



UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Urban Form and Travel Behavior
. Evidence among individuals from two districts within Bangkok

Koranis Tanangsnakool

Graduate School
Master of Science in Environmental Management and Economics
Master Degree Project No. 2011:31
Supervisor: Jerry Olsson

ABSTRACT

One of the major contributors to climate change is transportation. It is an important emitter of greenhouse gases, especially carbon dioxide which has been rising rapidly in the last two decades. Understanding how travel behavior is affected by urban form contributes to an urban land-use planning in order to achieve a more sustainable transport. This study intends to investigate the influence of urban form on individual travel behavior and to examine the causal mechanism between them. The Bangkok Metropolitan Area is selected (BMA) as the case study area due to the lack of knowledge and understanding of this issue in developing countries. The primary source material of this study is an investigation of travel behavior among residents of two selected districts. Urban form was found related to travel behavior. Residents of the inner district, with a large share of commercial area, a high population and employment density, and a high access to public transport, travelled less distance and dominantly rely on non-motorized transport. Besides, urban form was found to be a contributor of a causal mechanism. The major contribution of this study is that it reveals how people select activity location and transport modes which are crucial when considering any transport-related policy.

ACKNOWLEDGEMENTS

First of all I would like to thank my supervisor Jerry Olsson for his invaluable guidance and encouragement throughout the writing of this thesis. I am indebted to School of Business, Economics and Law, the University of Gothenburg for financial support, for travel expense in particular. I owe a grateful thank you to Ajarn. Wanpen Charoentrakulpeeti for her attention and advice. This thesis would not have been possible without all the respondents who devoted their time for my interview. I am thankful to the officers at the district offices and the Department of City Planning for their facilitation and assistance.

I would like to thank friends in Gothenburg for their understanding, love and help and for making me feel close to home throughout these two years. Another thank you to Warut Woradithee for his help and support. Finally I would like to show my deepest gratitude to my family and friends for their never ending love and care.

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1. INTRODUCTION

1.1 Background: Transport sector and Environmental problems

Global warming is one of the most important problems of our time. An increasing global average temperature, caused by the emissions of carbon dioxide and other greenhouse gases (GHG) could threaten livelihood and human wellbeing, for example, a reduction in food yields, water shortages, rise in sea level, changes in biodiversity and species extinction (Marsden and Rye, 2010). These consequences would unquestionably cause social and economic upheaval (ibid). According to Stern (2006), the economic effects on human life and the environment could be as high as 20% of world GDP while it would take around one percent of world GDP to reduce GHGs emissions to avoid the worst impacts of climate change.

One of the major contributors to such a problem is transport (Marsden and Rye, 2010). Transport is an important emitter of GHGs, especially carbon dioxide (CO₂) (Azar et al., 2003; Grazi and van den Bergh, 2008; Grazi et al., 2008), which has been rising rapidly in the last two decades. In 1971, the transport sector accounted for 19% of the global emissions of GHGs. This number had grown to 23% in 1997 (Price et al., 1998; Akerman and Hojer, 2005). It was found difficult to reduce emissions in this sector, which is the fastest-growing emitter in the European Union (Akerman and Hojer, 2005; Marsden and Rye, 2010).

Apart from GHGs emissions, transportation produces other negative environmental impacts, particularly in urban in urban areas, for example, local air and noised pollution, congestion, and loss of green area for road construction (Naess, 2006). For this reason, it is crucial to examine the transport sector, including the relationship between urban form and transportation, in order to reduce its impacts on the environment.

In order to bring further knowledge and understanding on the above mentioned problems, this study investigates how the urban form of Bangkok Metropolitan Area (BMA) influences travel behavior among individuals residing in two districts which demonstrates different characteristics. The city is notorious for many transport problems, for example, congestion and air pollution (World Conference on Transport Research Society and Institute for Transport Policy Studies, 2004). Bangkok, as well as other Southeast Asian cities, have experienced a rapid increase in vehicle ownership in the past decade (Acharya and Morichi¹, 2007; Dissanayake and Morikawa², 2010). However, the studies of travel behavior in developing countries have neglected the importance of urban conditions (Vasconcellos, 1997). Therefore, the knowledge with respect to the relationship between urban form and travel behavior is lacking in these countries. A case study of Bangkok fulfills and provides a better understanding of travel behavior in this region.

¹ Asian cities in Acharya and Morichi (2007) are Seoul, Taipei, Jakarta and Bangkok.

² Asian cities in Dissanayake and Morikawa (2010) are Hong Kong, Jakarta, Bangkok, Seoul and Beijing.

1.2 Research problem

Transport comprises many components, including travel behavior. Holden (2007) proposes three approaches to achieve sustainable transport; the efficiency, the alteration and the reduction approaches. The efficiency approach suggests that transport technological developments in transport can reduce transport-caused environmental problems. The alteration approach suggests changes in transport patterns, particularly to change the pattern dominated by private motor vehicles to a pattern of collective public transport, which are more environmental friendly. The reduction approach suggests that a reduction in transport volume, only for those who have already met basic transport needs, is necessary because the former approaches may not be sufficient. Mode shift and travel reduction suggested in the alteration approach and the reduction approach represent travel behavior aspects embodied in the transport sector.

Travel behavior issues have been investigated throughout various academic areas (Holden, 2007). It is an important component in dealing with transport problems. A large body of research finds the correlation between travel behavior and other factors from personal and household attributes, like income, family composition and participation in workforce to contextual factors, like place of residence, city size, the built environment and government policies (Dieleman et al., 2002). Though travel behavior is very complex and is influenced by many different factors, urban form is of central importance. However, its influences on travel behavior remain unclear (Badoe and Miller, 2000). Knowledge of how travel behavior is affected by urban form may contribute to a more sustainable urban land-use planning in order to achieve sustainable transport, or as stated by Holden (2007): “the way we form the built environment had consequence for individuals’ transport patterns and demands” (p.75). A better coordination between land use and transport may not only reduce the need for travel and travel length, but also encourages a shift in travel mode away from car use (Meurs, 2003; Holden, 2007). Although, as it may take many years to sufficiently change structural conditions in order to change travel patterns, it is important to avoid creating undesirable travel patterns that create negative impacts (Naess, 2006).

Much of the studies on the relationship between urban form and travel behavior focuses on the cities in developed countries (e.g. Cervero, 1996; Frank and Pivo, 1994; Handy, 1996; Kitamura, 1997; Giuliano and Narayan, 2003; Naess, 2006; Holden, 2007) while the studies of travel behavior in developing countries have neglected the importance of urban conditions (Vasconcellos, 1997). The lack of knowledge and understanding may obstruct the improvement of a better coordination between land use and transport, which in turn hinders sustainable transport. This is very crucial since a reduction of GHGs emissions requires cooperation from all countries.

1.3 Research purpose and question

The purpose of this study is to investigate the influence of urban form on individuals’ travel behavior and to examine the causal mechanism between them. Empirically, this is carried out through a comparative study between two districts in the Bangkok Metropolitan Area (BMA)

which demonstrate different urban forms. According to Handy (1996b), urban form refers to characteristics of land-use patterns, transportation system and urban design in general. In this study, *urban form includes population and employment density, location and distance to the city center, the mixture of land-use, and access to public transport*. The research question fulfilling the first objective of the study is how these urban form characteristics influence trip purpose, travel frequency, travel distance and mode choice. The second research question concern how travel behaviors between those individuals residing within a household with access to privately owned motor vehicles differ from those individuals without access to private motor vehicles. The third research question concerning how people choose activity locations and modes of transport will contribute to the second objective.

Though the previous research on this issue have added value to the academic arena, it has been criticized for lacking the ability to define a causality of urban form and travel behavior (Clifton and Handy, 2001). Gaps left by quantitative techniques can be fulfilled by qualitative methods (ibid). It offers an effective tool to get more understanding of how the influences occur (Naess, 2006) and to identify the complexities of such mechanism (Clifton and Handy, 2001). Therefore, a qualitative method is appropriate for this study.

1.4 Limitations

The study intends to find differences in travel behavior between individuals living in different urban forms. The primary source material of this study is an investigation, through interviews, of travel behavior among inhabitants of the two selected districts. These districts are selected due to their differences in urban structural conditions which allows for a comparison of individuals' travel patterns. Although, this comparison is not adjusted for other factors involved in a multi-causal situation, the finding is still able to indicate the basic relationship between urban form and travel behavior. Generalization is the major limitation of a case study. The findings from the investigation may not be applicable for all other cities. The other limitation is that this study is not designed to distinguish the impacts of each urban characteristic. It examines how urban form in general influences travel behavior.

1.5 Structure of the paper

The structure of the paper is as follow. Chapter 1 presents the background of the study, research problem, research purpose and questions. The next chapter reviews the literature regarding the relationship between urban form and transport. In chapter 3, the theoretical perspectives applied in this study are presented. It will assist the readers to get a better understanding about the concept of travel, urban form, and the interaction between them. Then, the research method selection, the selection of case study areas, data collection, sample selection, and methods used in the analysis are presented in chapter 4. Chapter 5 is the introduction of the BMA. Bangkok's urban characteristics and the development as well as problems in transportation are demonstrated. Chapter 6 focuses on the selected area of the study. The urban structural conditions, namely location and distance to the city center, mixture of land-use, population and employment density, and access to public transport, of Ratchathewi and Bangkhen districts are illustrated. Travel frequency, trip purpose, mode

choice and travel distance among the respondents living in the study districts are demonstrated in chapter 7. Chapter 8 illustrates travel behavior of two sub-groups, namely individuals residing in a household with access to private motor vehicles and those residing in a household with no access to a private motor vehicle. Chapter 9 presents the results in a search of causal mechanism, including rationales behind the selection of activity location and modes of transport.. This is followed by conclusion in chapter 10.

2. LITERATURE REVIEW

This chapter reviews the empirical literature regarding the interaction between the built environment and transport. It presents a summary of some relevant studies on the connections between travel behavior and urban form characteristics which can be divided into four main categories: neighborhood design, residential density, employment density and accessibility. These structural conditions are interwoven. The level of accessibility is determined by the neighborhood design which, in turn, is affected by residential and employment density.

2.1 Neighborhood design impact

The study on the relationship between neighborhood design and travel behavior have focused on the mixture of land-use and land-use design. Much of the studies affirm the significant impacts of design on travel behavior; however, some studies show a contradictory finding. Cervero (1996) investigated the effects of mixed land-use on travel behavior using data from the 1985 American Housing Survey. The presence of retail activities in the neighborhood was used as an indicator. The findings show that having variety of services within 300 feet of the residence encourages the use of mass transit, walking and bicycling. Cervero (1988) found mixed land-use to be associated with vehicle ownership rate as well as commuting distances. The existence of nearby shops significantly affected the levels of walking and bicycling. Likewise, Frank and Pivo (1994) examined the impact of urban form on three modes of travel. Land-use mix was found positively related to transit usage and walking while negatively associated with single-occupant vehicle.

