motorized travel (Barter, 2000). Compare to developed countries, commuters' behavior in developing countries is highly fluctuating. it is, therefore, hard to predict and handle because of unstable environment in many aspects; rapid growing economy, people migration towards city centers, urban population raises, and increase in traffic flow. Due to the dynamic structure of the urban areas, it is difficult to employ the lessons learned from developed countries directly in order to address the issues of difficulties in accessing mass transit stations. Bus feeder designed from the TOD method would not effectively be implemented in the high-density areas of megacities. It is from the fact that most of those areas have narrow road spaces and poor connectivity of roads. Also, high traffic congestion, inadequate bus fleet and less demand, particularly for short-distance access trips, make bus feeder services cannot be justified in terms of economic returns. In addition, people in developing cities tend to have shorter preferable walking distance than people in developed countries do. These reasons are the important impediments of applying the concepts of compact city developed in the TOD.

Over the last two decades, motorized paratransit, uncontrolled and unrestrained, small to medium sized motorized vehicles e.g. motorcycle-taxi in Bangkok, jeepney in Manila, and van in Indonesia and Rio de Janeiro have emerged as one of the transportation modes in the developing countries. They have gradually become an outperforming mode of transportation. Paratransit modes provide a variety of services from door-to-door collectors to intermediate line-haul due to the advantages of vehicle size and unrestrained operation that make paratransit effectively response to the fluctuated demand. According to the growth of motorization and public transit deficiency, people in urban areas are discouraged to use public transport and car users have become more car-dependent riders, notwithstanding the fact that mass transits such as BRT and rail transit have been implemented. Inefficient land use plans and low service coverage have caused difficulties in accessing public transports. In addition, there are none or only few feeder systems provided. In the areas left by public transport, paratransit have shown outstanding performance of shuttling people up and down the narrow alley areas off the main streets, especially from their residences, to main streets and public transport. This performance reflects the potential of paratransit's feeder function. At present, a combination of paratransit as a feeder and public transport has become one of typical travel choices for commuters in major developing cities and this will continue into the future. Paratransit, nevertheless, has not been systematically considered or included in the urban transportation systems and planning.

Thus, studies on paratransit in the developing world have become popular. Most of studies focused on paratransit's characteristics, performances and operations especially for the intermediate line haul types. The effects of the line haul paratransit on urban traffic flow and on commuter attitudes and willingness to use were investigated. Market structures, regulations and impacts on controlling paratransit in developing cities were deliberated in addition to the studies on of the line haul paratransit. In past decades, the potential to be feeder system has been gradually reviewed and suggested by many researchers. For example, a strategy of establishing jeepney terminal adjoining MRT3 station in Manila was considered high priority for improvement in people's viewpoint due to a high weight score of convenient level of access to stations (Okada et al., 2003). Moreover, a well integrated paratransit as a feeder of Bangkok's BRT project was proposed along with density land use allocation and controlling parallel existing local bus as a set of solutions for improving BRT performance (Satiennam et al., 2006). It showed that the proposed strategies can improve BRT performance and overall traffic network conditions and air pollution emissions.

Therefore, an idea of integrating paratransit as a feeder system into urban transportation, particularly for mass transit system, should not be overlooked in order to effectively utilize the existing resources, advantages and performances of paratransit for urban transportation planning. The advantages of demand responsive services offered by paratransit could alleviate the fixity issue of public transport systems, notably rail and subway systems, while cities are dynamical entities, even if the pace of change can take decades. This research is proposed to emphasize an important of considering attributes regarding access trip into the urban transportation planning and developments. The approach of paratransit feeder aims to improve the performance of the existing transport modes that seem more financially and economically feasible for the developing countries. Consequently, this research intends to render and to provide one of the important steps to achieve the policy for enhancing public transport performance and urban transportation in developing countries through the idea of integrating paratransit as a feeder into mass transit systems. This research selects Bangkok, Thailand, as a representative megacity of developing countries. All framework and procedures constructed in this research are demonstrated and applied through the study areas of Bangkok because there are rapid pace of economic development, urbanization and motorization, two mass transit systems are operating, varieties of paratransit are functioning, and various transportation plans in particular mass transits are under the process of development.

1.2 Statement of problems

According to the vehicle size and nature of services, paratransit could be an effective instrument in addressing the city specific problems of the short-distance access to mass transit stations. The motorized paratransit offers more convenient and shorter access time comparing with walk to the stations, and accommodates commuters with door-to-door service that can minimize walking distance. In addition, paratransit can be the cost-effective complementary mode that provides incremental peak hour service especially in the areas left by regular public transport modes. This is because paratransit can operate the services to handle wide diversity of travel demands without any investment and subsidy required from public agencies.

Even though the previous study (Satiennam et al., 2006) reviewed performances in enhancing urban transportation of combining paratransit as feeder, the study depended on the assumption that this feeder could enlarge BRT's catchment areas beyond BRT's designed walking distances. This assumption might not be effective in the real situation. It is from the fact that present operating paratransit is partially controlled, the services provided by paratransit modes are regarded as unsafe, uncomfortable, inconvenient and unreliable services. These shortcomings might discourage use of paratransit and affect use of public transports and mass transits of overall commuters especially caused from attitudes towards paratransit services. Moreover, impacts of paratransit on commuters' travel choice have never been investigated.

Currently, several types of paratransit are functioning as a feeder of public transport; however, they have never been systematically integrated in the transportation planning. As paratransit operations have often been ignored in the transportation planning, the influences of paratransit to be integrated as a feeder on usage of mass transit in the view point of commuters have not been studied yet. How the service quality of different types of paratransit affect commuters' preferences and attitudes has rarely been examined. This information is very important factors for planning process of integrating paratransit as a feeder into mass transit systems. Moreover, due to the large diversity in economic status of people in developing countries, considering homogeneity of commuters might lead to some mistakes and ineffective results. Therefore, to propose the policy of integrating paratransit as a feeder into mass transit system, it is important to know how paratransit influences and affects commuters on their preferences of accessing mass transit stations and willingness to use mass transits and paratransit. Besides, which type of the existing paratransit own the ability of feeder, who will be the potential patrons, and what are the most effective service areas provided by paratransit are the valuable information for promoting paratransit as a feeder. Improving the short-distance connection between commuter residences and mass transit stations would not significantly affect the total travel time reduction, hence it is important to put more attention to commuter's preferences and attitudes to the services of paratransit and trips connecting with mass transit stations. The satisfactory paratransit feeder services would accommodate commuters more convenience and high level of satisfaction of trips connecting between mass transit stations and trip origin or destination. While, the dissatisfactory service quality of paratransit could hinder and discourage use of public transports and commuter's travel choice decision especially trade off between private car and public transport alternatives which combine paratransit as an access mode. Whether the travel choice of paratransit feeder and public transport is taken into consideration by the commuters or not is in doubt because of the pessimism over a level of services of the existing paratransit and differences among commuters' preferences. Therefore, the satisfaction of feeder services provided by paratransit and connecting trips to mass transit stations would be the important keys to the success of integrating paratransit as a feeder system.

1.3 Research purpose and objectives

The main purpose of this research is to provide the basic framework and strategies for integrating the existing paratransit as a feeder into mass transit systems in the developing countries. These strategies aim to improve the trips connecting between mass transit stations and travelers' origins and destinations, with anticipation, in order to provide more convenient access trip, a starting point of public transport, and enhance performance of mass transit systems in transferring car users to mass transits and increasing more ridership. To achieve the research goal, there are four specific objectives to be performed as follows;

1. To explore the feeder potential of the existing paratransit and identify the potential users and effective service areas
2. To understand and examine commuter's travel choice consideration based on commuter preferences and attitudes towards services of public transports and paratransit as a feeder

3. To investigate the influences of commuter attitudes towards paratransit services on mass transit access satisfaction and willing to use mass transit and paratransit
4. To develop and recommend the proper policies for integrating paratransit as a feeder into mass transit systems

1.4 Scopes and limitations

This research has attempted to render the insights of efficiently utilizing the existing paratransit as a feeder system to enhance performance of mass transit operations in developing countries. The study focused mainly on urban transportation of the cities of developing countries that have the important criteria as follows;

- The megacities that have experienced rapid pace of economic development resulting in rapid increase in car ownership, urbanization and traffic congestion in past two decades.
- There are high-density urban areas with mass transits are operating, but the ridership of mass transit has not reached the expected level.
- Several types of paratransit are functioning as feeder.
- There are plans for mass transit development in the future.

Nevertheless, this research could not be able to cover all perspectives involving with present situation of urban transportation and capture all problems emerged in developing countries because of limitation of time and resources. The study focuses on paratransit that functions as a feeder mode in short to intermediate distances connecting to mass transit stations, and it is unable to cover many cities in developing countries. Only Bangkok, a capital city of Thailand, is selected to be a representative megacity of developing countries and it satisfies the mentioned criteria of cities in focus. There are three operating corridors of two mass transit systems, the elevated rail transit and subway. Varieties of paratransit are functioning and cover two main types of services that are route-based service, i.e. passenger van and Songtaew (a converted pick up truck), and demand-based service, i.e. motorcycle-taxi, taxi and Tuk-tuk (tricycle). Several plans of mass transit network expansion are under process of design and implementation. The questionnaires are developed using a Revealed Preference (RP) method to reflect only the present circumstance of urban transportation. The data collection covers only the 5-kilometer catchment areas along the operating mass transit corridors in Bangkok, yet it grasps all commuters not only passengers of mass transit and paratransit.

This research, nevertheless, not be able to deal with all available paratransit. But, the selected paratransit services, motorcycle-taxi and Songtaew, have covered the operating functions of paratransit in developing countries, route-based and demand-based services. Also, the analyses of this research aim to capture influences and factors of paratransit services on commuters' travel choice consideration; however, some basic factors affecting travel decision have not been taken in to account which are travel time and travel cost. It is because improving travel time of short-distance trip could not offset total travel delays. Travel cost of the short-distance trip is not directly applied in the analysis, but it is captured in terms of satisfaction of suitability of fare based on travel time and distance. This research gives more attention on the influences of commuters' behavior and attitudes to service quality of paratransit that will be the important keys of integrating paratransit as a feeder into mass transit system.

1.5 Organization of dissertation

This dissertation contains a total of nine chapters and appendices. The background and motivation for this research, the problems which are to be mainly focused, the main purpose, objectives and scope established for this research have already been described in this chapter. The remaining chapters and appendices, and their brief contents are arranged as follows:

Chapter 2 describes the background and motivation that had helped to develop this research in more details. A literature review of the relevant researches and ideas are also discussed. It includes present situation of urban public transportation, mass transit systems and their issues, paratransit and its opportunity in developing countries, and lesson learned from developed countries in improving mass transit performance.

Chapter 3 explains the overall picture of the research through the framework of the study. The study area, data collection procedure, and collected data are described. The study design of all analysis processes and methodologies applied in each procedure are explicated.

Chapter 4 demonstrates the modes used in accessing mass transit station at present and explores the feeder capability of the existing paratransit. The potential users, effective service areas and important factors classifying each access mode are also examined.

Chapter 5 exhibits the influences and relations of commuter behavior and attitudes towards paratransit and public transport on commuter’s travel choice consideration. This chapter reviews how a travel choice of combination between paratransit feeder and public transport are taken into consideration by commuters and explore the influencing factors that important for managing an integration of paratransit strategy.

Chapter 6 investigates the influences of commuters’ attitudes towards service quality of paratransit on the satisfaction of trips accessing mass transit stations and future intention to use of commuters. The influences on commuter’s satisfaction of access trip to mass transit stations are examined in more details by considering different groups of travelers in Chapter 7.

Chapter 8 illustrates the proper policies and their managing strategies for integrating paratransit as a feeder into mass transit systems developed from the obtained results of Chapter 4 to Chapter 7.

Finally, Chapter 9 concludes the research by bringing out key notes realized from the research and recommends important implications and contributions for applying this research framework in the developing countries. This chapter also postulates possible future prospects for further research that can enrich the validity of the research findings.

CHAPTER 2

BACKGROUND AND MOTIVATION

This chapter aims to provide the backgrounds and motivation of this research. The present situations and future trends of urban transportation in developing countries are described. Reviews of paratransit including its opportunity in developing countries are also discussed. In addition, mass rapid transit situations and issues in developing countries are determined and the lessons learned from the solutions dealing with mass rapid transit dilemma are conferred. Accordingly, the inspirations of conducting this research will also be explicitly explained and clearly defined.

2.1 Urban transportation and trend in developing countries

Most of the urban areas in developing countries are the cities with high density and mixed uses. Their urban transport systems are land-based transportation and generally operate in mixed traffic. The urban transport sector accounts for at least 50 percent up to over 70 percent of the gross national products in most developing countries. Transport expenses, in urban areas, have been found to be around 5 percent to 15 percent of household income. In the last half century, pace of change in population, economics and urbanization has been obviously perceived particularly in megacities of the developing countries and brought about huge needs of public services and infrastructures to supply the growing population and urbanization especially the needs for transportation. A greater need for transport services is obviously increased as the population becomes denser. The rapid, unplanned and uncoordinated growth of cities has ailed urban sprawl that caused more travel demand, excessive longer travel distance and uncommon growth of vehicle ownership and usage. Since cities continue to become more dispersed, the cost of building and operating public transportation systems increases. Furthermore, dispersed residential patterns characteristic of car or automobile dependent cities makes public transportation systems less convenient to support urban mobility. The growth of private car usage is resulted from increase of level of income, and the growth rate tends to continue rising quickly reflecting economic growth of developing countries that seems to follow the pattern of American cities (Acharya, 2005; Barter, 2000). The development and improvement of public transport especially mass transit system are much slower than private transport (Barter, 2000). It results in unusual pace of vehicle ownership growth rate in last three decades and vehicle ownership in most of developing countries (Brazil, Indonesia, and Taiwan) grew twice as fast as per-capita income or more than twice as fast in some countries (Mexico, Malaysia, Thailand, India and Korea), and this rate tends to continue into the future as illustrated in Figure 2-1 (Dargay and Gately, 1999; Dargay et al., 2007). At present, urban transportation situation in most megacities of developing countries become the stage called traffic-saturated bus city and motorcycle city as shown in the Figure 2-2 i.e. Bangkok, Kuala Lumpur, Taipei, Jakarta and Manila (Barter, 2000). It is resulted from efforts to increase flow of traffic and unrestraint motorization, land use development and vehicle use. Deficiencies of public transport in addition to slow mass transit development due to budget shortage and poor urban structure and road network have contributed to the decline of public transport’s patronage.

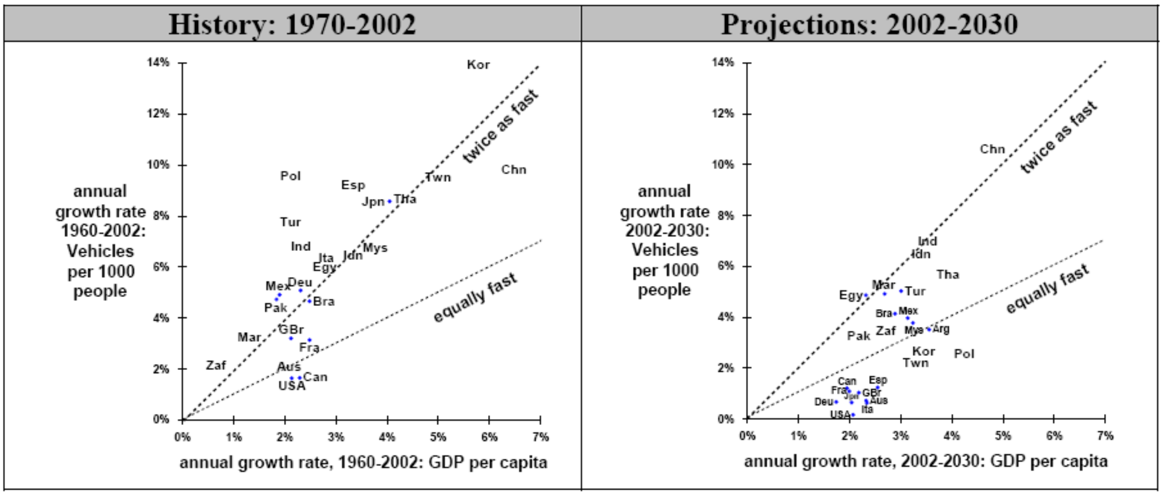

Figure 2-1: Growth rate for vehicle ownership and per-capita income
Source: Dargay et al., 2007

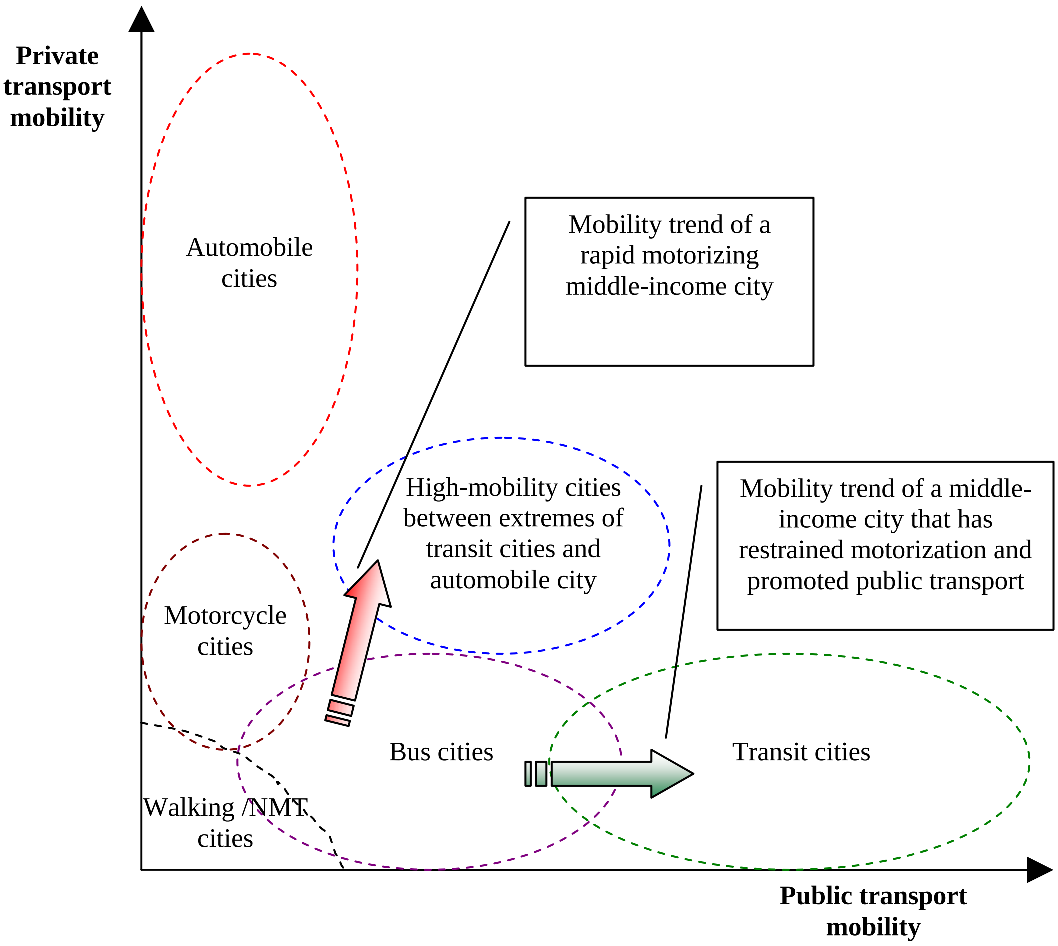

Figure 2-2: City types on a plot of private versus public motorized travel per person
Source: Barter, 2000

As a result from motorization and large income difference, high income people tend to rely on private vehicle while low income people tend to rely on public transport. Unbalanced growth between rapid urbanization and motorization and gradual road and transportation infrastructure development, particularly in urban areas, has caused a premature congestion and public transport deterioration. Moreover, traffic congestion also results in huge energy consumption, environment degradation and high risks on traffic safety and security which are endemic in the developing megacities. Despite lower car ownership level, traffic congestion in urban areas and increasing rate of car ownership are often more serious in developing countries than in developed countries at the same income levels. Several factors of traffic congestion include of inadequate road capacity, poor road network structure, traffic indiscipline, misuse of road space and mix traffic. Traffic congestion has resulted in low average speed in urban areas. The average speed for road network is below 20 km/hour in developing cities, and average speed of bus transport is less than average road speed i.e. Bangkok, Manila, Jakarta, and Cairo (Acharya, 2005). The difference of bus speed and road speed is wider when a city gets richer. It is because of the fact that a bus generally operates in the mixed traffic, has no flexibility in choosing the routes, and confronts a delay in loading and unloading passengers. Thus, if the public transport system is based only on bus system, the speed will be always lower than that of private car. The results of public transport deterioration and advantages offering by car use will give commuters an incentive to switch to car travel when the income increases. This trend will continue into the future especially in low and middle income developing countries as the economic development is rapidly growing while urban transport infrastructure development is developing slower than the growth of economic. In addition, if public transport and mass transit improvement continue slowly and unrestraint motorization has not been implemented, urban transport in developing countries will confront with traffic severe traffic congestion and become automobile city (Barter, 2000). On the other hand, if public transport is dominated by off-road rapid transit such as urban rail transit, subway and Bus Rapid Transit (BRT) average speed of public transport can be higher than that of road network as witnessed in the cases of Tokyo and Mumbai. Regarding the prospect of improving situation through more road infrastructures, it appears to be impossible for them to provide road space comparable to that in developed cities.

While more road constructions have been recognized as improper solutions, various strategies of effective coordination between land use and transport systems have been introduced and implemented to confront ever-increasing traffic congestion. One of the best strategies is to encourage transferring urban commuters from private car to public transport. Mass Rapid Transit (MRT), a term of transport modes that carry large volume of passengers quickly, has been widely implemented in many developing megacities in order to handle huge travel demand. Most of MRT systems have, typically, reserved right-of-way with different levels and capacities based upon the system. The common land-based MRT introduced in developing countries are bus-based system, Bus Rapid Transit (BRT), and rail-based systems, Heavy Rail Transit (HRT), Light Rail Transit (LRT) and subway. BRT have been activated in many countries such as Jakarta, Seoul, Bogota and Curitiba, while rail transit systems have been implemented, for example, in Seoul, Delhi, Shanghais, Manila and Bangkok. According to MRT performance and capability, MRT systems have conclusively been recommended to be the solutions for the future urban transportation plans of developing megacities. In addition, effective land use plans and transportation demand and supply management policies, namely Transit Oriented Development (TOD), have been recognized to be well incorporated with MRT systems in order to make urban transportation more efficient. Environmental friendly vehicles and non-motorized transport modes have also been promoting for the sustainable urban transportation.

2.2 Mass Rapid Transit in megacities of developing countries: Reviews and problems

2.2.1 Mass rapid transit reviews

Public transport is considerably vital for travelers without access to private transport in developing countries, especially the low income people who are able to afford only a very basic standard of public transport. The common land-based public transports provided in urban areas of megacities are conventional bus and commuter rail; however, bus owns a majority. The provided public transport services have been considered inadequate and unsatisfactory because they are operating in mixed traffic and poor land use, and facing rapidly increasing travel demand. These shortcomings resulted in low level of patronage in public transport and increasing use of private vehicles that have gradually deteriorated public transport level of service and worsened traffic congestion.

Consequently, the MRT, BRT and rail-based transit, is one of the determinant solutions that have been implemented in many developing megacities in the last decades. This is because it indeed showed efficiency in moving mass of commuters and accommodating environmental benefits for urban transportation in the developed countries. However, BRT and rail transits have different efficiencies based on not only passenger-handling capacity and speed of travel but also design feature, operating strategy and city specific. Bus Rapid Transit has been implemented in many developing countries such as in Latin America and Asia includes cities in Brazil (Curitiba, Goiania, Fortaleza, Manaus, São Paulo), Colombia (Bogotá, Pereira), Ecuador (Quito, Guayaquil), Chile (Santiago), Mexico (Mexico City, León), China (Beijing, Hangzhou), Indonesia (Jakarta), and Korea (Seoul). Rail-based transit and subway have also been inaugurated in several developing countries i.e. China (Beijing and Shanghais), Seoul (Korea), India (Mumbai and Delhi), Thailand (Bangkok), Philippine (Manila) and Brazil (Rio de Janeiro). There are many successful mass rapid transit systems in developing cities such as BRT in Curitiba and Bogota. On the other hand, some of mass transits implemented, unfortunately, have not achieved their expected targets in relief traffic congestion and shifting private car users to mass transit or public transport as witnessed in the two rail systems of Bangkok, and MRT3 of Manila. These deficiencies are the results of incomplete network coverage and poor connectivity with other transport modes. Moreover, limited resources, high motorization, ineffective land use plan and control, inefficient and massive bureaucracies and political instability make most cities in developing countries face epic dilemmas of selecting the most appropriate mass transit mode and providing more public transport services to cope with the high level of public transport demand.

2.2.2 Mass rapid transit problems

Shortage of investment and incomplete network

The financial scarcity of investment in mass rapid transit has been much more controversial particularly rail-based system that is a relatively capital intensive solution. Most of mass transit projects in developing countries need ambitious financial supports from the developed countries or foreign financial resources that often confront granting impediments. Therefore, only small network coverage of rail transit system was able to be implemented in many cites of developing countries. Few lines of MRT mainly operate in high density urban areas because these areas are centers of many activities and have severely suffered from traffic congestion. Commuters can not complete their trips by using only mass transit systems and will be required to transfer to other transport modes. This problem makes mass transit inferior to private vehicle and results in low ridership. Though the network expansion of mass transit systems could successfully implemented in the future, the extensive networks that commuters can directly walk to the stations would be very difficult to be provided. Therefore, difficulties in accessing mass transit stations probably exist.

Ineffective collaborative planning

Even though mass transit has been implemented recently after the conventional public transport, the connections between newly developed mass transit system and the existing public transport modes and among different systems of mass transit are still ineffective. Consequently, the low level of intermodal integration with other transport modes makes commuters unable to reach their destination by public transport and confront with difficulty and dissatisfaction of many transfers, incompatible fare systems, and despicable expenses. Commuters are required, sometimes, to transfer from mass transit to other modes such as buses, commuter rails and feeders. However, lack of well-connected among public transports causes traveler long walk and waiting time. Besides, incompatible fare collection between different mass transit services and separate payments definitely increase total fare costs for commuters, and cause difficulties in using mass transits and public transports. These make private vehicle more preferable to mass transit and public transport for commuters, both middle- and high-income people, who can afford private car or motorcycle. Fare structures of mass transit, in particular rail transit, are relatively higher than of the conventional public transports that often deter the low income from patronizing mass rapid transits.

Poor land use and growth control

Unplanned scattering of population specially in high density urban areas have wrought very skewed distribution and diversity of socioeconomic needs. Most of urban areas have long been developed with poor land use plan and control that result in large areas of mixed residential and business land use, widely dispersed pockets of high-density residences and informally built lanes and narrow roads. These also have impeded the mass transit development in order to handling with wider dispersal of travel demands. Mass transit network, therefore, could be assigned only along the main streets and sometimes duplicate with existing public transports in some corridors and feeder services could not be provide efficiently especially in densely populated and developed areas. These problems also provoke ineffective and inadequate public transports particularly in urban areas of many developing megacities. Regular transit services such as conventional bus normally employ full size vehicles and operate in the poor connectivity of road network. These vehicles, sometime, are unable to serve residential areas with narrow entryways, poor roads or difficult terrain. These problems have impeded and discouraged people to use mass transits and public transports because they perceive a major hurdle of accessing to mass transits form the start of their trips.

Overlooked city specific urban transportation

Generally, most of mass transit plans in developing countries have been studied and formulated by foreign advisers or expatriate planners who typically employ design application learned from the developed worlds. They probably fail to recognize some complexity of urban transportation problems of the developing cities such as erratic urban development, meteorological discrepancy and differences of commuter’s perception and behavior. People specifically the wealthy often have pessimism about public transports that conventional public transports are inconvenient and unattractive, and confined mass transit services are meretricious. As per capita incomes are rising, the majority of people aspire to ownership of car or motorcycle though public transport services are of a high standard. They prefer door-to-door capability that car offers and staying in stationary car in traffic jams for long periods, and very difficult to persuade to use public transport, even if the alternative public transports would enable them shorter travel time, cheaper travel cost, or both.

Besides, weather discrepancy, particularly tropical climate, is an important disincentive factor of walking for a long distance. Lacks of good walking environment due to many obstructions on side walk and poor or absent walking facilities also reduce a propensity to walk. It is also difficult and dangerous to ride bicycle in the cities because of too many cars in the traffic, little road surface and parking facility. These make an important difference in commuter’s perception of accessing to MRT stations and other public transports. Ipso facto, direct copying approaches used by developed countries might lead to inefficient and inappropriate applications for the developing cities.

Further, existing regular public transports such as buses, sometime, are unable to serve residential areas with narrow entryways, poor roads or difficult terrain. In many of these cases, paratransit modes informally and illicitly enter the market to fill the gap left by the regular public transports in terms of line-haul transport and feeder over the last decades. They have gradually become outperforming mode of transportation and this will continue into the future due to their advantages in vehicle size and unrestraint operation that make paratransit effectively respond to the fluctuated demand. Nevertheless, this transport mode is often ignored by professionals and politicians in the urban transportation planning stages due to its backward country images and malign operations.

2.3 Paratransit and its opportunities in developing countries

Paratransit, especially in developing countries, is defined as an urban passenger transport mode, almost always, provided by private sector operated on public streets in mix traffic and its services are adaptable in routing and scheduling to meet various user desires (Vuchic, 2007). Paratransit services are mostly operated in terms of small to medium-sized, motorized and non-motorized vehicles ranging from human-powered rickshaws (becaks, tricycles) and two-and three-wheel motorized vehicles (motorcycle-taxi, Tuk-tuk, bajas) to minibus (vans, matatu, mikrolets). Paratransit services are usually fall between private transport and conventional public transport. Paratransit is considered as informal transport from the beginning due to its services operate with lack, to some degree, official and proper sanctions and fail to meet certification requirements for commercial and public-carrier vehicles. Most of vehicles are distinguished by small-sized, low-performing, aging or unfit vehicles. Moreover, paratransit services have poor organization that cause them to compete vigorously for passengers, overload vehicles, pick up or drop off passengers away from designated areas, lowering the quality of service. However, the services of this transport mode have shown their performances in complementing regular transit services without subsidies. Paratransit offers a wide range of services in terms of coverage areas, speeds, carriage capacity, fares and level of comfort that satisfied urban traveler needs to some degrees (Cervero, 2000; Shimazaki and Rahman, 1996). The services serve shirt-distance door-to-door collectors and intermediate line-haul travel in urban areas, and cover entire regions.

2.3.1 Roles and benefits of paratransit

Paratransit sector significantly provides key benefits to urban development and urban transportation of many cities in the developing countries. These are discussed as follows;

Mobility

The significant benefit of paratransit is that it offers valued mobility especially for the poor and travellers who do not own or have access to private vehicles. Those people entirely rely on public transport for their daily life. Where regular public transports are unreliable and inadequate, paratransit is the complementary mode to serve traveller needs. Paratransit services have an important role in connecting poor neighbourhoods to city centres and outlying residences to public transports provided on main streets. In addition, they are not only serving the poor, but also currently catering to the mobility needs of middle-class commuters as have seen from passenger vans in Bangkok, Jakarta and Rio de Janeiro.

Complementarity

In high density urban areas, paratransit play an important role in providing feeder connections between neighbourhoods and trunk routes. Shortage of budget and poor and narrow roads cause difficulties in providing systematic feeder service and it seem economically infeasible because this tend to cost more per passenger trip. In many cities of developing countries, the diversity of paratransit offerings better connectivity for the lack of good distributor roads and the discontinuity of local streets and off-loading large investment for to public transport operators. In addition, paratransit services show their compensatory role for the declining intermediate line-haul public transports by offering more frequent services, less stops, and guaranteed seat.

Market responsiveness and Low cost services

Paratransit provides effective flexible services. They can easily alter routes, schedules and operating strategies in response to fluctuated travel demands because the operators are unconstrained to accommodate their services. According to low capital and operating cost, paratransit services are able to keep costs low while they are also well-responsive to ever-changing markets. Consequently, paratransit is an efficient transport mode for supporting and supplementing rather than substituting regular public transports while considering its limitations in carrying capacity.

Source of employment

Paratransit is considered as a gateway to urban employment because it offers job opportunities for unskilled, young men and many who emigrated from rural areas (Cervero, 2000; Shimazaki and Rahman, 1996; Vuchic, 2007). It was reported that paratransit sector comprises around 15 percent up to 30 percent of total employment in many developing countries particularly in poor cities (Cervero, 2000). Not only drivers but this sector also provided jobs for hauling patrons and vehicle production and maintenance units.

2.3.2 Effects and concerns of paratransit

Paratransit sector is responsible for significant negative impacts such as traffic congestion and accidents, over-competition, energy consumption and air pollution. This sector also provides unreliable services and relates to some illegal and improper activities. These issues are reviewed as follows;

Traffic congestion

The unrestricted market entry leads to excessive supplies and over-competition. These are the main reasons that slow the traffic. To maximize number of passengers, drivers cut each other off, stop in middle lanes to load or unload customers and weave erratically across lanes. They also cause bottlenecks clogging traffic upstream especially at the main markets, i.e. bus terminals and marketplaces (Cervero, 2000). Paratransit services generally consume more road space per passenger comparing with conventional buses because of the limitations of carriage capacity. Moreover, low travel speed of the non-motorized paratransit vehicles resulted in impeding traffic, and many cities have banned their services or provided separate lanes for them.

Disorderly operation

The over-competition breeds chaotic and reckless driving behaviour. The operators frequently contend for customers by getting in front and arriving first at busy pick-up points. When facing dwindling demand, they tend decide to halt services or change their service areas easily regardless of how others might be impacted. In addition, the operators perform unfair practice in poaching regular public transports by coaxing waiting passengers to use their services instead and standing for customers at bus stops. In addition, intensely cutthroat competition among private operators has led to full-fledged gang warfare especially in South Africa.

Creaming off and unprofitable services

Many paratransit operators attempt to operate only along lucrative routes and during the peak hour because of perceived costs and higher ridership rates. They leave high-cost, unprofitable services to the public transport sector. Most of public transit companies serve public interest by a cross-subsidization, operating both gaining and losing routes. Paratransit operations take away a considerable opportunity of the peak hour demand and make public transport operators incur deficits. In some developing cities, a large number of passengers from public buses have been lured into paratransit services as witnessed in Buenos Aires and Bangkok. However, this problems could be alleviated, if proper policies or regulations to control and mange the services of paratransit. Since many paratransit operators often serve low-density and outlying areas, they could compensate for public transport deficiency. Moreover, they could allow the public sector to reduce their investments in covering the peak hour, while informal operators, with better access to marginal labor, could more cost effectively handle the incremental peak hour travel demand.

Traffic safety and public security

Notorious for driving aggressively and recklessly of paratransit operators is a result of the hyper-competition. They often make dangerous driving behaviors such as cutting off traffic to pick up customers, blocking lanes to load and unload passengers, overloading and ignoring traffic rules. Operating generally in mix traffic, the low speed modes such as pedicabs and motorcycle-taxis are vulnerable to face accidents, serious injuries and fatalities. Moreover, using poorly maintained and unsafe vehicles and long hard working hours also become the important contributors to accidents. The overcrowding not only possibly harms children and the elderly but also invites pickpocketting and bullying to the services.

Energy and environmental problems
Aging and unfit vehicles is the significant factors in inefficient consuming fuel. Low carriage capacity and operation constraints especially between associations lead to the low-performing use of energy resources per passenger compared to regular buses. In addition to old and poorly maintained motor-vehicles, frequent acceleration and deceleration in congested traffic also cause in waste of energy. These reasons including a prevalence of low-stroke engine-powered vehicles make paratransit modes become the gross-emitters of air and noise pollution. And, air pollution problems are exacerbated particularly in the cities where large congregation of paratransit services exists.

Intangible factors
Other than the above-mentioned tangible issues, pessimistic image of informality is one of the intangible factors seen as modes for the poor, being and representing backward countries. In addition, paratransit has been considered as inferior transport mode among professionals and politicians. These groups experience only malignity of paratransit because it suffers the most from traffic congestion, safety threats and antiquated images. Also, most of them have never boarded paratransit services, thus lead them to ignore the vital mobility and equity role the informal paratransit plays and to downsize or, even, terminate this mode.

2.3.3 Paratransit opportunities in urban transportation
In urban areas of developing countries, paratransit provides a variety of services from door-to-door collectors (flexible for hired services i.e. Ojek in Jakarta and Motorcycle-taxi in Bangkok and Rio de Janeiro) to intermediate line-haul (fixed route services i.e. Minibus in Jakarta and Vans in Bangkok, and Rio de Janeiro). Around 20 to more than 50 percent of travel demand from captive riders and car dependent users are handled by motorized paratransit (Shimazaki and Rahman, 1996; Joewono and Kubota, 2007; Cervero and Golub, 2007; Vuchic, 2007). Taking advantage of vehicle size and unrestrained operation, paratransit services take less time in boarding and alighting, stop less frequently, and run on shorter headways (Cervero, 2000; Shimazaki and Rahman, 1996). Therefore, paratransit can admirably respond to fluctuated markets, fill voids of areas left by public transports at relatively low fares, and supplement for public transit without subsidies. Besides, they were recognized as efficient road-utilizing carriers, low cost service, fleet-footedness, and users' gratifying mode (Cervero and Golub, 2007). Paratransit appears to be popular modes and seems to satisfy captive rider's needs in terms of mobility especially in feeder function by shuttling people up and down the narrow alley areas off the main streets specially from their residences to main streets and public transports.

In recent years, researches focused on paratransit performance, service quality and user satisfaction have become popular for study. The performance to be integrated with urban mass transit as a feeder system has been gradually revealed and suggested. Numbers of actions are necessary to put into practice for managing efficient use of paratransit and improve urban mobility in developing countries as mentioned by Shimazaki and Rahman (1996). The strategy of establishing jeepney terminals adjoining the MRT3 stations was proposed as one solution of MRT3's performance improvements in Manila, Philippines. The result from people's demand of the proposed strategy was considered high priority for improvement reflecting high weight score of convenient level of access to stations (Okada et al., 2003). Performance of paratransit (resident coach services) to be integrated into overall public transport system and to get people out of their car was shown in a case study of Hong Kong (Loo, 2007). Moreover, a well integrated paratransit as a feeder of Bangkok's BRT project was proposed along with density land use allocation and controlling parallel existing local bus as a set of solutions for improving BRT performance (Satiennam et al., 2006). The proposed solutions were used to gather traveler's mode choice behaviors and assess overall BRT operations. It showed that the proposed strategies can improve traffic network conditions and air pollution emissions. It is explored that the future of paratransit depends on its service quality and passenger satisfaction as a case study in Bundung, Indonesia (Joewono and Kubota, 2006). Even they feel dissatisfied and tend to move to other beneficial modes easily, passengers still want to use it.

As have been reviewed, the dominant roles of paratransit should not be overlooked on the way to urban transportation planning goals especially in terms of feeder system. In brief, not only does integration of paratransit as a feeder system possibly improve ease of accessibility, but also enlarge public transit catchment areas, and offer potential latent demands to mass transits in the future especially those who are living in the areas beyond acceptable walking distance.