In order to evaluate the effect of neo-traditional neighborhood design, which was not widely established, Friedman et al. (1994) investigated and compared the impact of traditional design and suburban design. Traditional design allowed residents to reach various activities in a relative short distance. The traditional neighborhood was considered to be centralized. On the contrary, suburban neighborhood was more decentralized and residences were sparsely located. The findings showed that the usage of private motor-vehicle was higher in the suburban neighborhoods while transit usage, walking and bicycling were higher in the traditional ones. This led to the conclusion that neighborhood design had significant impacts on travel behavior.

In a case study of the San Francisco Bay Area by Handy (1996a), neighborhood design was found to affect travel behavior for non-work trips. The design affected travel behavior through the level of accessibility. Designs that kept destinations in short distance created high accessibility and led to shorter average distance travel. Those designs that provided greater destination choice were found associated with a greater trip frequency. A higher percentage of walking trips was found in traditional neighborhood which had stores within walking distance; however, this was not necessarily associated with lower travel since residents shopped at a variety of stores.

Kitamura et al. (1997) analyzed the relationship between land-use design and travel behavior using data from the San Francisco Bay Area. The regression analysis showed that the

neighborhood design was statistically associated with trip rate and mode choice. However, the neighborhood had a significant explanatory power only when socio-economic factors were controlled for. It was also found that the attitudinal variables generated the most meaningful impact on travel behavior. This led to the conclusion that changing only urban form characteristics may not be sufficient to considerably change travel behavior, attitudes also need to be changed.

2.2 Residential density impact

The relationship between residential density and travel behavior is less conclusive. Evidence from the studies is mixed. Among those who supports a dense urban city, Newman and Kenworthy (1989) investigated energy use by cars in 32 cities in the US, Europe, Asia, Australia and Canada. They found a negative correlation between residential density and energy consumption for transport. The study has been criticized for methodological flaws (see Gordon and Richardson, 1989; Gomez-Ibanez, 1991). Handy (1996b) criticized this study for the fundamental problem of comparing cities that differed in cultural, political and historical contexts. However, in Newman and Kenworthy's subsequent study in 1999, the negative correlation still remains. They found that the gasoline use decreased with increasing residential density (as referred in Dieleman et al., 2002).

The impact of residential density on travel behavior was also found in Holtzclaw (1994). The study examined the influences of neighborhood characteristics on travel distance and motor-vehicle usage in 28 communities from four California's neighborhoods. The result showed that when residential density doubled, household driving decreases by 25-30 percent. However, the reduction may be contributed by other conditions, such as a better transit, a more pedestrian-friendly design and an increase in local shops. Likewise, Frank and Pivo (1994) found the correlation between residential density and travel behavior. When non-urban factors were controlled for, an increase in residential density was found associated with a reduction in single-occupant vehicle usage and an increase in transit usage as well as walking. This result was found in both work trips and shopping trips.

Another evidence of residential density impacts on travel behavior is demonstrated in Levinson and Kumar (1997). The study examined travel behavior across 38 US cities using the data from the 1990/91 Nationwide Personal Transportation Survey. Travel variables, including trip distance, speed and travel time, were regressed on a measure of residential density. Travel time for auto commuters was found negatively and positively related to density below and above threshold (10000 populations per square mile) respectively. For transit users, travel time and density were found negatively related both below and above threshold.

Though many studies have indicated the meaningful influence of residential density on travel behavior, a large number of studies have come to other conclusions. Schimek (1996) analyzed the influences of residential density on automobile travel using 1990 Nationwide Personal Transportation Survey data. The impact of residential density was found fairly weak. A 10 percent increase in residential density contributed to a 0.7 percent reduction in

household automobile travel. He concluded that even an enormous change in residential density would cause an insignificant effect on travel behavior.

Giuliano and Narayan (2003) found an ambiguity of residential density effects. They investigated the relationship between urban form and individual travel behavior from a comparative perspective using travel diary data from the US and Great Britain. The results indicated that residential density had an impact on travel distance for the US sample, but this relationship was absent for the British sample.

In some studies residential density was found to be influential only in combination with other urban factors. Cervero and Kockelman (1997) examined the influences of residential density on trip rate and design using 1990 travel diary data and land-use records from the US census. Results showed that residential density alone only marginally affected trip rate and mode choice. It must be combined with other conditions to create significant impacts on travel behavior.

2.3 Employment density impact

Though the effects of employment density have not been investigated to the same extent as residential density, the findings are congruent. Increased employment concentration was found associated with an increase in transit usage, walking and ride-sharing in many North American cities (Badoe and Miller, 2000). Cervero and Landis (1991) conducted a study of the impacts of decentralization of jobs on commuting behavior using a survey of 320 relocated former downtown San Francisco workers. The results showed that the relocation of jobs caused a shift from public transport to private car. Cervero and Wu (1998) found that job decentralization in the Bay Area substantially affected average commuting distance per worker. Similarly, a study of Greater Oslo by Naess and Sanberg (1996) found modal choice to be influenced by location of the workplace. Workplaces in low density area were found associated with more car usage, and consequently higher energy use for the journey to work. Frank and Pivo (1994) found that increased employment density was associated with declining single-occupant vehicle usage, increasing transit usage and increasing walking for both work and shopping trips. In a comprehensive review by Badoe and Miller (2000), it was found that having higher employment density in station area was found related with greater number of boarding at commuter rail stations.

2.4 Accessibility impacts

The term accessibility refers to the ability to participate in activities (Handy, 1996a; Badoe and Miller, 2000). The level of accessibility represents the distribution of potential activity location in specific areas (Handy, 1996a). The level of accessibility is mainly determined by two sets of factors. The first set associates with the separation of activities which reflects individual's mobility, for example, travel distance, travel time, and the transport network. The second set of factors associates with the nature of the destinations, or the location of activities, including the amount and quality of the activity (Handy, 1996a; Litman, 2003).

Miller and Ibrahim (2001) conducted a study of accessibility and work trip. They investigated the relationship between urban form and work trip commuting efficiency (measured in term of average vehicle kilometer travelled (VKT) per worker) in the Greater Toronto Area using data from the 1986 Transportation Tomorrow Survey. It was found that moving away from the city center or other high density employment centers within the region caused an increase in VKT per worker. This displays the negative correlation between accessibility and distance travelled. Holtzclaw (1994) found that accessibility was a significant determinant of motor-vehicle usage. Handy (1996) investigated the relationship between accessibility and travel behavior. Accessibility was indicated by the distance to various activities and the variety of activities. Accessibility was found related to trip frequency and mode choice. Residents in the higher accessibility areas made more trips since they had a greater variety of activity destinations within a shorter distance. Furthermore, a good accessibility was found to encourage non-motorized travel; however, it did not necessarily reduce automobile travel.

In a case study of the Copenhagen Metropolitan Area (Naess, 2006), the relationship between residential location and travel behavior was investigated. Residential location is related to all other urban characteristics, namely population and employment density, distance to the city center, access to public transport, and mixture of land-use. Residential location that is closer to the inner city usually has higher density and better accessibility. It was found that residents living in the inner area close to the city center travel less distances and rely more on non-motorized transport compared to those living in the outer area. Residential location was also found associated with car ownership, in which car ownership was higher in the outer area than the inner area.

2.5 Summary

Urban form characteristics can be divided into four main categories: neighborhood design, residential density, employment density and accessibility. These characteristics are interconnected. The level of accessibility is determined by the neighborhood design which, in turn, is affected by residential and employment density. Travel distance was found shorter in traditional neighborhood design that keeps various activities within a short distance. Traditional neighborhoods were found located in the central area where residential and employment densities were high, and land-use was mixed. This contributed to a high accessibility to various activities. Transit usage, walking, and cycling were found higher in these central areas than in the outer area.

3. THEORETICAL PERSPECTIVE

This chapter presents the theoretical perspectives applied in this study. The aim of this chapter is to assist the readers to get a better understanding about the concept of travel, urban form, and the interaction between them. The concepts related to this study are i) a multi-causal situation, ii) the concept of accessibility, iii) urban form impacts on travel activity, iv) choice theory and utility-maximization, v) an activity based approach, and vi) a time-geographical approach, time minimization and a reasonable travel time.

3.1 A multi-causal situation

Based on theories of transport geography and transport economics, travel between different destinations is influenced by the attractiveness of locations; the reasons for going to a particular place, and the friction of distance. The friction of distance refers to the barriers that occur due to the spatial separation between places, objects and people. Urban form determines the distance between activities; therefore, it encourages some modes and discourages other modes of travel (Naess, 2005, 2006).

Travel behavior is also determined by individual characteristics, for instance, sex, age, income, profession, attitudes, values, norms, lifestyle and experience. The actual travel is a result from people's resources and individual characteristics, modified by constraints and opportunities from the structural conditions in society (Figure 3.1). Urban structure is a small part in the structural conditions of the society. It is one among categories of factors that influence travel behavior. Urban structure comprise various measures, for example, the land-use design, the location of activities, and the transport network, like road capacity and public transport service (Naess, 2005, 2006).

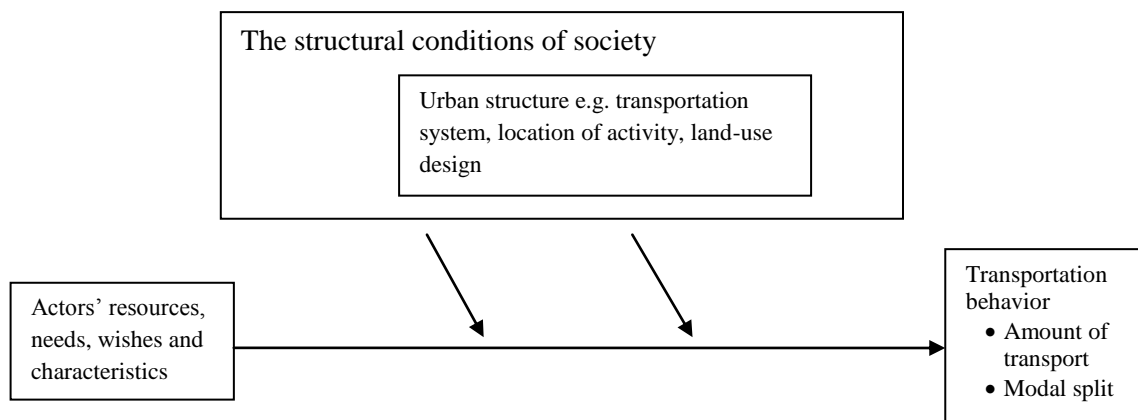


Figure 3.1: Transportation behavior as a function of land use characteristics and travelers' individual characteristics.

Source: Modified from Naess (2005: 172).

Human actions not only play a passive role affected by surrounding structure, but also play an active role in changing the surroundings. Thus, urban structure is one among several causes of travel behavior and one among several surroundings affected by this action. Therefore, urban form is considered as a part of a multi-causal mechanism. The two way interaction between structure and human actions is where the urban planning is based on. Travel behavior is not only affected by urban form, but also a contributor of changes and productions of urban form. This is considered as a fundamental concept of urban planning since its purpose is to influence such transformation processes in the desired directions and for the desired outcomes (Neass, 2005, 2006).

3.2 The concept of accessibility

Accessibility is incorporated within the urban structural condition (presented in Figure 3.1) that modifies travel activity. Hansen (1959) defined accessibility as the intensity of the possibility of interaction. Accessibility can also be defined as the ability to participate in activities or to reach various places as well as facilities (Handy, 1996a; Badoe and Miller, 2000). Two direct relationships between accessibility and travel can be implied from this definition (Handy, 1996a). Firstly, the level of accessibility indicates the distance to activities and the number of activities within a specific area. Secondly, the number of activities may refer to the variety of activity and the range of options (ibid). According to Litman (2003), accessibility also reflects individual's mobility; hence, it is not only the distance to destinations that matters, but also other factors that affect the movement between locations such as the quality of transport network and the availability of public transport. For example, the activity location may be located hundred meters away but without a bridge or a boat to cross the river, this location cannot be reached. In this way, the level of accessibility is low though location is located in a short distance.

3.3 Urban form impacts on travel activity

As discussed earlier, travel activity/behavior is the result of a complex set of factors. Urban form provides a context that shapes human behavior, including location decisions, auto ownership decisions, and travel decisions. High residential density, for example, does not directly produce a high transit usage, but rather provides an appropriate context that result in such travel behavior (Badoe and Miller, 2000).

In addition, the mechanism between urban form and travel behavior is a two way interaction, which comprises a continual response of one to the other. Changes in one element affect the other, which subsequently responds (Figure 3.2). For example, travel decision affects congestion levels which, in turn, affect travel decision; residential density affect the transit service provision which, in turn, affect the attractiveness of the residential area (ibid).

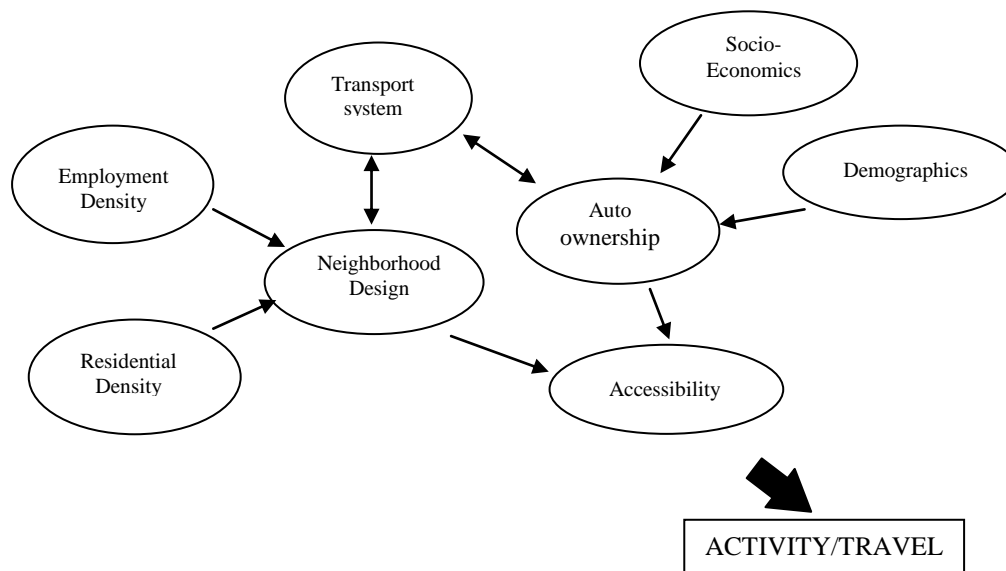


Figure 3.2: A simplified mechanism of urban form impacts.

Source: Modified from Badoe and Miller (2000: 253).

3.4 Choice theory and utility-maximization

According to Handy (1996a), a discrete choice theory provides a foundation for explaining a causal mechanism between urban form and travel behavior. It is the utility of a particular choice relative to the utility of other possible alternatives that an individual bases his decision making. Since an individual evaluates choices in different ways, the utility of any choice not only depends on the characteristics of that choice, but also the characteristics of the individual (see 3.1). The theory based on the assumption that choosing the most utilized from all possible alternatives, an individual is rational, thinking in a systematic way and evaluating the utility of each choice with complete knowledge of alternatives and consequences (Clifton and Handy, 2001).

To apply this theory to travel behavior, three components must be scrutinized; i) the set of possible choices, ii) the characteristics of choices and iii) the individual's characteristic. The first two represents the supply side while the latter represents the demand side. Similarly, urban form should be evaluated in terms of a set of choices it provides and the characteristics of those choices, such as cost, degree of convenience and the quality of activity at destination. For this reason, when analyzing density or type of neighborhood, it is the set of choices that such urban form provides that matters and influences travel behavior (Handy, 1996a)

3.5 An activity based approach

An activity based approach considers, almost, all travel activity as a derived demand from the need to perform other stationary activities. Everyday life is comprised of sequences of activities carried out by individuals at various locations so as to fulfill four kinds of needs; physiological needs (eating, sleeping), institutional needs (work, education), personal obligations (childcare, shopping) and personal preferences (leisure activities) (Vilhelmson, 2007). Recently, this view has been challenged, especially when income rise and leisure travel become more valuable. Travel, leisure trips in particular, is considered having purpose

and value in itself rather than an instrument moving from one place to another (Naess, 2005; Banister, 2008).

Vilhelmson (2007) divides trips into four categories according to how fixed and flexible they are in time and space (see Table 3.1). Bounded trips are trips in which geographical location and time to perform activity are fixed, like work or school. Non-bounded trips are trips where time and location of activity is flexible, like leisure trips and outing. An intermediary group comprises of trips where time of activity is fixed but location may vary and trips where location is fixed but may vary in time, take visiting parents for instance. The semi-bounded trips are those where the location may vary and time can be flexible, but the trips take place quite regularly, for example grocery shopping (Naess, 2005, 2006).

Table 3.1: Classification scheme for fixed and flexible activities according to their temporal and spatial flexibility.

		Spatial location of the activity	
		Fixed	Flexible
Temporal location of the activity	Fixed	Necessary activity, specific location	Necessary activity, varying location
	Flexible	Optional activity, specific location	Optional activity, varying location

Source: Naess (2005: 175).

For some types of facilities, which refers to the activity possibilities or services used and visited, it is usual that individuals choose the closest facility since the various facilities are nearly identical, such as post office, or have regulated catchment area, like social security offices. People may travel a greater distance to reach a more attractive facility, usually this facility is perceived to differ in their quality or symbolic aspects. Consequently, other features rather than distance are also important (Naess, 2005, 2006).

3.6 A time-geographical approach, time minimization and a reasonable travel time

Spatial reach, determined by travel speed and time available for travelling is associated with three kinds of constraints: capacity, coupling and control restrictions. Capacity restrictions are limitations due to the individuals' biological properties or the capability of the tools they have at disposal, for example, the ownership and the speed of vehicle. Coupling restrictions are regulation that requires individuals, instruments, materials and signs to be joined together, for instance, the necessity of being present at a workplace. Control restrictions include spatial restriction and temporal restriction. A spatial restriction relates to the matter of who holds the right to move or stay in different places while a temporal restriction relates to a time aspect of an activity, for example, the length of working hours at a location. A typical example of control restrictions is the layout and time schedule of public transport. All types of restrictions put a limitation on individuals' distribution of time and space in performing their activities (Naess, 2005).

In the conventional perspectives, travel is a cost so travel time should be as short as possible. Speedy mode of transport is preferable since it allows more time for other activities. However, there is a contradiction between the desire to speed up and the desire to slow down. There is much effort to slow down the traffic for safety and environmental reasons, even when time saving is proved beneficial. As a consequence, the idea of transport is shifting from travel time minimization to reasonable travel time (Banister, 2008).

3.7 Application to the study

The aim of this study is to investigate the influence of urban form on individual travel behavior. Though the study focuses on urban form, it does not deny that urban form is a small part in a multi-causal situation. The main concept used here is the mechanism which urban form influences travel behavior. Urban form influence travel behavior through the way it provides a context which encourages some kinds of travel and discourages others, as well as affects the level of accessibility of residents in a given place to perform various activities. This reflects the fundamental idea of an activity-based approach that views travel as a derived demand to fulfill the need to carry out four types of activities. This study assumes that all respondents are rational; therefore, the actual travel is the most utilized alternative for each individual. Besides, it is rational for them to minimized cost. This study adopts the conventional viewpoint that considers travel as a cost. For this reason, it is also rational for individual to minimize cost of travel, time and distance in particular.

4. METHOD

This chapter starts with the selection of research method, then, continues to the selection of case study areas, data collection, and sample selection. This is followed by the method used in the analysis. The remaining of the chapter demonstrates the basic characteristics of the respondents.

4.1 Selection of research method

In designing the methods for this particular study, two principles are applied to analyze the appropriateness of various methods and techniques. The first principle concerns types of research method. According to Creswell (2009), there are three types of research method: qualitative, quantitative and mixed method. There is no such thing as the best method, instead the choice of method depends on the purpose of the study. Qualitative research involves the aim to study and understand the meaning of people's lives under realistic conditions as well as to explain human social behavior (Yin, 2010). In an attempt to investigate the influence of urban form on travel behavior and to examine the causal mechanism between them, a qualitative method is appropriate. As claimed by Clifton and Handy (2001), a qualitative method offers an effective tool for identifying the complexities of such mechanism and fills the gaps left by quantitative techniques.

The second principle involves the search for a proper strategy. Yin (2009) proposes three conditions to consider the suitability of research techniques. The first condition concerns research question. What types of research question are being asked, whether it is a question of how, why, what, where, how many or how much. The next thing to consider is the extent of control over behavioral events, whether an investigator can manipulate and control over an actual behavior. The last condition is the degree of focus on contemporary or historical events (Table 4.1).

Table 4.1: Relevant situations for different qualitative research methods.

Method	Form of research question	Require control of behavior events?	Focuses on contemporary events?
Experiment	How, Why	Yes	Yes
Survey	Who, What, Where, How many, How much	No	Yes
Archival Analysis	Who, What, Where, How many, How much	No	Yes/No
History	How, Why	No	No
Case study	How, Why	No	Yes

Source: Yin (2009: 8).