2.4 Lesson learned in improving mass rapid transit

The main purpose of implementing mass rapid transit system is to alleviating traffic congestion in urban areas by reducing number of cars in the traffic and transferring commuters from private vehicle to mass rapid transit services. Nevertheless, most of MRT projects confront many problems in transferring car trips to their systems and attracting more ridership. Providing excessive and extensive MRT networks seems to be the preferred approach reflecting TOD concept as have seen in many developed megacities such as Tokyo and London. The networks are linked to all main activity centers and residences, and MRT lines are accessible with comfortably walking distance. However, this approach requires huge investment that seems financially infeasible for many countries. In addition, urban area in developing cities have been developed for sometime and settled without land use plans and control. This scheme particularly requires very effective and strong land use plans and control, which practically take time.

Another approach called "Trunk and Feeder" has been considerably recognized more feasible especially within the limited budget projects. The main MRT lines with effective collector systems could efficiently provide more transit ridership. The strategies of providing bus feeder and restructuring existing bus services have been found as the most effective method in feeding more number of ridership to MRT systems in developed countries. In short, this bus feeder system shows well performance in connecting suburban areas and mass transit stations, especially long-distance access, and covering larger areas instead of duplications of service in the cities having good land use planning and traffic control. This solution has been implemented in many cities such as Baltimore, New York, Lille, and Nantes.

In practice, however, the cost per seat-service distance is reduced but the cost per passenger-service distance is often increased because the incremental rate of passengers is lower than the incremental rate for additional seat offered. In other words, the ridership could not be increased by percentage higher than the expansion of the system's nominal capacity. The dilemma is that while choice riders want an improved transit service before considering transit commuting. Thus, the cost-effective system of MRT could be achieved if the system attracts new riders. The bus feeder system might not be the economically feasible solution and not effectively serve the high-density areas of the developing cities because of investment limitation, high traffic congestion, and poor road connectivity.

In addition, people's acceptable walking distances seem to be very much shorter than they are in developed countries. People prefer door-to-door service, i.e. taxi and motorcycle-taxi because they are required to walk up for very short distances. Therefore, special feeder services are required. The special feeder can be perceived as small to medium size vehicles serving with less waiting time, faster than walk, more maneuverable and better adapted to operate on high traffic local routes, and directly connect to the MRT stations.

Recently, MRT performance improvement concept, Transit Oriented Development (TOD), has been developed and implemented in several countries. A main concept of TOD is to provide a mixed-use residential or commercial area designed to maximize access to public transport, namely "compact city". TOD often incorporates features to encourage transit ridership. A typical TOD has a rail or bus station at its center, surrounded by relatively high-density development, with progressively lower-density spreading outwards one-quarter to one-half mile (400 to 800meters) from a transit stop, which represents pedestrian scale distances. The designed features of TOD include of the following items.

- The high-density neighborhood designed for walking and cycling
- Streets with good connectivity and traffic calming features
- Mixed-use development that includes residential and business areas
- Parking Management that can reduce the amount of on-street parking, and takes advantage of the parking cost savings associated with reduced automobile use
- Transit stops and stations as prominent feature of town center
- Collector support transit systems including trolleys, streetcars, light rail, and buses, etc

This concept of compact city has succeeded in many developed countries such as Japan, United Kingdom and America. As a result, there are a number of developing countries try to imitate the same concept. But outcome are not as good as it should be. In theory, the potential of TOD should be high for high-density cities with mixed land use. Anyhow, the results of previous study suggested that high density does not necessarily guarantee success for public transport and encourage non-motorized travel, particularly in developing countries (Barter, 2000). Consequently, service quality of public transport including mass transit that enhances competitiveness of public transport's speeds and door-to-door services with private vehicle must be the important factors.

2.5 Motivation of integrating paratransit into mass transit systems

The public transportation in urban areas of megacities in developing countries has been facing service deterioration by rapid growth of motorization and low level of patronage. Also, the operating MRT systems have not well achieved their main targets which are to reduce number of car trip and collect more ridership. One of the most important impediments is difficulties in accessing the stations. This makes the public transport and mass transit travels inconvenient from the beginning of the journey and inferior to the services that automobile offers. The impediment would keep the growth of private car usage continually rising reflecting economic growth of developing countries as resulted from increase of level of income. Currently, several TOD strategies designed to apply in developed countries have been introduced to improve MRT performances; however, these strategies do not fit for developing country specific problems, especially in the short-distance connecting between MRT stations and origins or destinations.

At present, the need for greater co-ordination and integration in transport services becomes more significant and essential for urban scale in order to boost public transport's competitive power. Integrated urban transport is being promoted in several megacities i.e. Santiago, Sao Paulo, Hong Kong and Singapore. The main logic of integration is that all components related with transportation must be taken into account. The piecemeal approaches, addressing only a single transport mode or the needs of a particular locality, cannot solve the overall dilemmas of urban transportation. The components of integrated urban transport planning and management consist not only logistics and scheduling but also traffic management and restraint, resource management and traffic safety. However, successful integrated urban transport systems remain very much the exception rather than the rule (Simon, 1996). The need for a more holistic approach should be demonstrated especially in the high congested megacities such as Bangkok and Jakarta. Therefore, the proper policies to be adopted depend on the existing transport systems, the gap between supply and demand for urban travel, physical character of urban area, attitudes to urban transport modes, economic condition and political commitment.

The motivation of this research is the idea to enhance what already exists by optimizing the potential contribution of each existing and planned mode of transport. Paratransit should be seen as making a potentially positive contribution rather than representing an unwelcome residual of the past or a malign transport mode so called "parasite transit". Nevertheless, paratransit may not be appropriate for all urban areas. So many forms of paratransit are well suited to densely populated areas, particularly where a substantial proportion of the inhabitants are on low incomes and where roads are narrowed and irregular. From the reviews of paratransit, this transport mode has a potential to alleviate the short-distance access difficulties and increases the door-to-door ability of public transport especially the MRT systems that play a major role along high-volume and long distance routes. However, paratransit has often been ignored from transportation planners because of their pessimism of paratransit. This research, therefore, intend to propose some insights and managing strategies in promoting paratransit as a feeder for mass transit systems with anticipation that this solution would enhance the performance of MRT and urban public transportation in the developing countries.

CHAPTER 3

RESEARCH METHODOLOGY

This research attempts to recommend appropriate framework for integrating the existing paratransit as a feeder into mass transit systems in the developing countries. This study is proposed, with anticipation, to provide new approaches adapted to addressing the city specific transportation of the developing countries in addition to the solutions designed for developed countries in order to enhance the performance of urban transportation. This chapter explains the overall picture of this research. The overall study framework developed in achieving the research goal is presented at first. The selecting strategies and the characteristics of study areas will be explained. Then, the required data, data collection, and survey methods will be clearly discussed. Finally, the hypotheses and analysis methodologies applied in each process illustrated in the framework will be described.

3.1 Research framework

The research framework was developed to achieve the research goal by reflecting the several objectives as illustrated in the Figure 3-1. The conceptual framework provides the overall process through which the steps of research have been developed, the interrelation between various steps to be followed. A brief explanation on the research structure is as follows;

- A review on urban transportation and paratransit in developing countries and developed countries is performed at first. Therefore, research purpose, objectives and scopes are developed.
- Developing megacities that satisfied the scopes of this study will be selected as representative case study. Bangkok, Thailand, has been selected to be a represent of megacity of the developing countries that satisfy the criteria and scope of the research.
- Questionnaires are then constructed based upon the study area and respondent characteristics. The questionnaire is set to reflect the objectives and hypotheses of each step. Then, data collection is conducted in the selected study areas.
- Feeder potential of the existing paratransit will be explored including other modes accessing mass transit stations. Moreover, the potential users and effective service areas of paratransit and other access modes will then be examined.
- After obtained results from the previous step, it is also important to know that do the commuters consider the combination between paratransit and public transport as one of their travel choices. The influences of attitudes to paratransit and public transport will again be performed in the investigation model as well as personal behavior.
- Paratransit services that have feeder potential are selected to be investigated their influences on commuters based on their perceptions and attitudes. The perceptions and attitudes towards paratransit service quality and access trips to mass transit stations are the main factors that will be used in the analysis process. The important factors of paratransit and their impacts that influences commuters will, therefore, be defined.
- Finally, the results obtained from the three main analyses are employed in the policy development process. The feasible and practicable policies will be drawn carefully from the valuable information obtained from each analysis. Thus, the proper policies can be concluded and recommended.

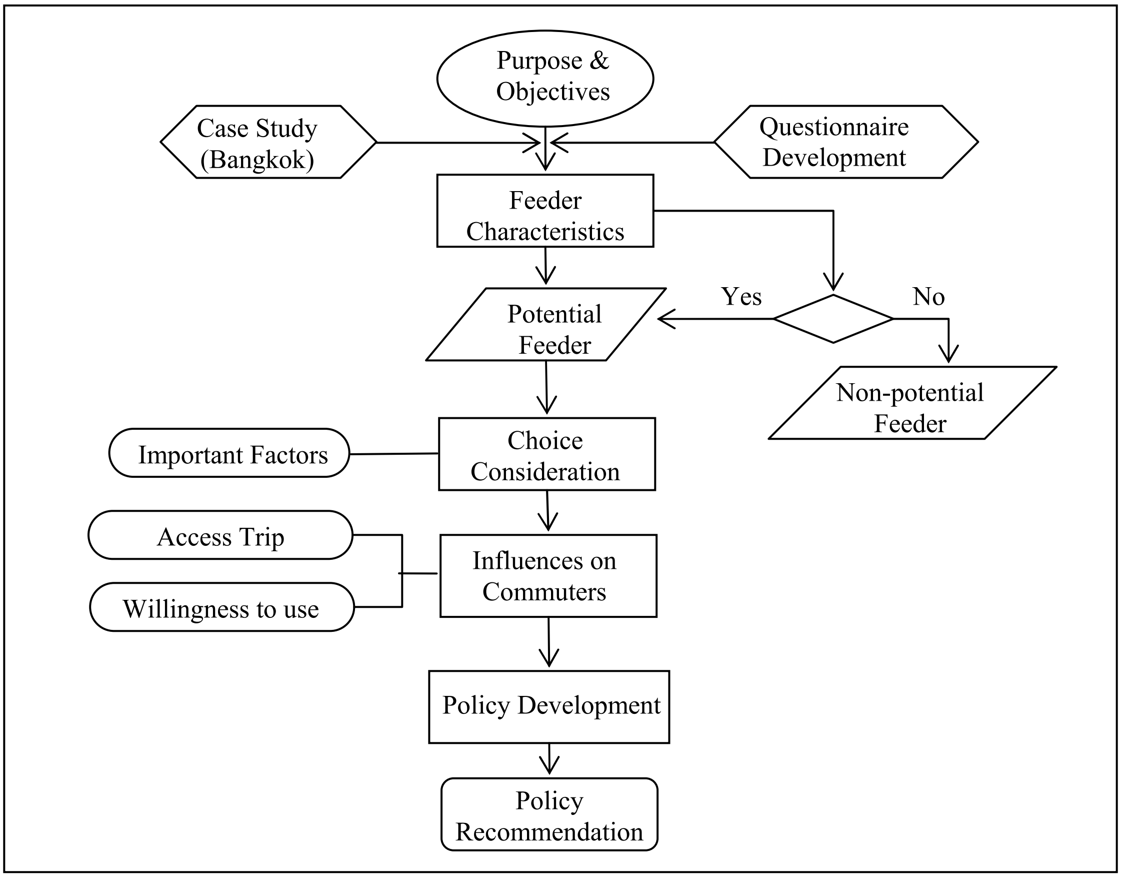

Figure 3-1: Research framework

3.2 Study area

This research proposes to study on the megacities of the developing countries that their urban transportation relied mainly on land-based transportation and some mass transits, rail-based and/or bus-based systems, have already inaugurated. The focus cities are the megacities that have high-density population in urban areas, confront with rapid increase in economic and motorization, and have slow improvement and development of public transport. The development and improvement of public transport especially mass transit system are much slower than private transport (Barter, 2000). It results in unusual pace of vehicle ownership growth rate in last three decades and vehicle ownership in most of developing countries (Brazil, Indonesia, and Taiwan) grew twice as fast as per-capita income or more than twice as fast in some countries (Mexico, Malaysia, Thailand, India and Korea), and this rate tends to continue into the future. Thus, these megacities of developing countries have high risk of turning to be at the stage of automobile city as mentioned by Barter (2000), if there are no restraint motorization policies and few public transport and mass transit development. Moreover, significant mass transit investments have generally occurred recently after motorization reached rather high levels and road investments have continued in competition with mass transits. These cause more difficulties and impediments of mass transit developments. Nevertheless, these countries have continued the future developments of mass transit planning.

The next important criterion of focused cities is that there are operations of paratransit. Among various types of paratransit operations, this study mainly focus the attention on a feeder type that play an important role in connecting people between their residences to main streets and public transports. This type of service is available in many cities of developing countries such as Bangkok, Jakarta, Kuala Lumpur, Manila and Rio de Janeiro (Cervero, 2000; Shimazaki and Rahman, 1996). The operating paratransit that serves as feeder mode consists of (1) demand-based service, i.e. motorcycle-taxi (Bangkok, Rio de Janeiro, and Jakarta) and motorized tricycle or auto rickshaw (Bangkok, Jakarta, Mumbai and Delhi), and (2) route-based service such as minibus (Bangkok, Jakarta and Hong Kong) and Jeepney (Manila).

Bangkok, a capital city of Thailand, was selected in order to represent the case study of megacities in developing countries. The reason is that Bangkok is one of the megacities that face rapid growth of motorization and private vehicle use, public transport is increasingly unattractive due to poor service levels and slow developments. In addition, there are only two mass transit systems implemented in the city center, varieties of paratransit are functioning, and various transportation plans in particular mass transits are under the process of development. The city of Bangkok has long been developed with mixed land use that make the development grew everywhere not only concentrated around the stations as in developed countries. This have caused some commuters to live in the excessive distances from the main streets or mass transit stations, which are longer than acceptable walking distance, around 800 meters, applied in mass transit system plans. In some areas, public transport services could not be provided due to geographic limitations such as narrow and poor roads. In addition, differences in meteorological condition and perception of walking distance, which seems to be shorter than developed countries, have discouraged people's propensity to walk or cycling. Thus, the short preferable walking distance, poor connectivity of road and tropical climate have accentuated the dominant role of feeder of both demand-based and route-based paratransit in Bangkok. Consequently, these have posed difficulties in going to main streets and accessing public transports including mass transit stations. Therefore, the characteristics of Bangkok city satisfy research assumption and purpose that aim to improve short-distance travel connecting to mass transit stations.

3.2.1 Backgrounds and characteristics

Bangkok is a mega city comprising 50 districts with the total area of 1568.74 km^2 and registered population of 10.162 million (BMA, 2009). The rapid growths of population, urbanization and motorization have witnessed since 1960 as happened in other developing megacities. Following the western development pattern, Bangkok had emphasized plans that accelerate economic growth and road infrastructure development without much consideration of land use. This gradually converted Bangkok into an automobile dependent city and made the city spread outwards (Rujopakarn, 2003). Thus, these have generated many travel demands and excessive longer trips to the city areas of Bangkok because they are the centers of many activities. For road-based transport city like Bangkok, bus is the dominant form of public transport and for most commuters is uncomfortable, inconvenient and slow, although cheap. Moreover, vernacular growth of road network and unplanned land use with mixed residential and business areas has led to the phenomenon of "superblock", a numerous narrow alleys off the main streets, and poor connectivity of roads. Consequently, cars have become the preferred mode for those who can afford and have increased dramatically. However, unbalanced between rapid growth of car usage and gradual road infrastructure development has caused congestion and resulted in deterioration of public bus services operating in mixed traffic. To relieve traffic congestion, mass rapid transit has been recently introduced rather than constructing new road infrastructures as had been favored in last two decades. At present, two rail transit systems, an elevated rail system (BTS) in 1999 and subway (MRT) in 2004, have been implemented and extension plans are currently underway.

3.2.2 Bangkok mass transits and access modes

In Bangkok, two rail transit systems, operated mainly in the central areas of the city, are widely known as BTS and MRT in 1999 and 2004, respectively. BTS is elevated rail system that comprises two main lines with the total of 23.5 kilometers, and operated by The Bangkok Transit System Company (BTSC) under the concession from Bangkok Metropolitan Administration. MRT is the subway line operated by Bangkok Metro Public Company Limited (BMCL) under the concession from The Mass Rapid Transit Authority of Thailand on the 20 kilometer-service length. The present mass transit network is shown in Figure 3-2. Moreover, network extension plans are in the process of being implemented. Presently, both rail transit systems have not yet achieved the main goals to reduce traffic congestion and attract more riderships. The three main reasons are (i) incomplete and small network that generally follow middle- and high-income residential areas, (ii) lack of connections to main transportations, and (iii) difficulty in accessibility (Charoentrakulpeeti et al., 2006). Furthermore, traffic congestion and low level of connectivity discourage commuters to use mass transits.

From the beginning of BTS, a total of 13 routes of free shuttle bus service were provided by BTSC and they could handle approximately 20,000 passengers/day based on BTS interview. Unfortunately, they were reduced to 6 routes in 2001 and finally only 1 route in September 2004 under the responsibility of private company because of financial problem. Unlike developed countries, there are many ways to access mass transit stations other than walking and conventional public bus in present i.e. motorcycle-taxi, Tuk-tuk, Songtaew, Silor-lek, and taxi. It is a result of the unique characteristics of Bangkok's Soi Superblocks, numerous narrow alleys off the main streets, with poor connectivity of roads.. At present, BTS and MRT riders access to the stations by four main modes; walking, private vehicle (car and motorcycle), public bus, and paratransit (motorcycle-taxi, Songtaew, Silor-lek, Tuk-tuk, and taxi). Past study showed that bus including passenger van owned the highest share among modes used in accessing mass transit stations, whereas walk and motorcycle-taxi were the second (Chalermpong and Wibowo, 2007). It also found that park-and-ride (P&R) and kiss-and-ride (K&R) handled around one fifth of access trips. However, within a 2-kilometer radius from stations, the three most popular access modes to BTS and MRT stations are walking (around 40%), motorcycle-taxi (around 30%), and bus (around 15%), respectively. Share of walking sharply declined beyond the distance of 400 meters (from 70 percent to 40 percent) and less than 20% of travelers walked from the distance longer than 800 meters. The study also found that motorcycle-taxi becomes the dominated access mode in the distance beyond 900 meters. Share of motorcycle-taxi rose eminently from 30 percent to 60 percent at the access distance beyond 900 meters. Moreover, other motorized modes such as Songtaew (a converted pick-up truck), Silor-lek (a small 4 wheel vehicle), bus, car dependent, also become more preferable than walking beyond the distance of 1 kilometer. Currently, there are 2 main operating paratransit which are served areas along the mass transit corridors in Bangkok. These are (1) demand-based service - motorcycle-taxi, and (2) route-based service - Songtaew.

Figure3-2: Bangkok's present mass transit network
Source: http://johomaps.com/as/thailand/bangkok/bangkokmetro.html

Motorcycle-taxi service: There are more than 73,000 motorcycle-taxis by 2007. Their main role is to shuttle people up and down the Sois. They are managed by private associations. Motorcycle-taxi fares are more expensive than other paratransit on short trips and cannot be controlled by government. Nonetheless, they offer the fastest service. Motorcycle-taxi enjoyed the lion's share among access modes. This is because of their ability to beat traffic jams due to its advantages of flexibility, taxi-like service, compact size, and speed. Therefore, motorcycle-taxi is tailored for operating in high density areas of traffic. However, a trade-off between safety and less travel time is generally made by the travelers. The BMA has finally stepped into cleaning up the motorcycle-taxi business in 2003 which required operators to register motorcycle-taxi with the police. They must attend training sessions before official licenses are given and different colored vests are assigned to indicate areas where they work.

Songtaew service: A pick-up truck specially adapted to take passengers on the back with an overhead cage, two row seats, and stepped up the back that can move up to 14 passengers or more (Cervero, 2000). It operates as a fixed route service. Each route concession is awarded to the operators from Bangkok Mass Transit Authority, BMTA. All operating vehicles have to register for a license also and fares are controlled by BMTA. The services are managed by the concessionaires however. Though, Songtaew is a cost-effective mode, and has advantages over motorcycle-taxi on lower fares, longer service range, and more carrier capacity. Nonetheless, it offers long travel time and unreliable waiting because of its size and suffering from traffic congestion.

Base on the objectives in improving short-distance accessibility, the 5-kilometer catchment areas along mass transit corridors, BTS and MRT, in Bangkok were selected as the main study areas. The selected catchment areas of this study, somehow, are differed from the past studies, which normally based on acceptable walking distance fallen within 2 kilometers (Mitchell and Stokes, 1982: O'Sullivan and Morrall, 1996: Rastogi and Krishna Rao, 2003: Stringham, 1982). The reason is this research aims to grasp an influence of Songtaew services, which cover the service length of 3 to 5 kilometers (Cervero, 2000). However, Songtaew services are mainly available at two stations; MRT-Huay Khwang station and BTS-Onnut station, while motorcycle-taxi services are operating everywhere.

3.3 Data collection

3.3.1 Survey

Along BTS and MRT corridors in Bangkok, paper-based questionnaire surveys were performed using methodologies of household survey and on-site survey. Pick-up & drop-off and direct interview modes were implemented in the study areas. The on-site survey was conducted around the station areas in the evening (4.00 pm – 8.00 pm) during their return trips in order to earn ease of participation and gather the commuters living in specific areas. The respondents were interviewed individually by the survey staffs. For pick-up and drop-off survey mode, the survey staffs visited each household, asked for corporation and explained the questionnaire details. The respondents were requested to return the given questionnaires by mail after completion, preferably within two weeks.

Two data collections were performed at the selected areas. The first data collection was conducted during December 11-24, 2008, and the second survey was launched during December 17-24, 2009. The objectives of these two data collections are discussed below.

The main objectives of the fist survey are; (1) to explore present trip patterns in accessing mass transit stations and feeder capability of paratransit, (2) to capture commuter's attitudes towards present service quality of paratransit services, motorcycle-taxi and Songtaew, and satisfaction in accessing mass transit stations, and (3) to obtain commuter's future intention to use mass transit.

The main objectives of the second survey are; (1) to obtain commuter's present travel patterns and preferable travel choice consideration, and (2) to grasp commuter's attitudes towards present public transports, paratransit and the combination between paratransit and public transports, and personal preferences.

3.3.2 Questionnaire and data

3.3.2.1 Survey for mass transit access and commuter perceptions

The surveys mainly focused on short trips connecting between mass transit stations and residences or trip destinations which are access trip from home and the egress trip to destinations. The data obtained will be applied in the two main objective analyses; (1) present access mode and paratransit's feeder potential analysis and (2) Influences of commuter attitudes towards paratransit on mass transit access. All commuters were asked to explain their access and egress trips especially for access trip to mass transit stations in order to gather the current short access and egress trip patterns. In addition, present travel patterns were also collected. The target groups are commuters who regularly travel for work and study, and not only BTS/MRT users but also private vehicle users and public transport users such as bus and van passengers. Access and egress trips were classified into three main parts illustrated in Figure 3-3.

- *Part 1* is going from home/destination to find the mode for access to main streets or public transport services,
- *Part 2* relates to the access mode's usage i.e. motorcycle-taxi, Songtaew, Silor-lek, bus etc, and
- *Part 3* is a section to the mass transit stations/bus stops/van terminals after getting off the access mode.

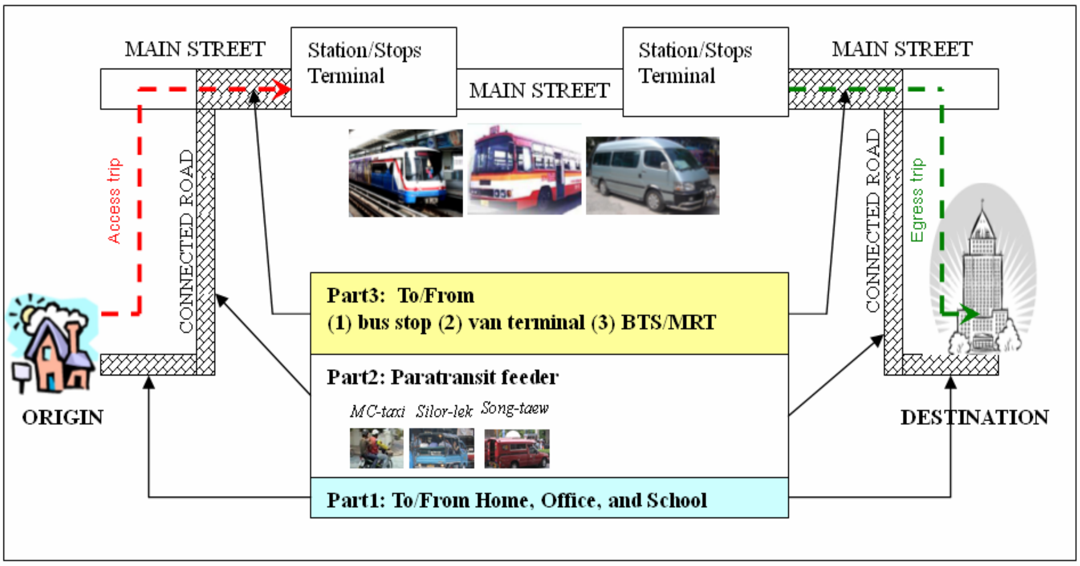

Figure 3-3: Access and Egress Trip definition

The final questionnaire designed to grasp the data mention above and important for achieving research objectives was included in the Appendix A and contained 4 sections as follows;

- *General question*: the respondents were asked about their socio-economics, residential area characteristics, and experiences of using mass transits and paratransit.
- *Present trip pattern*: respondents were asked to explain their trip patterns and details of access trip and egress trip - number of modes used, walking time, waiting time, in-vehicle time, costs and etc.
- *Mass transit access trip*: respondents were requested to explain their access trips to the stations in details as explained in present trip pattern.
- *Commuter's attitudes and future intention to use*: respondents were asked about their attitudes on access trip to mass transits and paratransit services. The attitudes were rated on four-point satisfaction scale ranging from "1 = very dissatisfied" to "4 = very satisfied" with the purpose of avoiding "no opinion" answer. Further, the questionnaire contained questions that ask the respondents whether they would decide to use paratransit (motorcycle-taxi and Songtaew) for their access trips and mass transits in the future.

3.3.2.2 Survey for commuter's travel choice consideration

The surveys focused on how commuters considered their choice options. Individual attitudes and preferences on available alternatives as well as present travel patterns of all travelers were also collected. The target groups were commuters, public transport users as well as private vehicle users, who regularly traveled for work, studied, and lived within the catchment areas of 5 kilometers from mass transit stations. It was intended to grasp use of motorcycle-taxi and Songtaew services. The surveys focused on how commuters considered their choice options. Individual attitudes and preferences on available alternatives as well as present travel patterns of all travelers were also collected.

The complete questionnaire was attached in Appendix B and contained four main sections, which are described below.

- *Present travel patterns*: respondents were required to explain their daily trips to work or education (mode and frequency), travel time and cost, and public transit usage in the last two months.
- *Travel choice consideration:* respondents were required to state the most preferable travel choice for their regular trips from thirteen choice options. These options consisted of all possible alternatives such as private vehicle, bus and van, mass transits, and combinations of paratransit and public transits.
- *Individual attitudes and preferences:* the preferences for car use, safety and security, risk assessment, and environmental concern were measured by using level of agreement. Individual attitudes to public transits and paratransit were also assessed by respondents. The attitudinal questions were set in terms of reasons that discourage usage of public transit services. All respondents were requested to rate their attitudes on a four-point scale, ranging from "1 = strongly disagree" to "4 = strongly agree" with the purpose of avoiding the "no opinion" answer.
- *General section*: the respondents had to provide demographic details as explained in the general question part of the first survey, which were used to prepare the demographic profile.

3.4 Discriminant Analysis

Discriminant function analysis or Discriminant analysis is a statistical technique with the main purpose to classify the dependent variable between two or more categories or groups. Discriminant analysis also has a regression technique, which is used for predicting the value of the dependent categorical variable. The procedure starts with a set of observations where both categories and the values of the independent variables are known. The procedure develops a model that allows prediction of group membership while only the independent variables are available. Another purpose of discriminant analysis is an understanding of the data set from the prediction model that can give insight into the relationship between group membership and the variables used to predict group membership. The discriminant analysis was used to predict the value of two categories from the beginning. To deal with more than two categories, the multiple discriminant analysis had been developed by an extension of the simple discriminant analysis. The most common application of discriminant analysis is to include several measures in the study, in order to determine the ones that discriminate between groups. For example, a marketing planner interested in predicting the companies interested in export business for further development would probably include as many measures of capital, size of company, number of products, number of staff, achievement motivation, etc. as possible in order to learn which one(s) offer the best prediction.

3.4.1 Important assumptions of discriminant analysis

There are important assumptions in discriminant analysis which are discussed as follows;

- *Sample size:* There must be at least two cases for each category of the dependent variable, and unequal sizes are acceptable. However, it is recommended that there should be at least 20 samples or four or five times as many cases as independent variables, while the maximum number of independent variables is (n – 2), where n is the sample size.
- *Variance:* No independents have a zero standard deviation in one or more of the groups formed by the dependent.
- *Homogeneity of variances:* Variance with each group of independent variables should be equal. It is better to review the within-groups variances and correlation matrices.
- *Non-multicollinearity:* If one of the independent variables is very highly correlated with another, or one is a function of other independents, then the tolerance value for that variable will approach 0 and the matrix will not have a unique discriminant solution. To the extent that independents are correlated, the standardized discriminant function coefficients will not reliably assess the relative importance of the predictor variables.
- *Normally distribution:* It is assumed that the predictor variables represent a sample from a multivariate normal distribution. However, violations of this assumption are not severe and the resultant significance tests are still reliable as long as non-normality is caused by skewness and not outliers (Tabachnick and Fidell 1996).

3.4.2 Computational approach

The basic concept of discriminant analysis is to determine whether groups differ with regard to the mean of a variable, and then to use that variable to predict group membership. Discriminant analysis is very similar to analysis of variance, ANOVA, and multivariate analysis of variance, MANOVA, in dealing with multiple variables. Discriminant analysis generally involves with step-wise analysis based on basis of two steps: (1) F test, Wilks' lambda, is used to test whether or not the discriminant model is significant as a whole, and (2) if the F test shows significance, then the individual independent variables are assessed to see which differ significantly in mean by group and these are used to classify the dependent variable. There are several methods of step-wise analysis such as forward stepwise analysis, backward stepwise analysis, F to enter & F to remove, and capitalizing on chance. The important terms and concepts of the discriminant analysis are as follows;

- *Variables*: there are two types of variables; (1) Discriminating variables is the independent variables called predictors, and (2) Criterion variable is the dependent variable called grouping variable, which is the object of classification efforts.
- *Discriminant function*: it is a latent variable which is developed as a linear combination of independent variables which can be simply explained as $Y = \beta_1 x_1 + \beta_2 x_2 + ... + \beta_n x_n + c$, where β's are discriminant coefficients, x's are discriminating variables, and c is a constant. This is the same as multiple regression, but the β's are the coefficients which maximize the distance between the means of the criterion variable. The discriminant function is estimated by using ordinary least-squares and, sometimes, using maximum likelihood estimation. Number of discriminant functions is determined by the lesser of (g - 1), where g is the number of categories in the grouping variable, or p, the number of discriminating variables. Each discriminant function is orthogonal to the others.

- *Discriminant score*: this is the value calculating from applying a discriminant function formula to the data for a given case. The score is the standardized discriminant score.
- *Standardized discriminant coefficients*: these are used to compare the relative importance of the independent variables, much as β weights are used in regression. Addition or deletion of variables in the model can change discriminant coefficients markedly.
- *Functions at group centroids*: these are the mean discriminant scores for each of the dependent variable categories for each of the discriminant functions. For example, two-group discriminant analysis has two centroids, one for each group. The larger the difference of means, the more clearly discriminating there likely will be.

3.4.3 Interpreting discriminant functions

It is important to interpret the contributions of functions obtained from the discriminant analysis. The power of classification and influences of each discriminating variable will provide better understanding for the researchers. The main important interpreting terms are explained below.

- *Structure coefficients and structure matrix:* they are the correlations between a given independent variable and the discriminant scores associated with a given discriminant function. They are used to explain how closely a variable is related to each function in multiple discriminant analysis. Researchers can assign a label to the dimension it measures by using the structure coefficients for a function. The structure coefficients are whole coefficients, similar to correlation coefficients, and reflect the uncontrolled association of the discriminating variables with the criterion variable. The discriminant coefficients are partial coefficients reflecting the unique, controlled association of the discriminating variables with the criterion variable, controlling for other variables in the equation. Thus, for example of two-categories, the structure coefficients show the order of importance of the discriminating variables by total correlation, while the standardized discriminant coefficients show the order of importance by unique contribution. The sign of the structure coefficient also shows the direction of the relationship. In case of multiple discriminant analysis, the structure coefficients additionally allow the researcher to observe the relative importance of each independent variable on each dimension.
- *Standardized discriminant function coefficients:* whereas the structure coefficients are used to assign meaningful labels or categories to the discriminant functions, the standardized discriminant function coefficients are used to assess the importance of each independent variable's unique contribution to the discriminant function.
- *Mahalanobis distance*: it is the distance between a case and the centroid for each category in attribute space (n-dimensional space defined by n variables). A case will have one Mahalanobis distance for each category, and it will be classified as belonging to the category for which its Mahalanobis distance is smallest. Because the Mahalanobis distance is measured in terms of standard deviations from the centroid, therefore a case which is more than 1.96 Mahalanobis distance units from the centroid, for example, has 95% of confidence level of belonging to the group represented by the centroid.
- *Wilks's lambda:* It is a measure of the difference between groups of the centroid (vector) of means on the independent variables. It is used to test the significance of each discriminant function in multiple discriminant analysis, particularly the significance of the eignevalue for a given function. Lambda varies from 0 to 1. The smaller the lambda, the greater the differences will be.

3.4.4 Validation of discriminant analysis

To test the classification power of discriminant function analysis, a hold-out sample method is often applied. It is a split halves test, were a portion of the cases are assigned to the *analysis sample* for purposes of developing the discriminant function, then it is validated by assessing its performance on the remaining cases.

3.4.5 Applications of discriminant analysis in transportation study

In transportation and urban planning fields, it is vital to understand the differences of people demographic, psychographic and attitudinal factors related to products they consume. The discriminant analysis has found to be a useful tool for analyzing market segmentation.

Burning et al., (1985) studied the effects of experiences and preferences of passengers in the process of consuming airline service attributes. The analysis results showed that environmental factors (convenience, economy and safety) and personality factor (life style) were discriminating variables; however, none of demographic variables were found significant. The results of each segment were used in developing strategic implications for airline marketing plans.

A multiple discriminant analysis was applied to examine the differences and similarities in residential movement patterns and motivations among generations - young, pre-elderly and elderly households – in Franklin County, Ohio metropolitan area (Morrow-Jones and Kim, 2009). This study expressed the effects of land use, needs of moving, and travel and accessibility related attributes based on the different age groups of home buyers. These results would be valuable information for planning transportation and housing in dealing with the future movements of each generation.

3.5 Feeder potential exploration

Past studies have provided fascinating insights into paratransit potential and capability and the future of paratransit in developing countries especially in terms of a feeder for urban transportation. To improve mass transit accessibility and manage the existing paratransit as a feeder system in the developing countries, the segmentation of mass transit access mode and the potential of paratransit to be integrated as feeder must be clearly understood. Therefore, this section is proposed to investigate the potential users of mass transit access modes and the classification factors, and to reveal the feeder capability of the existing paratransit. In addition, the obtained results can provide valuable information for the future urban transportation plans of many developing megacities.

A key hypothesis of this study is that certain issues will be more or less important to different access modes. The distance to a transit station will be the key affecting mode choices of access trip as mentioned by many researchers (Cervero, 2001: Kim et al., 2007: O'Sullivan and Morrall, 1996: Rastogi and Krishna Rao, 2003: Stringham, 1982). In the unplanned urban areas, urban sprawl and narrow alleys off the main roads impede the efficiency of public transport service coverage. This reduces an ability of direct access mass transit by using bus and makes people choose other available access modes. The ability to travel by private vehicle, determined from who own car or motorcycle and driving license, and individual experiences with paratransit could be the important factors affecting commuter's access choice. Moreover, commuter demographics, mass transit station characteristics and perceptions of paratransit services are also investigated. Not only mass transit users but also conventional public transport users and private vehicle users were included in the target groups.

The descriptive statistics is employed to examine present access patterns and capability of the existing paratransit services. The present travel modes including main line-haul and access mode will be determined as well as the modes accessing mass transit stations will also be explored. The descriptive statistical results will be explained based upon respondent demographics, travel patterns and etc. Thus, paratransit capability in terms of feeder service will be reviewed and evaluated.

Discriminant analysis is then applied to explore the extent to which different factors distinguish between the users of the four main access modes. Commuter's socioeconomic data, experience of using paratransit and perception of access trip to stations and paratransit services are introduced as analysis variables as well as access trip charateristics such as accessing distance and station characteristics and facilities. Furthermore, it is also applied to all available access modes in order to investigate more detailed explanation.

3.6 Attitudes and travel behavior

More understanding about travel behavior is important in the evaluation of transportation plans. It is extremely useful to know which group of people will use, how do they make decision on selecting travel choice and how do they perceive the transport services. In the empirical literature on travel behavior, most of travel choice models use modal attributes (e.g. travel time and cost) and commuter demographics (e.g. income and household cars) to explain the choice decision process. Nevertheless, those variables have not clearly explained the commuter's travel choice decision process that was affected by other unobserved factors driven travel choice decision. In recent years, many researchers have introduced commuter's preferences as latent variables to explain the consumer's black box in the empirical travel choice models. The preferences are measured and modeled mostly in terms of attitudinal and behavioral indicators towards all alternatives e.g. modal comfort, convenience, safety and security, car preference and pro-environment (Morikawa and Sasaki, 1998; Ben-Akiva et al., 1999; Ben-Akiva et al., 2002; Nilsson and Kuller, 2000; Morikawa et al., 2002; Johansson et al., 2005; Temme et al., 2008). In addition, Eagly and Chaiken (1993) have suggested that attitude towards the target, habits, and outcomes from norms and personal-identity might be significant in improving the prediction power of behaviors from attitudes. Psychologists generally describe attitudes into three types:

(i) *Perceptions*: this is the attitudes that encompass evaluative beliefs about the existence and attributes of an object or concept.
(ii) *Feelings*: this type can be defined as affective judgments of like or dislike.
(iii) *Conation*: this is the attitudes that encompass wishes, drives, instincts and inclinations to act purposefully.

The most attitudes related to travel behavior are perceptions and feelings. Past studies illustrated that there are strong causal relation ship between attitudes and behavior. Moreover, they also found that attitudes, particularly perceptions, are resulted by choices, whereas attitudes affect choices at the same time (Dobson et al., 1987; Golob and Hensher, 1988; Golob et al., 1979). The inclusion of latent variables outperformed the empirical choice model, and increased explanatory power and understanding of decision making process resulting from commuter's preferences. They found that there are many considerable personality traits that can be explored and aid a better understanding of the driving forces behind individual travel choice decision. Recently, it has been popular to study attitudes and behavior. Most of the studies considered travel choice behavior and attitudes by assuming to be a function of attitudes in the form of perceptions. To understand attitude-behavior relationships, Structural Equation Modeling, SEM, is one of the famous estimation methods designed for dealing with latent variables and capturing these causal relationships (Fujii and Kitamura, 2000; Garling et al., 2001; Golob and Hensher, 1988; Ghani et al., 2007).