Regarding the objectives stated earlier, the main research question asked is “How urban form influence individual travel behavior under different characteristics?”. Therefore, the study falls into an experiment, history and case study. A further distinction is the extent of control over behavior events. Actual travel behavior occurring in the real-world conditions cannot be controlled by the investigator. For this reason the alternatives are narrowed to two. It is possible for both history and case study techniques to be applied for a study of travel behavior as shown by previous research. However, when it comes to the investigation of causal mechanism, direct observation of people involved in the events is consider necessary. Therefore, the proper method and technique for this study regarding these two principles is a qualitative case study.

4.2 Case study area: Bangkok Metropolitan Area, Ratchathewi and Bangkok districts

Bangkok Metropolitan Area (BMA) was selected as the case study area since the city has experienced interesting features of notorious traffic congestion and a rapid increase in vehicle ownership (see chapter 5). As to answer the research questions, two districts, Ratchathewi district and Bangkok district, were selected based on their urban forms. The selected districts differ in urban structural conditions; namely, distance from the city center, population and employment density, land-use mixture and accessibility to public transport (see Chapter 6). The impacts of these conditions on individual travel behavior are the main interest. Information regarding urban structural condition is obtained from Bangkok authorities, namely Bangkok Metropolitan Administration.

4.3 Data collection method

The residents’ travel behavior was accessed through interviews. According to Clifton and Handy (2001), an interview is one of various qualitative techniques that are appropriate for the area of travel behavior research, where some issue remain unidentified. Furthermore, an interview helps revealing residents’ motivations and how they are related to any travel activities. The interview was semi-structured, comprising of four parts: basic characteristics, vehicle ownership, travel behavior, and rationales for travel decision (see Appendix 1). Questions about travel behavior cover the issue of trip purpose, trip frequency, mode choice and trip distance. The last part intends to identify the causal mechanism between urban form and individual travel behavior by revealing motivations and rationales behind activity location and mode choice.

As for data sampling, a qualitative research method uses non-probability sampling as it does not aim to produce generalizable results or to draw statistical inference (Marshall, 1996; Wilmot, 2005). Sampling often employed in a qualitative study is purposive sampling, of which the goal is to select samples that suit the purpose (Yin, 2010). A large sample is not as important as selecting criteria when adopt a purposive non-probability sampling (Wilmot, 2005) and the proper sample size is one that sufficiently answers the research question (Marshall, 1996). Urban form characteristics of residential areas are the criteria for sample selection. Participants are recruited under the condition of whether they live in either

Ratchathewi district or Bangkhen district so as to compare their travel behavior of those who live under different urban forms.

In accordance with above, the study included 91 respondents, 49 and 42 of which were from Ratchathewi and Bangkhen districts respectively. This number of respondents was found sufficient to answer the research questions. The interviews were carried out at the respective districts offices during March, 2011. Respondents were the people who visited the district offices. Interviews took place while they were waiting for the service. For this reason, interview time was difficult to manage. However, those who did not complete the questions were omitted.

4.4 Analysis method

Qualitative information was recorded by taking notes and modified into a form of a one week period, then, analyzed by descriptive statistics. Trips were divided based on the purpose of the trip into 7 groups, namely; work, education, shopping, leisure, visiting, socializing, and taking children to/from school. Trip frequency between the two districts is compared. Information about residential location and destinations of various activities are the main material for analyzing trip distribution which reflected travel distance. In the trip distribution analysis, the 7 purposes trip are divided into two broader categories based on temporal and spatial flexibility (presented in chapter 3); i) Bounded trips, including work trips, education trips, and taking children to/from school, and ii) Other trips which refers to non-/semi-bounded trips, and the intermediary group, including shopping trips, leisure trips, visiting trips, and socializing trips.

The weekly travel information is distributed by trip purpose, and modes of transport for the mode choice analysis. However, when it comes to trip-counting, dividing trip purpose is problematic since a single trip may comprise several activities. For example, on a journey back home an individual make a stop at the shopping mall. This journey can be considered as two trips or one trip with two purposes. Therefore, to avoid confusion, trips are divided into 6 categories. At this stage, taking children to/from school trips are included in work trips based on that they were fixed in time and place. Socializing trips are incorporated in leisure trips since their temporal and spatial flexibility is similar. Visiting trips are also included in leisure trips; however, for simplicity. Six trip categories are in the following:

Trips categories include

- 1) Home-based work trip (HBW) trips between place of work and residence. This also includes trips between residence and child's school.
- 2) Home-based education (HBE) trips between place of education and residence.
- 3) Home-based shopping (HBS) trips between shopping location and residence.
- 4) Home-based leisure (HBL) trips between leisure location and residence. Leisure purpose includes visiting and socializing trips.

- 5) Home-based shopping/leisure (HBS/L) trips between shopping/leisure location (when these purposes are combined) and residence.
- 6) Non home-based (NHB) trips between one out-of-home location to another out-of-home location.

It is worth noting that the HBS/L category was a result of special circumstances where shopping and leisure were merged and could not be defined as HBS or HBL. Under this classification, a trip fitted one of the trip categories whereas it could comprise more than one mode of transport. Modes of transport were divided into 5 groups as follows.

Modes of transport;

- 1) Private car
- 2) Private motorcycle
- 3) Public transport (bus, minivan, urban rail and boat)
- 4) Para-transit (hired motorcycle, taxi, songtheaw)
- 5) Walking and cycling

Take two examples for clarification, *Example 1:* A journey from home to workplace starts with walking to a stop to catch a bus, then, make a transfer to urban rail. The trip fits HBW category and modes of transport are walking/cycling and public transport. This makes a total trip equals to 1 while the sum of transport modes are 2. *Example 2:* On a journey from workplace back home, an individual travelling by a private car make a stop at for grocery shopping. This comprises two trip which are NHB trip and HBS trip, a private car is a mode of transport for both trips. Information of trips by categories and modes of transport was used in the mode choice analysis.

Later on in the comparison of travel behavior between individuals residing in a household with and without access to private motor vehicle are divided into four groups which are i) Ratchathewi respondents without an access to motor-vehicle, ii) Ratchathewi respondents with an access to motor-vehicle, iii) Bangkhen respondents without an access to motor-vehicle, and iv) Bangkhen respondents with an access to motor-vehicle.

4.5 Basic characteristics of the respondents

The study includes 91 respondents, 49 of which are from Ratchathewi district and 42 are from Bangkhen district. Males made up 51 percent and 50 percent in Ratchathewi and Bangkhen districts respectively.

Table 4.2 displays number of respondents distributed by age. The majority of the respondents from both districts are in the 18-30 age group while the oldest age group contain least

respondents. The figure shows the similar age composition between two districts; however, Ratchathewi district holds the larger share of young respondents.

Table 4.2: Number of respondents by age.

Age	Ratchatewi	Bangkhen	Total
18-30	33	21	54
31-50	10	15	25
51-65	6	6	12
Total	49	42	91
Average	31.76	35.4	33.44

The respondents' level of education is displayed in Table 4.3. Around 70 percent of the respondents from both districts has a high education and held at least a bachelor degree. The difference is that Ratchathewi district had a larger share of respondents with high school education and below.

Table 4.3: Number of respondents by level of education.

Highest level of education	Ratchatewi	Bangkhen	Total
Primary school	3	-	3
Middle school	1	2	3
High school	7	2	9
Vocational education	-	3	3
Diploma	2	3	5
Bachelor	17	23	40
Above	17	8	25
N/A	2	1	3
Total	49	42	91

Note: N/A: Not applicable

The respondents' occupation shows significant dissimilarities (Table 4.4). The occupation in Bangkhen is dominated by private employees while respondents' occupation in Ratchathewi district is more diverse. In addition, occupation for Ratchathewi respondents is composed of a high number of students and self-employed workers. This may accounts for the different in level of income between the districts (Table 4.5).

Table 4.4: Number of respondents by occupation.

Occupation	Ratchathewi	Bangkhen
State employee	9	4
Private employee	7	24
Self-employed	11	2
Housewife	1	3
Student	9	3
Student working part-time	7	3
Retired	2	2
Unemployed	3	-
N/A	-	1
Total	49	42

Note: N/A: Not applicable

The average income of Ratchathewi respondents and Bangkhen respondents was around 18000 and 23000 Baht respectively (Table 4.5). None of the respondents was considered as poor³. The main difference is that a larger share of the Bangkhen respondents falls into the higher income group while a larger share of the Ratchathewi respondents falls into the lower income group. What might accounts for this situation is respondents' occupation presented earlier Bangkhen respondents comprise a large number of private employees who on average get higher salary than other occupations. On the contrary, many respondents from Ratchathewi are students who mainly get allowances from their parents and/or a part-time job. In addition, Ratchathewi respondents contain a large share of self-employed worker which has relatively lower income. As a consequence, the average monthly income of Ratchathewi respondents is lower.

Table 4.5: Number of respondents by income.

Per capita income (Thai Baht)	Ratchatewi	Bangkhen	Total
5000-10000	14	7	21
10001-15000	8	9	17
15001-30000	14	10	24
30001-50000	2	9	11
50000<	1	1	2
N/A	10	6	16
Average	18220.39	23404.76	20708.8876

Note: N/A: Not applicable

³ According to the National Statistical Office, an individual is defined as poor if his/her monthly expenditure is below 1586 Baht (year 2009). This study is based on this standard although it uses the figure of monthly income.

Respondents' household size is presented in Table 4.6. The most noticeable is that many of Ratchathewi's respondents live alone while 3 to 4-member households are common for Bangkhen respondents. This is mainly due to that Ratchathewi respondents are composed of many students. Most of them moved from other areas or provinces and live alone.

Table 4.6: Number of respondents by household size.

Number of household member	Ratchatewi	Bangkhen	Total
1	20	6	26
2	8	6	14
3	3	12	15
4	9	9	18
5	5	5	10
6-10	4	4	8
Total	49	42	91

Overall, the composition of the respondents by sex, age, and level of education is similar between the districts. The figure shows the difference in occupation which contribute to different average monthly income. The household size is also related to occupation. Since 9 of 20 Ratchathewi respondents living alone are students, a high number of 1-member household is contributed by occupation.

Vehicle ownership figure presented in Table 4.7 indicates that vehicle ownership is higher among respondent from the outer district (Bangkhen).

Table 4.7: Vehicle ownership distributed by number of motor-vehicle in a household.

Vehicle ownership	Ratchathewi	Bangkhen	Total
None	25	11	36
1 motorcycle	2	2	4
1 car	8	7	15
2 vehicles	10	14	24
3 vehicles or more	4	8	12

Half of Ratchathewi respondent does not belong to a household with access to privately owned motor vehicles. On the contrary, half of Bangkhen respondents belong to a household which owns at least two motor vehicles. This dissimilarity reflects the possible relationship between urban form and travel behavior, which will be investigated in the second research question. The differences in urban characteristics between two districts may contribute to the difference in motor-vehicle ownership. However, it cannot be denied that the ability to own vehicles is associated with the level of income since Bangkhen district show the higher average income as presented earlier. At this stage, it can only be stated that different vehicle ownership exists in two districts that differ in urban form.