3.7 Structural Equation Modeling

Structural Equation Modeling (SEM) is a general and powerful multivariate analysis technique to find the causal effects of the exogenous variables on the endogenous variables and the causal effects of endogenous variables upon one another. It is a relatively new method, having its roots in the 1970s. Most applications have generally been in psychology, sociology, the biological sciences, and market research. An application in travel behavior research has started from 1980. At present, use of SEM is rapidly increasing due to its powerful ability, familiarity of researchers and availability of user-friendly software.

The primary objective of SEM is to improve the statistical reliability of the relationship between the socioeconomic data and the estimation of factors. It is a confirmatory, rather than exploratory method. A structural equation model postulates a structure of the covariance matrix of the measures. Once the model's parameters have been estimated, the resulting model-implied covariance matrix can then be compared to an empirical or data-based covariance matrix. If the two matrices are consistent with one another, then the structural equation model can be considered a plausible explanation for relations between the measures. Estimation of SEM is performed using the covariance analysis method (method of moments). Goodness-of-fit tests are used to determine if a model specified by the researcher is consistent with the pattern of variance–covariance in the data.

SEM can handle a large number of endogenous and exogenous variables, as well as latent (unobserved) variables specified as linear combinations of the observed variables (Golob, 2003). The components in these equations comprise observed/measured variable and/or unmeasured, latent variables. Although not observed, these latent variables are related to the observed variables. The underlying structure assumed in SEM is a causal one among a set of latent variables with the observed variables taking the role of being their indicators. The latent variables may be linearly related to the indicator variables or may themselves be mediating variables in a causal chain. SEM has a unique ability to not only examine multiple relationships of dependence but also, and at the same time, examine numerous dependent variables. Multiple regression, simultaneous equations (with and without error-term correlations), path analysis, factor analysis, time series analysis, and analysis of covariance are all special cases of SEM. Thus, these make SEM more useful than general linear regression for hypothesis testing and easy to express the results using path analysis diagram.

3.7.1 Composition and variables

SEM with latent variables consists of two model components:

(i) *Measurement models* are the applications of confirmatory factor analysis (CFA) applied to examine the relationship between observed variables and latent variables as linear functions (weighted averages) of indicators in the system. There are two types of measurement models; a measurement sub model for the endogenous (dependent) variables and a measurement sub model for the exogenous (independent) variables.

(ii) *Structural models* are the applications used to find the causal influences (regression effects) of the exogenous variables on the endogenous variables and the causal influences of endogenous variables upon one another. (Bollen, 1989; Blunch, 2008).

There are two main variables related with SEM:

(i) *Observed variables* are the variables directly measured from the data (Byrne, 1998). There are two types of observed variables; (1) the endogenous observed variable i.e. behavioral statements and (2) the exogenous observed variable i.e. socio-economic, trip and modal attributes.

(ii) *Latent Variables* or *unobserved variables* are the variables not directly measured but determined by the relationships or correlations among the observed variables (Byrne, 1998). There are also two groups of latent variables; (1) the unobserved latent variables such as travel factors, and (2) the error terms associated with each variable involved in SEM.

3.7.2 Computational Approach

The conventional approach to SEM can be characterized as follows;

Model specification

Model specification is a statement of the theoretical model represented either as a set of equations or as a path diagram. Path diagram presents a picture of the relationships that are assured to hold. Measured variables are usually designated by a box. Latent variables including errors are represented by circles. Paths are represented by straight lines with an arrowhead pointing toward the effect variable, and covariances or correlations between exogenous variables and between disturbances are represented by curved lines with arrowheads at both ends. Path analysis distinguishes three types of effects, which are direct, indirect and total effects (Bollen, 1989). An important distinction in SEM is that between direct effects and total effects. Direct effects are the links between a productive variable and the variable that is the target of the effect. Each direct effect corresponds to an arrow in a path diagram. Total effects are defined to be the sum of direct effects and indirect effects, where the indirect effects represent the sum of all of the effects along the paths between the two variables that involve intervening variables. The total effects of the exogenous variables on the endogenous variables are sometimes known as the coefficients of the reduced-form equations.

It is statement of the theoretical model either as a set of equations or as a diagram. According to Joreskog and Sorbom (1982, 2004), Bollen (1989), and Byrne (1998), structural equation can be represented as,

$$\eta_{(m\times1)} = B_{(m\times m)}\eta_{(m\times1)} + \Gamma_{(m\times n)}\xi_{(n\times1)} + \zeta_{(m\times1)} \quad (3.1)$$

$$\left.\begin{aligned} y_{(p\times1)} &= \lambda_{y(p\times m)}\eta_{(m\times1)} + \varepsilon_{(p\times1)} \\ x_{(q\times1)} &= \lambda_{x(q\times m)}\xi_{(n\times1)} + \delta_{(q\times1)} \end{aligned}\right\} \quad (3.2)$$

Where $\eta' = \eta_1, \eta_2, ...\eta_m$ and $\xi' = \xi_1, \xi_2, ...\xi_n$ are latent dependent and independent variables respectively. B(m×m) and Γ(m×n)are coefficient matrices and $\zeta' = \xi_1, \xi_2, ...\xi_n$ is a random vector of residuals. The elements of B represent direct causal effects of η variables on other η variables and the elements of Γ represent direct causal effects of ξ variables on η variables. The vectors η and ξ are not observed; instead vectors $y' = y_1, y_2, ...y_p$ and $x' = x_1, x_2, ...x_q$ are observed. The vectors of errors of measurement in y and x are ε and δ, respectively. The matrices $\lambda_y(p \times m)$ and $\lambda_x(q \times n)$ are regression matrices of y on η and of x on ξ, respectively. The errors of measurement are assumed to be uncorrelated with η, ξ and ζ, but may be correlated among themselves. The structural equation model can be represented graphically as shown in Figure 3-4.

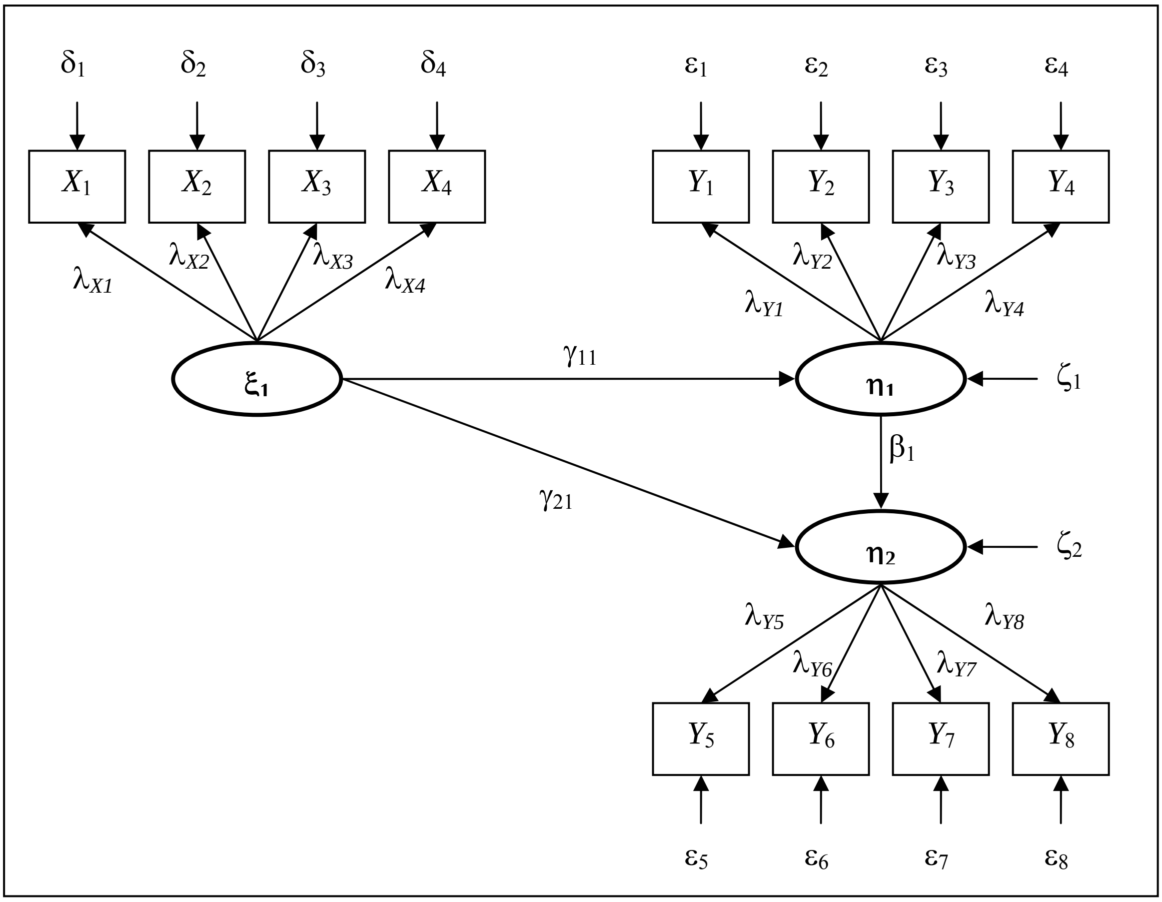

Figure 3-4: Conceptual SEM path diagram

If it is specified that there are no x and no ξ variables, the model (Equations 3.1 and 3.2) reduces to

$$\left.\begin{aligned} y &= \Lambda_y \eta + \varepsilon \\ \eta &= B\eta + \zeta \end{aligned}\right\} \qquad (3.3)$$

Which is an ordinary factor analysis model by specifying that there are no *x* variables and that *B* are zero matrixes, Equations 3.1 and 3.2 reduces to

$$\left.\begin{aligned} \eta &= \Gamma \xi + \zeta \\ y &= \Lambda_y \eta + \varepsilon \end{aligned}\right\} \qquad (3.4)$$

Sample and model identification

The sample size is one of the important factors affecting estimation power of SEM, and has received considerable attention. There are several consensus of the minimum sample sizes; (1) a minimum sample size of 200 is required to reduce biases to an acceptable level, (2) sample size should be at least fifteen times the number of observed variables or at least five times the number of free parameters in the model including error terms in case of Maximum likelihood estimation, and (3) with strongly kurtotic data, the minimum sample size should be at least ten times the number of free parameters (Golob, 2001).

Structural models may be just identified, over identified or under identified as stated by Bryne (1998). A just identified model is one in which there is a one to one correspondence between the data and the structural parameters. The number of data variances and covariances equals the number of parameters to be estimated. An over identified model is one in which the number of estimable parameters is less than the number of data points (i.e. variances, covariances of the observed variables). Further, an under identified model is one in which the number of parameters to be estimated exceeds the number of variances and covariance.

In SEM, the degrees of freedom of the model are equal to the difference between the number of free parameters in the model and the number of known quantities. For the standard specification, the number of known values is the number of covariances of the observed variables or Equation 3.5 given by Golob (2001).

$$t_{Konwn} = \frac{p_i(p_i + 1)}{2} \qquad (3.5)$$

Where, p is the number of observed variables.

In an over-identified model, only some of the possible parameters are free and many are restricted to zero (Golob, 2001). A just-identified SEM has zero degrees of freedom and fits perfectly. The most common ways of reducing model complexity are to eliminate weak regression effects, to reduce the number of indicators of each latent variable, and to minimize weak covariances between error terms. Estimation of a model is not possible if more than one combination of parameter values will reproduce the same data or covariances. Such an indeterminate model is termed to be unidentified, or under-identified.

Model estimation

The model estimation in SEM applied the fundamental principle of covariance analysis using simple matrix algebra. Covariance analysis performs by yielding parameter values such that the discrepancy between the sample covariance matrix and the population covariance matrix implied by model is minimal. The common SEM estimation methods currently applied are maximum likelihood (ML), generalized least square (GLS), weight least square (WLS), asymptotically distribution free weighted least square (ADF-WLS), and elliptical reweighted least square (EGLS). The most often used estimation method is the maximum likelihood. This method maximizes the probability that the observed variances are drawn from a population that has its variance-covariances generated by the process implied by the model, assuming multivariate normal distribution. The ML is considered to be more robust, with some exceptions, and yields estimators with good statistical properties. Thus, these make ML versatile and can be applied to most models and to different types of data, especially in transportation research.

Assessment of fit and modification
The most important part of SEM is to examine how well of the estimated results of one model does versus another. Many assessing criteria of the overall goodness of fit have been developed based on the basis of chi-square statistic (Bollen and Long, 1992; Joreskog and Sorbom, 2004). The common indices of goodness of fit measures are as follows;

- Overall chi-square measures
- Goodness-of-fit index, GFI
- Adjusted goodness-of-fit index, AGFI
- Root mean square residual, RMR
- Root mean square error of approximation , RMSEA

Finally, based on goodness-of-fit tests for a model, a travel demand modeler can take one of three different courses of action: (1) confirm or reject the model being tested based on the results, (2) two or more competing models can be tested against each other to determine which has the best fit, and (3) the cyclical modification process of alternative models based on changes suggested by test results can be performed until the model meets the standard of adequate or best fit (Golob, 2001).

3.7.3 Limitations and advantages of SEM

SEM cannot test directionality in relationships. The directions of arrows in a structural equation model represent the researcher's hypotheses of causality within a system. The researcher's choice of variables and pathways represented will limit the structural equation model's ability to recreate the sample covariance and variance patterns that have been observed in nature. Because of this, there may be several models that fit the data equally well. In spite of this, the SEM approach remains useful in understanding relational data in multivariate systems. The abilities of SEM to distinguish between indirect and direct relationships between variables and to analyze relationships between latent variables without random error differentiate SEM from other simpler, relational modeling processes.

The primary advantage of SEM is an ability to assess all pathways of a relationship simultaneously even though the dependent variable may become the indicator in a subsequent pathway. With regression analysis, such a model would have to be analyzed in separate regression runs where an allocated dependent variable played no other role. While SEM offers an ability to test all pathways at once, there are no statistical issues with a lack of connection between runs as you have with regression analysis.

Other advantages of SEM are expressed as follows:

- more flexible assumptions (particularly allowing interpretation even in the face of multicollinearity)
- ability to construct unobservable latent variables
- use of confirmatory factor analysis to reduce measurement error by having multiple indicators per latent variable
- ease of use of graphical modeling interface
- the ability to test models with multiple dependents,

- the ability to model mediating variables
- the ability to model error terms
- the ability to test coefficients across multiple between-subjects groups
- the ability to handle difficult data and large numbers of variables e.g. time series with auto-correlated error, non-normal data, incomplete data

3.7.4 Applications of SEM in transportation study

Recently, SEM has gradually introduced to be a tool for transportation studies in the last decade. Most of SEM practices were applied in dealing with latent variables that are commuters' behavior, attitude, and preference analysis that relate with travelers' choice decision and transit market segmentation.

Golob (2001) developed joint models of attitude and behavior using SEM to explain how both mode choice and attitudes regarding the San Diego I-15 Congestion Pricing Project differ across travelers. This study found that travelers' opinions and perceptions are attributable to mode choices, and public attitudes concerning acceptability, fairness and effectiveness of transportation project were the important attributes of project evaluation.

Shiftan et al., (2008) implemented an approach using SEM to identify simultaneously travelers' attitudes, travel behavior, and the causal relationships between a traveler's socioeconomic profile and attitude toward travel. The travel attitudes were used to identify distinct market segments and design strategies that best serve the needs of each segment and increase transit ridership.

A SEM was introduced to evaluate the trip-inducing effects of new freeways through the variables of commuters' daily activity pattern after work hours (Fujii and Kitamura, 2000). This model system explained the relation between time use and travel behavior and was use in evaluating the impacts of hypothetical freeway lines in Osaka-Kobe metropolitan area. Moreover, SEM was a useful analysis applied to examine effects of commuters' attitudes, values, and awareness of environment on willingness to reduce car use and pro-environmental behavior intentions (Nordlund and Garvill, 2003; Fujii, 2006).

From the advantages in explicitly dealing with latent variables, SEM was applied into the extended choice model and made a traditional Logit model and Multinomial Logit (MNL) model outperformed by simultaneously combine observed variables and latent variables (Temme et al., 2008; Dannewald et al., 2007; Johansson et al., 2005). The extended models enhanced explanatory power of travelers' mode choice decision by including travelers' attitudes and preferences in the traditional models. Besides, the latent variable part of the models expressed relations between the latent variables and observed variables, as well as causal relationships among the latent variables.

The SEM concepts have gradually been popular for the research regarding transportation in developing countries. The psychological factors affecting travel behavior were discussed their influences on travel mode choice and residential location choice by using SEM analysis (Sutomo et al., 2003; Choocharukul et al., 2008). These researches provided some insights and valuable information considering psychological factors for proposing and implementing Transportation Demand Management (TDM) strategies.

Fillone et al., (2005) proposed the divided groups of travelers namely private car users, public transport users who owned cars and captive public transport users in order to investigate and compare different preferences when they view urban travel especially for the second group. The obtained results gave useful information that important in the planning of new TDM schemes that could encourage use of public transport in Metro Manila.

Loomboonruang and Sano (2003) deployed SEM to set up utility function and perform traveler's modal choice by embodying traveler's attitudes. In addition, they employed SEM to test the hypothesis that access mode choice is affected by the public mode choice. The final results indicated that travelers are more likely to select public transport choice prior to making decision of access mode they will use. This rendered an importance of including an access mode variables and latent attitude variables on traditional public transport modal choice analysis.

The future of paratransit, angkutan kota, in Bundung, Indonesia, had been examined based upon user's satisfactions through the application of SEM (Joewono and Kubota, 2007). It discovered that future use and passenger's loyalty of the angkutan kota depended on its quality of service. Paratransit passengers expressed a willingness to use paratransit and to recommend it to others should there be an improvement in the future.

3.8 Commuter travel choice consideration

In developing cities, car riders seem to rely on commuting by their own cars and dissatisfactions of public transport services discourage commuter to patronize. Moreover, inadequate public transportation and poor land use plan posed difficulties in using public transport services especially on accessibility. Although, at present, paratransit services - motorcycle-taxi and Songtaew - become outperforming modes connecting between residential areas and main streets or public transports, their service qualities are only acceptable or unsatisfactory to commuters especially in the terms of unreliability, safety, and bad image that might discourage use of their services. Therefore, it is very crucial to know whether the commuters consider the combination between paratransit feeder and mass transits or public transport as their travel choice options while preparing for integrating paratransit into mass transit system and urban transportation. The hypothesis in this procedure is commuter's personal behavior and attitudes towards service qualities of paratransit and public transports affect their travel choice consideration while considering the combination of paratransit as an access mode.

3.8.1 Comparison of commuter behavior and attitude

In this step, the focus then will be to investigate the effects and interrelations of commuter's attitudes and behaviors considering the integration of paratransit into urban transportation based on their choice consideration. The results of this analysis could provide valuable information for the future mass transit development plans. There are three main travel choices for commuters: (1) *Private vehicle*: private cars and motorcycles that include of driver and passenger, (2) *Public transport*: bus, passenger van, BTS and MRT and access mode is not paratransit, and (3) *The combination*: bus, passenger van, BTS and MRT and access mode is motorcycle-taxi or Songtaew. Descriptive statistics, namely Mean difference analysis, is introduced to explain differences of attitudinal and behavioral variables among choice groups by using the combination choice as base. Thus, the significant differences in behavior and attitude between commuters who prefer the combination travel choice and the others shall be revealed.

3.8.2 Influences on commuter choice consideration

Also, factor analysis is applied to categorize the observed attributes in terms of attitudinal and behavioral measures, and facilitate the model development and accuracy. Structural Equation Model (SEM) is, then, applied to obtain the estimated influences of commuter's attitudes on their choice consideration. Three investigation models are constructed using the same latent variables of attitudinal and behavioral measures obtained from factor analysis. The three travel choices are examined and the important factors affecting mode selecting decision shall be recognized. The conceptual model is shown in Figure 3-5.

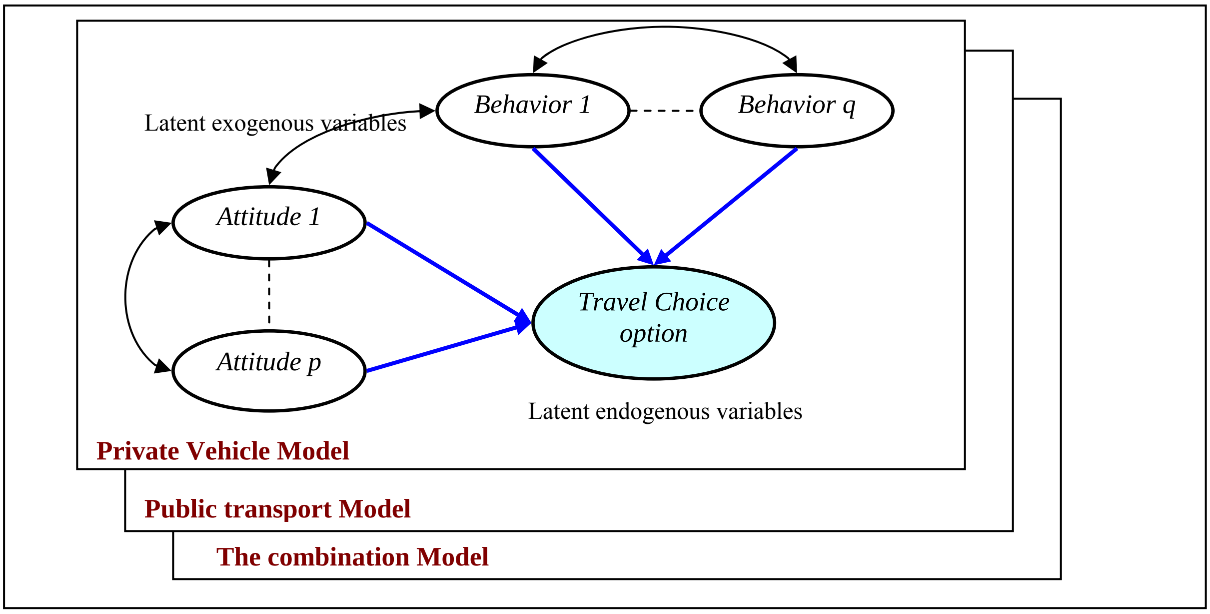

Figure 3-5: Conceptual SEM model for commuter travel choice consideration

3.9 Influences of commuter attitudes towards paratransit

The mobility improvement of the short-distance travel connecting mass transit stations and residences or destinations is too short to offset total travel time delays. As reviewed, latent variables such as preference and attitude towards travel modes become significant driving factors of the commuter's travel choice decision process. It is, therefore, important to understand commuter perceptions of paratransit services and the effects of such attitudes on access trip to mass transit stations as well as the intention of using paratransit and mass transits in order to fulfill the target of implementing paratransit as a feeder service.

3.9.1 Commuter's attitudinal assessments

The attitudinal preferences of com muters on the service quality of paratransit, motorcycle-taxi and Songtaew, and the access trip to mass transit station collected in terms of satisfaction scales are summarized into average scores. Thus, these could review how commuters assess the present service quality of motorcycle-taxi and Songtaew and their trips in accessing mass transit stations. These average scores provide valuable information to transportation planners which attributes regarding paratransit service and access trip to mass transit station should be concentrated. In addition, these also show the differences perceptions among several groups of commuters that are classified as follows;

- Overall commuters
- Mass transits experienced and non-experienced commuters

- Mass transit passengers and non-users
- Between commuters from different specific study areas
- Among commuters in different economic status

3.9.2 Influence investigation using Structural Equation Modeling

In order to develop Structural Equation Modeling (SEM), all collected satisfaction scores are applied in the factor analysis at first. This aims to categorize several attributes regarding satisfaction of paratransit service quality and access trip to mass transit station into main latent variables called service measurements. Moreover, this procedure also facilitates the SEM model development and accuracy. Factor analysis is applied to perform in the categorizing process by the analysis of moment structures, AMOS5.0 (Arbuckle, 2003). Then, all latent variables and related observed variables are deployed to construct the SEM model(s). The main targets are (1) to investigate interrelation between attitudes towards paratransit service and commuter's satisfaction of access trip to mass transit station, and (2) to explore whether such attitudes and satisfaction have any influence on the commuter's future intention to use paratransit as a feeder and mass transits.

This analysis is set into two main purposes of analyses. The influences of commuter's attitudes towards paratransit are examined by assessing commuter's attitudinal scores and investigating in SEM model.

Purpose I: this stage aims to discover the influences of attitudes to flexible for-hired service – motorcycle-taxi – and fixed route service – Songtaew – on commuter's satisfaction and willing to use by focusing on specific study areas. The specific study areas are selected based on the stations that Songtaew is regularly operating within the 5 kilometer catchment areas. In this stage, two main hypotheses will be examined as expressed below and the conceptual SEM model is illustrated in Figure 3-6.

- *Hypothesis1*: the attitudes to present paratransit's service qualities i.e. comfort and convenience and safety would affect commuter's satisfaction of trip accessing mass transit station.
- *Hypothesis2*: both attitudes towards present paratransit service qualities and satisfaction of mass transit station's access trip would influence the future intention to use of commuters.

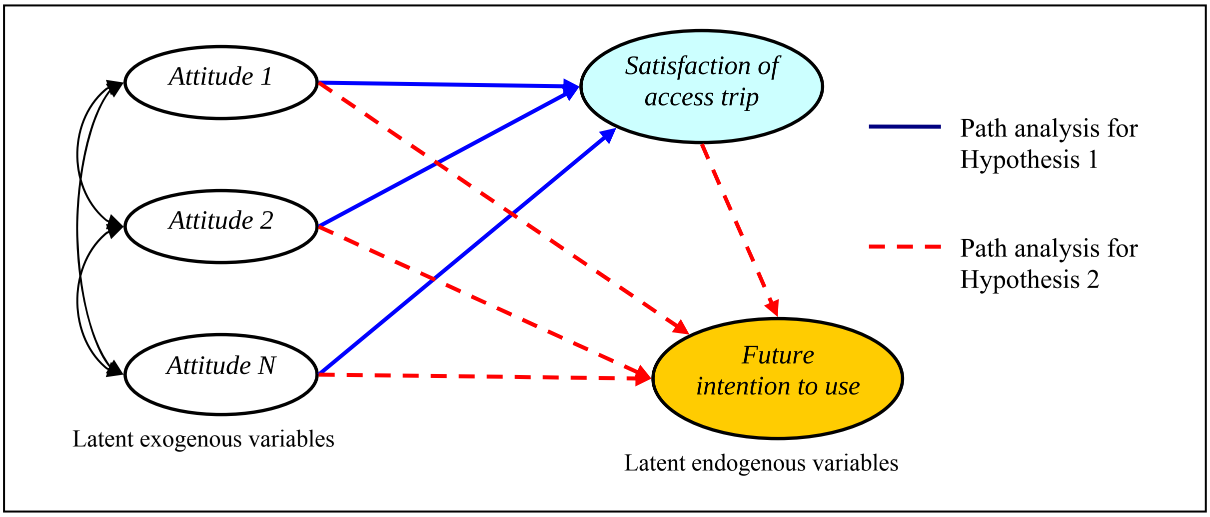

Figure 3-6: Conceptual SEM model of Stage I analysis

Purpose II: It is also necessary to observe how attitudes towards both types of paratransit affect the overall commuters along the mass transit corridors in order to introduce paratransit as a feeder for mass transit systems. This stage, therefore, aims to understand the differences in influences of paratransit's important service measurements on commuter's satisfaction of access trip to mass transit stations especially considering on different commuter's economic status. The main hypothesis here is differences in service measurements i.e. safety, comfort and convenience and information have various effects on commuters in different income groups. The conceptual SEM model of this stage is illustrated in Figure 3-7.

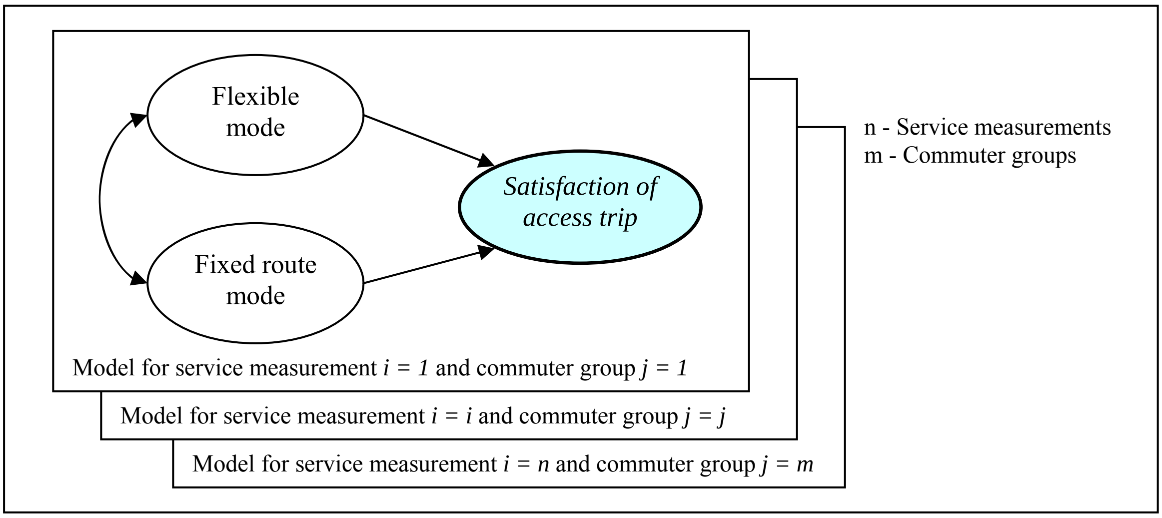

Figure 3-7: Conceptual SEM model for Stage II analysis

3.10 Policy development

The results obtained from all analysis processes are summarized and introduced as valuable information of drawing the proper policies for integrating paratransit as a feeder into mass transit systems. The effective management strategies for the existing paratransit services will be recommended based on their efficiencies. The factors related to paratransit's strengths and weaknesses will be used and utilized in policy development process. The merits of the developed framework of integrating paratransit as a feeder into mass transit systems will be postulated as valuable knowledge and useful contribution to developing countries.

CHAPTER 4

FEEDER POTENTIAL OF PARATRANSIT

4.1 Background

Difficulties in accessing transit stations can also hinder patronage of mass transit services in developing countries in addition to low service coverage and higher fare structures. Currently, there are no or only few systematic feeders provided for mass transit systems and some unplanned paratransit is functioning informally as a feeder. However, paratransit shows a capability of connecting people between their residences and transit stations. Therefore, the main purpose of this chapter is to understand the patterns of accessing mass transit station and to provide the beginning step of promoting integration of paratransit as a feeder into mass transit systems. An idea of integrating paratransit as a feeder system into urban transportation should not be overlooked in order to effectively utilize existing resources, advantages, and performances of paratransit for urban transportation planning. This approach aims to improve the performance of the existing transport modes that seem more financially and economically feasible for the developing countries. This chapter will cover the prospects of integrating the existing paratransit as a feeder into urban transportation, and to understand the potential of modes used in accessing mass transit stations through the case study of Bangkok. The potential patrons and important classification factors of each access mode are investigated, and the feeder capability of the existing paratransit is also revealed.

4.2 Objectives and approaches

The objectives of this study are (1) to explore the feeder capability of the existing paratransit operations, and (2) to understand the segmentation of modes accessing mass transit stations at present. Further, the potential patrons and important classification factors of each access mode are investigated. A key hypothesis of this study is that certain issues will be more or less important to different access modes. The important attributes influencing access mode choice decision will be observed and examined such as access distances, ability to use private vehicle, commuter demographics, mass transit station characteristics and perceptions of paratransit services. The descriptive statistics are introduced to discover present access modes and the feeder capability of paratransit. Further, both typical and multiple discriminant analyses are applied to examine the factors that could explain the segmentation of modes used in accessing mass transit stations.

4.3 Present access mode and feeder capability investigation

This chapter employs the survey data obtained from the first data collection explained in chapter 3, section 3.3.2.1. The areas within the distance up to 5 kilometers from mass transit stations along BTS and MRT lines in Bangkok were selected. It is for grasping Songtaew services, 3-5 kilometers. The study area's details are explained in chapter 3. The surveys focused on connectivity including access trip from home to the mass transit stations and egress trip to the destination. The attitudes and perceptions as well as present travel patterns were also collected. Access and egress trips were classified into three main parts as illustrated in Figure 3-3 of the chapter 3.

Questionnaire-based direct interview and pick-up/drop-off surveys were performed, using methodologies of household survey and on-site survey. The questionnaire contained 4 sections as follow;

- General question: respondents were asked about their socio-economics including experiences of using mass transits and paratransit.
- Present travel: respondents were asked to explain their travel patterns and details of access and egress trips – selected modes, walking time, waiting time, in-vehicle time, and costs.
- Mass transit access trip: respondents were requested to explain their access to the station in details as explained in present trip pattern.
- Commuter’s perception: respondents were asked about their perception on access trip to mass transits and paratransit services. The attitudes were rated on four-point satisfaction scale ranging from “1 = very dissatisfied” to “4 = very satisfied”.

Due to the limited survey duration and difficulties in approaching commuters’ houses, 600 copies of instruments were distributed, and a total of 200 effective samples from 257 returned questionnaires were used in the analysis process.

4.3.1 Respondent characteristics

The findings of personal demographics and household characteristics from questionnaires are summarized in Table 4-1 and Table 4-2. Form the effective respondents, 59% are female and 41% are male, 78% are in age between 21-40 years, around 14.5% are younger than 20, and 15% are older than 40. For their occupation, 47% work for private company and 26.5% are students. 75.5% of respondents own the at least bachelor degree. There are 31.5%, 31% and 37.5% of people who earned monthly less than 10,000 baht, 10,000 to 20,000 baht and more than 20,000 baht, respectively. The proportion of sample household with at least one car is 59% and the proportion of sample with at least one motorcycle was about 30.5%. Around 94.5% have experience with BTS or MRT and among this 43% of them use this service at least 2 days/week. As a result, 87%, 63.5% and 37% of respondents have experienced with motorcycle-taxi, Songtaew and Silor-lek (small 4-wheel vehicle), respectively.

4.3.2 Present travel mode and access trip characteristics

Present travel mode

Present travel mode of the respondents is illustrated in Figure 4-1. Around 34% are private car users and passengers, which consist of car drivers, motorcycle riders and ride sharing passengers. Regular public transports, bus and passenger van, owned 29% and Mass transits, BTS and MRT, shared 39% of the participants, respectively.

Present access and egress mode

Among public transit passengers, 57% are mass transit users, there are four most popular access modes that are walking, bus, motorcycle-taxi and Songtaew as illustrated in Table 4-3. Walking has the highest share, around 35%, especially for users of regular public transports, bus and passenger van. It can be concluded that public transport passengers prefer to go to the nearest stops or stations of public transports. The second mode is motorcycle-taxi (26%); the third are bus and Songtaew, around 11% each. Shares of bus and Songtaew are relatively high among mass transit users comparing with regular public transports as well as the share of ride sharing.

Table 4-1: Personal demographic data

Individual characteristics	Category range	Respondents	
		Number	%
gender	Male	82	41.00%
	Female	118	59.00%
Age	< 20 years old	29	14.50%
	21-40 years old	156	78.00%
	> 40 years old	15	7.50%
Education	Lower than bachelor	49	24.50%
	Bachelor or higher	151	75.50%
Occupation	Government officer	19	9.50%
	Private employee	94	47.00%
	Business owner	16	8.00%
	Student	53	26.50%
	labor	18	9.00%
Monthly income (Baht) 34 baht = 1 US dollar	< 10,000	63	31.50%
	10,000 – 20,000	62	31.00%
	> 20,000	75	37.50%
Car ownership	No	135	67.50%
	Yes	65	32.50%
Motorcycle ownership	No	176	88.00%
	Yes	24	12.00%
Ability to use private car or motorcycle	Unable to use	135	67.50%
	Able to use	65	32.50%
Paratransit availability	Motorcycle-taxi	190	95.00%
	Songtaew	122	61.00%
	Both	75	37.50%
Mass Transit Experience	No	11	5.50%
	Yes	189	94.50%
Motorcycle-taxi Experience	No	26	13.00%
	Yes	174	87.00%
Songtaew Experience	No	73	36.50%
	Yes	127	63.50%
Silor-lek Experience	No	126	63.00%
	Yes	74	37.00%

Table 4-2: Household characteristic data

Household characteristics	Category range	Respondents	
		Number	%
Household member	1	27	13.50%
	2	45	22.50%
	3	29	14.50%
	4	52	26.00%
	More than 4	47	23.50%
Household type	Private house	90	45.00%
	Rental apartment	79	39.50%
	Private condominium	25	12.50%
	Others	6	3.00%
Household car	None	82	41.00%
	1	64	32.00%
	2	31	15.50%
	More than 2	23	11.50%
Household motorcycle	1	139	69.50%
	2	36	18.00%
	3	14	7.00%
	More than 3	11	5.50%
Household commuter	1	52	26.00%
	2	71	35.50%
	3	37	18.50%
	More than 3	40	20.00%

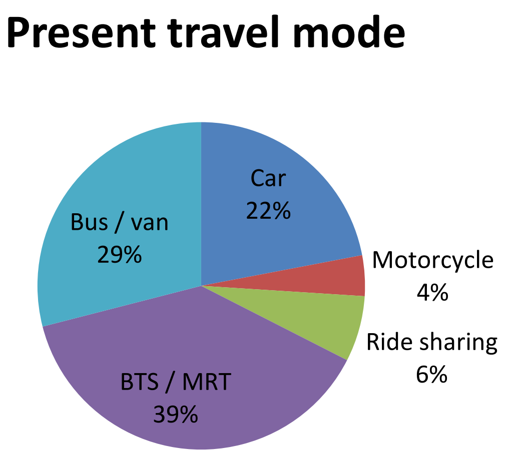

Figure 4-1: Present travel mode selection of the respondents

For egress trip, walking is, again, the most popular mode, which owned 67.41%, while motorcycle-taxi and Songtaew are the second and third, which owned 25.93% and 5.19%, respectively. The shares of motorcycle-taxi and Songtaew are relatively high among mass transit passengers as shown in Table 4-4.

Both motorcycle-taxi and Songtaew handled around 40% of the access trips and 30% of the egress trips among public transport riders, at present.

Table 4-3: Present access mode classified by public transportation users

Public transit classification	Number of users (person/percent)	Walk	Ride sharing	Bus related	MC-taxi related	Songtaew related	Silor-lek related	others
Mass transit	77 / 57%	27.03%	9.46%	16.22%	25.68%	13.51%	2.70%	5.41%
Regular public transit	58 / 43%	46.94%	4.08%	4.08%	26.53%	8.16%	4.08%	6.12%
All public transit	135 / 100%	34.96%	7.32%	11.38%	26.02%	11.38%	3.25%	5.69%

Table 4-4: Present egress mode classified by public transportation users

Public transit classification	Number of users (person/percent)	Walk	Ride sharing	Bus related	MC-taxi related	Songtaew related	Silor-lek related	others
Mass transit	77 / 57%	58.44%	-	1.30%	32.47%	1.30%	-	-
Regular public transit	58 / 43%	79.31%	-	-	17.24%	-	-	-
All public transit	135 / 100%	67.41%	-	0.74%	25.93%	0.74%	-	-

4.3.3 Mass transit access trip characteristics

The modal shares of accessing mass transit stations are expressed in Table 4-5. From the obtained data, there are seven modes used in accessing mass transit stations; walking, Park and Ride (P&R), Kiss and Ride (K&R), bus, motorcycle-taxi, Songtaew and the combination between bus and paratransit. This study classifies mass transit access modes into four main alternatives that are walk, car-related alternative (P&R and K&R), flexible mode (motorcycle-taxi), and fixed-route alternative (Songtaew, bus, and combination between bus and paratransit).

The three most popular modes accessing mass transit stations were walking (27.5%), motorcycle-taxi (18%), and bus-related alternatives (25%), which this alternative includes of bus and combination between bus and paratransit). This finding corresponded to the previous study (Chalermpong and Wibowo, 2007). However, car-related alternatives, P&R (17.5%) and K&R (7%), became one of the determinant access modes while considering all commuters not only mass transit passengers as reviewed from the previous study. Walking was the dominant mode for the distances within 1 kilometer between homes and stations. Motorcycle-taxi was the most famous mode in the distances of 1-2 kilometers. P&R and fixed-route alternative were more preferable for the distances more than 2 kilometers. Only 10.5% of commuters were able to directly access mass transit stations by bus, and most of them lived in the distances between 1 and 3 kilometers. P&R, motorcycle-taxi, and combination of bus and paratransit alternatives were the preferred access modes for commuters who unable to access directly by bus. Among commuters who were unable to use private vehicles, motorcycle-taxi, bus, and combination of bus and paratransit were more preferable. Other than car or motorcycle, motorcycle-taxi was the most preferable for respondents who were able to use their private vehicles.

This study classified commuters into three main groups based on availability of data that are (1) low income- those who earned less than 10,000 bath a month, (2) middle income - those whose incomes were 10,000-20,000 baht, and (3) high income - those who obtained revenue more than 20,000 baht. From Table 4-5, walking was the determinant alternative for all commuters. This was because around 30% of low and middle income and 47% of high income commuters lived within the distances of 1 kilometer from the stations. Bus and combination of bus and paratransit could handle around 30% of low and middle income groups. Songtaew and K&R had the highest shares for the low income while they owned the lowest shares for the high income. It could be explained that Songtaew offered relatively low fares but it did provide longer and unreliable travel time. In addition, students were included in the low income groups and they seemed to rely on the K&R alternative. Motorcycle-taxi possessed the largest share among the middle income. P&R and motorcycle-taxi became the most preferable access modes for the high income. This could be discussed that driving car was convenient and motorcycle-taxi offered faster travel time and the fare was considered acceptable.

Table 4-5: Mass transit access characteristics

Category	Walk	Car-related alternative		Flexible mode	Fixed route alternative		
		P&R	K&R	MC-	Songtae	Bus	Bus-paratransit
Access distance							
Access <0.7km	81.6%	2.0%	-	16.3%	-	-	-
Access 0.7-1.0 km	45.8%	4.2%	4.2%	29.2%	4.2%	8.3%	4.2%
Access 1.0-2.0 km	6.5%	17.4%	8.7%	34.8%	6.5%	21.7%	4.4%
Access 2.0-3.0 km	3.1%	28.1%	9.4%	12.5%	9.4%	12.5%	25.0%
Access > 3.0 km	-	32.7%	12.2%	4.1%	4.1%	10.2%	36.7%
Income category							
less than 10,000	22.2%	14.3%	14.3%	7.9%	7.9%	12.7%	20.6%
20,000 - 30,000	21.0%	14.5%	4.8%	22.6%	4.8%	12.9%	19.4%
more than 30,000	37.3%	22.7%	2.7%	22.7%	1.3%	6.7%	6.6%
Ability to use private							
Unable to drive/ride	27.4%	3.2%	10.5%	16.9%	6.5%	15.3%	20.2%
Able to drive/ride	27.6%	40.8%	1.3%	19.7%	1.3%	2.6%	6.6%
Direct access by bus							
Unable to access	30.7%	19.6%	7.8%	20.1%	5.0%	-	16.8%
Overall commuters	27.5%	17.5%	7.0%	18.0%	4.5%	10.5%	15.0%
Average access distance (km)	0.61	2.79	2.70	1.45	2.34	2.31	3.21

Based on the survey results, paratransit showed the potential to serve as an access mode to the mass transits. Both flexible for-hire and fixed route paratransit (motorcycle-taxi and Songtaew, respectively) attested their capabilities to handle around 40% of mass transit access trips especially for the distances between 1 and 3 kilometers.

4.4 Access mode segmentation

This chapter applied two types of discriminant analysis to investigate the important factors for determining the modes accessing mass transit stations. First, a multiple discriminant analysis was applied to explore the factors that could classify users of the four main modes accessing mass transit stations. Second, a typical discriminant analysis was employed to obtain the factors that could support more details in segmenting all available access modes. All available access modes were investigated using the typical discriminant analysis one by one. Commuter's socioeconomic data, experience of using paratransit and perception of access trip to stations and paratransit services are introduced as analysis variables as well as access trip charateristics such as accessing distance and station characteristics and facilities.

4.4.1 Main access mode analysis

Three functions were produced to explain the classification factors of each main access mode by applying the multiple discriminant analysis. Each mode's cases were used to calculate a mean for that group on each function as shown in Table 4-6.

On Function 1, the walk group has the largest positive mean (2.049) and the other groups have negative means or almost zero, indicating that this function will be best to distinguish the walk group from the others. The distances in particular within 1 kilometer from the stations are the important factors of those who decided to walk as expressed by standardized canonical coefficients that are 1.165 for the distance shorter than 0.7 kilometer and 0.817 for the distance of 0.7-1 kilometer. This result corresponds with an average walking distance of 0.61 kilometer. The distance of 1-2 kilometers also becomes positive. This could be the influence of motorcycle-taxi's mean. However, the results indicate that those who have more Songtaew experiences and are able to access directly to bus are potentially not accounted in the walk group.

Table 4-6: Multiple discriminant analysis results

		Function 1	Function 2	Function 3
Means of the discriminant function	Walk	2.049	0.375	-0.179
	Car-related alternative	-0.778	-1.027	-0.284
	Flexible mode (MC-taxi)	0.396	-0.463	0.624
	Fixed route alternative	-1.558	0.847	0.003
Standardized canonical discriminant function coefficients of the variables	Distance < 0.70 km	1.165	0.371	-0.008
	Distance 0.70 – 1.00 km	0.817	0.200	0.593
	Distance 1.00 – 2.00 km	0.401	-0.166	0.877
	Ability to use private vehicle	0.112	-0.573	-0.353
	Direct access bus	-0.435	0.705	-0.197
	More Songtaew experience	-0.144	0.373	0.132
% of correctly classified = 67.0%	Eigen value	2.069	0.559	0.106
	Canonical correlation	0.821	0.599	0.309
	Wilkes Lambda	0.189	0.508	0.904
	Significant (Pr<F)	< 0.0001	< 0.0001	< 0.0001

The means on Function 2 indicate that this function will be better at distinguishing the car-related and motorcycle-taxi groups from the fixed route alternative group (the fixed-route alternative's mean is positive and the other 2 groups' means are negative). The ability of direct access by bus and often use of Songtaew are the influential variables in distinguishing the fixed route alternative users, while an ability to use private vehicle and a distance of 1-2 kilometers can strongly differentiate the car related group and motorcycle-taxi users from the former.

In addition, the means of Function 3 better define the differences between motorcycle-taxi and car-related alternative. The distances between 0.7-2.0 kilometers, especially 1-2 kilometers, are the strong variables in distinguishing motorcycle-taxi users from the car related group which significantly be defined by the ability to use private vehicles. The quality of a discriminant analysis can be examined by a classification matrix. The developed models were applied to classify all the cases and then tally how the classification was correct. Overall 67% of the cases were correctly classified. This indicates the ability to distinguish between the modes of accessing mass transit stations. The classification functions correctly classified 72.7% of the walk, 64% of the car related alternative, 57.9% of the motorcycle-taxi, and 75.4% of the fixed route alternative. It is interesting that the functions were somewhat less successful in categorizing the motorcycle-taxi. When the motorcycle-taxi was misclassified, it was more likely to be assigned to the car-related or the walk groups. This supports the means of the discriminant functions discussed earlier, that motorcycle-taxi users sometimes were more like the walk group and sometimes were more like the car related group.

4.4.2 All access mode analysis

Table 4-7 presents the discriminant analysis results for all available access modes included in the four main alternatives. As discussed earlier, the distances within 1 kilometer were the driving factors that increase the propensity for walk, and impeding causes of driving to the stations. Motorcycle taxi became the competitive mode to walk in distances between 0.7 and 1 kilometer, and it was a preferable mode for people who were able to reach the stations by using only 1 public transport mode. However, motorcycle-taxi was unfavorable for low income commuters. This could be the effects of its higher fare. Songtaew, bus, and the combination alternatives were the popular modes for the access distance longer than 2 kilometers. Direct access by bus strongly influenced commuters to use bus rather than other fixed route alternatives. Not only the long distance but also experiences of Songtaew and satisfaction with Songtaew's ability to reach close to destinations were the classification factors of the users of Songtaew and the combination of bus and paratransit modes. An ability to use private vehicles and large park and ride facilities is the best classification factor of driving to the stations. It is interesting that motorcycle-taxi experienced commuters and a presence of motorcycle-taxi discouraged the driving option. Students and female office workers are the potential car sharing passengers in lieu of bus patrons. This could possibly be that they were unable to drive. Moreover, Songtaew inexperienced and pessimistic commuters were also categorized into K&R in addition to an availability of large park and ride.

Table 4-7: Discriminant analysis of each mode accessing mass transit station

	Walk	P&R	K&R	MC-taxi	Bus	Fixed-route alternative
Age < 20 years			0.991		-0.336	
Female office worker			0.412		-0.233	
Income < 10,000 baht/month				-.0.354		
Distance < 0.70 km	1.104	0.518				-0.333
Distance 0.70 – 1.00 km	0.620	0.382		0.353		
Distance 1.00 – 2.00 km				0.742		
Distance 2.00 – 3.00 km					0.448	0.420
Distance > 3.00 km					0.694	0.572
Large Park and Ride facility		-0.231	0.395			
Ability to use private vehicle		-0.810			-0.483	-0.603
Direct access bus		0.252			0.900	-0.579
Ability of using 1 access mode				0.389		
Motorcycle-taxi availability		0.228				
Motorcycle-taxi experience		0.325				
Songtaew experience						0.385
Songtaew reach destination						0.285
Songtaew know but never used			0.396			
Means of “use” function	1.857	-1.717	1.621	1.029	2.040	1.477
Means of “not use” function	-0.704	0.364	-0.122	-0.226	-0.609	-0.358
Eigen value	1.321	0.631	0.200	0.235	1.256	0.534
Canonical correlation	0.754	0.622	0.408	0.436	0.746	0.590
Wilkes Lambda	0.431	0.613	0.833	0.810	0.443	0.652
Significant (Pr<F)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
% of correctly classified	88.0%	85.0%	93.0%	83.5%	92.0%	88.7%

4.5 Summary

This chapter was set out to discover the potential patrons of the modes used in accessing mass transit stations and to reveal the feeder potential of the existing paratransit in developing countries through the case study of Bangkok. This study explored several important factors for categorizing each access mode’s characteristics and rendered one of the important steps to achieve the policy for enhancing mass transit systems in developing countries by improving accessibility and connectivity of mass transit. The existing paratransit modes, motorcycle-taxi and Songtaew, were found to be potentially integrated as a feeder system into mass transit systems. They could handle almost 40% of trips accessing to the stations especially in the distances longer than 1 kilometer. However, the two types of the existing paratransit services differed in their effective service areas and potential users. People living in the ranges of 1 to 2 kilometers from transit stations mostly accessed the stations by motorcycle-taxi. It is because motorcycle-taxi offers higher speed and demand responsive service that satisfy commuter’s need. However, the higher fare structure per travel distance of motorcycle-taxi can attract only high income and some of middle income commuters. In the distances longer than 2 kilometers, car-related alternative and fixed-route alternative became more preferable. Songtaew offers low fare per travel distance and better riding safety image that make Songtaew more preferable for long distance travel and low income people comparing with motorcycle-taxi.

CHAPTER 5

PARATRANSIT AND TRAVEL CHOICE CONSIDERATION

Plying the streets of Bangkok, motorcycle-taxi and Songtaew were reviewed their dexterity of feeder along mass transit corridors in chapter 4. Both types of paratransit have significantly performed serving commuters in accessing to mass transit stations especially in the distance beyond 1 kilometer. Each type of paratransit has its own effective service areas and potential users. The obtained results could provide valuable information for promoting paratransit as a feeder in urban transportation of the developing countries. However, the pessimism of accidental risks, night-time crimes, unreliable services and travel time, and images of informality are the critical drawbacks of paratransit services that hinder their patronages. These drawbacks might impair the overall public transport because access is the start of trips using public transport. It is, therefore, important to understand that do and how commuters consider a combination between paratransit and public transports, particularly mass transit, as one of their travel choice in order to promote an integration of paratransit as a feeder system into urban transportation. This chapter is, therefore, launched to cover the commuter choice consideration influenced by personal behavior and attitudes to the integration of paratransit and public transport.

5.1 Background

Over the last two decades, motorized paratransit, e.g. motorcycle-taxi in Bangkok, jeepney in Manila, and van in Indonesia and Rio de Janeiro, has continued their dominant function as a feeder in several developing cities due to their services satisfying captive riders in terms of mobility. According to the growth of motorization and public transit deficiency, people in urban areas are discouraged to use public transport and car users have become more car-dependent riders, notwithstanding the fact that mass rapid transits, such as BRT, and rail transit have been inaugurated. Inefficient land use plans and low service coverage have caused difficulties in accessing public transports. In addition, there are only few feeder systems provided. At present, a combination of paratransit as a feeder and public transports has become one of typical choices for commuters in major developing cities, particularly in Bangkok, and this will continue into the future. Paratransit services, nevertheless, have not been systematically considered or included in the urban transportation systems and planning. Since present operating paratransit is partially controlled, the services provided by paratransit modes are regarded as unsafe, uncomfortable, inconvenient and unreliable services. These shortcomings might discourage use of paratransit and affect choice consideration of overall commuters especially in terms of attitudes towards paratransit services. In addition, there are varieties of commuters and alternative travel modes in developing countries. Commuter behavior and preferences will be important keys not only for their travel choice decisions but also for the future development of integrating paratransit into urban transportation policy. Understanding of effects of paratransit on commuter’s choice consideration should be enriched with the previous research findings to fulfill the strategy of integrating paratransit to urban transportation. However, effects of paratransit on commuter’s choice consideration have rarely been scrutinized. Therefore, this study covers the prospects of integrating paratransit as a feeder system into urban transportation. The primary objective is to investigate the influences of the integration of paratransit and public transport on commuter’s travel choice consideration based on personal attitudes and behavior.

5.2 Objective and approach

In developing cities, car riders seem to rely on commuting by their own cars and dissatisfactions of public transportation discourage use of commuters. Moreover, inadequate public transportation and poor land use plan posed difficulties in using public transport services especially on accessibility. At present, there are varieties of public transportation modes provided in Bangkok; however, the two main public transits are (1) bus and passenger van, and (2) rail transit systems. Bus and passenger van are operated by Bangkok Mass Transit Authority (BMTA) that could handle around 6.228 million passenger-trip/day (OTP, 2009). Rail transits consist of 23-km elevated rail system, namely BTS, and 20-km subway line, called MRT. From the data of Office of Transport and Traffic Policy and Planning in 2009, these two rail systems handled around 0.548 million passenger-trip/day. As a result of traffic congestion, low level of bus service, and small coverage areas of rail transits, a share of private car and motorcycle is around 8 million passenger-trip/day. Currently, the number of bus users is decreasing; however, passengers of 2 rail transits are increasing and extension plans of rail transit are under the process. At present, paratransit, both motorcycle-taxi and Songtaew, shows their dominant role in shuttling people between their houses and main streets. This reflects their capabilities in terms of feeder function. In addition, past studies provided useful information regarding paratransit performances, their perceptions in passenger's point of views, and the future of paratransit in developing countries. The perspective of integrating paratransit as a feeder into urban transportation is very interesting. However, paratransit quality of services is only acceptable or unsatisfactory to commuters especially in the terms of unreliability, safety, and bad image that might discourage use of their services. Therefore, careful consideration should be done while planning to integrate paratransit into urban transportation.

To achieve this perspective, commuter's attitudes and their interrelations on travel choice consideration must be clearly understood. The integration of paratransit as a feeder might impact commuter's choice consideration to the overall commuters, both public transit users and car riders. However, effects of the paratransit combination on commuter's choice consideration have rarely been discussed. As mentioned above, the combination of paratransit as a feeder affects commuters not only on comfort and convenience but also on reliability, traffic safety, and image of using public transit.

In this research, the focus then will be to investigate the effects and interrelations of commuter's attitudes and behaviors considering the integration of paratransit into urban transportation based on their choice consideration. In addition, the areas along the rail transit lines in Bangkok are intentionally selected as a case study. Since the extension plans of rail transits are under the process, the results of this study could provide valuable information for the future urban transportation plans. Descriptive statistics is introduced to explained differences of attitudinal and behavioral variables among choice groups, and Structural Equation Model (SEM) is applied to obtain the estimated influences of commuter's attitudes on their choice consideration. However, the travel choice model is not considered in this study.

5.3 Findings

5.3.1 Respondent backgrounds and demographics

The 318 effective samples from 113 returned samples and 292 interviewed samples were used in the analysis. The main gender of respondents is female (73 percent). Ages of respondents are between 15 and 58 years old, which approximately 82 percent of them completed bachelor degree at least. Most of respondents are private company staffs (31 percent), workers/laborors (30 percent), and students (24 percent). Around 35 percent of respondents earn monthly salaries less than 10,000 baht, while 53 percent of them earned 10,000 – 20,000 baht. In addition, only 22 percent and 8 percent of them are able to use private cars and motorcycles, respectively. Other respondent's demographics are shown in Table 5-1.

Table 5-1: Respondent demographics

Individual characteristics	**Category range**	**Respondent**		**Individual characteristics**	**Category range**	**Respondent**	
		No.	**percent**			**No.**	**percent**
Gender	Male	85	26.73%	**Ability to use car**	unable to use	250	78.62%
	Female	233	73.27%		able to use	68	21.38%
Age	15 - 25	126	39.62%	**Ability to use motorcycle**	unable to use	294	92.45%
	25-60	192	60.38%		able to use	24	7.55%
Education	Lower than bachelor	57	17.92%	**Household motorcycle**	0	283	88.99%
	Bachelor or higher	261	82.08%		1	29	9.12%
Occupation	Gov Officer	16	5.03%		2	5	1.57%
	Private company	98	30.82%		more than 2	1	0.31%
	Own business	20	6.29%	**Household car**	0	238	74.84%
	student	79	24.84%		1	62	19.50%
	worker/labor	97	30.50%		2	13	4.09%
	unemployed	8	2.52%		more than 2	5	1.57%
Monthly income	< 10,000	112	35.22%	**Household type**	Private house	53	16.67%
	10,000 – 20,000	167	52.52%		Apartment	265	83.33%
	> 20,000	39	12.26%				

5.3.2 Present travel and travel choice consideration

Among effective samples, 314 respondents commute to work and study for their daily trips, and the remaining 4 respondents work at their residences. The present travel patterns of respondents were classified as follows; (1) car-dependent riders (8.60 percent) – commuters who used only car or motorcycle and rarely used public transport, (2) choice riders (6.69 percent) – commuters who used both car/motorcycle and public transport, (3) public transport -only users (42.99 percent) – bus, passenger van, BTS and MRT users, and (4) combination of paratransit and public transport users (41.72 percent) – commuters who used paratransit, motorcycle-taxi and songtaew, as a feeder and public transport as a main mode. Men had higher proportion of car users, car-dependent riders and choice riders. In contrast, women seemed to rely on public transports including the combination of paratransit feeder alternatives as presented in Table 5-2.

In the present travel choice consideration, this study could not classify commuter choice options into car-dependent riders and choice riders due to the limitation of questionnaire instruments. As a result, the commuter choice considerations were observed and categorized as (1) private vehicle (12.74 percent) – car and motorcycle, (2) public transport-only (67.83 percent) - bus, passenger van, BTS and MRT, and (3) combination of paratransit and public transport (19.43 percent). Men still had higher proportion of using car or motorcycle. Women tended to use combination of paratransit and public transport more than men did. However, public transport-only choice was increasing while choice of paratransit combination was decreasing for both male and female as illustrated in Table 5-2.

Table 5-2: Present travel pattern and choice consideration

Present travel pattern				Present choice consideration			
Travel choice	**Overall**	**Male**	**Female**	**Travel choice**	**Overall**	**Male**	**Female**
Car-dependent	8.60%	34.52%	44.35%	**Private vehicle**	12.74%	21.43%	9.57%
Choice rider	6.69%	39.29%	44.35%				
Public transport-only	42.99%	15.48%	6.09%	**Public transport-only**	67.38%	65.48%	68.70%
Paratransit and Public transport	41.72%	10.71%	5.22%	**Paratransit and Public transport**	19.43%	13.10%	21.74%

How each type of commuters considers their most preferable choice for daily trips is shown in Table 5-3. Car-dependent riders strongly relied on driving. Also, 63 percent of choice riders chose car or motorcycle; however, 32 percent chose public transport-only and 5 percent selected a combination of paratransit and public transport. Most of the public-transport-only users (90 percent) chose the same travel pattern. It was interesting that 63 percent of combination of paratransit and public transport group shifted to the public-transport-only alternative. These results highlighted the assumptions that car riders tended to rely on driving and partransit services affected commuter's choice consideration.

Table 5-3: Present choice consideration of each commuter group

		Present choice consideration		
		Private vehicle	**Public transport-only**	**Paratransit and public transport**
Present travel pattern	**Car-dependent**	100%	-	-
	Choice rider	63.16%	31.58%	5.26%
	Public transport-only	0.74%	90.44%	8.82%
	Paratransit and public transport	-	63.64%	36.36%

5.4 Attitudinal and behavioral measures

5.4.1 Factor analysis and latent variables

From the assumptions of this study, different commuter's attitudes and behaviors on available alternatives have some effects on travel choice consideration especially from paratransit services. This section aims to categorize the observed attributes in terms of attitudinal and behavioral measures. This process not only classifies the observed data into main measures, but also facilitates the model development and accuracy (Kaplan, 2009; Shrestha et al., 2007). Confirmatory factor analysis (CFA) based on the significant criteria of 5% significance was conducted to perform in the categorizing process by the analysis of moment structures, AMOS5.0 (Arbuckle, 2003; Blunch, 2008). The model was assessed by multiple fit indices including chi-square (χ^2), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), root mean square residual (RMR), and root mean square error of approximation (RMSEA). The χ^2/df value is 1.82, which is less than 3. The fit indices of the established model can be explained by the RMR, 0.047, and RMSEA, 0.051, that satisfy the assessed criteria of less than 0.10 and 0.08, respectively. The GFI and AGFI values were 0.865 and 0.791 respectively that means around 80 percent of the co-variation in the data could be represented by the given CFA. The recommended values of GFI and AGFI are 0.90 and 0.80. Even though the indices obtained from CFA could not reach the recommended values, the model, however, could be concluded as reasonably good fit. The 12 factors were made based upon the variables that load on each factor. The factors obtained from CFA were classified into 8 main factors of attitudinal measure and 4 factors of behavioral measure as shown in Table 5-4. The standardized factor loadings were listed in Table 5-5a, 5-5b and 5-5c. The factor lodgings, the values greater than 0.4, were selected to construct the latent variables of attitudinal measure and behavioral measure.

Table 5-4: Latent variables of attitudinal measure and behavioural measure

Attitudinal Measure' s latent variables				**Behavioral Measure's latent variables**	
Items	**description**	**Items**	**description**	**Items**	**description**
ATT 1	Access to public transit	ATT 5	Risks of the combination alternative	BEH 1	Car preference
ATT 2	Personal convenience	ATT 6	Using environment of the combination alternative	BEH 2	Environmental concern
ATT 3	Difficulties of the combination alternative	ATT 7	Fare suitability of the combination alternative	BEH 3	Risk assessment
ATT 4	Images of the combination alternative	ATT 8	Comfort of the combination alternative	BEH 4	Safety and security

5.5 Descriptive statistics

Table 5-5a, 5-5b and 5-5c showed descriptive statistical analysis of differences in attitudinal and behavioral ratings assessed by three choice consideration groups. The private vehicle selecting and public transit selecting groups were compared with the group of commuters choosing combination of paratransit and public transit. This comparison revealed different attitudes and preferences among the three groups of travel choice selection that might support our hypotheses.

To discuss these descriptive statistics results, authors, again, would like to notify that the attributes related to attitudinal measure were assessed based on the reasons that discouraged usage of public transit. Relating to the access to public transit, public transit selecting group, in contrast to the other two groups, stated that accessing distance to public transportation was not far from their residences. As expected, the groups of paratransit combination and private vehicle were more likely to live in the longer distances. Moreover, private vehicle preferred group was considerably dissatisfied with the access cost. There were insignificant differences in the difficulties of paratransit combination alternative for the public transit and the combination of paratransit selecting groups, whereas the private vehicle preferred respondents were significantly dissatisfied, and stated that the paratransit combination alternative caused them inconvenience of transfer, longer time, and expenses.

This was because respondents who often used public transportation became familiar with the paratransit services as a feeder mode.

In terms of personal convenience, participants who liked to use public transit were significantly satisfied with public transit for specific trips rather than their regular trips, and also were not reluctant to stay close to other people, while private vehicle selecting respondents were more likely to avoid using public transportation. Also, images of paratransit and public transports, especially bus and passenger van, were more likely to discourage use from the view point of car preferred respondents. Risks of traffic accidents and crimes as well as facing with traffic congestion seriously concerned the private vehicle choosing group, while the direct access to destination was slightly considered as a risk. Only the risk of crime was slightly concerned by public transit selecting group comparing with the group of choosing a combination of paratransit and public transit. The suitability of motorcycle-taxi fare based on the travel time was complained by respondents who did not consider the combination of paratransit alternative, especially of the car preferred group. Difficulty in getting seats and uncomfortable seats significantly dissatisfied the car preferred group. Also, using combination of paratransit and public transit on a raining day and difficulty in getting on and off were not preferable.

For personal behavioral measure, car choosing group significantly rated high score on car preference attributes, but provided minor concern on environment as shown in Table 5-5c. However, the group of selecting combination of paratransit alternative was more likely to have more environmental concern compared to the group of choosing public transit alternative. The respondents preferring using public transit were significantly more concerned on their security than the other two groups were.

Table 5-5a: Standardized factor loading results and t-test results of attitudinal attributes

Attitudinal Attributes	Attitudinal Latent Variables								*t*-test results for Attitudinal attributes		
Description	**ATT 1**	**ATT 2**	**ATT 3**	**ATT 4**	**ATT 5**	**ATT 6**	**ATT 7**	**ATT 8**	**Private vehicle**	**Public transit**	**Paratransit combinatio**
I have to walk to find service more than 5 min	0.718								2.90 (0.78)	2.62 (0.82)	2.69 (0.79)
Distance to bus stop/van terminal is quite far from my home	0.826								2.80 (0.79)	**2.25 (0.87)**	2.56 (0.79)
Distance to BTS /MRT is quite far from my home/ office/ school	0.809								2.75 (0.87)	2.46 (0.86)	2.56 (0.76)
Access cost to bus stop/van terminal/ BTS / MRT is quite expensive	0.688								**2.78 (0.70)**	2.59 (0.83)	2.46 (0.77)
Because of no choice to access bus stop/van terminal/ BTS / MRT making me difficulties	0.695								2.70 (0.79)	2.51 (0.83)	2.48 (0.74)
Ticket and payment systems are complicated and require much time			0.606						2.62 (0.81)	2.31 (0.75)	2.44 (0.79)
Combination of paratransit & public transport make my trip inconvenient because of transfer			0.731						**2.85 (0.77)**	2.40 (0.72)	2.43 (0.81)
Combination of paratransit & public transport make my trip longer travel time			0.786						**2.98 (0.66)**	2.42 (0.69)	2.31 (0.72)
Combination of paratransit & public transport make me pay more money and many times			0.793						**2.98 (0.66)**	2.50 (0.70)	2.49 (0.83)
My image influence my trip decision		0.554							2.35 (0.95)	2.33 (0.88)	2.44 (0.98)
It is not convenient if I have irregular trips		0.520							2.95 (0.78)*	**2.43 (0.81)**	2.67 (0.75)
I don't like to sit close to other passengers		0.785							2.68 (0.76)	2.31 (0.70)*	2.49 (0.70)
I feel irritated to do something while staying with other people I don't know		0.743							2.75 (0.78)	2.41 (0.73)	2.52 (0.74)
My image is important to my job or daily life		0.511							2.52 (0.96)	2.33 (0.90)	2.30 (0.78)

Remarks: (1) All factor loading estimates are significant at the 0.05 level

(2) **Bold** and * indicate significance at the 0.05 level, and 0.10 level, respectively, in the *t*-test with the combination of paratransit and public transport travel alternative

Table 5-5b: Standardized factor loading results and t-test results of attitudinal attributes (cont.)

Attitudinal Attributes	**Attitudinal Latent Variables**								***t*-test results for Attitudinal attributes**		
Description	**ATT 1**	**ATT 2**	**ATT 3**	**ATT 4**	**ATT 5**	**ATT 6**	**ATT 7**	**ATT 8**	**Private vehicle**	**Public transit**	**Paratransit combination**
Vehicle condition is old, dirty and unsafe. It discourage me to use public transit				0.653					2.55 (0.85)*	2.23 (0.75)	2.26 (0.81)
BTS and MRT images discourage me to use				0.611					1.82 (0.81)	1.88 (0.82)	2.00 (0.91)
Motorcycle-taxi / Songtaew/ Silor-lek images discourage me to use				0.802					2.68 (0.92)*	2.18 (0.81)	2.36 (0.73)
Bus and van images discourage me to use				0.741					**2.75 (0.87)**	2.25 (0.77)	2.26 (0.75)
Public transit can not directly access close to my destination and I have to use other vehicles					0.404				2.75 (1.01)*	2.27 (0.93)	2.34 (1.09)
I do not like to use public transit service while the traffic is congested					0.475				**2.95 (0.71)**	2.50 (0.70)	2.62 (0.73)
It makes me more chance to face traffic accident					0.830				**3.25 (0.71)**	3.00 (0.79)	2.89 (0.84)
It makes me more chance to face crime					0.788				**3.38 (0.74)**	3.19 (0.78)*	2.98 (0.83)
Combination of paratransit & public transport make my trip inconvenient on the raining day						0.583			**3.60 (0.55)**	3.29 (0.65)	3.30 (0.74)
It is not safe while getting on/off on the street						0.654			**3.25 (0.63)**	3.09 (0.66)	2.97 (0.71)
Hot weather and rain make me inconvenient to use public transport						0.731			**3.20 (0.65)**	3.06 (0.7)	3.07 (0.73)
Motorcycle-taxi fare is suitable for travel time							0.818		**2.91 (0.82)**	2.58 (0.77)	2.30 (0.81)
Motorcycle-taxi fare is suitable for travel distance							0.786		2.50 (0.88)	2.50 (0.79)	2.46 (0.77)
It is difficult to get seat and I do not like crowd								0.759	**3.08 (0.76)**	2.62 (0.66)	2.67 (0.63)
Uncomfortable and inconvenient seat								0.807	**3.15 (0.70)**	2.77 (0.60)	2.79 (0.71)

Remarks: (1) All factor loading estimates are significant at the 0.05 level

(2) **Bold** and * indicate significance at the 0.05 level, and 0.10 level, respectively, in the *t*-test with the combination of paratransit and public transport travel alternative

Table 5-5c: Standardized factor loading results and t-test results of behavioral attributes

Behavioral Attributes	Behavioral Latent Variables				*t*-test results for Behavioral attributes		
Description	**BEH 1**	**BEH 2**	**BEH 3**	**BEH 4**	**Private vehicle**	**Public transit**	**Paratransit combination**
Using car increase my work efficiency	0.928				**2.55 (0.96)**	1.83 (0.97)	2.00 (1.02)
Private car or motorcycle is necessary for my trip	0.912				**2.52 (1.11)**	1.85 (0.97)	2.05 (1.01)
I feel more confident when I use my car	0.911				2.45 (1.06)*	1.87 (1.02)	2.07 (1.09)
For me using public transit instead of car for everyday route would be impossible	0.902				2.22 (1.00)*	1.69 (0.84)	1.89 (0.97)
I prefer to use car although other modes are faster	0.801				**2.20 (0.88)**	1.76 (0.85)	1.82 (0.79)
I think that separating garbage save environment and I am ready to do		0.786			**2.75 (0.81)**	3.00 (0.78)	3.11 (0.69)
I think that I can preserve environment by reducing car use and I am ready to do		0.758			**2.90 (0.81)**	3.08 (0.84)*	3.28 (0.76)
I have a habit if recycling paper, plastic in order to preserve environment		0.747			2.78 (0.80)	2.79 (0.77)	2.90 (0.79)
I am not afraid to stay with other persons I do not know or unpredictable			0.752		2.20 (0.82)	2.17 (0.80)	2.30 (0.86)
I always accept a dare/ I like to challenge everything			0.659		2.05 (0.93)	2.14 (0.79)	2.20 (0.96)
It disturb me if I am forced to change in my routine			0.637		2.22 (0.95)	2.28 (0.84)	2.21 (0.86)
I like to live in secure surrounding				0.786	3.40 (0.87)	**3.53 (0.66)**	3.31 (0.83)
I selects mode that can protect me from traffic accident for the 1st reason				0.712	3.10 (0.84)	3.08 (0.87)	3.18 (0.81)
I always drive or travel adhering to prevailing speed limit				0.541	2.58 (0.98)*	2.74 (0.89)	2.93 (0.95)

Remarks: (1) All factor loading estimates are significant at the 0.05 level

(2) **Bold** and * indicate significance at the 0.05 level, and 0.10 level, respectively, in the *t*-test with the combination of paratransit and public transport travel

5.6 Attitudinal and behavioral Influence investigation

5.6.1 Structural Equation Modeling design

The primary objective is to investigate influences of the combination of paratransit and public transit alternatives on commuter's choice consideration based on personal attitudes and behavior. Three investigation models were constructed using the same latent variables of attitudinal and behavioral measures for each choice consideration. The 8 latent variables of attitudinal measure and 4 latent variables of behavioral measure listed in Table 5-4 were constructed based on the results of CFA. Structural Equation Model (SEM) was applied to examine the influences as illustrated in Figure 5-1. The 8 latent variables of attitudinal measure and 4 latent variables of behavioral measure listed in Table 5-4 were constructed based on the results of CFA.

Each of the model developed contains one endogenous latent variable for one specific choice consideration namely *Travel Choice option*, and 12 latent exogenous variables for commuter attitudes, *ATT*, and behavior, *BEH*, as illustrated in Figure 5-1. The observed variables for each latent variable are listed in the Table 5-4. The latent exogenous variables are applied for all three travel choice, which are private vehicle, public transport only and combination of paratransit and public transport. The models of each choice option can be defined in terms of structural equations as expressed in equation 5.1:

$$Travel\ Choice\ option_i = \beta_{ij} ATT_{ij} + \beta_{ki} BEH_{ki} + \varepsilon_i \qquad (5.1)$$

where;

ι = travel choice i, i = 1 to 3

β_{ij} = parameter of commuter attitudes j of travel choice i, j = 1 to 8

β_k = parameter of commuter attitudes k of travel choice i, k = 1 to 4

ε_i = error term of travel choice i

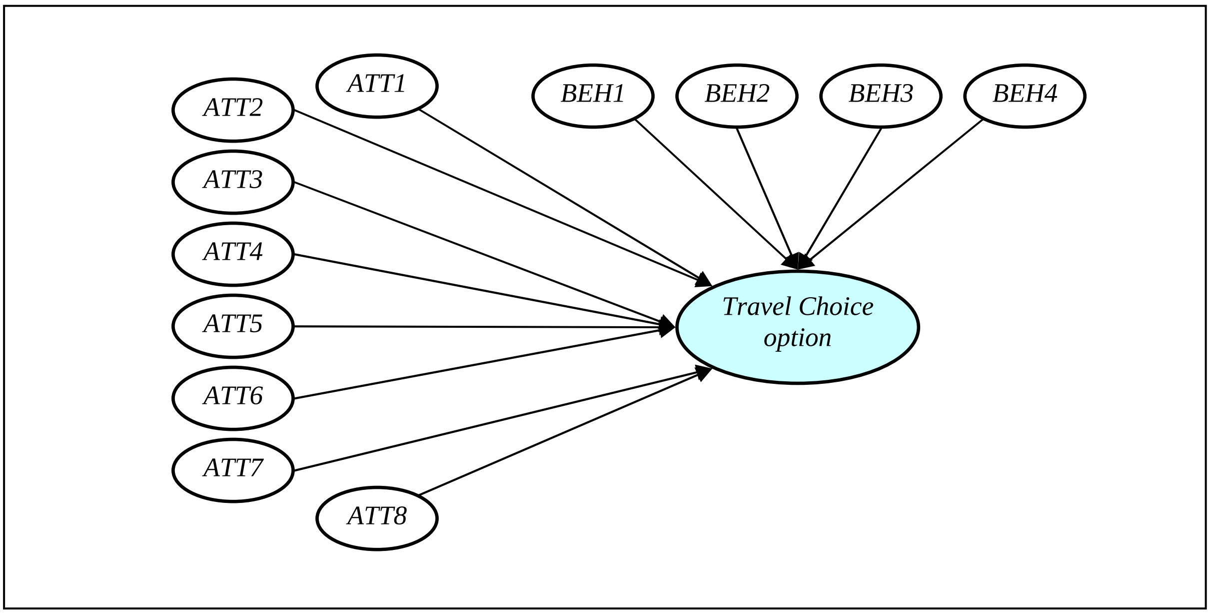

Figure 5-1: Conceptual SEM model for commuter travel choice consideration

As presented in Table 5-6, the three developed SEM models had almost the same goodness of fit indices. This was because all models were constructed based on the same independent variables of attitudinal and behavioral measures and only dependent variables were changed regarding each choice consideration. Therefore, the models developed were statistically significant. The χ^2/df values for all models were around 1.80, which was smaller than 3. These indices showed that the differences between the population covariance matrix and the model implied covariance matrix are small (Bollen, 1989; Kaplan, 2009). The RMR and RMSEA of all models satisfied the recommended value of within 0.10 and 0.08, respectively. The goodness of fit index (GFI) and adjusted goodness of fit index (AGFI) values were around 0.820 and 0.78 respectively. The AGFI indices were found close to the threshold of 0.80, while the GFI values were slightly lower than the recommended value of 0.90. The overall models appeared to be acceptable. The results will be discussed in the following section.

5.6.2 Model results and discussions

The model result of the analysis showed the empirical results supported the assumption that integration of paratransit and public transport alternative affects commuter's choice selection through personal attitudes and behaviors. Additionally, individual attitudes towards the service were found to have more influence compared with personal behaviors.