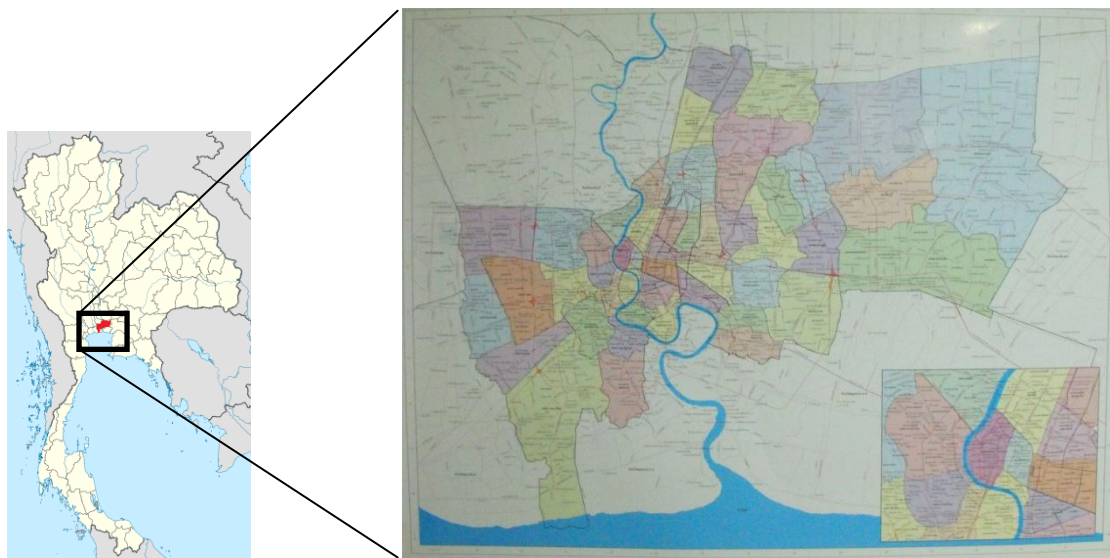
It seems that a large share of students in Ratchathewi sample lowers the average monthly income and affects the composition of household size as well as the vehicle ownership in the district. However, it is important to include them in the study since they represent a relatively large share of student in Ratchathewi district, resulting from a high concentration of education institutions in the inner area.

5. THE BANGKOK METROPOLITAN AREA

This chapter is the introduction of the Bangkok Metropolitan Area. It presents the development and problems of transport sector as well as Bangkok's urban characteristics; namely the transport network, land-use, and population and employment density.

5.1 Overview of Bangkok

Bangkok is the capital, the largest urban area and the primary city of Thailand. The city has become the economic center dominating the country's economy. Due to the close proximity to Indochina and its strategic location between the growing markets of China and India, it serves as the gateway to the region and the hub in Asia. Being the largest labor market in the country, it attracts large number of workers to the city, leading to the problems of housing, slum areas and life quality, not to mention transport problems. Bangkok is located on the low flat plain of Chao Phraya River which extends to the gulf of Thailand. The river divides the city into two parts, on the east is The Bangkok Metropolitan Area (BMA), which is divided into 50 districts (Map 5.1) and covers an area of 1568.74 km² (Bangkok Metropolitan Administration, 2011). Despite being relatively small in area, the city has about 5.7 million inhabitants which account for around 9% of country total population. This makes it the most densely populated city in Thailand. Bangkok population density as of year 2010 was 3634 people per km², while it was 124 people per km² at a country level (Bangkok Statistic, 2011).



Map 5.1a and b: Thailand (a) and the Bangkok Metropolitan Area (b).

Source: Department of City Planning, Bangkok Metropolitan Administrator (2011).

The Office of the Permanent Secretary for the Bangkok Metropolitan Administration has classified the city's districts into three groups based on their location and distance from the city center (Figure 5.1). The Inner City (orange) covers 21 districts which are located in the central area of Bangkok. The Urban Fringe (light orange) includes 18 districts and the Outer Area (white) contains 11 districts (BMA Data Center1, 2011). According to Rujopakarn (2003), the 200 km² central area of Bangkok is composed of the old central business district

(CBD) and the high density business area, presented in Figure 5.1(b) dark green and light green area respectively.

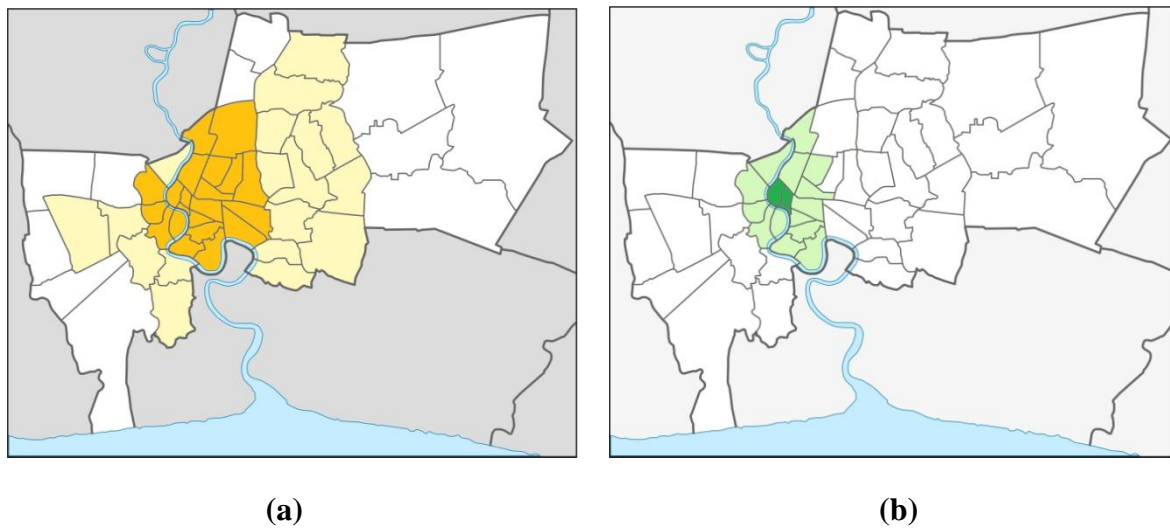


Figure 5.1: Inner city, urban fringe, and outer area of BMA (a), the central area of BMA (b).

Source: BMA Data Center (2011), Rujopadarn (2003), Images modified from Wikimedia.

5.2 Bangkok transportation development and problems

This part presents the historical information on transportation development in Bangkok demonstrating how current transport situation and problems have been generated.

5.2.1 Transportation development

Hundreds of years ago Thais life was bounded with rivers and canals. They preferred to settle on stilts along riversides and in boathouses. Similar to other countries in the region, water transportation was the most important mean of transport. During the mid 1800s, Thailand was influenced by the western transportation technologies. The authorities started constructing roads and bridges in the city which led to the expansion of the city to rural areas. Reliance on water transport was gradually decreasing while road-based transport was increasingly important. Boats were replaced by faster road-based vehicles like rickshaw and horse-drawn tram. This period can be seen as *A Change to Road-Based Transport* (Rujopakarn, 2003).

The Roads period continued between 1900 and 1960. The authorities constructed more roads to serve an increasing road-based travel needs. The golden age of water-based transport had come to an end and there was no new canal excavated after 1915. Thailand, like other countries, faced the economic stagnation after the World War II. For this reason, Thai Government accepted foreign aids without hesitation. Supports usually came with Western ideas which were never analyzed for their appropriateness for the Thai society. Bangkok, as a result, followed the western patterns (ibid).

The focus on road transport continued from 1960 to 1990 (ibid). Thailand introduced its first National Economic and Social Development Plan 1962-1966. The main commitment in the

first three plans was to accelerate economic growth and develop basic road infrastructure (ibid). As a consequence, Bangkok was converted into an automobile city. Road transport had become essential whereas canals have been filled to make ways for roads (Institute for Transport Policy Studies and World Conference on Transport Research Society, 2004). During the 3rd Plan (1972-1976), the first comprehensive Bangkok Transport Study was conducted (ibid). The study suggested a public transport orient policy that included the first Mass Rapid Transit System stage in Bangkok, the construction of expressways, the restriction of car ownership/usage, and polycentric development; however, only the expressways in the central city were implemented due to financial problems and change in government policy. The mass transit rail system was delayed for years (Rujopakarn, 2003; MRTA official website1, 2011).

Investment on road development was continued in the 4th Plan (1977-1981). The 5th Plan (1982-1986) tried to balance urban development by promoting orderly urban growth, but the land-use proposals developed for this plan had failed to decentralize growth from the BMA. The 6th plan (1987-1991) recommended a new urban management policy for the Bangkok Metropolitan Region, the BMA and five vicinities, to promote more systematic and efficient growth as well as to improve public transport system, but again failed and delayed. Although the government had adopted the international planning concepts, more severe transport problems were perceived; traffic congestion increased and uncontrollably expanded to the outskirts of Bangkok. The problems were mainly due to the absence of land-use plan and the uncoordinated transport projects and plans (Rujopakarn, 2003).

Major changes were made at the beginning of the 1990s. The government established a central transport database and model through a project called the Bangkok Transport Planning Unit I (BTPU I), followed by “the private sector phase” during the 7th Plan (1992-1996) with the objective to have infrastructure costs shared by the private sector. The first Mass Rapid Transit Systems Master Plan was approved in 1994 and a huge investment was allocated to the public transport starting the *mass transit era* (Office of Transport and Traffic Policy and Planning, 2011). The land-use plan was first issued in 1992 but only served to provide guidelines while the control of development was neglected. The 8th Plan (1997-2001) proposed to invest more than 650 billion baht in over 150 projects; however, it exceeded the financial capacity and consequently only 15% were implemented. Furthermore, some projects were delayed due to the 1997 economic crisis (ibid).

In the recent years, rail transport in Bangkok is becoming more important. However, a road transport remains on its primary position. The persistent and increasingly severe road congestion together with perceived automobile-caused environmental problems has shed the light to the need for more efficient modes of transport. A huge investment has been put into transport mega projects, particularly rail transport. The first two rail transport routes, apart from the traditional railway, were opened to the public in 1999 in accordance with the mass rapid transit project proposed by the German consultants in 1970s (MRTA official website2, 2011). This was followed by the introduction of the subway in 2004 (BTS official website, 2011) and Airport rail link in 2010 (Airport Rail Link website, 2011). These four routes currently form Bangkok’s rail transport network which mostly operates within the central

city, except the Airport Link that connects the inner city to Suvarnabhumi International Airport in Samut Prakarn province. The most recent means of transport introduced is the Bus Rapid Transit, BRT, with the main feature of a dedicated bus lane allowing the bus to operate separately. The *Mass Transit* era is expected to continue as the extensions for both rail network and BRT were planned some projects have already been approved and implemented (MRTA official website², 2011). However, the delays of the projects seem to be inevitable as usually occurred in the past.