For the private car choice consideration model, the car preference behavior was found to be the strongest positive influence on car choice. It meant that those who preferred car advantages would be more likely to choose their cars or motorcycles as their travel choices. It should be noted that the attitudes towards difficulties, images, risks, and using environment of the combination alternative were indicated to be the factors that significantly influenced the choice to drive. In other words, respondents who were dissatisfied with the service qualities of the existing paratransit and public transport modes would prefer the choice of private vehicle to public transports including the combination of paratransit and public transport alternatives. It is noted that the using environment variable was constructed from the attributes regarding weather condition and places for getting on and off while using the combination alternative. Moreover, the attitudinal variables that drive commuters to choose their cars or motorcycles mostly relate to their travel comfort and convenience as well as images and safety of the travel modes.

Again, the results of public transit only model, in terms of estimated negative parameter, illustrated that the car preference behavior had an influence on commuters in the matter of discouragement to using public transport modes. The negative parameters of attitude on images and difficulties of the combination between paratransit and public transit alternative were found significant in this model as well. It can be interpreted that respondents who encountered difficulties and possessed pessimistic images on using of paratransit combination alternative would potentially refrain from choosing public transport. However, the attitude indicator towards risks of the combination between paratransit and public transport choice, e.g. traffic accidents and crimes, was found to be the driving factor of selecting public transport only alternative, as indicated positive estimated parameter.

Table 5-6: Standardized parameter estimates of SEM models

Explanatory variables/ Fit indices	**Developed SEM models**		
	Private vehicle	**Public transit only**	**Combination of paratransit and public transport**
Access to public transit	0.017	-0.029	0.074
Personal convenience	-0.011	-0.036	0.051
Difficulties of the combination	0.211**	-0.110*	-0.047
Images of the combination	0.267**	-0.231**	-0.148*
Risks of the combination	0.172*	0.323**	-0.311**
Using environment of the combination	0.273**	-0.076	-0.026
Fare suitability of the combination	-0.013	0.071	0.062
Comfort of the combination	0.150*	-0.079	-0.022
Car preference	0.319**	-0.208**	0.059
Environmental concern	-0.066	-0.048	0.110*
Risk assessment	-0.026	0.015	0.004
Safety and security	-0.052	0.03	0.008
$\chi 2$	1504.616	1503	1483.35
df	825	825	825
$\chi 2/df$	1.824	1.822	1.798
p	0.000	0.000	0.000
GFI	0.820	0.819	0.820
AGFI	0.782	0.783	0.784
RMR	0.046	0.046	0.046
RMSEA	0.051	0.051	0.050

Remark: ** $p < 0.05$, * $p < 0.10$

Conversely, for the model of paratransit combination alternative, the car preference behavior was found not to be significant. It was possibly because of the effects of door-to-door services of paratransit that were functioning in the study areas. However, environmental concern behavior became positively significant. It could be implied that respondent who had more concern on the environment would be likely to choose their travel mode of the combination between paratransit and public transport. The attitudinal indicators towards risks and difficulties of the combination between paratransit and public transport were found negative for the selection of this alternative. These two indicators indicated that commuters who were dissatisfied with images of the combination between paratransit and public transport would potentially feel discouraged in using this alternative. It should be noted that risks, especially on traffic safety and personal security, of this combination alternative possessed the strongest influence on making respondents easily leave from choosing this alternative.

5.7 Summary

The travel choice of the combination between paratransit and public transport found in this study owned the share of patronages almost the same share of public transport-only mode. This revealed the fact that, presently, commuters considered the combination alternative as their typical travel choices. However, only 20 percent of the respondents considered this combination of paratransit and public transport alternative as their first choice. Most of car riders, especially the car-dependent, preferred to continue driving as expected. It should be noted that car preferred respondents seemed dissatisfied with public transportation services especially on comfort and convenience. They were also significantly dissatisfied with the expenses of access to use public transport services, images of public transit and paratransit, and difficulties and risk of using the paratransit combination alternative. In addition, public transport-only preferred respondents concerned chance of facing with crimes more than the commuters who chose the combination of paratransit and public transport travel mode. The important factors that significantly influence commuter's choice consideration are emphasized. Firstly, car preference strongly influences an increase of choosing to drive rather than using public transport especially for present car riders. Secondly, risks of the combination of paratransit and public transport alternative significantly result in increased potential of selecting private vehicle and public transport only travel modes, and refrain from the combination alternative. Thirdly, images and difficulties of using public transit and paratransit show the negative effects on all public transport patronages. Lastly, negative attitudes towards comfort and convenience of using public transport and paratransit possess the potential of choosing car rather than public transport services.

CHAPTER 6

PARATRANSIT INFLUENCES CONSIDERING HOMOGENEITY OF COMMUTERS

Chapter 4 explored the feeder capability of the existing paratransit, both flexible for-hired and fixed route services. The important factors, potential users and effective service areas were also discovered and reviewed. The existing paratransit showed the capability of feeder services with different groups of patrons and effective ranges of services. The obtained results in chapter 5 indicated that paratransit services have some impacts on commuter's travel choice consideration. Most of the impacts resulted from pessimistic images of paratransit operation and quality of service. In this chapter, influences of paratransit on mass transit access satisfaction and commuters' willing to use will be investigated based on the preferences and attitudes toward several paratransit service qualities. A Structural Equation Modeling (SEM) is applied to investigate the relation between commuter attitudes and satisfaction on accessing mass transit station and the future intention to use mass transits and paratransit. The important factors of paratransit service qualities influencing commuter's satisfaction and willing to use will be captured and discussed in order to provide valuable information for transportation planning into the future mass transit development. The analysis process of influence investigation is classified into two main stages as explained in the section 3.5 of chapter 3. This chapter, therefore, mainly explain the *Purpose I* analysis of paratransit influence investigation procedure.

6.1 Background

Bangkok has implemented two mass transits, an elevated rail system (BTS) in 1999 and subway (MRT) in 2004. Extension plans of mass transits are currently underway. However, the strategies are mainly focused on expanding the coverage of mass transit with little regard to improving the accessibility of passenger and connection to the stations. The two aspects have been given low priority even though they are considered necessary. Like in many other cities in developing countries, there are few systematic feeders provided for Bangkok's mass transits. Three most popular modes of accessing the BTS and MRT stations are: walking, bus, and paratransit (Chalermpong and Wibowo, 2007). Most of paratransit services have emerged to deal with the difficulty in accessing main streets and public transports. Currently they play an important role of an access mode. The paratransit consist of (i) the flexible for-hire service - motorcycle-taxi and Tuktuk - and (ii) fixed-routed service – Songtaew. Although both types of paratransit enhance urban mobility, the quality of services is not only unacceptable but also satisfactory to the users. Moreover, the future of public transits is based on their performances as well as how people perceive the quality of services they provide. Measurement of commuter's perceptions can be helpfully in assessment of the quality of service as well as reveal problems that should be tackled. As mentioned above, paratransit have a potential as a feeder; however, the existing services are considered informal, not well-organized and unsatisfactory. Therefore, the perceptions of the public are important in evaluating the possibility of implementing paratransit as a feeder system. Service attributes assessed by travelers such as safety and security, comfort, convenience, and etc must be captured and evaluated. Consequently, the strategies adopted in solving accessibility difficulties can be handled in an effective way.

6.2 Objective and approach

To fulfill the target of implementing paratransit as a feeder service, it is important to understand commuter perception on paratransit services and the effects of such attitudes on mass transit connectivity as well as the intention of using this mode. However, the part studies just focused only on paratransit's passenger opinions, and only travelers' behavior of riding mass transit was observed to develop mode choice model. The key question is how travelers, not only passengers, perceive paratransit services that might affect mass transit access trip satisfaction and level of patronage. It is also important to understand the preferences of different groups of commuters especially based on the economic status. The main objectives of this study are (1) to investigate interrelation between attitudes towards paratransit service and commuter's satisfaction of access trip to mass transit station, and (2) to explore whether such attitudes and satisfaction have any influence on the commuter's future intention to use paratransit as a feeder and mass transits.

The *Purpose I* analysis aims to discover the influences of attitudes to flexible for-hired service – motorcycle-taxi – and fixed route service – Songtaew – on commuter's satisfaction and willing to use by focusing on specific study areas. The specific study areas were selected using the reason of availability of Songtaew services in order to obtaining more samples of Songtaew users. This stage proposed to investigate two hypotheses.

- *Hypothesis 1* is to determine how attitudes concerning paratransit, both flexible for-hire and fixed route services influence on attitude concerning accessibility to mass transit from the viewpoint of overall commuters.
- *Hypothesis 2* is to observe whether both attitudes have any stimulus on the intention to use mass transits and paratransit in the future.

Structural Equation Model (SEM) is applied to estimate the effects of paratransit service satisfactions on the overall satisfaction of mass transit access trip, and the influence of both satisfactions on commuters' intention to use paratransit as a feeder. Moreover, the related secondary target is to determine the important attributes of paratransit service that affect mass transit connectivity and commuter's intention to use. If such attributes are effective in improving connectivity and enhancing mass transit ridership, they will provide useful information in drawing the improvement policy for utilizing and managing existing paratransit as a feeder system.

6.3 Specific study areas

The scope and methods of data collection and survey were explained in the section 3.3 of chapter 3. This section discusses the specific study areas of the *Stage I* analysis. Two mass transit stations in Bangkok, MRT-Huay Khwang station and BTS-Onnut station were selected for the commuter surveys as shown in Figure 6-1 and Figure 6-2. The important reason to focus mainly on these two stations is the availability of Songtaew. Moreover, these two stations have different station characteristics and land use pattern. MRT-Huay Khwang station is a typical station located in high-density residential and CBD commercial area and there are two adjacent MRT stations within 1.3-kilometer interval, while BTS-Onnut station is the terminal station located in medium-density residential in suburban area.

The study area around MRT-Huay Khwang station covers an area between adjacent MRT-Thailand Cultural Center station and Sutthisan station. Catchment range is determined from Vibhawadee-Rangsit Road to Praditmautham Road. The “A” sign means main streets that have bus service. For the collector roads, “B” means roads that have Songtaew service, and “C” means roads that have bus service. Most of collector roads and Sois have motorcycle-taxi service. Commuters mostly access the station from the shown collectors.

The study area around BTS-Onnut station covers an area from Sukhumvit Soi77 up to Sukhumvit Soi103. Catchment range is set from Along Railway Rd. to Srinakarin Rd. All signs are the same as explained in the Huay Khwang area. Also, most of collectors and Sois have motorcycle-taxis. As same as the first study area, Commuters mostly access the station from the shown collectors.

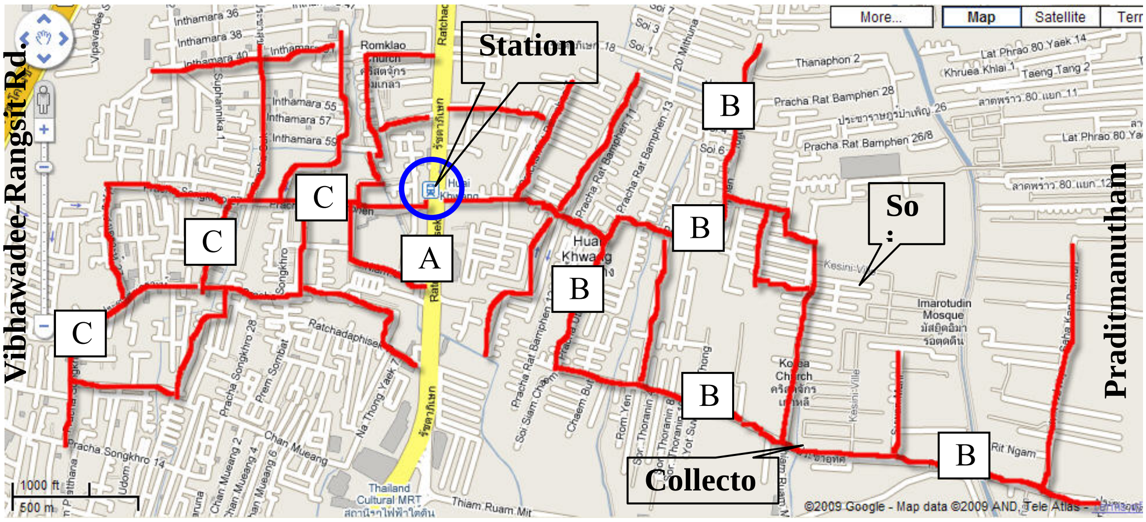

Figure 6-1: MRT-Huay Khwang study area map and access roads (http://maps.google.com)

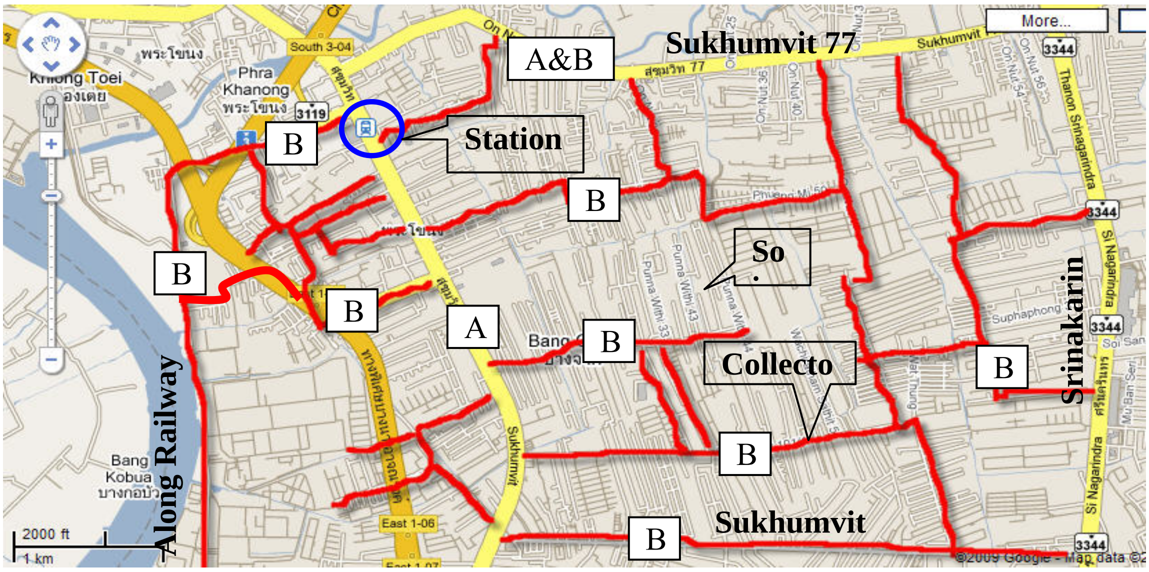

Figure 6-2: BTS Onnut study area map and access roads (http://maps.google.com)

6.4 Findings

6.4.1 Respondent characteristics

Form the effective respondents, 62% are female and 38% are male, 50% are in age between 21-30 years, around 20% are in age between 15-20 and 31-40, respectively. For their occupation, 53% work for private company and 23% are students. The proportion of sample household with at least one car is 61% and the proportion of sample with at least one motorcycle was about 39%. Almost 90% have experience with BTS or MRT and among this 42% of them use this service at least 2 days/week. As a result, 85%, 66% and 35% of respondents have experienced with motorcycle-taxi, Songtaew and Silor-lek (small 4-wheel vehicle), respectively. Commuters around Onnut station tend to live in longer distance from mass transit station than Huay Khwang area (average of 2.77 km and 1.85 km).

6.4.2 Present travel pattern and access characteristics

Present mode and access mode are illustrated in the Figure 6-3a and Figure 6-3b, respectively. Around 37% are private vehicle users (car users, motorcycle users and ride sharing), 12% are non-motorized users, and 51% are public transit riders. Among public transit passengers, 65% are mass transit users.

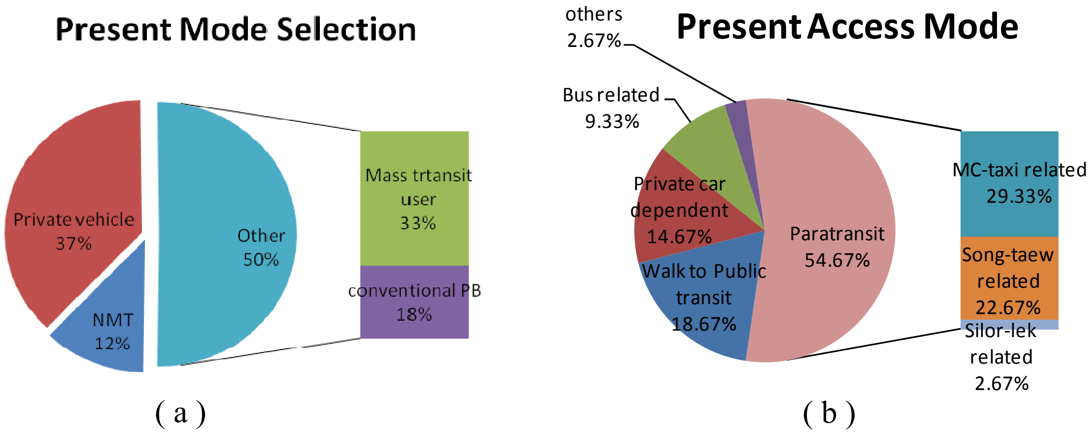

Figure 6-3: (a) Present travel mode selection; (b) Present access mode selection

Among public transit passengers, there are four most popular access modes these are: walking, motorcycle-taxi, Songtaew and ride sharing. Share of ride sharing is relatively high among mass transits users comparing with the conventional public transits as shown in Table 6-1. Among access modes to public transits, Songtaew also turn out to be another popular one. Consequently, motorcycle-taxi and Songtaew handled around 52% of the access trips which revealed their service capability as a feeder. Moreover, around 93% of public transit passengers used only 1 mode for their access trips. Walking is the main egress mode, around 58%, and the second is motorcycle-taxi, around 32%. It can be concluded that commuters prefer to go close to their destination as much as possible.

Table 6-1: Present access mode selection classified by type of public transit users

User	Walking	Ride sharing	Bus related	MC-taxi related	Songtaew related	Silor-lek related	others
Mass transits	12.00%	10.67%	6.67%	16.00%	10.67%	1.33%	1.33%
Regular public transports	6.67%	4.00%	2.67%	13.33%	12.00%	1.33%	1.33%
Overall	18.67%	14.67%	9.33%	29.33%	22.67%	2.67%	2.67%

6.4.3 Mass transit access trip characteristics

There are also four most popular access modes to mass transits in the study areas that are drive alone, bus, motorcycle-taxi and Songtaew as shown in Table 6-2. Drive to the stations is a dominant access mode for present private car users. However, motorcycle-taxi and Songtaew can handle 26% and 45% of private car users and public transit users, respectively. Walking, drive alone and motorcycle-taxi are three dominant access modes in MRT-Huay Khwang area. In BTS-Onnut, drive alone and motorcycle-taxi have a higher share; nonetheless, Shares of bus and Songtaew become drastically significant as expressed in table 2. The reasons can be explained by the differences in station type and land use, and commuters in Onnut area tend to live in longer distance as discussed above. Moreover, the park and ride facility was provided at MRT-Thailand Cultural Center station next to Huay Khwang station that makes drive alone mode more preferable. Walking and motorcycle-taxi are the dominant modes within the distance 1 kilometer and 2-3 kilometers, respectively, which correspond to the previous study (Chalermpong and Wibowo, 2007). In addition, drive alone, ride sharing, bus and Songtaew become significant in the distance more than 2 kilometers from the stations as illustrated in Table 6-2. As shown in the survey results, Silor-lek has the smallest share. Therefore, only motorcycle-taxi and Songtaew were taken in to account.

Table 6-2: Mass transit access characteristics

Commuter classification	Walking	Drive alone	Ride sharing	Bus related	MC-taxi related	Songtaew related	Silor-lek related
Private vehicle	9.43%	47.17%	7.55%	9.43%	15.09%	11.32%	-
Public transit	8.25%	8.25%	6.19%	29.90%	24.74%	20.62%	2.06%
All commuters	8.67%	22.00%	6.67%	22.67%	21.33%	17.33%	1.33%
Huay Khwang	28.21%	28.21%	7.69%	7.69%	25.64%	2.56%	-
Onnut	1.80%	19.82%	6.31%	27.93%	19.82%	22.52%	1.80%
Dist < 1 km	55.00%	5.00%	-	5.00%	30.00%	5.00%	-
Dist 1 - 2 km	3.13%	21.88%	9.38%	18.75%	34.38%	12.50%	-
Dist 2 - 3 km	-	21.74%	-	26.09%	21.74%	26.09%	4.35%
Dist 3 - 5 km	-	25.93%	11.11%	29.63%	11.11%	22.22%	-

6.5 Commuter attitude and satisfaction

Respondents were asked to express their satisfaction on 7 attributes regarding the connectivity of accessing mass transit stations and 15 attributes regarding the quality of service offered by motorcycle-taxi and Songtaew each.

The attitudes towards access trip to mass transit stations are captured in terms of satisfaction levels and summarized based upon the three main parts as explained in section 3.2.2.1 of chapter 3 into 7 attributes:

1. Access time: an attitude towards total access time from respondent's house to mass transit station

2. Waiting time: an attitude towards total time that respondents have to wait for the mode used in accessing mass transit station
3. Walking time 1: an attitude towards time spent in walking from home to catch the access mode or private vehicles (as shown in Part1 of Figure 3-3 of chapter 3) during the trip access to the station.
4. Walking time 3: an attitude towards time spent in walking to the station concourse (as shown in Part3 of Figure 3-3 of chapter 3) during the trip access to the station.
5. Transfer Difficulty: an attitude towards the hindrances that the respondents face during boarding an alighting an access mode to use other access modes or mass transits.
6. Access cost: an attitude towards total expense in accessing mass transit station.
7. Paratransit terminal: an attitude towards waiting facilities and pick-up & drop-off areas provided by paratransit operators.

The attitudinal preferences of commuters on the service quality of paratransit, motorcycle-taxi and Songtaew, are also measured in terms of satisfaction scores and encapsulated in four main aspects with 15 attributes:
1. An attitude towards riding or driving speed (drive too fast) and reckless driving (zig-zag and dangerous)
2. An attitude towards vehicle condition and safety equipment
3. An attitude towards night time security from crime
4. An attitude towards waiting time for using service
5. An attitude towards number of stops for loading and unloading passengers along the way
6. An attitude towards air pollution and weather protection
7. An attitude towards seat availability and level of crowd
8. An attitude towards adequacy and on-demand service
9. An attitude towards availability in the night & early morning
10. An attitude towards flexibility to change route
11. An attitude towards ability to reach at the exact point of destination
12. An attitude towards suitability of fare structures based on travel time and distance
13. An attitude towards availability of service schedule and fare structure information
14. An attitude towards availability of vehicle and driver registration information
15. An attitude towards availability of accident insurance information

6.5.1 Mass transit connectivity attitude and satisfaction

From Table 6-3, commuters seem to be satisfied with their access to mass transit stations; however, they are not satisfied with the cost of access and paratransit terminal. The term “Paratransit terminal” means waiting facilities and pick-up & drop-off areas. Commuters in both study areas expressed almost the same level of satisfaction. However, it is interesting to note that respondents with prior experience in BTS or MRT expressed higher level of satisfaction compared to the ones who had not encountered the transit systems. Non-experienced commuters stated that they experienced difficulties in transfer. The cost of access and paratransit terminal also posed a serious challenge. Moreover, mass transit users also gave relatively higher satisfaction level comparing with non-mass transit users. It can be explained that mass transit users get used to the access trips.

Table 6-3: Average satisfaction level of mass transit access trip

	Access time	Waiting time	Walking time (part1)	Walking time (part3)	Difficult Transfer	Access cost	Paratransit terminal
Variable	ToMassAcc	ToMassWT	ToMassWTH	ToMassWTSt	ToMassTrf	ToMassC	ToMassPrter
Overall	3.02	2.94	2.88	2.91	2.76	2.62	2.63
Mass Exp	3.04	2.95	2.89	2.93	2.81	2.65	2.67
Non Exp	2.83	2.83	2.75	2.75	2.25	2.42	2.25
Mass user	3.07	3.22	3.12	3.22	3.12	2.85	2.76
Not user	2.99	2.80	2.76	2.76	2.58	2.51	2.57
Huay Khwang	2.90	2.90	2.85	2.87	2.69	2.56	2.54
Onnut	3.07	2.95	2.90	2.93	2.79	2.65	2.67

6.5.2 Paratransit service attitude and satisfaction

Table 6-4 shows commuter's satisfaction on service quality of motorcycle-taxi and Songtaew. All commuters are dissatisfied motorcycle-taxi-service on the safety and security aspects. Conversely, motorcycle-taxi is satisfactorily preferred to Songtaew in terms of comfort and convenience. Nonetheless this mode does not protect passengers from elements of weather and pollution. Respondent were asked to assess fare structure of motorcycle-taxi and Songtaew by considering the suitability of time and travel distance. Respondents expressed dissatisfaction with present fare structure. However, Songtaew has more advantages than motorcycle-taxi, because Songtaew's fare is relatively cheap compared to motorcycle-taxi especially in the distance more than 1 kilometer. Nevertheless, satisfaction level of Songtaew's suitability of fare is only somewhat satisfied considering its long travel time and waiting time. Finally, all respondents were dissatisfied with the information services of motorcycle-taxi and Songtaew, especially information on accident insurance.

6.6 Paratransit influences investigation

This section aims to observe the influence of commuters' perceptions on paratransit services and attitude concerning accessibility to mass transit. Consequently, the effects of both attitudes on the intention to use mass transit and paratransit in the future shall be explored. The SEM model was introduced to investigate those two objectives. Two main procedures were performed to construct SEM model. These procedures were factor analysis and structural model formulation.

6.6.1 Factor analysis

This procedure deals with reduction and categorization of attitudinal attributes of mass transit connectivity (7 attributes) and paratransit services (15 attributes for motorcycle-taxi and Songtaew each). It describes the structural relationship between variables and the factors as well as facilitates the model development and accuracy. Factor analysis was applied to perform the categorization process by the analysis of moment structures, AMOS5.0 (Arbuckle, 2003; Blunch, 2008). The structure analyzed paratransit attributes and mass transit access attitudes by using confirmatory factor analysis (CFA) procedure based on the 5% significant criteria (Kaplan, 2009; Shrestha et al., 2007). Assessment of the model was done by observing the multiple fit indices including chi-square ($\chi 2$), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), root mean square residual (RMR), and root mean square error of approximation (RMSEA).

Table 6-4: Average satisfaction level of motorcycle-taxi and Songtaew services

	Paratransit Service Quality Attributes		Variables	Motorcycle taxi	Songtaew
Safety& Security	1	Riding/driving speed (drive too fast) Reckless driving (zig-zag/dangerous)	ST_Drive, MC_Drive	1.81	2.38
	2	Vehicle condition and safety equipment	ST_ Cond, MC_Cond	2.08	2.18
	3	Night time security from crime	ST_Secu, MC_ Secu	1.86	2.30
Comfort & Convenience	4	Waiting time duration for using service	ST_ Wait, MC_Wait	2.93	2.10
	5	Number of stops to pick-up/drop-off passengers along the way	ST_ Stop, MC_Stop	3.32	1.91
	6	Air pollution and weather protection	ST_ Prot, MC_Prot	1.56	2.23
	7	Seat availability and Level of crowd	ST_ Cwd, MC_Cwd	2.54	2.04
	8	Adequacy and on-demand service	ST_Find, MC_ Find	3.10	2.34
	9	Availability in the night & early morning	ST_Avail, MC_ Avail	3.02	2.37
	10	Flexibility to change route	ST_Flex, MC_ Flex	3.19	2.02
	11	Ability to reach at the exact point of destination	ST_Reach, MC_ Reach	3.38	2.27
Fare	12	The present fare structures are suitable for travel time and distance	ST_Fare, MC_ Fare	2.43	2.82
Information	13	Service schedule and fare structure information are provided	ST_Inf1, MC_ Inf1	2.29	2.24
	14	Passenger service vehicle / driver registration information	ST_Inf2, MC_ Inf2	2.08	2.19
	15	Accident insurance information	ST_Inf3, MC_ Inf3	1.78	1.94

Remark: MC = motorcycle-taxi, and ST = songtaew

The standardized factor loading results and categories are shown in Table 6-5. The χ^2/df value for this model is 1.589, which is less than 3. The fit indices of the established model can be explained by the RMR, 0.041, and RMSEA, 0.073, which satisfy the assessment criteria of less than 0.10 and 0.08, respectively. The GFI and AGFI values are 0.862 and 0.80 respectively that means 80% of the co-variation in the data could be reproduced by the given model. The recommended values of GFI and AGFI are 0.90 and 0.80. The indices obtained from CFA attained the recommended values, except for GFI. While considering the effects from a small number of samples and the level of model representation, the model can be concluded reasonably good fit. Finally, 4 main attitudinal factors consist of 16 significant attributes, are made based upon the variables that load on the factor, and classified into a mass transit access satisfaction, and three paratransit's service satisfactions as follows:

1. Mass transit access measurement: *MassAcc*
2. Safety and security service (both motorcycle-taxi and Songtaew): *Safety*
3. Comfort and convenience service of motorcycle-taxi: *MC Comf/Conv*
4. Comfort and convenience service of Songtaew: *ST Comf/Conv*

Table 6-5: Standardized factor loading results

Observed Variables	Latent Variables			
	Safety	MC Comf/Conv	ST Comf/Conv	Mass Acc
ST_Drive	0.748			
ST_Secu	0.841			
MC_ Drive	0.471			
MC_ Secu	0.480			
MC_Find		0.746		
MC_Avail		0.709		
MC_Flex		0.757		
MC_Reach		0.676		
ST_Wait			0.834	
ST_Stop			0.651	
ST_Find			0.748	
ST_ Avail			0.669	
ToMassTT				0.641
ToMassWT				0.759
ToMassC				0.632
ToMassTrf				0.759

$\chi^2 = 147.762$; $df = 93$; p = 0.001; RMR = 0.041; RMSEA = 0.073; GFI = 0.862; AGFI = 0.800; CFI = 0.918

6.6.2 Structural model formulation

The main targets here were to interrelate attitude concerning services of paratransit, both motorcycle-taxi and Songtaew to the perception regarding mass transit connectivity, and to observe the effects of those two attitudes on the commuter's intention to use mass transits and existing paratransit services. The four latent variables and their observed variables from factor analysis were applied in Structural Equation Model using AMOS 5.0 application. Three exogenous variables were established from paratransit service satisfactions which are *Safety, MC Comf/Conv,* and *ST Comf/Conv*. The satisfaction of mass transit access trip, *MassAcc*, was set as an endogenous variable to test the first objective (Hypothesis 1). For the second objective (Hypothesis 2), *MassAcc* variable became an exogeneous variable. An additional endogenous variable was introduced to explain the intention to use mass transits and paratransit in the future, named as "*FutureUse*". The structural diagram of Hypothesis 1 and Hypothesis 2 are illustrated in Figure 6-4 and their structural equations are expressed in equation 6.1 and equation 6.2, respectively.

$$MassAcc = \Gamma_{11} Safety + \Gamma_{12} MC\ Comf/Conv + \Gamma_{13} ST\ Comf/Conv + \zeta_1 \quad (6.1)$$
$$FutureUse = \Gamma_{21} Safety + \Gamma_{22} MC\ Comf/Conv + \Gamma_{23} ST\ Comf/Conv + \Gamma_{24} MassAcc + \zeta_2 \quad (6.2)$$

where;

Γ_{11}, Γ_{21} = parameters of safety attitude on mass transit connectivity and future intension to use, respectively

Γ_{12}, Γ_{22} = parameters of motorcycle-taxi's comfort and convenience attitude on mass transit connectivity and future intension to use, respectively

Γ_{13}, Γ_{23} = parameters of Songtaew's comfort and convenience attitude on mass transit connectivity and future intension to use, respectively

Γ_{24} = parameters of mass transit connectivity on future intension to use, respectively

ζ_1, ζ_2 = error terms of mass transit connectivity and future intension to use, respectively

ϕ_1, ϕ_2, ϕ_3 = covariance and correlation among latent variables

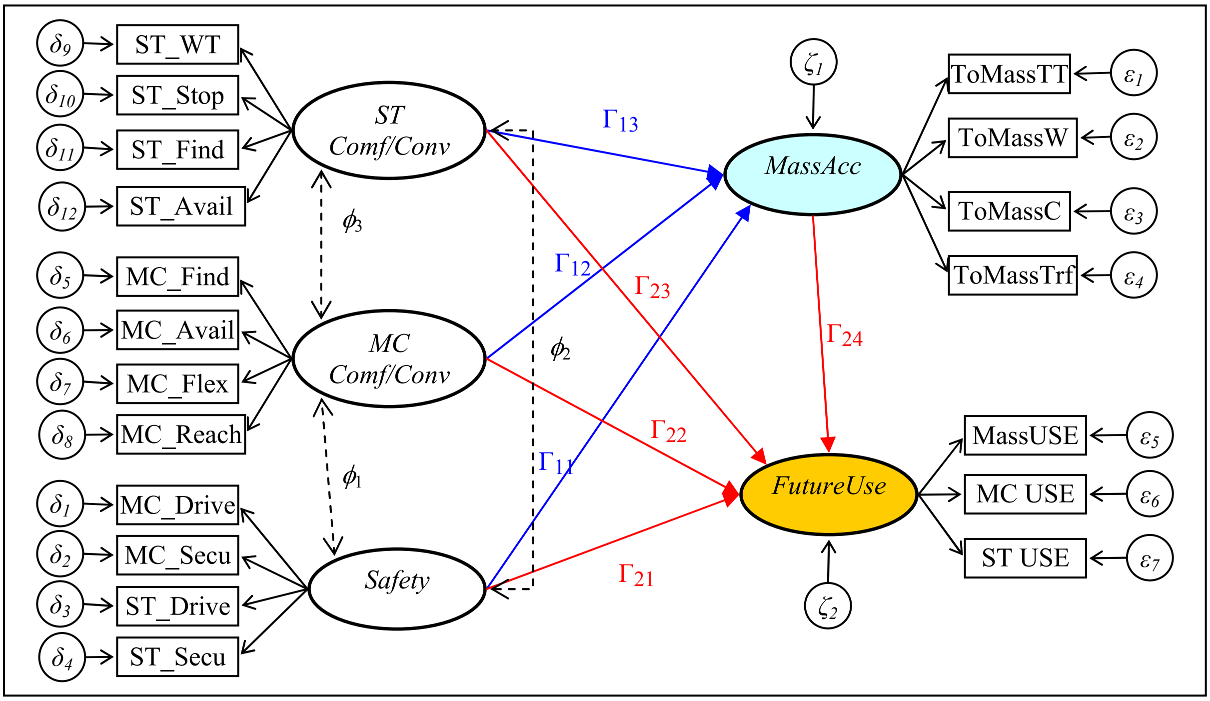

Figure 6-4: Path diagram of SEM

6.6.3 Model results

From Table 6-6, the model developed contained χ^2 value of 177.143 and statistically significant at 99% degree of confidence. The χ^2/df value for this model was 1.303, which was small than 2. This showed that the differences between the population covariance matrix and the model implied covariance matrix are small. The RMR and RMSEA of this model satisfied the recommended value of within 0.10 and 0.08, respectively. The goodness of fit index (GFI), adjusted goodness of fit index (AGFI), and comparative fit index (CFI) values were 0.865, 0.811 and 0.940 respectively. Only the GFI value was slightly lower than the recommended one. It can be concluded that this model has a reasonably good fit.

Table 6-6: Standardized regression estimates of structural and measurement models

Structural Models			Measurement Models					
	Hypothesis 1	Hypothesis 2	Observed variables	Latent variables	Estimate	Observed variables	Latent variables	Estimate
Exogenous latent variables	Mass transit Connectivity	Future intention to use						
Safety	$\Gamma_{11}=0.483^*$	$\Gamma_{21}=0.19^*$	ToMassTT	MassAcc	0.638	MC_Drive	Safety	0.473
	(p=0.005)	(p=0.039)	ToMassWT		0.765	MC_Secu		0.484
MC-taxi Comf/Conv	$\Gamma_{12}=0.141^*$	$\Gamma_{22}=0.21^{**}$	ToMassC		0.633	ST_Drive		0.746
	(p=0.024)	(p=0.061)	ToMassTrf		0.759	ST_Secu		0.841
Songtaew Comf/Conv	$\Gamma_{13}=-0.023$	$\Gamma_{23}=0.118$	MC_Find	MC Comf/Conv	0.743	ST_Wait	ST Comf/Conv	0.833
	(p=0.872)	(p=0.462)	MC_Avail		0.710	ST_Stop		0.643
Mass transit Connectivity	-	$\Gamma_{24}=0.245^*$	MC_Flex		0.762	ST_Find		0.754
	-	(p=0.048)	MC_Reach		0.677	ST_Avail		0.673
$\phi_1=0.396^*$	$\phi_2=0.579^*$	$\phi_3=0.287^*$	MC USE	FutureUse	0.759	***Note***: All estimated values of the measurement models are significant at 95% level of confidence		
χ^2/df	1.303		ST USE		0.503			
GFI	0.865		MassUSE		0.215			
AGFI	0.811							
CFI	0.940							
RMR	0.035							
RMSEA	0.053							

Note: 1) * = The estimates are significant at 95% level of confidence
2) ** = The estimates are significant at 90% level of confidence

6.6.3.1 Influence on mass transit connectivity (Hypothesis 1)

Safety and motorcycle-taxi's comfort and convenience services have significant positive influences on mass transit access trip. Safety satisfaction possesses a larger effect comparing with motorcycle-taxi's comfort and convenience. However, Songtaew's comfort and convenience is statistically insignificant, though it was assessed safer than the motorcycle-taxi as expressed by higher level of Songtaew's attributes in the Safety's measurement model. This is because commuters pay more attention to their access time that usually include waiting time, in-vehicle time, transfer and demand responsiveness as evaluated in Mass transit access, and motorcycle-taxi and Songtaew comfort and convenience measurement models. Moreover, Songtaew's nature of service offers long waiting time, frequent stops and inadequacy. There are strong correlations between safety and motorcycle-taxi comfort and convenience (ϕ_1), and safety and Songtaew (ϕ_2) comfort and convenience. This means that a change in one variable will affect all the others including the satisfaction on mass transit connectivity.

6.6.3.2 Influence on future intention to use (Hypothesis 2)

The results also showed that safety and motorcycle-taxi's comfort and convenience positively influence the future intention to use. However, the influence of motorcycle-taxi's comfort and convenience is only significant at 90% level of confidence. Songtaew's comfort and convenience is not significant. The reasons behind these phenomena are already explained in the Hypothesis 1 result. Interestingly, satisfaction of mass transit connectivity has the largest positive influence over paratransit service satisfaction. This means that increase of mass transit access satisfaction will stimulate the willingness to use of mass transits and paratransit access mode. Moreover, motorcycle-taxi's comfort and convenience satisfaction has higher level of influence over the safety. This is also understandable because it is common for commuters to decrease travel time with less care about the danger. The measurement model of future intension to use reveals that commuters prefer using motorcycle-taxi to using Songtaew. The future use of mass transit is given last priority. It is a result of the higher commuting fare and small service coverage that some commuters can not complete their trips by using BTS/MRT. Similarly, the effects of correlations, ϕ_1 and ϕ_2, on future intention to use and related variables are same as discussed in Hypothesis 1.

6.7 Summary

This chapter revealed and investigated the commuter's attitudes towards service quality of paratransit, both demand-based type (motorcycle-taxi) and route-based type (Songtaew), and perceptions of trip accessing mass transit stations. Further, this chapter also found that commuters' attitudes are powerful tools in assessing service qualities and revealing problems of paratransit and mass transit connectivity. Three important service measurements; safety, motorcycle-taxi and Songtaew comfort and convenience were evaluated by commuter attitudes. They were introduced in constructing the SEM models to investigate their influences on mass transit connectivity and future intention to use mass transits and paratransit as feeder mode. From both hypothesis testing models, increase in safety and motorcycle-taxi's comfort and convenience can raise commuter's satisfaction on mass transit connectivity that strongly influences the willingness to use of paratransit and mass transits. The obtained results indicated that the advantages of high speed and responsiveness of the demand-based operation, motorcycle-taxi, make commuters satisfy the access trips to mass transit stations and also willing to use mass transit and paratransit as a feeder in the future. Consequently, the survey and model's results provide beneficial information for paratransit operators and the government in drawing some policies to integrate existing paratransit as a feeder system and enhance mass transit attractiveness.

CHAPTER 7

PARATRANSIT INFLUENCES CONSIDERING HETEROGENEITY OF COMMUTERS

Chapter 6 investigated the influences of paratransit services, motorcycle-taxi and Songtaew, using the data obtained from the specific study areas. The results indicated that their services affect the commuter satisfaction in accessing mass transit stations and the future intention to use paratransit and mass transits. Therefore, this chapter is proposed to investigate the impacts of considering commuter's heterogeneity as described in the *Purpose II* of the influence investigation analysis, section 3.5.2 of chapter 3. Consequently, more detailed investigation will be performed to capture how the existing paratransit operations dispose the people in different economic backgrounds towards their quality of service. A Structural Equation Modeling is again applied to perform this analysis, which the model formulation differs from the model developed in the chapter 6.

7.1 Objective and approach

To achieve the target of introducing paratransit as a feeder system, the potential to be integrated as feeder system, and interrelations and influences of commuter attitudes on paratransit service to mass transit connectivity satisfaction must be clearly understood. However, the part studies just focused only on paratransit's passenger opinions, and only travelers' behavior of riding mass transit was observed to develop mode choice model. The key question is how travelers, not only passengers, perceive paratransit services that might affect mass transit connectivity satisfaction and level of patronage. It is also important to understand the preferences of different groups of commuters especially based on the economic status.

The *PurposeII analysis* is designed to understand the differences in influences of paratransit's important service measurements on commuter's satisfaction of access trip to mass transit stations especially considering on different commuter's economic status. This stage employed the data obtained from overall samples, not only samples of specific study areas, in order to examine the influences of paratransit services on the whole commuters along the mass transit corridors. The main hypothesis here is differences in service measurements have various effects on commuters in different income groups. The results could provide insights of planning the integration of paratransit as a feeder into mass transit system. Structural Equation Model (SEM) is also applied to obtain estimate the influences of paratransit service satisfactions on the overall satisfaction of mass transit access trip.

7.2 Findings

This chapter employs the same data, all respondents in the study areas, as examined in the chapter 4. The respondent characteristics and the present travel mode and present access trip characteristics can be reviewed from the section 4.2.1 and section 4.2.2, respectively. However, the mass transit access trip patterns are discussed in different manner. Moreover, the findings of commuters' attitudes towards access trips to mass transit stations and paratransit services are expressed in this section.

7.2.1 Mass transit access trip characteristics

Table 7-1 shows the shares and numbers of mode used to access mass transit stations of the respondents. Among all commuters, the three most popular modes are walking, bus and motorcycle-taxi that correspond to the previous study (Chalermpong and Wibowo, 2007). Walking is the dominant mode within the distance of 1 kilometer. Motorcycle-taxi is the most famous mode in the distance of 1-2 kilometers. Songtaew, bus and drive alone become preferable from the distance more than 2 kilometers. Most of people use only one access mode within the distance of 2 kilometers, but the share commuters who accessed to mass transit stations using two access modes become significant in the longer distances.

This study classified commuters into three main groups based on availability of data that are (1) low income - those who earned monthly less than 10,000 bath, (2) middle income - those whose incomes were 10,000-20,000 baht a month, and (3) high income - those who obtained revenue more than 20,000 baht per month. Table 7-1 revealed that lower income commuters use bus and Songtaew more than the higher income group. Bus and Songtaew are dominant modes for low income among commuters. The reasons are low income people in the samples tend to live in the longer distance, and both services offer relatively low expenses comparing with motorcycle-taxi. The average distances to the stations are 1.56, 2.14 and 2.19 kilometers for high, middle and low income commuters, respectively. For the commuters in middle class level, motorcycle-taxi and bus own larger shares. High income people prefer drive alone and motorcycle-taxi. However, walking and drive alone own the largest portion for the high income comparing with the others. High income group prefers using motorcycle-taxi to other motorized access modes except their own cars, because it offers faster travel time, door-to-door service and acceptable fare structure. Based on the survey results, paratransit show their potential to serve as an access mode to the mass transits. Both flexible for-hire and fixed route show their capability to handle around 30 percent up to 45 percent of mass transit access trips especially for the distance of 1 to 3 kilometers. Moreover, motorcycle-taxi can carry around 26% of middle and high income groups, and Songtaew serves 18 percent of commuters who earn less than 10,000 baht per month.

Table 7-1: Mass transit access characteristics

User	Walk	Drive alone	Ride sharing	Bus related	MC-taxi related	Songtaew related	Silor-lek related	No. of mode	
								1	2
< 1 km	68.92%	2.70%	1.35%	4.05%	21.62%	1.35%	-	98.63%	1.37%
1 - 2 km	6.25%	16.67%	8.33%	22.92%	37.50%	8.33%	-	95.65%	4.35%
2 - 3 km	-	23.08%	7.69%	28.21%	20.51%	17.95%	2.56%	78.13%	21.88%
3 - 5 km	-	24.62%	9.23%	32.31%	12.31%	18.46%	3.08%	65.31%	34.69%
Overall	24.34%	15.49%	6.19%	20.35%	22.12%	10.18%	1.33%	86.50%	13.50%
Low income	18.92%	12.16%	12.16%	22.97%	14.86%	17.57%	1.35%	82.54%	17.46%
Middle income	17.57%	12.16%	4.05%	27.03%	25.68%	10.81%	2.70%	80.65%	19.35%
High income	35.90%	21.79%	2.56%	11.54%	25.64%	2.56%	0.00%	94.67%	5.33%

7.3 Commuter attitude and satisfaction

This study observed two main attitudes that are (1) attitudes regarding paratransit, both motorcycle-taxi and Songtaew, and (2) attitudes concerning access trip to mass transit stations. All respondents were asked to express their perceptions on 7 attributes regarding mass transit connectivity, and 15 attributes with regard to service quality of both motorcycle-taxi and Songtaew. The dtealils of metioned attributes were explained in the section 6.5 of chapter 6. Thus, the total of 37 attributes was observed to each respondent with the satisfaction level ranging as 1 is "very dissatisfied", 2 is "somewhat dissatisfied", 3 is "somewhat satisfied", and 4 is "very satisfied".

7.3.1 Mass transit connectivity attitudes and satisfactions

Table 7-2 shows the average satisfaction scores of 7 attributes of mass transit station's connectivity. Commuters seem satisfied with their access trip to mass transit stations in present; but not so satisfied with the walking time, both from home to find access mode services and after getting off the services to stations which illustrated in Figure 3-3 of chapter 3. Only the high income stated that they satisfied with later part of walking time. Low income people not so satisfied with the access cost as well as middle income respondents who access by the modes other than walking and private car related modes. However, all commuters dissatisfied on the paratransit facilities provided in the present. Moreover, high income commuters expressed the higher level of satisfaction to mass transit stations based on the access time and part3 walking time comparing with the others. The potential reasons are most of them live closer to the station, as discussed in the average distances to the stations in previous section, and access to the stations by using only one mode such as walking, driving and motorcycle-taxi.

Table 7-2: Average satisfaction level of mass transit access trip

Commuter	Access time	Waiting time	Walking time (part1)	Walking time (part3)	Transfer Difficulties	Access cost	Paratransit facility
Overall	3.03	2.98	2.70	2.82	2.92	2.90	2.64
Low income	2.94 / 3.09	2.77 / 3.19	2.58 / 2.66	2.74 / 2.75	2.90 / 2.84	2.77 / 2.84	2.68 / 2.75
Middle income	2.89 / 3.00	2.92 / 3.04	2.68 / 2.60	2.73 / 2.56	2.97 / 2.80	3.00 / 2.88	2.51 / 2.84
High income	3.07 / 3.15	3.04 / 2.98	2.64 / 2.91	3.04 / 3.00	2.93 / 2.98	2.96 / 2.94	2.50 / 2.64

Remark: A/B: A = walking, drive alone and ride sharing; B = bus, paratransit and others

7.3.2 Paratransit service attitudes and satisfactions

The average satisfaction scores of 15 paratransit's service attributes are presented in Table 7-3. Both motorcycle-taxi and Songtaew service were assessed by three income groups of the respondents. All commuters dissatisfied motorcycle-taxi-service on the safety and security aspects that are riding quality, vehicle condition and safety equipment, and night time security. On the other hand, motorcycle-taxi are satisfactory preferred to Songtaew in terms of comfort & convenience (No. 4 -12), except it can not protect passengers from hot weather and rain. High income respondents expressed high satisfaction level for motorcycle-taxi especially for the ability to reach their destination, less stop, and flexibility. Commuters seem dissatisfied with Songtaew service. In addition, respondents dissatisfied with present fare structures, but Songtaew has advantage over motorcycle-taxi. It is because Songtaew's fare is relatively cheap compare to motorcycle-taxi especially in the distance more than 1 kilometer. However, satisfaction level of Songtaew's suitability of fare is only somewhat satisfied considering its long travel time and waiting time. All respondents dissatisfied on the information services of both paratransit especially the accident insurance.

Table 7-3: Average satisfaction scores of paratransit services

Paratransit Service Quality Attributes	Low income		Middle income		High income	
	MC-taxi	Songtaew	MC-taxi	Songtaew	MC-taxi	Songtaew
1. Riding/driving quality	2.05	2.48	1.98	2.31	1.88	2.21
2. Vehicle condition and safety equipment	2.32	2.38	2.19	2.13	2.07	2.09
3. Night time security from crime	2.02	2.43	2.03	2.27	1.88	2.12
4. Waiting time for using service	2.81	2.25	2.85	2.13	3.03	2.05
5. Number of stops along the way	3.16	2.16	3.21	1.85	3.33	1.96
6. Protection from air pollution & weather	1.87	2.43	1.58	2.13	1.59	2.27
7. Seat availability and Level of crowd	2.70	2.25	2.68	2.10	2.31	2.01
8. Adequate service and on demand service	3.06	2.43	3.08	2.29	3.24	2.23
9. Availability in night time/early morning	2.95	2.49	2.98	2.32	3.13	2.35
10. Flexibility to change route	3.19	2.17	3.15	2.19	3.23	1.97
11. Ability to reach the exact destination	3.29	2.24	3.26	2.37	3.43	2.19
12. Suitability of present fare structures	2.57	2.84	2.61	2.69	2.41	2.64
13. Service schedule/fare information	2.17	2.24	2.39	2.27	2.35	2.12
14. Service and registration information	2.35	2.44	2.13	2.10	2.00	2.05
15. Accident insurance information	1.98	2.13	1.76	1.87	1.71	1.73

7.4 Paratransit's service influences investigation

7.4.1 Mass transit access and paratransit service measurement

This section aims to categorize both mass transit connectivity and paratransit service attributes in term of service measurement. This categorization not only classifies the observed attributes into main service measurements, but also facilitates the model development and accuracy. Factor analysis was applied to perform in the categorizing process by the analysis of moment structures, AMOS5.0 (Arbuckle, 2003; Blunch, 2008). This structure analyzed the total of 37 attributes of paratransit service and mass transit access attitudes by using confirmatory factor analysis procedure (CFA) based on the significant criteria of 5% significance (Kaplan, 2009; Shrestha et al., 2007). The model was assessed by multiple fit indices including chi-square (χ^2), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), root mean square residual (RMR), and root mean square error of approximation (RMSEA).

The χ^2/df value for this model is 2.483, which is less than 3. The fit indices of the established model can be explained by the RMR, 0.04, and RMSEA, 0.08, that satisfy the assess criteria of less than 0.10 and 0.08, respectively. The GFI and AGFI values were 0.79 and 0.75 respectively that means more than 75% of the co-variation in the data could be represented by the given model. The recommended values of GFI and AGFI are 0.90 and 0.80. The indices obtained from CFA could not reach the recommended values. While considering the effects from a small number of respondents and the level of model representation, the model can be implied as acceptable. The four main factors consist of 26 significant attributes, are made based upon the variables that load on the factor, and classified into *Mass transit access measurement*, and three paratransit's service measurements – *comfort and convenient*, *safety and security*, and *information* – as shown in Table 7-4.

Table 7-4: Mass transit access and Paratransit service measurements

Mass transit access Measurement	**Paratransit Service Measurements**		
	Comfort and Convenient	**Safety and Security**	**Information**
1. Total access time	1. Waiting time for using service	6. Riding/driving quality	9. Service schedule/fare information
2. Total waiting time	2. Number of stops along the way	7. Vehicle condition and safety equipment	10. Service and registration information
3. Total access cost	3. Adequate service and on demand service	8. Night time security from crime	11. Accident insurance information
4. Transfer difficulty	4. Availability in night time/early morning 5. Flexibility to change route	The 26 attributes are; • 4 attributes of Mass transit access measurement • 2 x 11 attributes of paratransit service measurement	

Remark: Paratransit consist of (1) motorcycle-taxi and (2) Songtaew

7.4.2 Influence investigation model specification

The primary objective here is to interrelate attitude concerning services of paratransit, both motorcycle-taxi and Songtaew, to the perception regarding mass transit connectivity. Moreover, the related objective is to determine how commuters consider each service attributes of paratransit service quality and mass transit connectivity. Structural equation model is applied to examine the influences of paratransit services. A total of nine separate sets of models were developed based on three main paratransit service measurements, which are comfort and convenient, safety and security, and information, and each measurement are classified into three groups of income levels: *low, middle, and high income*.

Each of the model contains one endogenous latent variable for mass transit connectivity attitude (ξ), and two latent exogenous variables for attitudes of motorcycle-taxi (η_1) and Songtaew (η_2) as illustrated in Figure 7-1. The observed variables for each latent variable are listed in the Table 7-5. The observed variables of mass transit connectivity attitude are applied for all paratransit service measurement's models. The models of each measurement can be defined in terms of structural equations model:

$$\xi_k = \beta_{1k}\eta_{1k} + \beta_{2k}\eta_{2k} + \varepsilon_k \tag{7.1}$$

where;

ξ_k = mass transit connectivity attitude of paratransit service measurement *k*

η_{1k} = motorcycle-taxi attitude of paratransit service measurement *k*

η_{2k} = Songtaew attitude of paratransit service measurement *k*

β_{1k} = parameter of attitudes towards motorcycle-taxi service measurement k
β_{2k} = parameter of attitudes towards Songtaew service measurement k
ε_k = error term of paratransit service measurement k
X_{ik} = i^{th} observed motorcycle-taxi's variables of paratransit service measurement k
Y_{ik} = i^{th} observed Songtaew's variables of paratransit service measurement k
Z_k = observed mass transit connectivity's variables of paratransit service measurement k

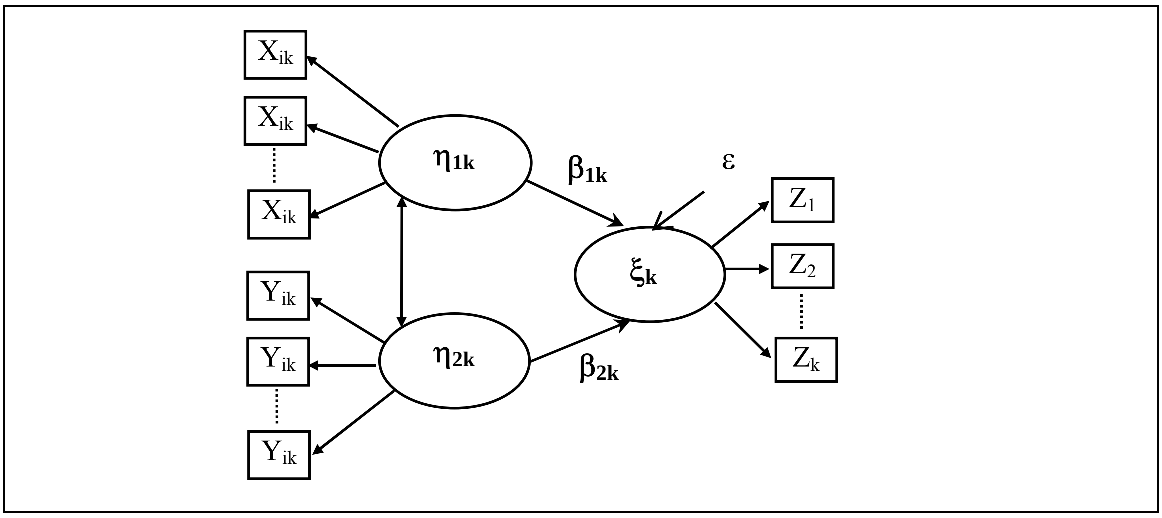

Figure 7-1: Structural model diagram

Table 7-5: Model's variables and symbols

Mass transit access trip		
Variable		**Description**
Z1		Total access time (Part1, Part2 & Part3)
Z2		Total waiting time (for feeder & transfer)
Z3		Total access cost (access to the station)
Z4		Transfer difficulty
Paratransit service [MC-taxi (X); Songtaew (Y)]		
Comfortable and Convenient service measurement		
Variable		**Description**
X1	Y1	Waiting time for using service
X2	Y2	Number of stops along the way
X3	Y3	Adequate service and on demand service
X4	Y4	Availability in night time/early morning
X5	Y5	Flexibility to change route
Safety and Security service measurement		
X6	Y6	Riding/driving quality
X7	Y7	Vehicle condition and safety equipment
X8	Y8	Night time security from crime
Information service measurement		
X9	Y9	Service schedule/fare information
X10	Y10	Service and registration information
X11	Y11	Accident insurance information

7.5 Model results

7.5.1 Models for comfortable and convenient service of paratransit

All income level models were significant at 95% level of confidence as explained by *p*-values, and contained the χ^2/df values of 1.455, 1.289 and 1.306, which is far behind 3, for low, middle and high income respectively. The RMR and RMSEA of all models were close to the recommended values of less than 0.10 and less than 0.08 respectively. In contrast, the goodness of fit index (GFI) and adjusted goodness of fit index (AGFI) values were not reach the recommended values of at least 0.90 and 0.80; however, their values, as shown in Table 7-6, closed to the thresholds. These fairly fit values are probably caused from the low number of samples. However, it can be implied that all models have a reasonably good fit.

Songtaew has positive effects to mass transit access satisfaction for the low income and middle income with the parameter (β_2) of 0.370 and 0.307 at the level of confidence more than 90%, respectively. But, it is not significant for the high income. The potential of these effects is low and middle income seem to aware on their access cost as expressed the higher weight in Table 7-7, and they ride Songtaew more than high income people. In contrast, motorcycle-taxi positively affects only to mass transit access attitude for the high income group with the parameter (β_1) of 0.485 at the p = 0.007. It implies that high income people pay more attention to the service finding, availability and flexibility of motorcycle-taxi as expressed by the coefficients of Z2, X4 and X5 in Table 7-7. It is because these attributes offer more convenient, faster access trip and less waiting time. Another potential is riding Songtaew usually take longer and unpredictable waiting time.

7.5.2 Models for safety and security service of paratransit

Low income and middle income models were significant at 95% level of confidence, but the high income's model was not significant. For the two significant models, their χ^2/df values were far behind 3 as shown in Table 7-6. The RMR and RMSEA of both models reached to the recommended values except the RMSEA of the low income model; however, it was acceptable. The goodness of fit index (GFI) and adjusted goodness of fit index (AGFI) values shown in Table 7-6 were also not reach the recommended values of at least 0.90 and 0.80; however, they were again acceptable and can be implied as reasonably good fit models.

Among the estimated coefficients, only β_2 of the middle income's model is significant that cannot be rejected at the p = 0.004 level. It can be explained that safety and security service of Songtaew has a positive effects to mass transit access satisfaction for the middle income commuters with the parameter β_2 = 0.857 as shown in Table 7-6. Moreover, from the high value of X7, X8 and Y7, Y8 in Table 7-7, middle income people pay more attention to the vehicle condition and night time security of both types of paratransit comparing with the other groups that mainly consider the driving quality. Though the Y8 of the middle-income is less than the low-income, it still shows its higher value comparing with other coefficients. Even though the coefficients were insignificant, they show the trends that all commuters prefer safety and security service of Songtaew as can be seen from the positive coefficients. Therefore, the interest is importantly required for the motorcycle safety and security service as it posed the negative impact to mass transit access.

Table 7-6: Parameter estimates and fitness indices of SEM models

Model	Comfort and convenience models			Safety and security models			Information models		
	Low	**Middle**	**High**	**Low**	**Middle**	**High**	**Low**	**Middle**	**High**
β_1	-0.161 (p = 0.384)	0.235 (p = 0.121)	0.485 (p = 0.007)	-0.144 (p = 0.535)	-0.143 (p = 0.587)	-0.126 (p = 0.623)	-0.219 (p = 0.352)	-0.109 (p = 0.583)	-0.004 (p = 0.981)
β_2	0.370 (p = 0.079)	0.307 (p = 0.045)	-0.055 (p = 0.728)	0.338 (p = 0.164)	0.857 (p = 0.004)	0.517 (p = 0.064)	0.294 (p = 0.204)	0.594 (p = 0.007)	0.048 (p = 0.753)
χ^2	100.407	95.397	95.306	53.175	45.273	32.579	49.606	46.242	51.279
df	69	74	73	31	32	29	30	31	31
$\chi^2/\ df$	1.455*	1.289*	1.306*	1.715*	1.415*	1.123*	1.654*	1.492*	1.654*
p	0.008	0.048	0.041	0.008	0.06	0.295	0.014	0.038	0.012
GFI	0.832	0.831	0.853	0.854	0.886	0.927*	0.873	0.881	0.898
AGFI	0.744	0.761	0.788	0.74	0.804*	0.862*	0.768	0.789	0.818*
RMR	0.055*	0.050*	0.048*	0.051*	0.041*	0.037*	0.045*	0.037*	0.044*
RMSEA	0.086	0.068*	0.065*	0.107	0.082	0.041*	0.103	0.089	0.095

*Recommended fitness indices; $\chi^2/df \leq 3.0$, GFI ≥ 0.90, AGFI ≥ 0.80, RMR ≤ 0.10 and RMSEA ≤ 0.08

Table 7-7: Standardized regression estimates of measurement equations from SEM models

Comfort and convenience models						Safety and security models						Information models					
Relation			**Low**	**Middle**	**High**	**Relation**			**Low**	**Middle**	**High**	**Relation**			**Low**	**Middle**	**High**
Z1	<--	ξ	0.491	0.801	0.605	**Z1**	<--	ξ	0.481	0.772	0.590	**Z1**	<--	ξ	0.475	0.802	0.640
Z2	<--	ξ	0.645	0.787	0.81	**Z2**	<--	ξ	0.638	0.785	0.775	**Z2**	<--	ξ	0.626	0.762	0.746
Z3	<--	ξ	0.649	0.647	0.515	**Z3**	<--	ξ	0.618	0.664	0.563	**Z3**	<--	ξ	0.618	0.620	0.571
Z4	<--	ξ	0.597	0.825	0.591	**Z4**	<--	ξ	0.650	0.840	0.614	**Z4**	<--	ξ	0.674	0.857	0.598
X1	<--	η_1	0.703	0.503	0.660	**X6**	<--	η_1	0.792	0.734	0.749	**X9**	<--	η_1	0.543	0.597	0.676
X2	<--	η_1	0.420	0.540	0.522	**X7**	<--	η_1	0.503	0.802	0.765	**X10**	<--	η_1	0.900	0.955	0.759
X3	<--	η_1	0.957	0.774	0.759	**X8**	<--	η_1	0.609	0.706	0.545	**X11**	<--	η_1	0.712	0.605	0.576
X4	<--	η_1	0.622	0.776	0.916	**Y6**	<--	η_2	0.734	0.749	0.753	**Y9**	<--	η_2	0.747	0.787	0.889
X5	<--	η_1	0.630	0.725	0.842	**Y7**	<--	η_2	0.549	0.814	0.689	**Y10**	<--	η_2	0.915	0.826	0.807
Y1	<--	η_2	0.868	0.802	0.599	**Y8**	<--	η_2	0.780	0.742	0.725	**Y11**	<--	η_2	0.840	0.802	0.491
Y2	<--	η_2	0.824	0.659	0.473												
Y3	<--	η_2	0.615	0.775	0.812												
Y4	<--	η_2	0.604	0.702	0.786												
Y5	<--	η_2	0.508	0.381	0.508												

Note:

All estimated values are significant at 95% level of confidence

7.5.3 Models for information service of paratransit

All models concerning paratransit's information service were significant at $p = 0.05$ level as explained by the fitness indices shown in Table 7-6. Though the RMSEA values were quite high, the all models can be roughly implied good fit as the GFI and AGFI nearly reached the recommended thresholds.

It is again that only β_2 of the middle income's model is significant at 95% of significant. The interrelation shows that Songtaew's information positively influences on the satisfaction level of mass transit access for the middle level commuters. They also put more awareness to their access time, waiting time and out-of-pocket expenses, as obtained from endogenous observed variables (Z1 - Z4) in the Table 7-7 that directly relate with operation's information. Moreover, they pay attention to the service's registration of both paratransit corresponding to their safety and security concerns. In addition, the important reason of insignificant influence of motorcycle-taxi is plausibly that all commuters get used to motorcycle-taxi's operating information. As expressed by X9, Y9 and X11, Y11 in Table 7-7, high income people concerned more on the operating information, but very less on the insurance comparing with the other users. It is because they always aware for their time especially for waiting the services, as can be explained from the high coefficient of Z2 for all models, and rarely use paratransit services. In contrast, low income commuters show higher coefficients on registration and insurance information. The potential reasons are that they have to use paratransit more often, and availability of insurance can save their money in the case of accidents based on the surveys and personal interviews.

7.6 Summary

Commuters' attitudes are the powerful tools that helpfully assess quality of service and reveal problems that need to be considered for both paratransit and mass transit connectivity. Three important service measurements - comfort and convenient, safety and security, and information - were evaluated according to commuter's income segments in this chapter. The developed SEM models demonstrate that commuters' satisfactions on service quality of paratransit have various effects to mass transit access trip and several influences on commuters in different income status. The comfort and convenience of motorcycle-taxi positively influences the high income and middle income commuters, whereas the safety and security service measurement of this mode seemed to decrease satisfaction of commuters in accessing mass transit stations for all travelers. In contrast, Songtaew service seemed to satisfy, mainly, the low income commuters in terms of comfort and convenient, but its level of safe and secure services are considered more preferable for all commuters. Only the middle income commuters are influenced from the information services of Songtaew. These obtained results highlight the important of the impacts of commuter's heterogeneity that the transport planning of developing countries should not overlook the large divergence of travelers.

CHAPTER 8

POLICY DEVELOPMENT

Up until this chapter, several investigations were performed and various important data were discovered. Present modes accessing mass transit stations were examined in the study areas along mass transit corridors of Bangkok, BTS and MRT. The demand-based paratransit, motorcycle-taxi, and route-based paratransit, Songtaew, showed their outperforming operations in connecting people between their residences and mass transit stations. Commuters' travel choice consideration was conducted in order to understand the repercussions of paratransit operations on commuter travel choice decision and to determine whether the combination of paratransit as a feeder is included in commuters' travel choices. Further, the influences of two selected paratransit services on commuters were appraised by considering the effects on the satisfaction of access to mass transit stations and the willingness to use of mass transits and paratransit as a feeder. The influences were mainly examined based upon commuter's perceptions and attitudes to qualities of services of the selected paratransit operations. Both types of paratransit showed that their services could encourage more satisfaction of trip accessing mass transit stations and increase willingness to use of mass transits and paratransit as a feeder. Nevertheless, paratransit has often been ignored by most of transportation planners and policy makers to integrate it as one of urban transport modes. Therefore, the obtained results provide valuable information of drawing the policies of integrating paratransit as a feeder into mass transit systems that will be discussed in this chapter.

8.1 Background

As have been investigated, motorcycle-taxi and Songtaew have different benefits and issues in providing the feeder services. Motorcycle-taxi offers fast, demand responsive and door-to-door services that seem satisfy basic needs of commuters who travel in urban areas. The relatively high speed operations, nevertheless, make commuters confront with high risks of traffic accidents. Moreover, the higher fare comparing with Songtaew and bus is unfavorable for the low income commuters. Songtaew, on the other hand, provides cheaper fare structure and safer service. However, passengers of Songtaew have suffered from traffic congestion, many stops, and unreliable waiting time because of vehicle size and needs of sufficient patrons. In addition, this research obtains that motorcycle-taxi is suitable for the short-distance trips while Songtaew is preferable for the intermediate-distance travels.

This research also acquires that the service quality of paratransit has various significant influences on commuters in accessing mass transit stations and willingness to use. Safe and secure service is an important factor enhancing access trip satisfaction of commuters. Satisfaction of trips connecting between residences and stations show the positive influences in encouraging commuters to use paratransit as a feeder and mass transits. In addition, paratransit services has been explored that they influence commuters' travel choice consideration while a combination between paratransit and public transport is taken into account as one of available choices. The difficulties, pessimistic images and risks of using paratransit and public transport discourage commuters to travel by this combination choice. Therefore, the policies regarding paratransit services are required more attentions in order to promote the integration of paratransit as a feeder into mass transit systems.

8.2 Insightful information for policy development

The travel choice consideration model rendered that difficulties of a travel choice of combination between paratransit feeder and public transports could hinder public transport's patronage. The difficulties were considered as number of transfers, longer out of vehicle time (waiting time and walking time), and many expenses. Further, risks of facing traffic accident and pessimism of paratransit services also impeded usage of public transports.

From the paratransit's influence investigation models developed in Chapter 5 and Chapter 6, the obtained structural equations provide appreciable information to develop the policies of integrating paratransit into mass transit systems. The structural equations of mass transit access satisfaction and future intention to use are constructed based on equation 6.1 and 6.2, respectively. These equations are expressed in the equation 8.1 and 8.2. Moreover, the detailed structural equations regarding the heterogeneous effects are generated based on the equation 7.1 and listed in the equation 8.3 to equation 8.11. The developed structural equations for policy development are as follows;

For Mass transit access satisfaction:

$$MassAcc = 0.483Safety + 0.141MC\ Comf/Conv - 0.023ST\ Comf/Conv + 0.130 \quad (8.1)$$

For Future intention to use:

$$FutureUse = 0.19Safety + 0.21MC\ Comf/Conv + 0.118ST\ Comf/Conv + 0.245MassAcc + 0.036 \quad (8.2)$$

The equations regarding heterogeneous effects are developed based on three paratransit's service measurements and three types of commuter's socioeconomic levels as explained in section 7.4.2. The equations are shown below.

For Comfort and convenience service:
High income: 0.485 MC Comf/Conv – 0.055 ST Comf/Conv + 0.143 (8.3)
Middle income: 0.235 MC Comf/Conv + 0.307 ST Comf/Conv + 0.318 (8.4)
Low income: -0.161 MC Comf/Conv + 0.370 ST Comf/Conv + 0.086 (8.5)

For Safety and security service:
High income: -0.126 MC Safety/security + 0.517 ST Safety/security + 0.139 (8.6)
Middle income: -0.143 MC Safety/security + 0.857 ST Safety/security + 0.160 (8.7)
Low income: -0.144 MC Safety/security + 0.338 ST Safety/security + 0.084 (8.8)

For Information service:
High income: -0.004 MC info + 0.048 ST info + 0.202 (8.9)
Middle income: -0.109 MC info + 0.594 ST info + 0.286 (8.10)
Low income: -0.219 MC info + 0.294 ST info + 0.085 (8.11)

The equation of Future intention to use (equation 8.2) indicated that satisfaction of accessing mass transit stations has the strongest positive influence, coefficient of 0.245, in encouraging commuters to use mass transits, and motorcycle-taxi and Songtaew as feeder.

Comfort and convenience service of motorcycle-taxi possesses the second, coefficient of 0.210, and safety and security service owns the third, coefficient of 0.190, while comfort and convenience service of Songtaew shows the smallest positive influence. The positive coefficients elucidate that increase in satisfaction of access to mass transit stations and paratransit service quality would inspire commuters to use both mass transits and paratransit feeder in the future.

The equation of Mass transit access satisfaction (equation 8.1) indicates that motorcycle-taxi's comfort and convenience and paratransit safety and security enhance commuter's satisfaction of access trip to mass transit stations. It is from the fact that travelers prefer safe and secure trips and motorcycle-taxi offers fast and demand responsive services. Though safer and cheaper services offered by Songtaew operations positively influence commuter's future intention to use, the comfort and convenience service of Songtaew not significantly affects satisfaction of accessing the stations resulting from inadequate services and unreliable waiting and travel time. However, it shows strong correlation with paratransit safety service. In addition, commuters evaluate their satisfaction of access trip mainly on waiting time and transfer illustrated by the coefficients of measurement model of mass transit access satisfaction in Table 6.6.

Fast and demand responsive service of motorcycle-taxi positively boosts mass transit access satisfaction of commuters, high and middle income groups, who can afford higher fare structure of motorcycle-taxi. These groups of travelers, especially the high income group, seem to consider more on motorcycle's advantages of higher speed and responsiveness over the risks of facing traffic accident as illustrated in equation 8.3, 8.4, 8.6 and 8.7. Besides, the high income people rarely use Songtaew, though it was considered safer than motorcycle-taxi. On the other hand, Songtaew offers affordable fare and safer services that satisfy both low and middle income groups. It should be noted that safety and security, and comfort and convenience services of Songtaew were assessed dissatisfied by all commuters, however.

In addition, people rarely consider the information of motorcycle-taxi as expressed by the low coefficient's values in the equation 8.9 to 8.11. It is because motorcycle-taxi is available almost everywhere and provide services throughout the day. The low and middle income commuters are influenced by information of Songtaew because its services could alleviate their travel expenses. In contrast, Songtaew's information not significantly affect the high income people because they do not interest to use Songtaew as shown by the coefficient of 0.048 in the equation 8.9.

It could be summarized that the policies of integrating paratransit as a feeder into mass transit systems should pay more attention to improve satisfaction of trips accessing mass transit stations. The important points that must be taken into consideration are enumerated below.

- Safe and secure service is the important attribute which positively influences the satisfaction of access trip. At present, motorcycle-taxi, demand-based service, was evaluated high level of satisfaction and shows capability in attracting high and middle income people, who are able to use private vehicle, and boosting satisfaction of access trip and willingness to use mass transits and paratransit as a feeder. Despite the fact that these groups of people consider their travel time over the safety, high risks of facing traffic accident, nevertheless, could fade away usage of paratransit feeder and public transport. Not only motorcycle-taxi but also Songtaew should be focused especially vehicle condition, because both types of paratransit are appraised dissatisfied in terms of safety and security.

- An ability of responsiveness and faster service dispensed by motorcycle-taxi satisfied commuters and overcome higher accidental risks of motorcycle-taxi's operation. Songtaew, route-based service, enhances level of satisfaction of access trips in terms of safety more than motorcycle-taxi do. Nevertheless, its unreliable waiting and travel time can not attract commuters especially the high income people. When income level is increasing in the future, commuters will easily shift to other modes, notwithstanding Songtaew's higher level of safety. Therefore, improving reliability of travel time (waiting and number of stops) and responsiveness of the route-based service could mitigate Songtaew's shortcomings, secure existing patronages, and attract more travelers.

- Reducing difficulties of travel by the combination between paratransit and mass transits should be implemented especially in terms of transfer. Less number of transfers and short connecting walking distance could alleviate these difficulties and enhance an ability of door-to-door service of mass transit.

8.3 Policy development

According to the obtained results, the policy of integrating paratransit as a feeder into mass transit systems can be developed into two main aspects;
1) Paratransit service improvement
2) Ease of accessibility improvement

8.3.1 Paratransit service improvement

In terms of paratransit influences, safety and security operation is the most important factor affecting commuters in accessing mass transit stations. The majority of travelers really aware of time spent in access trips and difficulties of transfer. Motorcycle-taxi's fast and flexible operation expresses positive effects on accessing to stations and willingness to use of commuters. Nevertheless, motorcycle-taxi is considered as unsafe travel mode. Songtaew is considered relatively cheaper and safer than motorcycle-taxi; however, the services are unreliable especially in terms of waiting and in-vehicle time. Risks of easily facing traffic accidents and unpredictable travel time caused by motorcycle-taxi and Songtaew have deteriorated images of paratransit services in travelers' points of view, though the images of discourteous operation have been fading away. Hence, these shortcomings of both types are seriously required to be improved or minimized in order to effectively integrate paratransit as a feeder system. The policies for improving paratransit services must crucially focused on two main service measurements that are (1) safety and security operation and (2) reliable and demand responsive operation.

Safety and security operation

Priority should be given to the safety and security aspect. It strongly influences mass transit access satisfaction and the future intention to use. Nevertheless, commuters are dissatisfied with safety and security provided by both types of paratransit especially the motorcycle-taxi as witnessed in the survey and model results. Though Songtaew is considered safer, its safety and security somewhat dissatisfied the commuters. Therefore, hazardous and reckless driving must be intensively controlled as expressed by low satisfaction scores and coefficient indicated in measurement models. Moreover, it was revealed that drivers play a vital role in causing traffic accident (Joewono and Kubota, 2006). The enforcements such as speed control and helmet use, and regulations of service license issue can be implemented by the government. Nevertheless, the proposed enforcements necessarily require strong ascendancy and supervision. Drivers must participate and pass a driving training program before their service licenses will be issued. The above mentioned strategies could be handled by the police and government units.

Effectiveness at curbing illegal and injurious urban transport services ultimately rests with a vigorous and dedicated program to enforce rules and requirements. This means devoting sufficient resources - trained officers, judiciary systems, administrators, technologies - to monitor activities in the field. Despite the fact that those regulation and enforcement have been activated, the demerits in safe and secure services probably remain. These demerits are the results of lack of supervision and inadequacy of police officers. Effective oversight and control, it should be added, does not necessarily mean costly administrative outlays. Modest, low-cost initiatives can be highly effective. Consequently, this research aspires to propose a solution of paratransit operators' collaboration to handle this improvement strategy. Some control and penalty regulations can be set and regulated by the chief of association from within that might be more effective than desultory enforcements. The control and regulations can be directly applied to the operators from the beginning of entering the association and during running the services. Proper communication between policy planners and operators is required in order to fulfill this solution. Not only driving manner but also condition of in-service vehicles could be successfully supervised by the operator associations. In-service vehicles must be maintained in acceptable safe condition that satisfies commuters. The preventive maintenance should be regulated periodically. Further, night time security must be improved especially motorcycle-taxi because drivers tend to drive faster and passengers generally use the service alone. Driver and vehicle registration details should be provided for the passengers such as printing on the vests, attaching inside vehicle and providing at terminal.