5.2.2 Main reasons for failure

From the beginning of the 19th century Bangkok transport development has experienced various problems which were originated from three main contributors. Firstly, weak coordination accounts for the failure of transport system development. Responsibilities for traffic have been separated among many government agencies working under different ministry (Rujopakarn, 2003). The poor coordination has always delayed project implementation. Secondly, Bangkok has no real master plan for development. Often, the contradictions between plans and different units arise, the interventions from politic are common (ibid). Lastly, the absence of planning standard has created tremendous problems. Bangkok borrowed standards from various countries which sometimes have not been analyzed for the suitability for Thais (ibid). Road-based transport obtained top priority and large share, nearly all, of the budget was allocated to road constructions (Vichiensan, 2007). Meanwhile, less attention was given to land-use planning. As a consequence, Bangkok has grown disorderly causing not only transport problems, but also various problems relating to the urban living environment that exist at the present time (ibid).

5.3 Bangkok Transport Network

Transportation can be categorized into three groups; water transport, rail transport and road transport. Information is briefly provided in the following.

5.3.1 Water Transport

Even though water transport had lost its primary role to road transport hundred years ago, it still serves more than 360,000 passengers per day (World Bank, 2011). There are two major water ways in Bangkok, Chao Phraya River and Khlong Saen Saeb. Chao Phraya River is running from the north through the heart of Bangkok and extends to the Gulf of Thailand. In 2009, there were around 34,000 trips/day for Chao Phraya Express boat (Marine Department¹, 2011) and around 75,000-80,000 trips/day for ferry boat (Marine Department², 2011). Khlong Saen Saeb is a branch canal of Chao Phraya River, stretching west to east and connecting Bangkok to the east adjacent provinces. Fares for ferry boat are 3 baht per trip while fares for Chao Phraya Express boat are varied from 12 to 28 Baht depending on type of boat and travel distance. Likewise, fares for Khlong boats are between 10 to 20 Baht depending on distance. The routes for the two major water ways are displayed in Figure 5.2.

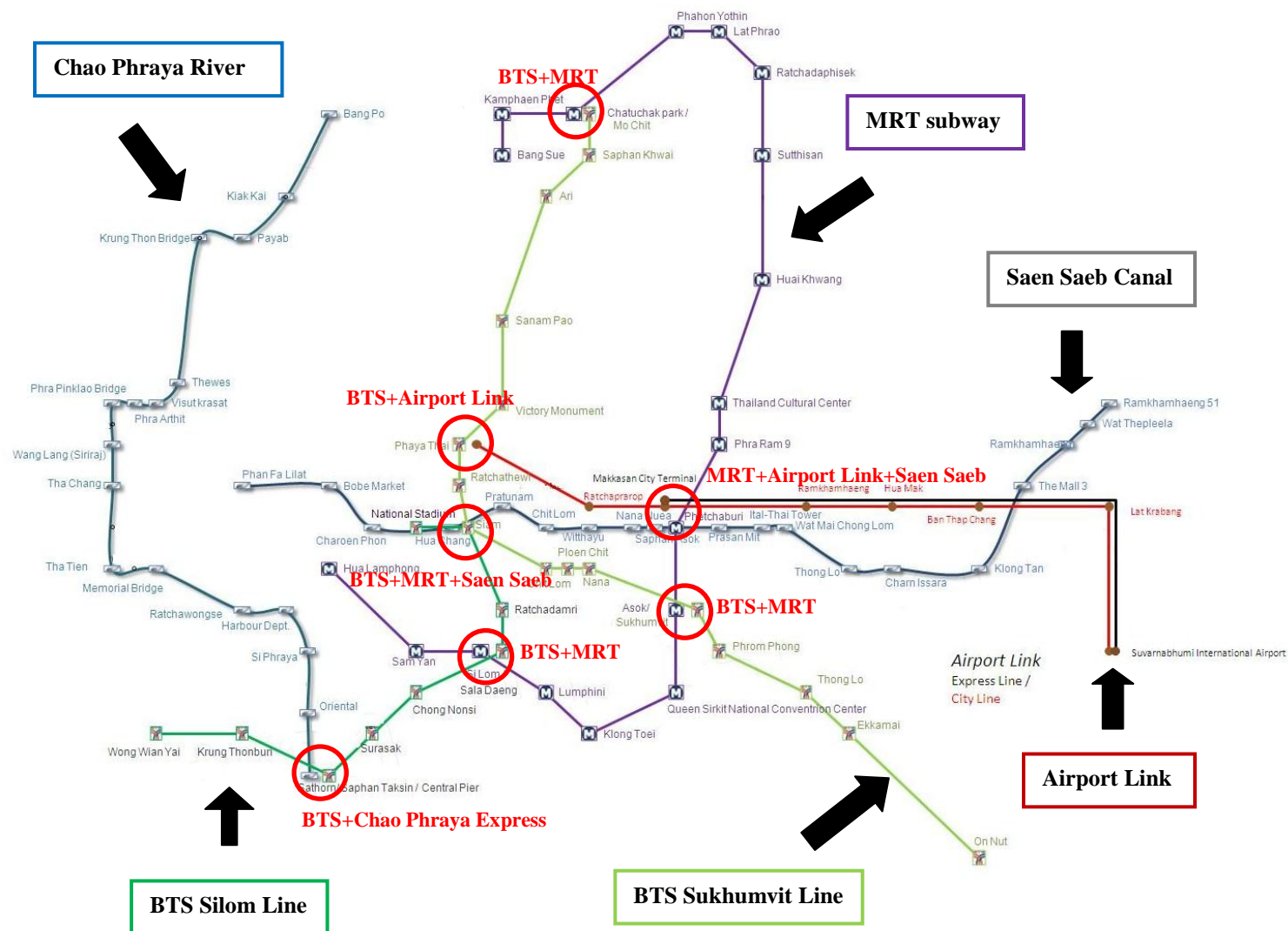


Figure 5.2: Urban Rail System, Water transport and their connections.

Source: TransitBangkok (2011).

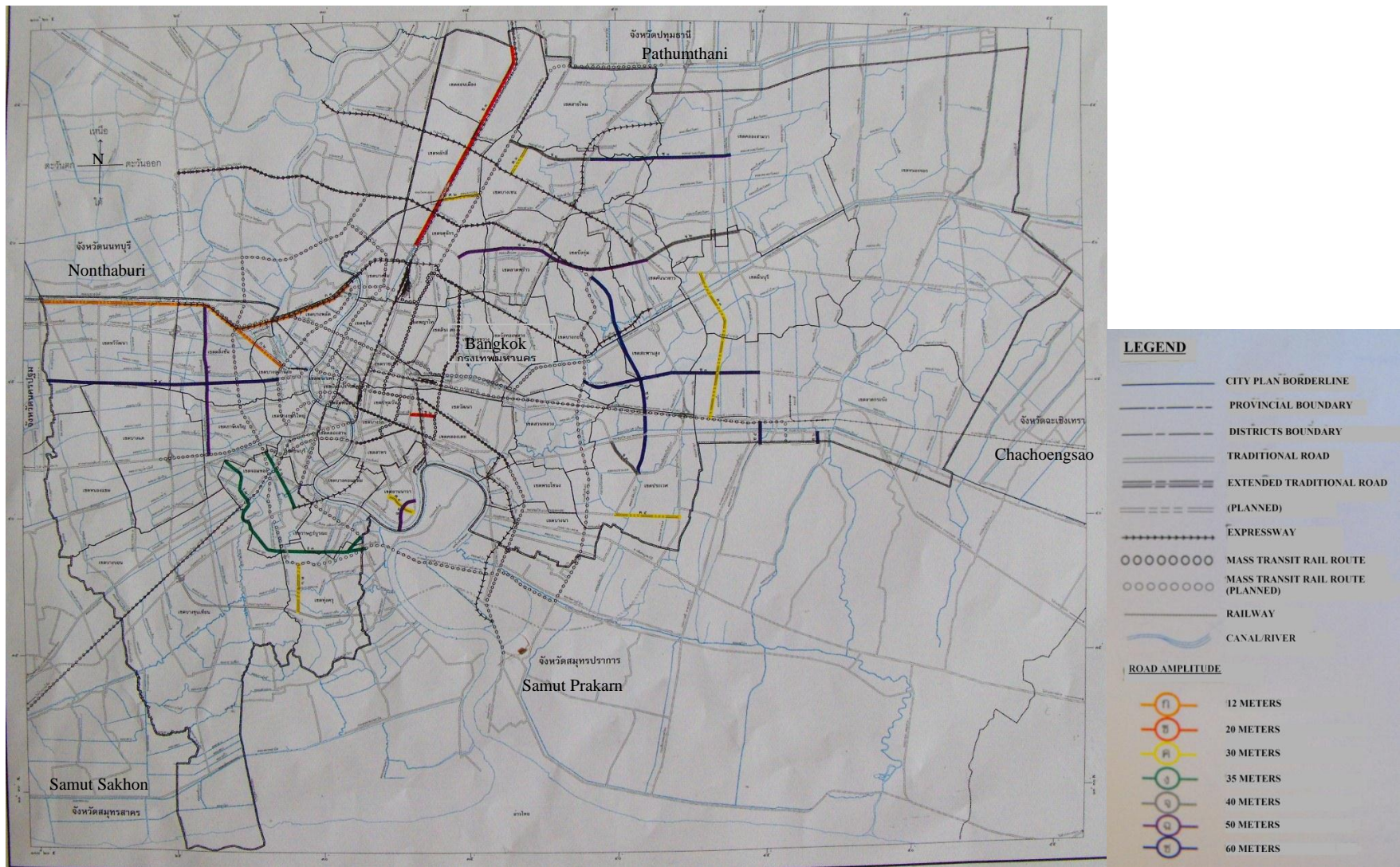
5.3.2 Rail Transport

Bangkok gained its first railway in 1891. Rail transport provided by State Railway of Thailand (SRT) has been considered less attractive and been blamed for its inadequate service coverage and poor quality, though it is still important for some suburban residents to commute to central Bangkok (Vichiensan, 2007). Urban rail transit was introduced in 1999. The BTS skytrain has transformed the face of public transportation and for the first time offers a comfortable ride by lifting commuters above the congested, noisy and polluted streets below (BTS official website, 2011). Five years later, the new MRT subway was opened and in 2010 the most recent Airport Link was opened. Currently, the BTS skytrain provide two routes, the Sukhumvit Line and the Silom Line, while the MRT subway and the Airport Rail Link provide one route each. The MRT subway connects SRT's northern train station, Bang Sue, to Hua Lamphong station in central city whereas the Airport Rail Link provides quick transfer to Suvarnabhumi International Airport in Samut Prakarn Province. These four routes together form the Bangkok urban rail transit system. Providing altogether 74 k.m., covering mainly the central city, important commercial, residential and tourist areas, and connecting to the international airport, the urban rail transit is considered inadequate for improving traffic circulation in Bangkok (MRTA official website1, 2011). Therefore, the 20-year extension project was planned for 12 routes 495 k.m. (MRTA official website2, 2011) in which some parts have been approved and constructed (Office of Transport and Traffic Policy and Planning, 2011).