Reliable and demand responsive operation

Reliability of access time and comfort and convenience of feeder services are very important factors that reflect the level of satisfaction of mass transit connectivity and service quality of motorcycle-taxi and Songtaew. These factors are clearly expressed in the investigation models. Motorcycle-taxi takes advantages of fleet-footedness, flexibility and demand responsiveness in raising mass transit access satisfaction and commuter's willingness to use, while Songtaew not significantly influences. This probably results from Songtaew's nature of services. However, people still willing to use its service as shown in future use measurement model. Songtaew offers relatively high level of safety in terms of traffic accident. As discussed earlier in the correlation effects, the improvements to the operation of Songtaew are expected to enhance mass transit connectivity as well. Consequently, the improvement strategies must concentrate on relieving unreliable waiting time and in-vehicle time. The idea of Express Songtaew could be one of the solutions that offers predictable travel time and mounts travel speed. Control of scheduling should be applied to alleviate unreliable waiting. Moreover, the frequent stops of Songtaew received the lowest satisfaction score from the respondents. Therefore, designated stop locations should be introduced to reduce number of stops and improve satisfaction in travel time. Since this controlled stop strategy would attenuate flexibility of Songtaew, rigorous design of stop spacing and locations are required to minimized disadvantages and commuter's dissatisfactions. Crowd and inadequacy of Songtaew also dissatisfy commuters. The frequent service is needed to be considered to alleviating crowd and benefiting service finding.

8.3.2 Ease of accessibility improvement

Difficulties in transfer, the cost of access and paratransit terminal are evaluated to be somewhat dissatisfied. Waiting time and transfer attributes have been considered high priority for mass transit connectivity perception. These attributes must be underlined because the satisfaction of access to mass transit has positive consequence to the willingness to use as illustrated in the equation 8.2. As discussed in section 8.2, less numbers of transfers, short connecting walking distance, and safe transfers especially between access modes and mass transits could alleviate difficulties of using paratransit as a feeder to access mass transit stations and satisfy commuters' needs. There are two strategies that suitable for this improvement: (1) direct access and (2) connecting facility.

Direct access

The solution of direct access mode, as witnessed from the previous BTS's shuttle bus service performance, should be reconsidered by applying to the existing paratransit services. Motorcycle-taxi is very effective in providing door-to-door function, especially in the range of 1-2 kilometers, that commuters are able to minimize their walking distances. However, Songtaew requires well planned re-routing projects from BMTA as have been done in bus network plans. This re-routing plan will offer short walking distance in connecting to the stations or bus stops in order to provide ease of access trip to mass transit stations. Increase of easiness of accessing the stations could encourage commuters who lived in the distances longer than 2 kilometers from the stations and the low income commuters to use mass transits. This solution offers lower expenses comparing with accessing by two modes, Songtaew and bus, as required at present.

Connecting facility

Proper small terminals and parking facilities for paratransit should be provided at close proximity to the stations in collaboration between paratransit operators and mass transit authorities in order to pick-up and drop-off passengers. This facility can provide easiness of passenger boarding and alighting as the park and ride facility offers, but requires only small space that fits for the high-density areas. Not only do the strategies facilitate connection from feeder to mass transit such as reduce transfer difficulty and walking distance, but also offers safety to passengers and operators. Besides, this facility is also able to provide standby paratransit services that ready to response traveler's demand. The solution of providing connecting facility were rated high priority for improvement reflecting high weight score of convenient level of access to stations as explored by Okada et al. (2003). In addition, collaboration on fare promotion between two parties can also be an effective solution.

8.4 Summary

This chapter develops some important policies in order to provide insights of integrating paratransit as a feeder into mass transit systems through a case study of Bangkok. The proposed policies and their strategies are drawn from the results obtained from the analyses and investigations conducted in the former chapters. Two main improvement policies have been proposed that are paratransit service improvement and ease of accessibility improvement. The regulation and enforcement have been canvassed to enhance level of safety of both types of paratransit, especially motorcycle-taxi. In addition, this research has proposed the strategy of collaboration from paratransit operators with anticipation that it could support strong and effective control from within. The driving manner and vehicle condition should be regulated by the chief of associations. In addition, the reliable and time-saving operations of Songtaew must be performed in order to encourage commuters to patronize its services. A re-routing of Songtaew to directly access to mass transit stations and facility for paratransit services to load and unload passengers including standby vehicles are suggested.

CHAPTER 9

CONCLUSION

The main purpose of this dissertation is to provide the appropriate framework for integrating the existing paratransit as a feeder into mass transit systems in the developing countries. The recommended policies and strategies of complementary paratransit would enhance the performance of the existing mass transits and, with anticipation, the future developments by offering more convenience of the trip connecting between mass transit stations and commuters' residences. This chapter concludes the findings obtained from the paratransit's feeder potential examination, the impacts of paratransit services on commuter's travel choice consideration, and the investigations of paratransit feeder capability, influences of paratransit on commuter's satisfaction and willingness to use. The proper managing strategies of integrating paratransit as a feeder are then deduced and recommended. Further, the research contribution and implication are explained. Finally, the future prospects for further research regarding this field are discussed.

9.1 Summary of findings

9.1.1 Paratransit feeder potential

The existing paratransit, motorcycle-taxi and Songtaew, was found to be potentially integrated as a feeder system into urban transportation. They could handle almost 40% of trips accessing to the stations especially in the distances longer than 1 kilometer. Not surprisingly, walking was the considerable means of home-station travel for distances within 1 kilometer. Therefore, providing better walking environments and facilities specifically in the 1-kilometer radius from mass transit stations could increase the propensity to walk. People living in the ranges of 1 to 2 kilometers from transit stations mostly accessed the stations by motorcycle-taxi. Direct bus also owned a large share in this distance. Improving motorcycle-taxi quality of service, particularly, traffic safety and reasonable fare structure, will be the keys to attract more latent mass transit riders who lived in the distances of 0.7 to 2 kilometers, and probably the low income.

In the distances longer than 2 kilometers, car-related alternative and fixed-route alternative became more preferable. Commuters who were able to drive, female office workers and students, seemed to rely on personal automobiles (Park and Ride and Kiss and Ride) rather than public transports. However, direct access bus services between home and station increased the patronage of bus. This supported the previous findings that feeder bus services were keys to the success of rail systems. Experiences and satisfaction with Songtaew services showed better classification power in determining users of Songtaew and the combination of bus and paratransit alternatives. Therefore, direct bus feeder systems connecting between homes and transit stations are important for transportation planners in consideration to increase use of mass transits (Edwards and Mackett, 1996; Kim et al., 2007). In addition, public transit authorities may consider the rerouting of bus and Songtaew in order to provide direct access, good connectivity, and expansive service coverage.

9.1.2 Paratransit impacts on commuter's choice consideration

In the case study areas of Bangkok, the travel choice of the combination between paratransit, motorcycle-taxi and Songtaew, and public transport found in this study owned the patronages of about 42 percent of the respondents or almost the same share of public transport-only mode. This revealed the fact that, presently, commuters considered the combination alternative as their typical travel choices. However, only 20 percent of the respondents considered this combination of paratransit and public transport alternative as their first choice and 63 percent of present users of this alternative decided to shift to public-transport-only travel choice. Most of car riders, especially the car-dependent, preferred to continue driving as expected.

Only an attribute of agreement on reduction of car use could preserve the environment and was significantly different between the public transport-only choosing group and the combination of paratransit and public transport choosing group. The later group rated the highest average rating score among three choices; however, all respondent agreed with this attribute. The car preferred group significantly assessed low average scores on the attributes of environmental concern. However, this did not mean that car preferred respondents thought environment preservation was unimportant. Also, in the attitudinal measure, there were few statistically significant differences between the public transport-only choosing group and the combination of paratransit and public transport choosing group. The first group seemed satisfied with access distances and using public transport for the trips other than the regular trips. In addition, public transport-only preferred respondents concerned chance of facing with crimes more than the commuters who chose the combination of paratransit and public transport travel mode. It should be noted that car preferred respondents seemed dissatisfied with public transportation services especially on comfort and convenience. They were also significantly dissatisfied with the expenses of access to use public transport services, images of public transit and paratransit, and difficulties and risk of using the paratransit combination alternative.

The important factors that significantly influence commuter's choice consideration are emphasized. Firstly, car preference strongly influences an increase of choosing to drive rather than using public transport especially for present car riders. Secondly, risks of the combination of paratransit and public transport alternative significantly result in increased potential of selecting private vehicle and public-transport-only travel modes, and refrain from the combination alternative. Thirdly, images and difficulties of using public transit and paratransit show the negative effects on all public transport patronages. Lastly, negative attitudes towards comfort and convenience of using public transport and paratransit possess the potential of choosing car rather than public transport services.

Although the patronage of the combination between paratransit and existing public transport seems to be decreasing, it can be implied from the findings of the present study that paratransit services are still taken into consideration by the commuters in Bangkok and have a potential to continue their dominant function as a feeder in urban transportation system. The reduction in level of patronage is potentially caused by the dissatisfaction with paratransit services qualities as well as deficiency of existing public transportation. Not only commuter demographics and alternative specific attributes but also personal behavior and attitudes towards travel alternatives are found to considerably affect the commuter mode choice. As indicated in the investigation, car preferences encourage use of private vehicles and discourage public transport patronage as well as the pessimism over services of existing public transport and paratransit. The obtained results indicated that access trip and service quality of access modes influence commuter's perceptions and travel choice consideration. Therefore, it is necessary for transportation planners to focus on the personal behavior and attitudes towards the combination of paratransit and public transportation in order to enhance the performance of public transport and urban transportation by integrating paratransit as a feeder into transportation system. Additionally, the current findings therefore imply that strategies of improving the level of services for existing public transports including paratransit services should be promoted. Improvement on travel time reliability, safety and security, and comfort and convenience, can potentially alleviate the pessimism over a level of services of the existing public transport and paratransit. Probably, these will also elevate the level of public transport patronage of the car riders. Moreover, the strategies to attenuate commuter's car preference by means of mobility management, soft measures, and hard measures, must be stimulated.

9.1.3 Paratransit influence investigations

This research did separate the paratransit influence investigations into two main parts: (1) overall paratransit service investigation considering homogeneity of commuters, and (2) detailed investigation and effects of commuter's heterogeneity, as described in chapter 3, chapter 6 and chapter 7.

The overall service investigation found that the satisfaction of trips accessing mass transit stations positively encourages commuters to use paratransit feeder and mass transits. Safe and secure operations hold the strongest positive influence on commuter's satisfaction of trips accessing mass transit stations. Nevertheless, commuters are dissatisfied with safety and security provided by motorcycle-taxi and Songtaew, notwithstanding Songtaew is assessed safer. The satisfaction of access trips to the stations is also positively affected by motorcycle-taxi service whereas it is not significantly influenced by the service of Songtaew. These influences can be indicated that people put more concerns to the travel time, waiting time and transfer as these attributes have strong relation with satisfaction of trips accessing mass transit stations. From overall commuters, it can be indicated that the higher speed and demand responsive paratransit access mode is more attractive to travelers as can be seen from the significant influences of motorcycle-taxi and insignificant of Songtaew. It is because motorcycle-taxi offers faster travel time and more reliable services. However, Songtaew has a strong correlation with safety and security service while motorcycle-taxi seems to negatively impact on this measurement. In addition, this research found that safety and security service of motorcycle-taxi showed their influences in discouraging commuters to use paratransit and mass transit in the future as well as the satisfaction of trip accessing to the stations. It can be concluded that increasing in level of safety and security service and improving service quality, especially responsiveness to commuter's travel demand, of paratransit could raise commuter's satisfaction of accessing to mass transit stations and willingness to use of mass transits and paratransit.

For a detailed investigation and effects of commuter's heterogeneity, three important service measurements - comfort and convenient, safety and security, and information - were evaluated according to commuter's income status. The developed models demonstrate that commuters' attitudes towards each service measurement of paratransit have various effects to mass transit access trip based upon their economic status. People in middle income and high income levels put more awareness to the waiting and travel time for their access trips to the stations. In addition, middle income group stated higher consideration on the transfer difficulties. This implies that time is very important for middle and high income people. The expenses of access trip as well as waiting time are very important for the low and middle income respondents.

Motorcycle-taxi's comfort and convenient aspect presents positive influence for the high income people who always prefer faster and convenient mode to cheaper or safer mode. They evaluated paratransit services mainly on easiness of finding and quick responsiveness. Therefore, the demand-based paratransit, motorcycle-taxi, is the suitable mode that effectively offers high demand responsive and maneuver ability. From the advantages of fast and flexible, it also shows positive influence to the middle income. It should be noted that motorcycle-taxi dissatisfied and posed slightly negative impact for all commuter groups regarding the safety and security attitudes, although the parameters are not so significant. Having been continuously served for a long time and its large number, motorcycle-taxi is get used to by the commuters, and therefore people do not pay attention on operating information. However, the information of service's registration is considered important and low income people have an interest in the insurance information more than the other groups. The route-based paratransit, Songtaew, offering lower fare and safer travel shows positive effects to mass transit connectivity satisfaction for both low income and middle income commuter who often use its services. In term of safety and security measurement, it illustrates optimistic influences from all commuters especially the middle income. All commuters keep in a view mainly for operating and service's registration information, because they strongly relate with travel time, safety and security. Insurance information is taken into account mainly by low and middle income people, but rarely from the high income. It is because they prefer faster service and rarely use paratransit services.

To effectively implement paratransit as a feeder system for mass transit, it is important to understand how paratransit influence the commuters and mass transit connectivity. As in the case study of Bangkok, people especially in middle and high income groups prefer the fast and flexible of motorcycle-taxi; yet it is dangerous. All commuters are dissatisfied with Songtaew; nevertheless, it shows positive influences to mass transit connectivity satisfaction for all service measurements. As a result, Songtaew capability should not be overlooked. The shortcomings on long travel time and unreliable waiting time must be minimized. Moreover, the improvements regarding safety and security are required not only driving quality of motorcycle-taxi, as it shows the negative effect to the connectivity, but also the vehicle condition and safety equipment of both paratransit. Service information is also important especially operating and registration because they relate directly to waiting time, travel time and security that all commuters stated important.

9.2 Policy development

As mentioned in the main purpose, this dissertation, finally, proposes some policies of integrating paratransit as a feeder into mass transit systems that are carefully derived from the validity of the research findings. This research intentionally develops the policies of integrating paratransit as a feeder into mass transit systems based on the operational managements with anticipation that the proposed policies would not much result in increasing cost of operations and higher fares to passengers. Two main policies and their strategies can be summarized as follows;

Paratransit service quality improvement policy

This policy intends to reduce risks and pessimisms of paratransit operations especially in terms of traffic accidents, insecurity and unreliable services. There must be focused mainly on two improvement strategies that are;

- Increase in safety and security operation should be given a first priority, especially for motorcycle-taxi. Reckless driving and unpleasant vehicle condition - worn-out interior, decrepit exterior and under-tuned engine - must be minimized. The enforcement tools and control must be strengthened as well as the regulations related with paratransit operations. In addition, this research would like to emphasize that paratransit's operator collaboration will be the powerful tool of this strategy. The control from within the association, especially from the chief of operators, may results in more effective way than the desultory enforcements.
- Raising comfort and convenience and reliability of services will be the important strategies that can provide more convenience and confidence to commuters in using paratransit as a feeder mode, particularly Songtaew. The unreliable waiting time and frequent stops must be minimized in order to make travel time more predictable and increase travel speed. It can be proposed through the strategies of providing express service that offers less stops and controlled headway. This express service might be one of the proper solutions.

Ease of accessibility improvement policy

This policy aims to provide high level of convenience for the trips accessing mass transit stations, particularly an easy transfer. There are two recommended strategies that fit for this policy.

- Direct access should be provided such as Songtaew rerouting that it can reach as close as possible to the stations or obtain well coordination with bus networks. This solution could reduce walking distance, number of transfers and offer low expenses, especially the people living in the long access distances and low income commuters.
- Connecting facility such as small terminal areas for paratransit should be implemented at close proximity to the stations. This strategy could accommodate not only minimizing walking distance and enhancing convenience of finding services but also offering safety to passengers and operators as well.

9.3 Implication for developing countries

This research is proposed to emphasize the utilization of the existing transport modes and their advantages through the strategy of integrated urban transport. The existing paratransit services in the megacities of developing countries currently play a major role of complementary mode in connecting between the areas left by public transport services and main streets as well as public transport. Though paratransit is functioning as a feeder mode, paratransit, nevertheless, has often been maligned and ignored by transportation planners and policy makers, and ought to be eliminated. Finding the right balance between private, unsubsidized paratransit and public, government-supported bus and mass transit services is crucial toward ensuring mobility future of urban transportation in developing countries. In this research, however, the existing paratransit has been realized as making a positive contribution to urban transportation through its feeder function. The systematic integration of paratransit as a feeder could enhance performance of mass transit systems, particularly the limited network of mass transit systems at present and in the future. Paratransit feeder has a potential to increase an ability of door-to-door services of mass transits that make mass transit more attractive to commuters.

The effective utilization and management of integrating paratransit as a feeder into mass transit systems require more attention in terms of economic and technical aspects. There are still many unknowns surrounding paratransit operations, supply and demand, in the developing countries. For supply side, care must be taken in examining the service characteristics of each existing paratransit modes. This research found that each type of paratransit has its effective service areas and potential passengers. For demand side, the precise results could not be obtained by assuming homogeneity of commuters because of a large diversity of traveler's economic status. However, the results of people's homogeneity assumption render the basic needs in accessing mass transit stations of travelers. Most of travelers prefer fast, flexible and predictable access mode to the unreliable access mode even though it offers cheaper and safer services. However, safety and security of the trip accessing mass transit stations is considered very important. Different commuter's backgrounds give large differences in travel choices, attitudes and preferences. As have been investigated, high income commuters prefer the access mode that can save their travel time to the mode offers safe journey. In contrast, the cheap access mode is more favorable to the low income people, though travel time is unreliable.

Therefore, transportation planners should pay attention to all potential paratransit modes, all aspects of their service qualities, all types of commuters and their attitudes and preferences. It is important to focus on the quality of service because the connecting trips between mass transit stations and commuters' residences and destinations are generally too short comparing with the total travel distance, and paratransit's images are often perceived malignity especially from policy planners and inexperienced people. Thus, data collection must cover important aspects of paratransit service quality in order to observe different perceptions of all groups of commuters based on income status, present travel choice and etc. To grasp commuters' perceptions of all service aspects, it is vital to carefully develop the data collection instruments and strategies, and to handle enormity and complexity of variables methodically. This would provide valuable information for obtaining strengths and weaknesses of paratransit services, handling various needs of diverse commuters and enhancing effective resource utilization.

9.4 Future prospects

This study is only a beginning step of promoting integration of paratransit as a feeder into urban transportation system and addresses to focus on short-to-mid term operational management of integrating paratransit into mass transit systems. In addition, the selected case study was limited to only the areas along the mass transit corridors and focused only on the influences of commuter attitudes and preferences. Several issues are yet to be addressed in this study in order to provide more complete and fruitful conclusions. Additional variant samples, commuter demographics and mode specific attributes are necessary to obtain more accurate conclusions of commuters' choice consideration. Moreover, all types of the existing paratransit should be included in future studies. People along the future mass transit corridors must be taken into consideration as well. Furthermore, a balance between supply and demand and impacts on traffic flow, energy consumption and environment should be carried out in order to achieve sustainable solutions. These prospects would benefit future planning and development of mass transit systems. Finally, further studies, that can enrich the validity of our findings and draw the general conclusion to implement this strategy, are being looked forward to in order to enhance urban transportation performance in the developing countries.

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Tangphaisankun, A., Nakamura, F. and Okamura, T. (2009) Influences of Paratransit as A Feeder of Mass Transit System in Developing Countries Based on Commuter Satisfaction, **Journal of the Eastern Asia Society for Transportation Studies**, **Vol. 8**

Tangphaisankun, A., Okamura, T. Nakamura, F. and Wang R. (2010) A Study in Integrating Paratransit as A Feeder System into Urban Transportation and Its Effects on Mode Choice Behavior: A Case Study of Bangkok, Thailand, **12th World Conference on Transport Research**

Tangphaisankun, A., Okamura, T. and Nakamura, F. (2010) Paratransit: Urban Transportation Planning Challenges in Developing Countries, **International Symposium on City Planning (CPIJ)**

APPENDIX A

QUESTIONNAIRE SHEET FOR FIRST PHASE SURVEY

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Questionnaire to development of trip accessing mass transit stations

The transportation and urban planning laboratory, Yokohama National University (Japan) is carrying out a surveying regarding trip accessing mass transit stations along the corridors of BTS and MRT lines in Bangkok.

This data collection attempts to understand the trip patterns in accessing mass transit stations in order to improving connectivity between mass transit station and residential areas by integrating paratransit (motorcycle-taxi, Songtaew, Silor-lek and etc) as a feeder mode. The questionnaire requires you to record data about your travel patterns especially trip connecting between your residence and mass transit station, and you preferences and attitudes towards access trip and paratransit services. Besides, some of your personal, household, and vehicle ownership information would be collected. We assure you that any information declared here will kept confidential and be used only for research purpose. Your completed questionnaire will be collected by the survey team personal.

The transportation and urban planning laboratory really appreciate your kind cooperation that provides useful and valuable information to our research.

Professor Fumihiko NAKAMURA
Advisor

Associate Professor Toshiyuki OKAMURA
Co-Advisor

Akkarapol Tangphaisankun
PhD Student

Research-help and Survey team personal
Students from department of civil engineering, Sripatum University

For Questionnaire Distributor

Area [station ....] Questionnaire No. [...........]

Distributor [...............................] Date [......................]

Type of distribution [int , pick] Time [......................]

GENERAL PART: Socioeconomic Information

Please mark " X " in the [ ] of your best answer

1	Gender	( ) Male ( ) Female			
2	Age (years)	( ) 15 or less ( ) 15-20 ( ) 21-30 ( ) 31-40 ( ) 41-50 ( ) 51-60 ( ) 60-70 ( ) 70 over			
3	Household members	( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) More than 6			
4	Education level	( ) No education ( ) Primary school ( ) High school ( ) Diploma ( ) Bachelor ( ) Master and above			
5	Occupation	( ) Government officer ( ) Private employee ( ) Self employed ( ) Student ( ) Labor/worker ( ) Unemployed ( ) salesman ( ) others.....................			
6	Where do you live?	street name [.......................................] and soi's name [.......................................]			
7	Household Motorcycle	( ) None ( ) 1 ( ) 2 ( ) more than 2			
8	Household car	( ) None ( ) 1 ( ) 2 ( ) more than 2			
9	Household type	( ) own house ( ) rental apartment/mansion ( ) condominium ( ) others..................			
10	Number of household commuters (person)	who travel for work or study on weekdays ( ) none ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) More than 6			
11	Your monthly income(Baht)	( ) No income ( ) less than 10,000 ( ) 10,000-20,000 ( ) 20,000- 30,000 ( ) 30,000-40,000 ( ) 40,000-50,000 ( ) more than 50,000			
12	Do you have car driving license	( ) yes ( ) no	Do you have motorcycle driving license	( ) yes ( ) no	
	How long do you have it?	[..............] yrs	How long do you have it?	[..............] yrs	
13	Use your own car?	( ) yes ( ) no	Use your own motorcycle?	( ) yes ( ) no	
14	Experiences with BTS or MRT	( ) yes ( ) no	How often do you use BTS or MRT	( ) > 3 days/weekday ( ) 1-2 days/weekday ( ) weekend or holiday ( ) rarely (when in a hurry)	
15	Experiences with motorcycle-taxi	( ) yes ( ) no	How often do you use motorcycle-taxi	( ) > 3 days/weekday ( ) 1-2 days/weekday ( ) weekend or holiday ( ) rarely (when in a hurry)	
16	Experiences with song-taew	( ) yes ( ) no	How often do you use song-taew	( ) > 3 days/weekday ( ) 1-2 days/weekday ( ) weekend or holiday ( ) few per month	
17	Experiences with silor-lek	( ) yes ( ) no	How often do you use silor-lek	( ) > 3 days/weekday ( ) 1-2 days/weekday ( ) weekend or holiday ( ) few per month	
18	What are the access modes available in your living area to go to main streets and BTS/MRT station (you can select more than one)			( ) Motorcycle taxi ( ) Song-taew ( ) Silor-lek ( ) tuk-tuk ( ) Others..................	
19	Does walkway in your living are to main streets and BTS/MRT station is in good condition and able to walk?			( ) yes, along the way ( ) only some parts ( ) have no walkway	
20	What is the size of street from your home to main streets that public transits (van and BTS/MRT) are available			( ) 1 lane ( ) 2 lanes ( ) 4 lanes ( ) larger than 4 lanes	
21	How is the traffic condition along the way from your home to main streets or BTS/MRT station during rush hour?			( ) not congested ( ) congested ( ) very congested	

1

The following parts of the questionnaire aim to obtain your information as stated below.

PART I: your regular trip (to work / to study) information

The information of your trip pattern will be asked as follow;

1. Trip information of your regular trip (to work or to school) which mostly occur on Monday to Friday/Saturday
2. Access and Egress trip to/from public transits (bus, van and BTS/MRT)

Information	Trip type	Description
Access Trip	Going trip	From Home *to* Public transits (bus, van and BTS/MRT)
	Return trip	From Destination/Office/School *to* Public transits (bus, van and BTS/MRT)
Egress trip	Going trip	From getting off public transits (bus, van and BTS/MRT) *to* your Destination/Office/School
	Return trip	From getting off public transits (bus, van and BTS/MRT) *to* your Home

Remark:

In this questionnaire, you will be asked to express " How do you go to BTS/MRT station? " in the assumption that " you have an opportunity to use BTS/MRT for your regular trip.

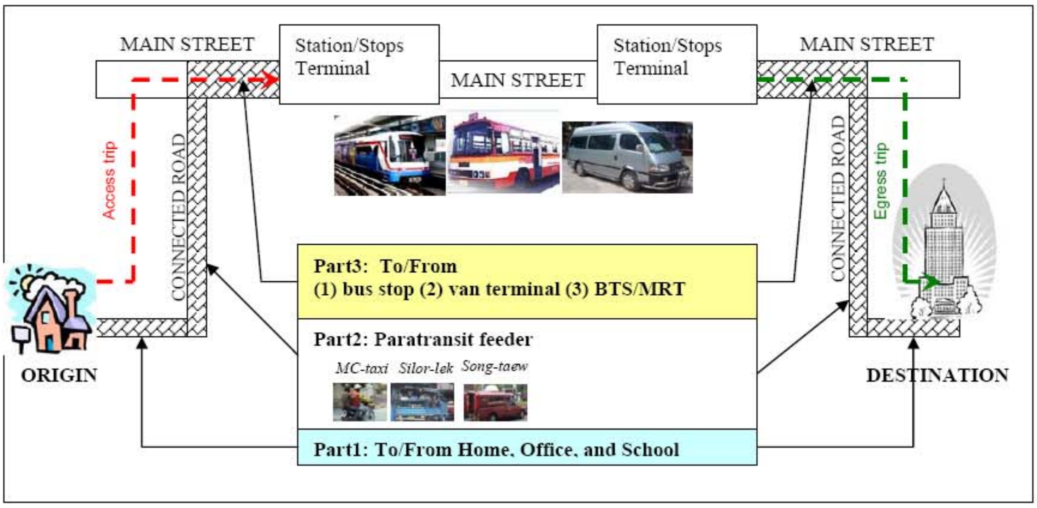

Figure 1: Access trip and Egress trip explanation

PART II: your preferences and attitudes with access trip and egress trips between your home/office/school and public transit especially BTS and MRT in Present situation.

PART III: your preferences, attitudes and willing to use on the feeder mode services (motorcycle-taxi, song-taew and silor-lek), and the mass transit services (BTS and MRT) under the assumption that some improvements will be implemented.

Questionnaire answer instructions

Choice for answer	How to answer
1.xx 2.xx 3.xx etc.	to be circled " O" according to your best suited answer
[.......] , ...	to be enter the selected number from directed/given in the table or source and/or to be answered by your own

2

PART I : Trip and Travel pattern information

Please circle " O " to the number 1, 2, 3, etc that is the best choice of your answer

Q1	For your regular trip (to work/to study) How do you go to your destination or complete your trip?	1. private car 2. private motorcycle 3. ride sharing 4. private vehicle & public transport (bus, van, BTS, MRT) 5. public transport (bus, van, BTS, MRT) 6. others …………………………………
	Where is your destination?	street name […………………………………….] and soi's name [………………………………….…..]
	Total travel time from your home to your destination?	1. 0-15 min 2. 16-30 min 3. 31-45 min 4. 46-60 min 5. 60-90 min 6. more than 90 min
	How much for your travel cost per month (baht)? (car&mc user: fuel, toll, parking costs should be included)	1. 0-1,000 2. 1,001-2,000 3. 2,001-3,000 4. 3,001-4,000 5. 4,001-5,000 6. more than 5,000
	Who pay for your travel cost?	1. yourself 2. parent 3. company 4. others………………

The following parts aim to gather your regular trip information (to work/to study) both access to and egress from public transports as illustrated in Figure1

Section1: For your going trip (go from home to work/study), If you use public transport, please answer in Q2 to Q7.

If you are private car/motorcycle user or ride sharing passenger to complete your trip, please go to Q5

Q2	You go to public transport directly from your home?	1. yes 2. no (go to Q3)
	How do you go? How long (min)?	1. walk [………]min 2. drive yourself [………]min 3. ride sharing [………]min 4. other …………….,[………]min
Q3	Do you use BTS/MRT for your regular trip?	1. yes (go to Q5-Q7) 2. no (continue to Q4-Q7)

Table A is for Q4 to Q7, please enter the number of mode/vehicle you use for access and egress trip in the bracket [……..]

Table A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Mode	Ride sharing	Motorcycle-taxi	Song-taew	Silor-lek	Bus	Van	Other ……………….

Example. **Home** –walk 5min---**motorcycle-taxi**—wait 0min, ride 5min---walk 1 min---**bus stop**—wait 5min, in bus 10min---**BTS**

Mode [Table A]		***Walking time***	***Waiting time***	***Travel time***	***Cost***
Mode 1	*[… **2**.....]*	*Home to Mode1 [.……**5**…....] min*	*[......**0**…...] min*	*[.……**5**…....] min*	*[….**10**……..] baht*
Mode 2	*[….**5**.....]*	*Mode1 to Mode2 [......**1**…….] min*	*[…..**5**…....] min*	*[……**10**…...] min*	*[…..**9**……..] baht*
Mode 3	*[……......]*	*Mode2 to Mode3 [………..……..] min*	*[……..…....] min*	*[…………..…..] min*	*[………..…..] baht*

Q4	Which public transit mode do you use?	1. bus 2. van 3. other………………
	How many modes you use to access the public transport from your home?	1. 1 mode 2. 2 modes 3. more than 2 modes
	Please explain the details of your access trip to public transport (please use the mode given in Table A)	
	Mode [Table A] / **Walking time** / **Waiting time** / **Travel time** / **Cost**	
	Mode 1 [……....] Home to Mode1 [………….....] min […….……] min [………..…..] min […………..] baht	
	Mode 2 [……....] Mode1 to Mode2 […………….] min […….……] min [………..…..] min […………..] baht	
	Mode 3 [……....] Mode2 to Mode3 […………….] min […….……] min [………..…..] min […………..] baht	
	After getting off the last access mode, Do you have to walk to bus stop or van terminal?	1. yes [……………]min 2. no

3

Table A	1	2	3	4	5	6	7
Mode	Ride sharing	Motorcycle-taxi	Song-taew	Silor-lek	Bus	Van	Other ……………….

Q5	If you use BTS/MRT or you have an opportunity to use BTS/MRT, please explain how you go to the station.	
	What is your station name?	[………………………………………………]
	Why do you go to this station? Please rank your important reasons by using 1 = most important to 3 = less important	[……] nearest station [……] park & ride availability [……] less transfer and walking time
	How many modes you use to access BTS/MRT from your home?	1. 1 mode 2. 2 modes 3. more than 2 modes
	Please explain the details of your access trip to BTS/MRT station (please use the mode given in Table A)	

Mode [Table A]		Walking time	Waiting time	Travel time	Cost
Mode 1	[……....]	Home to Mode1 [……………..] min	[…………..] min	[……………..] min	[…………...] baht
Mode 2	[……....]	Mode1 to Mode2 […………….] min	[…………..] min	[……………..] min	[…………...] baht
Mode 3	[……....]	Mode2 to Mode3 […………….] min	[…………..] min	[……………..] min	[…………...] baht

After getting off the last access mode, Do you have to walk to BTS/MRT station?	1. yes [……………]min 2. no
Walking time from arriving station/leaving vehicle to platform (climb up/down, buy ticket, go to platform)	[.....................] min

Q6	Please explain how you go to your destination (egress) from the last main public transport mode	
	How many modes you use to access the public transport from your home?	1. 1 mode 2. 2 modes 3. more than 2 modes
	Please explain the details of your egress trip to your destination (please use the mode given in Table A)	

Mode [Table A]		Walking time	Waiting time	Travel time	Cost
Mode 1	[……....]	PT to Mode1 [……………..] min	[…………..] min	[……………..] min	[…………...] baht
Mode 2	[……....]	Mode1 to Mode2 […………….] min	[…………..] min	[……………..] min	[…………...] baht
Mode 3	[……....]	Mode2 to Mode3 […………….] min	[…………..] min	[……………..] min	[…………...] baht

After getting off the last mode, Do you have to walk to your destination?	1. yes [……………]min 2. no

Section2: For your return trip (from your office/school/destination to home)

Q7-1	Do you use the same trip from your destination to public transit?	1. yes (go to Q7-2) 2. no (please explain below)
	Please explain the details of your access trip to your public transport (please use the mode given in Table A)	

Mode [Table A]		Walking time	Waiting time	Travel time	Cost
Mode 1	[……....]	Dest to Mode1 [……………..] min	[…………..] min	[……………..] min	[…………...] baht
Mode 2	[……....]	Mode1 to Mode2 […………….] min	[…………..] min	[……………..] min	[…………...] baht
Mode 3	[……....]	Mode2 to Mode3 […………….] min	[…………..] min	[……………..] min	[…………...] baht

Q7-2	Do you use the same trip from public transit to your home?	1. yes (go to PART II) 2. no (please explain below)
	Please explain the details of your egress trip to your home (please use the mode given in Table A)	

Mode [Table A]		Walking time	Waiting time	Travel time	Cost
Mode 1	[……....]	PT to Mode1 [……………..] min	[…………..] min	[……………..] min	[…………...] baht
Mode 2	[……....]	Mode1 to Mode2 […………….] min	[…………..] min	[……………..] min	[…………...] baht
Mode 3	[……....]	Mode2 to Mode3 […………….] min	[…………..] min	[……………..] min	[…………...] baht

4

PART II: Attitudes in present situation

Section 1: This part aims to obtain your attitudes with the access and egress trip

Please select the number to enter in [……] by using the given level next to the question		BTS / MRT	Bus and Van
Have you experienced with these modes?	1. yes-often use 2. yes-rarely use 3. never	[……….]	[……….]
Do you have knowledge with these modes?	1. very well 2. fair 3. don't know	[……….]	[……….]

Please mark " X " in the column of your preferring number that relate to your perception on access parts of your present trip.

By using these levels → **1** = very dissatisfy **2** = dissatisfy **3** = satisfy **4** = very satisfy

	Access to public transit description	BTS/MRT				Bus and Van			
	Level	1	2	3	4	1	2	3	4
Q1	Total access time from home/office/school to public transits								
Q2	Total waiting time from home/office/school to public transits								
Q3	Total access cost from home/office/school to public transits								
Q4	Number of transfers or modes used from home/office/school to public transits								
Q5	Walking time to bus stop/van terminal/BTS&MRT station from the last access mode (part3 in figure 1)								
Q6	Walking time to ride paratransit mode from your home/office/school (part1 in figure 1)								
Q7	Pick-up and drop-off facility for paratransit service (motorcycle-taxi and song-taew)								

Section2: This part aims to obtain your attitudes with different types of paratransit in present situation

Please select the number to enter in [……] by using the given level next to the question		Motorcycle-taxi	Song-taew/Silor-lek
Do you have knowledge with these modes?	1. very well 2. fair 3. don't know	[……]	[……]

Please mark " X " in the column of your preferring number that relate to your perception regarding each type of paratransit.

By using these level → 1 = very dissatisfy 2 = dissatisfy 3 = satisfy 4 = very satisfy

	Variables	Motorcycle-taxi				Song-taew / Silor-lek			
	Level	1	2	3	4	1	2	3	4
Q1	Riding speed (drive too fast) and Reckless driving (zig-zag/dangerous)								
	Availability of safety equipment								
	Night time security from crime								
Q2	Waiting time duration for using service								
	Number of stops to pick-up drop-off passengers along the way								
Q3	Protection from air pollution & sunshine & rain								
	Seat availability and Level of crowd → (having seat, seating comfort)								
Q4	Adequate service and on demand service								
	Availability in night time and early morning								
	Flexibility to change route								
	Ability to reach at the exact point of destination								
Q5	The present fare structures are suitable for travel distance								
Q6	Service schedule and fare structure information are provided								
	Passenger service vehicle / driver registration information								
	Accident insurance information								

5

PART III: your preferences, attitudes and willing to use on the feeder mode services (motorcycle-taxi, song-taew and silor-lek), and the mass transit services (BTS and MRT) under the assumption that some improvements will be implemented

TABLE B: improvement information (Please use as information for your attitudes and mode choice preferences)

Item	Topic	Description
IP1	Driver training and Riding safety	(1) drivers will **not drive too fast, safe and smooth** controlled by association's chief or regulation. (2) reduction and **control of hazardous behaviour** → no drunk/ no mobile phone using while driving and ask passenger for safety collaboration (wear helmet, do not stand on the danger position while riding). (3) drivers are required to **participate & test driving training before applying/reapplying for license.**
IP2	Vehicle standard, safety and security equipment	(1) operating vehicles are required to **pass a minimum service condition standard** → good condition engine, exterior and interior, seating position. (2) every vehicles are required to **install safety equipment** → grips for motorcycle-taxi, hand rail for song-taew and first-aid tool box. (3) every vehicles are required to **install ring/bell** that can attract other commuters while having unsecure especially in night time, **and install GPS tracking** (might use GPS function from mobile phone).
IP3	Passenger workshop & training	Passengers can **learn the instruction for using paratransit service safely and securely.** (1) how to get on/get off and sit properly while riding motorcycle-taxi and song-taew. (2) awareness from crimes and how to cope with when happening. (3) first-aid training.
IP4	Motorcycle-taxi calling service	You can call to the motorcycle-taxi terminal nearby to pick-up you from your home (in range of 200m) without additional payment → **no need to walk to find motorcycle-taxi service**
IP5	Express song-taew	(1) **limited specific stops** at main/important points (market, residential area, etc.) or every 500 m (2) **pick up/drop-off passengers only at the specific stops** with special **song-taew layby.** (3) from (1) & (2) it can **reduce song-taew travel time for 25%** (ex. normal = 20 min, express = 15 min) (4) **controlled headway** → 5 min during rush hours, and 15-20 min during off-peak. (5) **exclusive lane** or **special priority to run service on the main routes** and other private cars will be detoured to other alternative routes to avoid traffic congestion and control song-taew travel time.
IP6	Motorcycle-taxi comfort seating	**Rearrange seating standard with soft, larger and horizontal position** that provide more comfortable, easy to seat and not too close to the driver, especially for lady.
IP7	Air-condition song-taew	(1) provide **air-condition** for passenger cabin and **protect passengers from hot, rain & air pollution.** (2) **service as normal song-taew with increasing fare rate → 2 baht / trip.**
IP8	Operation Safety & insurance information	(1) **Service schedule** → operating time (start-stop) and headway (for song-taew) are provided. (2) **Fare structure** → fares are provided on the board that passengers can check before using services. (3) **Vehicle and driver information** → vehicle license number, driver's name who will be your driver. (4) **Insurance information** → type of insurance, right of insurance and process for insurance claim. (5) "**How to complain** for harmful driving and impolite behavior of the drivers to the terminal (vin) manager
IP9	Paratransit terminal in cooperation with BTS/MRT	(1) **Paratransit terminal** for pick-up & drop-off with waiting shelter **close to the stations** (1 min walk) (2) Provide **roof for walkway from terminal to the station** (protection for sunlight and rain) (3) 1-2 song-taew, 10 motorcycle-taxis **stand by for passengers** (4) Facilities are **managed by BTS/MRT**, service operation is managed **by paratransit operators**, and service schedule is controlled for consistency by **cooperation between BTS/MRT and paratransit**
IP10	Cooperation for fare promotion	(1) Paratransit ticket promotion → **discount monthly ticket** (ex. fare calculated from distancewise) (2) BTS/MRT ticket promotion → **special discount for monthly ticket** (30-day smart pass) for passengers using paratransit monthly ticket

6

Section1: This part aims to capture your attitudes regarding paratransit service improvements

Please express your attitude level to each improvement, explained in table B, by marking " X " in the column of your preferring number

By using these level → 1 = very dissatisfy 2 = dissatisfy 3 = satisfy 4 = very satisfy

Item	Improvement description (as in Table B)	Motorcycle-taxi				Song-taew / Silor-lek			
	Levels	1	2	3	4	1	2	3	4
IP1	Driver training and riding safety								
IP2	Vehicle standard, safety and security equipment								
IP3	Passenger workshop and training								
IP4 & IP6	Motorcycle-taxi calling service/ Express song-taew service								
IP5 & IP7	Motorcycle-taxi comfort seating/ Air-condition song-taew service								
IP8	Operation, safety and insurance information								
IP9	Paratransit terminal in cooperation with BTS/MRT								
IP10	Cooperation for fare promotion between paratransit & BTS/MRT								

Section2: your willing to use both access modes and BTS/MRT, if the improvements are provided.