Current urban rail network is shown in Figure 5.2. It displays the connection among four routes. Siam is the interchange station between the BTS Sukhumvit line and Silom line. Skytrain is connected to the MRT subway at three transfer station, Mo Chit, Asoke and Sala Deang. The Airport Rail Link originates at Phayathai BTS station and connected with MRT at Makkasan Station.

5.3.3 Road Transport

King Mongkut ordered the construction of the first roads in 1857 which was completed five years later (Institute for Transport Policy Studies and World Conference on Transport Research Society, 2004). This was accompanied by the introduction of motorcar in 1902. Road transport increased in importance and eventually replaced the primary role of water transport in the mid 1900 (Rujopakarn, 2003). At present, roads cover ten percent of Bangkok's total area, which is considered inadequate and insufficient as compared to Tokyo and New York that have road area of 23 and 38 percent respectively, therefore, the expansion of road area in one of the main objectives (BMA Data Center2, 2011). Roads and expressways cover the entire Bangkok area (Map 5.2 and Figure 5.3), and have played an important role in accommodating travel demand. Meanwhile, the public transport service is not sufficiently provided (Vichiensan, 2007).



Map 5.2: Bangkok Road Network.

Source: Department of City Planning (2006).

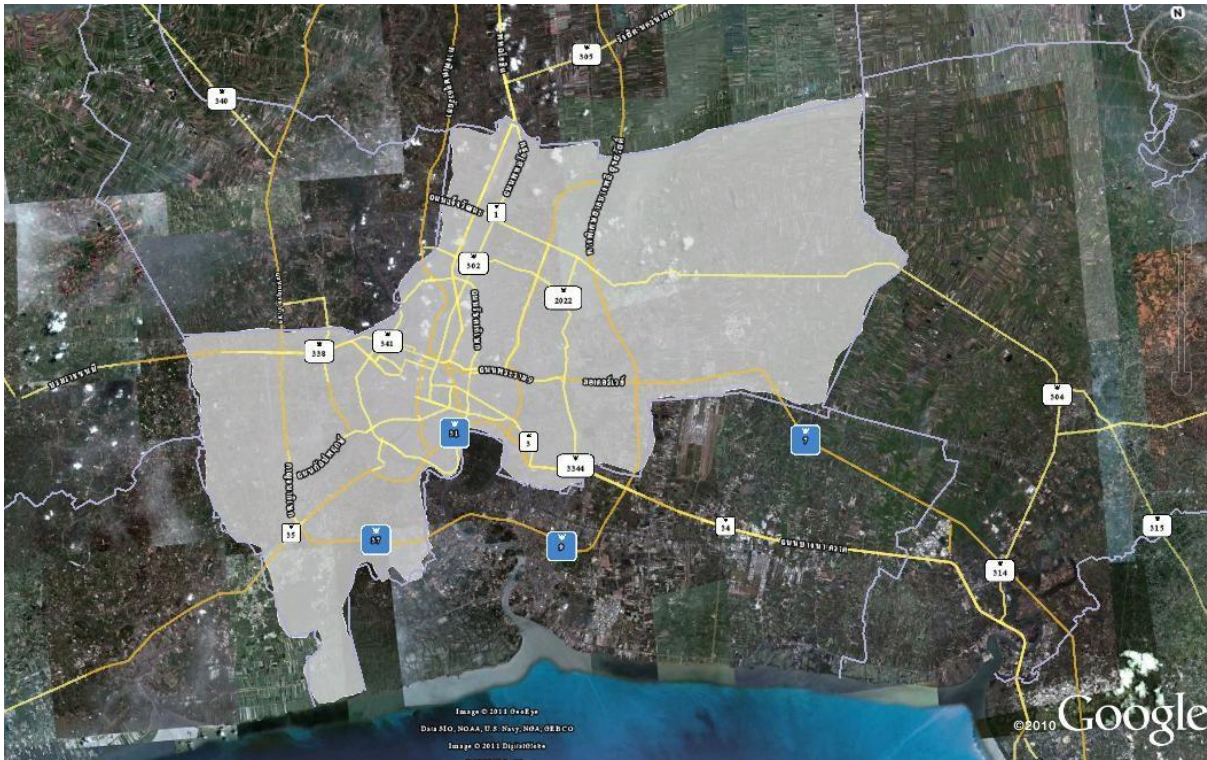


Figure 5.3: Bangkok Road Network.

Source: Google Earth.

Buses are the major modes of mass transit in Bangkok. It serves more than 1 million passenger trips per day which is higher than any other public transport mode in Bangkok. Currently, there are 211 bus routes jointly provided by Bangkok Mass transit Authority and other minor private companies. Bus service roughly covers the whole Bangkok but the service is concentrated in the central area. The more distance away from the central, the less the service. Fares are varied between 7 to 24 Baht depending on bus type and distance (BMTA1, 2011). BMTA also provides 117 additional routes (BMTA2, 2011) for public *vans* which is increasingly popular. Van service covers much of central area and connects it to important residential and commercial areas in the outskirts. As many van routes are overlapped with those of buses, van becomes a good alternative especially in rush hours. Buses can be reached at every urban rail stations and every piers; nevertheless, without proper timetable.

Hired motor-cycles and share taxi, called *songthaew*, mainly operate in small residential streets, referred to as *soi*, fulfill travel needs by transferring passengers from rather inaccessible areas to bus stops, piers and rail stations. There are approximately 110 routes of *songthaew* operated in Bangkok (BMTA3, 2011) while hired motor-cycles can be seen in nearly every *sois*. Fares for hired motor-cycles usually start from 10 Baht and go hand in hand with distance. Fares for *songthaew* are fixed but varied across the city.

Overall, there are many problems regarding transportation in Bangkok. The first problem concerns an insufficient provision of public transport service. Bus service is not only lacking in outskirts, but are also very crowded in rush hours while speedy urban rail is only available

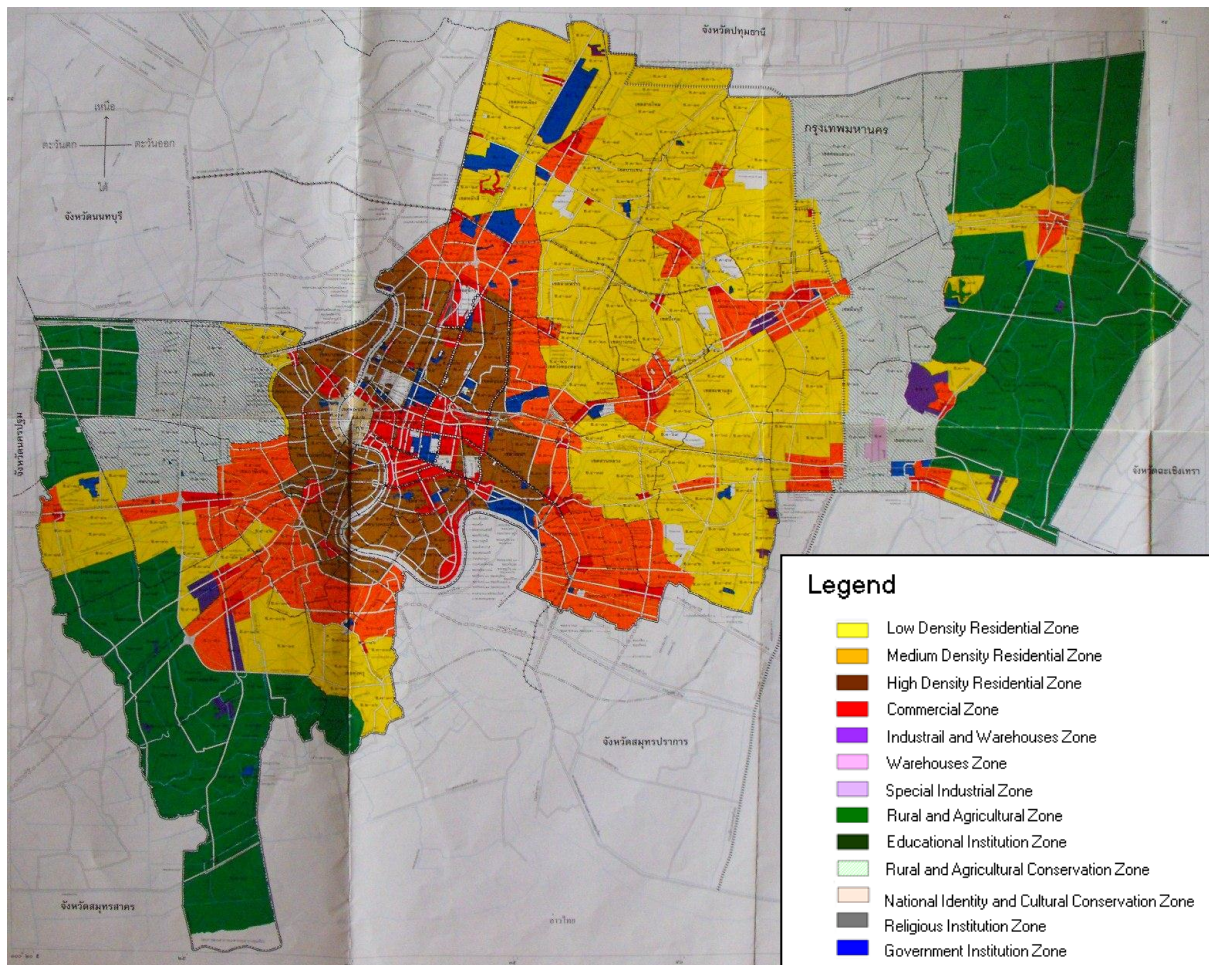
in the inner area. Quality is another important problem. The buses are unreliable. It does not have an accurate timetable or facilitating condition. Neither route information nor official names of the stops are provided. Destinations are written on side of the buses which is rather hard to capture regarding a short time of transfer (Figure 5.5). One last thing is the condition for walking and cycling. Walkability in Bangkok is quite poor because of air pollution, noise and pedestrian environment. Roads and residential streets that connect to the main roads have poor footpaths which are crowded by street vendors, stalls and trolleys leaving little space to walk. Cycling has been seriously promoted the past few years. Bike lane and racks have been installed in some routes but are still missing in most areas.