If the quality of paratransit service is improved as given, (1) will you change to use the service of paratransit? and (2) will it affect your decision to use BTS/MRT? Please mark " X " in the column that states your most suited answer.

Motorcycle-taxi and Song-taew Improvement Strategies (The details of each improvement (IPxx) are illustrated in Table B)			Willing to use paratransit			Willing to use BTS/MRT	
	MC-taxi	Song-taew	Not use	MC-taxi	Song -taew	Yes	No
1	**IP1** (Driver training and riding safety)	**IP1** (Driver training and riding safety)					
2	**IP2** (Vehicle standard and equipment)	**IP2** (Vehicle standard and equipment)					
3	**IP3** (passenger workshop & training)	**IP3** (passenger workshop & training)					
4	**IP6** (Motorcycle-taxi calling service)	**IP4** (Express song-taew service)					
5	**IP7** (Motorcycle-taxi comfort seating)	**IP5** (Air-condition song-taew service)					
6	**IP8** (information)	**IP8** (information)					
7	**IP9** (Paratransit terminal cooperating with BTS/MRT)	**IP9** (Paratransit terminal cooperating with BTS/MRT)					
8	**IP10** (Cooperation for fare promotion between paratransit & BTS/MRT)	**IP10** (Cooperation for fare promotion between paratransit & BTS/MRT)					
9	**[IP1+IP2-**safety**]** + **IP6** (calling service)	**[IP1+IP2-**safety**]** + **IP4** (express)					
10	**[IP1+IP2-**safety**]** + **IP7** (comfort seat)	**[IP1+IP2-**safety**]** + **IP5** (air-condition)					
11	**IP6**(calling service) + **IP7** (comfort seat)	**IP4** (express) + **IP5** (air-condition)					
12	**[IP1+IP2-**safety**]** + **IP6** (calling service) + **IP9** (terminal)	**[IP1+IP2-**safety**]** + **IP4** (express) + **IP9** (terminal)					
13	**[IP1+IP2-**safety**]** + **IP6** (calling service) + **IP10** (fare promotion)	**[IP1+IP2-**safety**]** + **IP4** (express) + **IP10** (fare promotion)					
14	**IP6**(calling service) + **IP7** (comfort seat) + **IP9** (terminal)	**IP4** (express) + **IP5** (air-condition) + **IP9** (terminal)					
15	**[IP1+IP2-**safety**]** + **IP8** (information) + **IP10** (fare promotion)	**IP4** (express) + **IP5** (air-condition) + **IP10** (fare promotion)					

7

Section3: This part aims to obtain your willing to use paratransit services and BTS/MRT service in present

Q1	Please rank the reason for selecting **motorcycle-taxi** using 1 = the most important until 6 = the last important	[……..] cheap [……..] easy to find [……..] safety [……..] fast [……] reach close to destination [……] necessary
Q2	Please rank the reason for selecting **song-taew** using 1 = the most important until 6 = the last important	[……..] cheap [……..] easy to find [……..] safety [……..] fast [……] reach close to destination [……] necessary

Please mark " X " in the column of your preferences and attitudes.

By using these level → 1 = totally disagree / unimportant 2 = somewhat disagree / somewhat unimportant
3 = somewhat agree / somewhat important 4 = totally agree / important

		Degree of Agreement				Degree of Important			
Q1	The following services make you go to main streets/bus stops/BTS or MRT stations faster and easier?	1	2	3	4	1	2	3	4
	Motorcycle taxi								
	Song-taew and Silor-lek								

Q2	Do you have a willing or opportunity to use paratransit access mode?	Definitely not use	Not use if better mode available	Use if service quality is improved	Definitely use
	Motorcycle taxi				
	Song-taew and Silor-lek				
Q3	Do you have a willing or opportunity to use BTS/MRT? (please circle " O " to the best answer)	1. Not use 3. Use if service is expanded		2. Use if it is easy to access 4. Definitely use	

Q6	Do you think that the present services of motorcycle-taxi and song-taew are adequate?	**Inadequate**	**Adequate**
	Motorcycle taxi		
	Song-taew and Silor-lek		

APPENDIX B

QUESTIONNAIRE SHEET FOR SECOND PHASE SURVEY

Transportation and Urban Planning Laboratory Department of Civil Engineering Yokohama National University

For Staff only

Collection site [.....................................] **Staff** [..................................] **QN-number** [..................]

Method [interview , pick-drop] **DD/MM/YYYY** [......................]

PART 1 Your travel pattern

Please mark √ in the ☐ of your best answer

1.1 What is the mode **you often use** to go your destination (office/school)?

you can select more than one




Mode	How often? weekend/ holiday	1 - 3 days /week	> 3 days /week
☐ Drive car	☐	☐	☐
☐ Ride motorcycle	☐	☐	☐
☐ Ride sharing	☐	☐	☐
☐ Bus	☐	☐	☐
☐ Van	☐	☐	☐
☐ BTS/MRT	☐	☐	☐
☐ Other [............]	☐	☐	☐

1.2 What are the vehicles you **go to** main streets/bus stop/van terminal/BTS or MRT station **from your home**

you can select more than one



Mode	How often? weekend/ holiday	1 - 3 days /week	> 3 days /week
☐ walk	☐	☐	☐
☐ motorcycle-taxi	☐	☐	☐
☐ Songtaew	☐	☐	☐
☐ Silor-lek	☐	☐	☐
☐ others [........................]	☐	☐	☐

1.3 What are the vehicles you **go from** main streets/bus stop/van terminal/BTS or MRT station **to your office or school**

you can select more than one



Mode	How often? weekend/ holiday	1 - 3 days /week	> 3 days /week
☐ walk	☐	☐	☐
☐ motorcycle-taxi	☐	☐	☐
☐ Songtaew	☐	☐	☐
☐ Silor-lek	☐	☐	☐
☐ others [........................]	☐	☐	☐

	Your total travel time?	☐ 0-15 min ☐ 16-30 min ☐ 31-45 min ☐ 46-60 min ☐ 60-90 min ☐ more than 90 min
	How much for your travel cost per month (baht)? (car&mc user: fuel, toll, parking costs should be included)	☐ 0-1,000 baht ☐ 1,001-2,000 baht ☐ 2,001-3,000 baht ☐ 3,001-4,000 baht ☐ 4,001-5,000 baht ☐ more than 5,000 baht
	Who pay for your travel cost?	☐ myself ☐ parents ☐ company ☐ others..................
1.4	Vehicles that take you from home to main streets/bus stop/van terminal/BTS or MRT station ***you can select more than one***	☐ motorcycle-taxi ☐ Songtaew ☐ Silor-lek ☐ Tuk-tuk ☐ taxi ☐ others [........................]
1.5	Vehicles that take you to main streets/bus stop/van terminal/BTS or MRT station around your office/school ***you can select more than one***	☐ motorcycle-taxi ☐ Songtaew ☐ Silor-lek ☐ Tuk-tuk ☐ taxi ☐ others [........................]

1.6 **In the last 2 months,** have you used public transport?

Mode	**Never**	**Less than 6 times**	**1 - 2 days /week**	**> 3 days /week**
bus	☐	☐	☐	☐
van	☐	☐	☐	☐
BTS / MRT	☐	☐	☐	☐
motorcycle-taxi	☐	☐	☐	☐
Songtaew	☐	☐	☐	☐
Silor-lek	☐	☐	☐	☐
taxi / Tuk-tuk	☐	☐	☐	☐

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PART 2 In present, *what are the first 2 options for your trip decision regarding different trip purposes and conditions*

Please write down the number given in "*Trip option*" into the boxes of [1st option] and [2nd option]

No.	Trip option		
1	Drive car / ride motorcycle		
2	Bus or van		
3	BTS / MRT		
4	taxi / Tuk-tuk		
5	motorcycle-taxi		
6	Songtaew / Silor-lek		
7	motorcycle-taxi	*and*	Bus or van
8	Songtaew / Silor-lek	*and*	Bus or van
9	motorcycle-taxi	*and*	BTS / MRT
10	Songtaew / Silor-lek	*and*	BTS / MRT
11	Drive car / ride sharing	*and*	BTS / MRT
12	taxi / Tuk-tuk	*and*	BTS / MRT

	Trip purpose and condition	1st option	2nd option
2.1	Go to work or study (from home)		
2.2	Back from work or study (to home)		
2.3	Everyday trip to work or study **within a limited time**		
2.4	Everyday trip to work or study **with wanting to save travel cost**		
2.5	**Trip with a group of more than 3 persons** ex. with family or friends		
2.6	Everyday trip to work or study **in the raining day**		
2.7	Go for **shopping during holiday** within the distance **1-2 km from home**		
2.8	Go for **shopping during holiday** within the distance **3-5 km from home**		
2.9	Trip that important or related with your job/study during working hour		
2.10	Trip that passed by BTS/MRT within 1 km from the stations		

PART 3 Your opinions and attitudes

3.1	**Your opinion** ▶▶ please circle O around your best answer **I do not want to use public transport ➔ Because...?**	**Totally disagree**	**Somewhat disagree**	**Somewhat agree**	**Totally agree**
1	I have to walk to find service more than 5 min	1	2	3	4
2	Distance to bus stop/van terminal is quite far from my home	1	2	3	4
3	Distance to BTS /MRT is quite far from my home/office/school	1	2	3	4
4	Access cost to bus stop/van terminal/ BTS / MRT is quite expensive	1	2	3	4
5	Because of no choice to access bus stop/van terminal/ BTS / MRT making me difficulties	1	2	3	4
6	I do not like transfer while travelling by public transits	1	2	3	4
7	Travel time is unpredictable and has much variation more than 5 -10 min	1	2	3	4
8	Waiting time is long (more than 5 -10 min) and unreliable	1	2	3	4
9	I want to minimize my travel time	1	2	3	4
10	Travel cost is not different or sometime higher than using private car	1	2	3	4
11	Ticket and payment systems are complicated and require much time	1	2	3	4
12	Combination of [motorcycle-taxi /Songtaew/Silor-lek] ▶▶ [bus / van/ BTS / MRT] Make my trip ***inconvenient because of transfer***	1	2	3	4
13	Combination of [motorcycle-taxi /Songtaew/Silor-lek] ▶▶ [bus / van/ BTS / MRT] Make my trip ***longer travel time***	1	2	3	4
14	Combination of [motorcycle-taxi /Songtaew/Silor-lek] ▶▶ [bus / van/ BTS / MRT] Make me ***pay more money and many times***	1	2	3	4
15	Combination of [motorcycle-taxi /Songtaew/Silor-lek] ▶▶ [bus / van/ BTS / MRT] ***I think it can not relief traffic congestion***	1	2	3	4
16	Combination of [motorcycle-taxi /Songtaew/Silor-lek] ▶▶ [bus / van/ BTS / MRT] ***I think it can not improve environmental problem***	1	2	3	4
17	Combination of [motorcycle-taxi /Songtaew/Silor-lek] ▶▶ [bus / van/ BTS / MRT] Make my trip ***inconvenient on the raining day***	1	2	3	4

2

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3.1	**Your opinion** ▸▸ please circle O around your best answer **I do not want to use public transport ➔ Because...?**	Totally disagree	Somewhat disagree	Somewhat agree	Totally agree
18	My image influence my decision on making a trip	1	2	3	4
19	Using car makes my work more efficient	1	2	3	4
20	It is not convenient if I have trips other than home-based trip after work or study by using public transport	1	2	3	4
21	I don't like to sit or stay close to other people I don't know while using public transit	1	2	3	4
22	I feel irritated to do something while staying with other people I don't know	1	2	3	4
23	Vehicle condition is old, dirty and unsafe. It discourage me to use public transit				
24	My image is important to my job or daily life	1	2	3	4
25	BTS and MRT images discourage me to use	1	2	3	4
26	Motorcycle-taxi /Songtaew/Silor-lek images discourage me to use	1	2	3	4
27	Bus and van images discourage me to use	1	2	3	4
28	Public transit can not directly access close to my destination and I have to use other vehicle for the distance more than 1 km	1	2	3	4
29	BTS and MRT fares are quite expensive	1	2	3	4
30	I do not like to use public transit service while the traffic is congested	1	2	3	4
31	It makes me more chance to face traffic accident if I use public transit every day	1	2	3	4
32	It makes me more chance to face crime if I use public transit every day	1	2	3	4
33	Motorcycle-taxi fare is suitable for travel time	1	2	3	4
34	Motorcycle-taxi fare is suitable for travel distance	1	2	3	4
35	I feels that Motorcycle-taxi has more chance to face accident	1	2	3	4
36	Songtaew makes me waste my time	1	2	3	4
37	Songtaew and Silor-lek make my trip safer	1	2	3	4
38	It is difficult to get seat and I do not like crowd	1	2	3	4
39	Uncomfortable and inconvenient seat	1	2	3	4
40	It spends a lot of time for pick-up & drop-off passenger along the way	1	2	3	4
41	It is not safe while getting on/off on the street	1	2	3	4
42	Hot weather and rain make me inconvenient to use public transport	1	2	3	4
43	It has no place or inconvenient to carry things while travelling by public transport	1	2	3	4

3.2	**General Opinion and attitude** ▸▸ please circle O around your best answer	Totally disagree	→		Totally agree
1	I always accept a dare/ I like to challenge everything	1	2	3	4
2	I am not afraid to stay with other persons I do not know or unpredictable	1	2	3	4
3	I like to live in secure surrounding	1	2	3	4
4	It disturb me if I am forced to change in my routine	1	2	3	4
5	I **prefer time saving to safety** for my trip decision	1	2	3	4
6	I **prefer time saving to cost saving** for my trip decision	1	2	3	4
7	I **prefer convenience to safety** for my trip decision	1	2	3	4
8	I **prefer convenience to cost saving** for my trip decision	1	2	3	4
9	I **prefer comfort to cost saving** for my trip decision	1	2	3	4
10	I always drive or travel adhering to prevailing speed limit	1	2	3	4
11	I selects mode that can protect me from traffic accident for the 1st reason	1	2	3	4
12	I always us e safety belt while travelling	1	2	3	4
13	I have a habit if recycling paper, plastic in order to preserve environment	1	2	3	4
14	I think that I can preserve environment by reducing car use and I am ready to do	1	2	3	4
15	I think that separating garbage save environment and I am ready to do	1	2	3	4
16	I think frugality is bad/ it is not good to waste anything	1	2	3	4
17	I always compare price, quantity and quality before I buy things	1	2	3	4

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3.2	**General Opinion and attitude** ▶▶ please circle O around your best answer	**Totally disagree**	→		**Totally agree**
18	I feel regretful if I bought something useless	1	2	3	4
19	I prefer to use car although other modes offer faster travel time	1	2	3	4
20	If possible I would rather use private car or motorcycle	1	2	3	4
21	Private car or motorcycle is necessary for my trip	1	2	3	4
22	For me using public transit instead of car for everyday route would be impossible	1	2	3	4
23	Using car increase my work efficiency	1	2	3	4
24	I feel more confident when I use my car	1	2	3	4

3.3	**What is the best mode for you while considering the following conditions?**				
1	Waiting time and easiness to catch the service	☐ Motorcycle-taxi	☐ Songtaew	☐ Silor-lek	☐ Bus
2	Less variation in travel time/ reliable travel time	☐ Motorcycle-taxi	☐ Songtaew	☐ Silor-lek	☐ Bus
3	Suitability of fare comparing with travel distance	☐ Motorcycle-taxi	☐ Songtaew	☐ Silor-lek	☐ Bus
4	Suitability of fare comparing with travel time	☐ Motorcycle-taxi	☐ Songtaew	☐ Silor-lek	☐ Bus
5	Ability to reach at exact destination	☐ Motorcycle-taxi	☐ Songtaew	☐ Silor-lek	☐ Bus
6	Traffic safety and security	☐ Motorcycle-taxi	☐ Songtaew	☐ Silor-lek	☐ Bus
7	Seating comfort	☐ Motorcycle-taxi	☐ Songtaew	☐ Silor-lek	☐ Bus
8	Environment while using service ▶▶ The operators	☐ Motorcycle-taxi	☐ Songtaew	☐ Silor-lek	☐ Bus
9	Environment while using service ▶▶ The passengers	☐ Motorcycle-taxi	☐ Songtaew	☐ Silor-lek	☐ Bus

Please mark √ in the ☐ of your best answer

3.4	**Would you like to you use BTS or MRT??**	
1	If BTS or MRT *can pass or go close to your destination* due to the extension project	☐ Yes ☐ No
2	If *access* to BTS or MRT *becomes more reliable and safe*	☐ Yes ☐ No
3	If you can *access* to BTS or MRT *directly / no need to transfer*	☐ Yes ☐ No
	Will you use Motorcycle-taxi / Songtaew / Silor-lek??	
4	If services become more safe from traffic accident and crime	☐ Yes ☐ No
5	If travel time becomes more reliable, predictable and systematic	☐ Yes ☐ No
6	If there are facilities for pick-up/ drop-off including stand-by vehicles close to the stations (within 3 min walking distance)	☐ Yes ☐ No

PART 4 General Information

1	gender	☐ Male ☐ Female	Age	.... years
2	Education level	☐ No education ☐ Primary school ☐ High school ☐ Diploma ☐ Bachelor ☐ Master and above		
3	Occupation	☐ Government officer ☐ Private employee ☐ Self employed ☐ Student ☐ Labor/worker ☐ Unemployed ☐ others...............		
4	Your monthly income(Baht)	☐ No income ☐ < 10,000 ☐ 10,000-20,000 ☐ 20,000- 30,000 ☐ 30,000-40,000 ☐ 40,000-50,000 ☐ more than 50,000		
5	Where do you live?	Bldg [.....................................] street [.......................................] Soi [.....................................]		
6	Your destination?	Bldg [.....................................] street [.......................................] Soi [.....................................]		
7	Household member	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ more than 5		
8	Kid under 15 year-old	☐ 0 ☐ 1 ☐ 2 ☐ more than 2		
9	Household motorcycle	☐ 0 ☐ 1 ☐ 2 ☐ more than 2		
10	Household car	☐ 0 ☐ 1 ☐ 2 ☐ more than 2		
11	Household type	☐ private house ☐ rental apartment ☐ condominium ☐ others............		
12	Mode you never have experienced	☐ bus ☐ van ☐ BTS ☐ MRT ☐ Motorcycle-taxi ☐ Songtaew ☐ Silor-lek		
13	Are you able to use car for your everyday travel	☐ yes ☐ no	14	Are you able to use motorcycle for your everyday travel ☐ yes ☐ no
15	Do you have car driving license	☐ yes obtained for.........years ☐ no	16	Do you have motorcycle driving license ☐ yes obtained for.........years ☐ no

4

APPENDIX C

SAMPLES OF STRUCTURAL EQUATION MODELING

C1 Overall paratransit service influence investigation

C1.1 Factor Analysis Modeling

Notes for Model

Computation of degrees of freedom

Number of distinct sample moments:	136
Number of distinct parameters to be estimated:	43
Degrees of freedom (136 - 43):	93

Result (ÓÃÞÙ”Ô† 1)
Minimum was achieved
Chi-square = 147.762
Degrees of freedom = 93
Probability level = .000

Scalar Estimates

Maximum Likelihood Estimates

Regression Weights:

			Estimate	S.E.	C.R.	P	Label
MC_Reach_Att	<---	MC_Comf/Conv	1.000				
MC_Flex_Att	<---	MC_Comf/Conv	1.179	.179	6.577	***	
MC_OPRTT_Att	<---	MC_Comf/Conv	1.093	.170	6.426	***	
MC_Find_Att	<---	MC_Comf/Conv	1.220	.186	6.557	***	
ST_Secu_Att	<---	Safety	1.000				
ST_Drive_Att	<---	Safety	.787	.111	7.101	***	
MC_Secu_Att	<---	Safety	.531	.114	4.643	***	
MC_Drive_Att	<---	Safety	.553	.122	4.552	***	
ToMass_TT_att	<---	MassAcc	1.000				
ToMass_WT_att	<---	MassAcc	1.150	.214	5.384	***	
ToMass_Cost_att	<---	MassAcc	1.054	.212	4.965	***	
ST_OPRTT_Att	<---	ST_Comf/Conv	1.000				
ST_Find_Att	<---	ST_Comf/Conv	1.116	.157	7.111	***	
ST_Stop_Att	<---	ST_Comf/Conv	.907	.149	6.067	***	
ST_WT_Att	<---	ST_Comf/Conv	1.177	.159	7.385	***	
ToMass_TRF_att	<---	MassAcc	1.492	.257	5.803	***	

Standardized Regression Weights:

			Estimate
MC_Reach_Att	<---	MC_Comf/Conv	.676
MC_Flex_Att	<---	MC_Comf/Conv	.757
MC_OPRTT_Att	<---	MC_Comf/Conv	.709
MC_Find_Att	<---	MC_Comf/Conv	.746
ST_Secu_Att	<---	Safety	.841
ST_Drive_Att	<---	Safety	.748
MC_Secu_Att	<---	Safety	.480
MC_Drive_Att	<---	Safety	.471
ToMass_TT_att	<---	MassAcc	.641
ToMass_WT_att	<---	MassAcc	.759
ToMass_Cost_att	<---	MassAcc	.632
ST_OPRTT_Att	<---	ST_Comf/Conv	.669
ST_Find_Att	<---	ST_Comf/Conv	.748

			Estimate
ST_Stop_Att	<---	ST_Comf/Conv	.651
ST_WT_Att	<---	ST_Comf/Conv	.834
ToMass_TRF_att	<---	MassAcc	.767

Covariances:

			Estimate	S.E.	C.R.	P	Label
MC_Comf/Conv	<-->	ST_Comf/Conv	.062	.028	2.237	.025	
MC_Comf/Conv	<-->	Safety	.114	.038	3.001	.003	
Safety	<-->	ST_Comf/Conv	.202	.051	4.003	***	
MassAcc	<-->	ST_Comf/Conv	.066	.029	2.300	.021	
Safety	<-->	MassAcc	.154	.043	3.547	***	
MC_Comf/Conv	<-->	MassAcc	.060	.024	2.459	.014	
f1	<-->	f4	-.019	.042	-.453	.650	
b4	<-->	a2	-.076	.029	-2.657	.008	
b1	<-->	a3	.087	.030	2.910	.004	
b2	<-->	a4	.128	.032	3.957	***	
c2	<-->	c1	.129	.050	2.601	.009	

Correlations:

			Estimate
MC_Comf/Conv	<-->	ST_Comf/Conv	.285
MC_Comf/Conv	<-->	Safety	.396
Safety	<-->	ST_Comf/Conv	.579
MassAcc	<-->	ST_Comf/Conv	.296
Safety	<-->	MassAcc	.526
MC_Comf/Conv	<-->	MassAcc	.326
f1	<-->	f4	-.069
b4	<-->	a2	-.300
b1	<-->	a3	.367
b2	<-->	a4	.484
c2	<-->	c1	.280

Variances:

	Estimate	S.E.	C.R.	P	Label
MC_Comf/Conv	.181	.048	3.758	***	
Safety	.460	.097	4.731	***	
MassAcc	.186	.059	3.168	.002	
ST_Comf/Conv	.266	.068	3.915	***	
b4	.215	.035	6.085	***	
b3	.187	.035	5.343	***	
b2	.214	.037	5.832	***	
b1	.214	.039	5.465	***	
c4	.190	.055	3.463	***	
c3	.224	.044	5.147	***	
c2	.433	.063	6.901	***	
c1	.493	.071	6.923	***	
f1	.266	.048	5.558	***	
f2	.181	.038	4.778	***	
f3	.311	.050	6.237	***	
a4	.327	.052	6.317	***	
a3	.260	.046	5.668	***	
a2	.297	.046	6.393	***	

	Estimate	S.E.	C.R.	P	Label
a1	.161	.037	4.353	***	
f4	.290	.067	4.316	***	

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
ÓÃÞÙ”Ô † 1	43	147.762	93	.000	1.589
Saturated model	136	.000	0		
Independence model	16	784.343	120	.000	6.536

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
ÓÃÞÙ”Ô † 1	.041	.862	.799	.590
Saturated model	.000	1.000		
Independence model	.153	.421	.344	.372

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
ÓÃÞÙ”Ô † 1	.812	.757	.921	.894	.918
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
ÓÃÞÙ”Ô † 1	.775	.629	.711
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
ÓÃÞÙ”Ô † 1	54.762	25.560	91.889
Saturated model	.000	.000	.000
Independence model	664.343	579.510	756.661

FMIN

Model	FMIN	F0	LO 90	HI 90
ÓÃÞÙ”Ô † 1	1.356	.502	.234	.843
Saturated model	.000	.000	.000	.000
Independence model	7.196	6.095	5.317	6.942

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
ÓÃÞÙ”Ô † 1	.073	.050	.095	.049
Independence model	.225	.210	.241	.000

AIC

Model	AIC	BCC	BIC	CAIC
ÓÃÞÙ”Ô † 1	233.762	249.653	349.882	392.882
Saturated model	272.000	322.261	639.265	775.265
Independence model	816.343	822.256	859.551	875.551

ECVI

Model	ECVI	LO 90	HI 90	MECVI
ÓÃÞÙ”Ô † 1	2.145	1.877	2.485	2.290
Saturated model	2.495	2.495	2.495	2.957
Independence model	7.489	6.711	8.336	7.544

HOELTER

Model	HOELTER .05	HOELTER .01
ÓÃÞÙ”Ô † 1	86	95
Independence model	21	23

C1.2 Overall paratransit service influence investigation modeling

Notes for Model

Computation of degrees of freedom

Number of distinct sample moments: 190
Number of distinct parameters to be estimated: 54
Degrees of freedom (190 - 54): 136

Result

Minimum was achieved
Chi-square = 177.143
Degrees of freedom = 136
Probability level = .010

Scalar Estimates

Maximum Likelihood Estimates

Regression Weights:

			Estimate	S.E.	C.R.	P	Label
MassAcc	<---	ST_Comf/Conv	-.019	.116	-.161	.872	
MassAcc	<---	Safety	.306	.108	2.823	.005	
MassAcc	<---	MC_Comf/Conv	.142	.122	1.166	.024	
FuturePara	<---	MC_Comf/Conv	.115	.080	1.434	.061	
FuturePara	<---	Safety	.186	.069	.943	.039	
FuturePara	<---	ST_Comf/Conv	.053	.072	.736	.462	
FuturePara	<---	MassAcc	.133	.092	1.447	.048	
MC_Reach_Att	<---	MC_Comf/Conv	1.000				
MC_Flex_Att	<---	MC_Comf/Conv	1.185	.179	6.624	***	
MC_OPRTT_Att	<---	MC_Comf/Conv	1.094	.170	6.449	***	
MC_Find_Att	<---	MC_Comf/Conv	1.215	.185	6.560	***	
ST_Secu_Att	<---	Safety	1.000				
ST_Drive_Att	<---	Safety	.785	.110	7.134	***	
MC_Secu_Att	<---	Safety	.536	.114	4.695	***	
MC_Drive_Att	<---	Safety	.553	.121	4.577	***	
ToMass_TT_att	<---	MassAcc	1.000				
ToMass_WT_att	<---	MassAcc	1.165	.214	5.455	***	
ToMass_Cost_att	<---	MassAcc	1.062	.212	5.004	***	
ST USE	<---	FuturePara	1.000				
ST_OPRTT_Att	<---	ST_Comf/Conv	1.000				
ST_Find_Att	<---	ST_Comf/Conv	1.119	.156	7.174	***	
ST_Stop_Att	<---	ST_Comf/Conv	.891	.148	6.017	***	
ST_WT_Att	<---	ST_Comf/Conv	1.169	.158	7.420	***	
ToMass_TRF_att	<---	MassAcc	1.484	.256	5.807	***	
MC USE	<---	FuturePara	1.558	.502	3.104	.002	
MassUSE1	<---	FuturePara	.088	.050	1.751	.080	

Standardized Regression Weights:

			Estimate
MassAcc	<---	ST_Comf/Conv	-.023
MassAcc	<---	Safety	.483
MassAcc	<---	MC_Comf/Conv	.141
FuturePara	<---	MC_Comf/Conv	.210
FuturePara	<---	Safety	.190
FuturePara	<---	ST_Comf/Conv	.118
FuturePara	<---	MassAcc	.245
MC_Reach_Att	<---	MC_Comf/Conv	.677
MC_Flex_Att	<---	MC_Comf/Conv	.762
MC_OPRTT_Att	<---	MC_Comf/Conv	.710
MC_Find_Att	<---	MC_Comf/Conv	.743
ST_Secu_Att	<---	Safety	.841
ST_Drive_Att	<---	Safety	.746
MC_Secu_Att	<---	Safety	.484
MC_Drive_Att	<---	Safety	.473
ToMass_TT_att	<---	MassAcc	.638
ToMass_WT_att	<---	MassAcc	.765
ToMass_Cost_att	<---	MassAcc	.633
ST USE	<---	FuturePara	.503
ST_OPRTT_Att	<---	ST_Comf/Conv	.673
ST_Find_Att	<---	ST_Comf/Conv	.754
ST_Stop_Att	<---	ST_Comf/Conv	.643
ST_WT_Att	<---	ST_Comf/Conv	.833
ToMass_TRF_att	<---	MassAcc	.759
MC USE	<---	FuturePara	.759
MassUSE1	<---	FuturePara	.215

Covariances:

			Estimate	S.E.	C.R.	P	Label
MC_Comf/Conv	<-->	ST_Comf/Conv	.063	.028	2.253	.024	
Safety	<-->	ST_Comf/Conv	.203	.051	4.013	***	
MC_Comf/Conv	<-->	Safety	.114	.038	3.000	.003	
f1	<-->	f4	-.015	.042	-.362	.717	
b4	<-->	a2	-.074	.029	-2.575	.010	
c1	<-->	g2	.035	.027	1.263	.207	
b1	<-->	a3	.084	.030	2.857	.004	
b2	<-->	a4	.127	.032	3.942	***	
c2	<-->	c1	.122	.049	2.500	.012	

Correlations:

			Estimate
MC_Comf/Conv	<-->	ST_Comf/Conv	.287
Safety	<-->	ST_Comf/Conv	.579
MC_Comf/Conv	<-->	Safety	.396
f1	<-->	f4	-.053
b4	<-->	a2	-.290
c1	<-->	g2	.159
b1	<-->	a3	.359
b2	<-->	a4	.482
c2	<-->	c1	.266

Variances:

	Estimate	S.E.	C.R.	P	Label
MC_Comf/Conv	.181	.048	3.766	***	
Safety	.460	.097	4.746	***	
ST_Comf/Conv	.268	.068	3.939	***	
e1	.130	.043	3.011	.003	
e2	.036	.017	2.131	.033	
b4	.214	.035	6.095	***	
b3	.184	.035	5.310	***	
b2	.214	.037	5.843	***	
b1	.216	.039	5.521	***	
c4	.190	.054	3.493	***	
c3	.225	.043	5.199	***	
c2	.431	.062	6.895	***	
c1	.489	.071	6.934	***	
g2	.097	.041	2.380	.017	
g3	.160	.027	5.885	***	
f1	.268	.047	5.655	***	
f2	.177	.037	4.735	***	
f3	.310	.050	6.243	***	
a4	.324	.051	6.298	***	
a3	.255	.046	5.613	***	
a2	.303	.047	6.444	***	
a1	.162	.037	4.396	***	
f4	.298	.066	4.509	***	
g1	.009	.001	7.213	***	

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
ÓÃÞÙ”Ô † 1	54	177.143	136	.010	1.303
Saturated model	190	.000	0		
Independence model	19	857.661	171	.000	5.016

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
ÓÃÞÙ”Ô † 1	.035	.865	.811	.619
Saturated model	.000	1.000		
Independence model	.133	.429	.366	.386

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
ÓÃÞÙ”Ô † 1	.793	.740	.943	.925	.940
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
ÓÃÞÙ”Ô † 1	.795	.631	.748
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
ÓÃÞÙ”Ô † 1	41.143	10.780	79.617
Saturated model	.000	.000	.000
Independence model	686.661	598.967	781.869

FMIN

Model	FMIN	F0	LO 90	HI 90
ÓÃÞÙ”Ô † 1	1.625	.377	.099	.730
Saturated model	.000	.000	.000	.000
Independence model	7.868	6.300	5.495	7.173

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
ÓÃÞÙ”Ô † 1	.053	.027	.073	.407
Independence model	.192	.179	.205	.000

AIC

Model	AIC	BCC	BIC	CAIC
ÓÃÞÙ”Ô † 1	285.143	309.412	430.969	484.969
Saturated model	380.000	465.393	893.091	1083.091
Independence model	895.661	904.200	946.970	965.970

ECVI

Model	ECVI	LO 90	HI 90	MECVI
ÓÃÞÙ”Ô † 1	2.616	2.337	2.969	2.839
Saturated model	3.486	3.486	3.486	4.270
Independence model	8.217	7.413	9.091	8.295

HOELTER

Model	HOELTER .05	HOELTER .01
ÓÃÞÙ”Ô † 1	102	110
Independence model	26	28

APPENDIX D

SAMPLES OF DISCRIMINANT ANALYSIS

D1. Multiple Discriminant Analysis: Main Access Mode Analysis

Eigenvalues

Function	Eigen value	% of Variance	Cumulative %	Canonical Correlation
1	2.069[a]	75.7	75.7	.821
2	.559[a]	20.4	96.1	.599
3	.106[a]	3.9	100.0	.309

a. First 3 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 3	.189	323.181	18	.000
2 through 3	.580	105.669	10	.000
3	.904	19.529	4	.001

Standardized Canonical Discriminant Function Coefficients

	Function		
	1	2	3
STEXP	-.144	.373	.132
Ability to drive/ride	.112	-.573	-.353
Mass Transit Access by Bus	-.435	.705	-.197
Access <0.7km	1.165	.371	-.008
Access 0.7-1.0 km	.817	.200	.593
Access 1.0-2.0 km	.401	-.166	.877

Functions at Group Centroids

groupAcc2	Function		
	1	2	3
Walk	2.049	.375	-.179
Drive + K&R	-.778	-1.027	-.284
MC-taxi	.396	-.463	.628
Fixed route	-1.558	.847	.003

Unstandardized canonical discriminant functions evaluated at group means

Classification Function Coefficients

	groupAcc2			
	Walk	Drive + K&R	MC-taxi	Fixed route
STEXP	2.869	2.593	2.936	4.388
Ability to drive/ride	2.118	3.284	2.140	.468
Mass Transit Access by Bus	-1.205	-.193	-1.319	5.973
Access <0.7km	14.583	2.200	7.299	1.503
Access 0.7-1.0 km	10.853	2.523	7.586	2.231
Access 1.0-2.0 km	5.409	2.960	5.860	2.041
(Constant)	-9.066	-3.624	-5.599	-4.495

Fisher's linear discriminant functions

Classification Results[b,c]

			Predicted Group Membership				
		groupAcc2	Walk	Drive + K&R	MC-taxi	Fixed route	Total
Original	Count	Walk	40	2	13	0	55
		Drive + K&R	1	32	11	6	50
		MC-taxi	7	6	22	3	38
		Fixed route	1	7	6	43	57
	%	Walk	72.7	3.6	23.6	.0	100.0
		Drive + K&R	2.0	64.0	22.0	12.0	100.0
		MC-taxi	18.4	15.8	57.9	7.9	100.0
		Fixed route	1.8	12.3	10.5	75.4	100.0
Cross-validated[a]	Count	Walk	40	2	13	0	55
		Drive + K&R	1	32	11	6	50
		MC-taxi	15	8	12	3	38
		Fixed route	1	7	6	43	57
	%	Walk	72.7	3.6	23.6	.0	100.0
		Drive + K&R	2.0	64.0	22.0	12.0	100.0
		MC-taxi	39.5	21.1	31.6	7.9	100.0
		Fixed route	1.8	12.3	10.5	75.4	100.0

a. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

b. 68.5% of original grouped cases correctly classified.

c. 63.5% of cross-validated grouped cases correctly classified.

D2. Simple Discriminant Analysis: Each Access Mode Analysis

Park and Ride (P&R) analysis

Eigenvalues

Function	Eigen value	% of Variance	Cumulative %	Canonical Correlation
1	.631[a]	100.0	100.0	.622

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.613	95.200	7	.000

Standardized Canonical Discriminant Function Coefficients

	Function
	1
MCTAXIEXP	.325
MCAVAIL	.228
Ability to drive/ride	-.810
Direct Access by Bus	.252
Large Park&Ride	-.231
Access <0.7km	.518
Access 0.7-1.0 km	.382

Functions at Group Centroids

P&R	Function
	1
0	.364
1	-1.717

Unstandardized canonical discriminant functions evaluated at group means

Classification Function Coefficients

	P&R	
	0	1
MCTAXIEXP	6.910	4.877
MCAVAIL	19.908	17.700
Ability to drive/ride	.299	4.236
Direct Access by Bus	2.399	.673
Large Park&Ride	.418	1.719
Access <0.7km	1.782	-.783
Access 0.7-1.0 km	1.654	-.800
(Constant)	-13.541	-13.239

Fisher's linear discriminant functions

Classification Results[b,c]

		P&R	Predicted Group Membership		Total
			0	1	
Original	Count	0	161	4	165
		1	18	17	35
	%	0	97.6	2.4	100.0
		1	51.4	48.6	100.0
Cross-validated[a]	Count	0	146	19	165
		1	19	16	35
	%	0	88.5	11.5	100.0
		1	54.3	45.7	100.0

a. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

b. 89.0% of original grouped cases correctly classified.

c. 81.0% of cross-validated grouped cases correctly classified.