Figure 5.4: Bus number shown at the bus stop and typical bus in Bangkok.
Source: Oknation (n.d.).

5.4 Land-use

According to the Department of City Planning, land-use is mainly characterized into 10 groups based on the usage purpose (Map 5.3): 1) Low Density Residential Zone 2) Medium Density Residential Zone 3) High Density Residential Zone 4) Commercial Zone 5) Industrial Zone 6) Warehouse Zone 7) Rural and Agricultural Conservation Zone 8) Rural and Agricultural Zone 9) National Identity and Cultural Conservation Zone and 10) Government Institution Zone.



Map 5.3: Land-use designation in Bangkok Metropolitan Plan 2006.

Source: Department of City Planning (2006).

5.5 Population density and employment density

According to BMA Data center, population density recorded in December 2010 for Bangkok is 3,634 people/km²; however, the number varies from 640 people/km² to 27,179 people/km² in the most densely populated district. The densest area is the inner city and becomes sparser farther away from the center. Figure 5.5a demonstrates the level of population density using the data from 2005. While the information of population density is quite complete and up-to-date, information on employment density at the district level is missing. The latest employment density data is from year 2005 (Vichiensan, 2007). The study showed that employment density is higher in the inner areas than in the outer areas (Figure 5.5b). Overall, the same situation applies to both population density and employment density. That is, the farther away from the center, the lower the density.

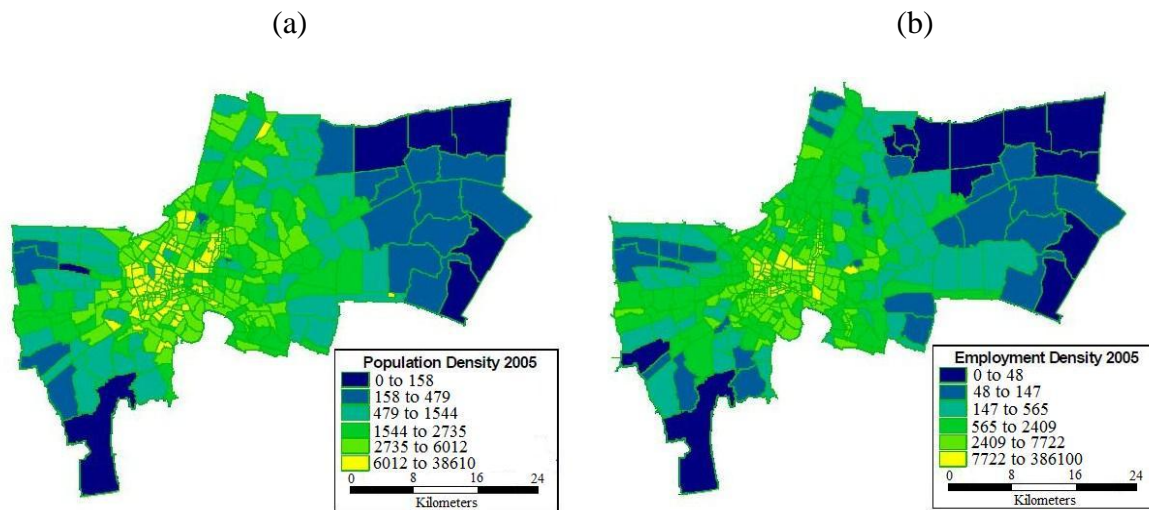


Figure 5.5a and b: Population density (a) and employment density (b) 2005.

Source: Modified from Vichiensan (2007: 1564).

In order to investigate how urban form influence travel behavior, participants selected for the interview were recruited from areas of which urban characteristics are different. Ratchathewi district and Bangkhen district are appropriate for this reason. Further details of the selected area are presented in the following chapter.

6. CHARACTERISTICS OF SELECTED CASE STUDY DISTRICTS

The urban characteristics of BMA have been demonstrated in the previous chapter. This chapter focuses on the selected areas of the study, Ratchathewi district and Bangkhen district. The objective is to present the urban structural conditions characterizing the investigated districts and to clarify the distinct differences between them. Urban structural conditions include location and distance to the city center, mixture of land-use, population and employment density, and access to public transport.

6.1 Location and Distance to Central city

Both Ratchathewi district and Bangkhen district are located on the east side of the Chao Phraya River (see Figure 6.1). While the former is situated in the central area of Bangkok, the latter is situated in the northern part of the city. The total area of Rathathewi and Bangkhen districts is 42.123km² and 7.126km² respectively (BMA Data Center, 2010). This makes Bangkhen district close to 6 times bigger than Ratchathewi district. According to the criteria given by the Office of the Permanent Secretary for the Bangkok Metropolitan Administration, Ratchathewi district is classified into the inner city districts whereas Bangkhen district is classified into the urban fringe districts. The distance between the two districts is approximately 15 km. and the distance from the core business area to Ratchathewi district and Bangkhen is 4 km. and 19 km. respectively (Figure 6.1).

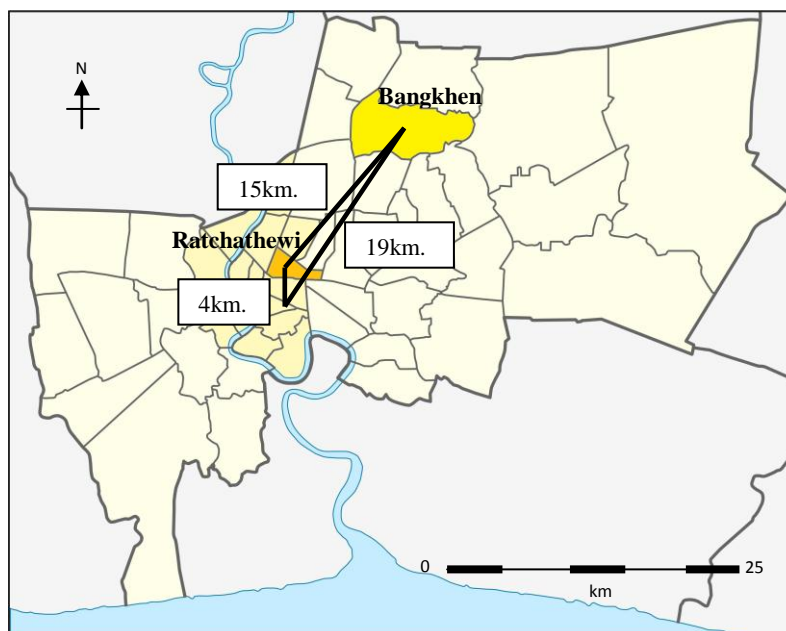


Figure 6.1: Location of Ratchathewi district and Bangkhen district.

Source: Modified from Wikimedia.

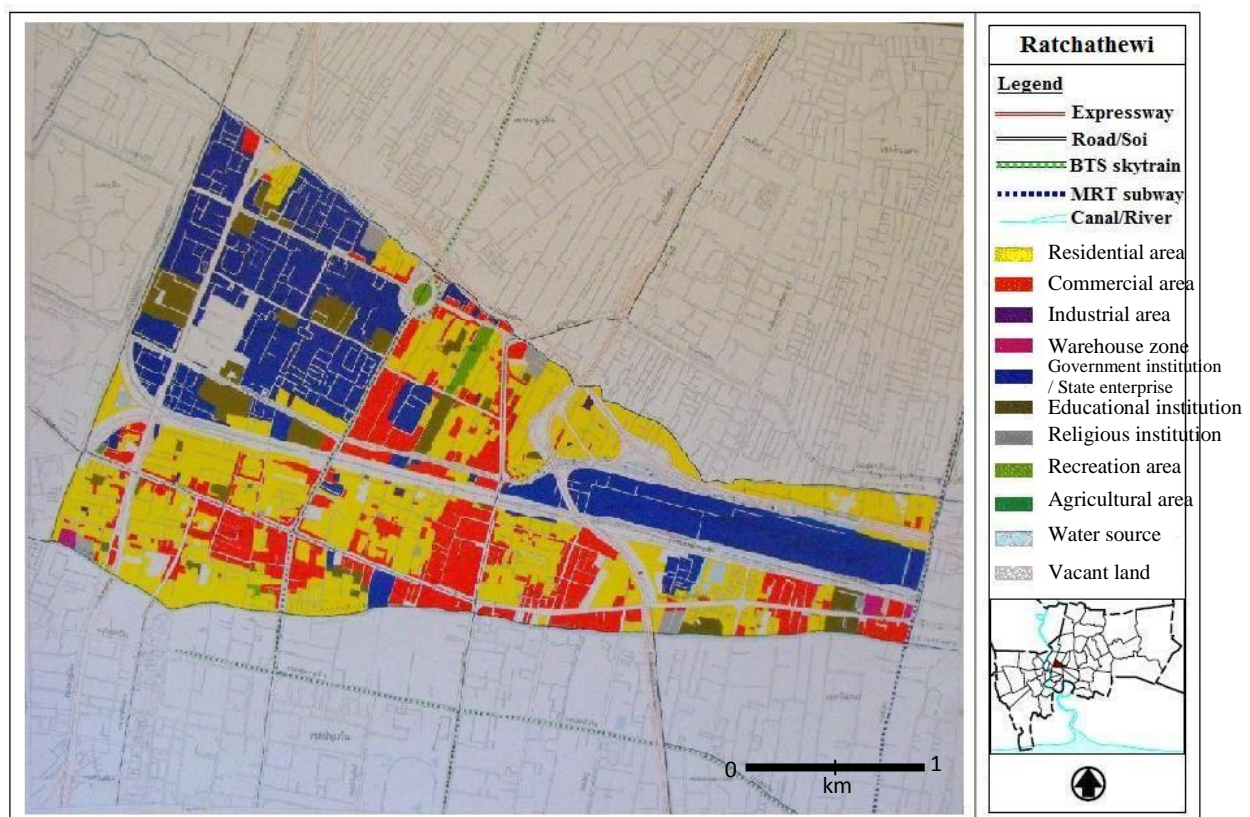
In terms of distance to the core business area, the location of Ratchathewi district is more advantageous. Besides the core business area, other important business and shopping areas, the old business district, the important government institutions as well as the prestigious schools and universities are mostly located within 5 km. radius. For Bangkhen district,

though located further away from the central area of Bangkok, it benefits from the urban expansion that brought some essential facilities and activities closer to the area, such as shopping malls, banks and hospitals.

6.2 Mixture of Land-use

This part displays how the land of each district is allocated for various purposes. The Department of City Planning distinguish land-use into nine categories which are 1) Residential area, 2) Commercial area, 3) Industrial area, 4) Warehouse zone, 5) Government institution and State enterprise, 6) Educational institution, 7) Religious institution, 8) Recreation area, and 9) Agricultural area.

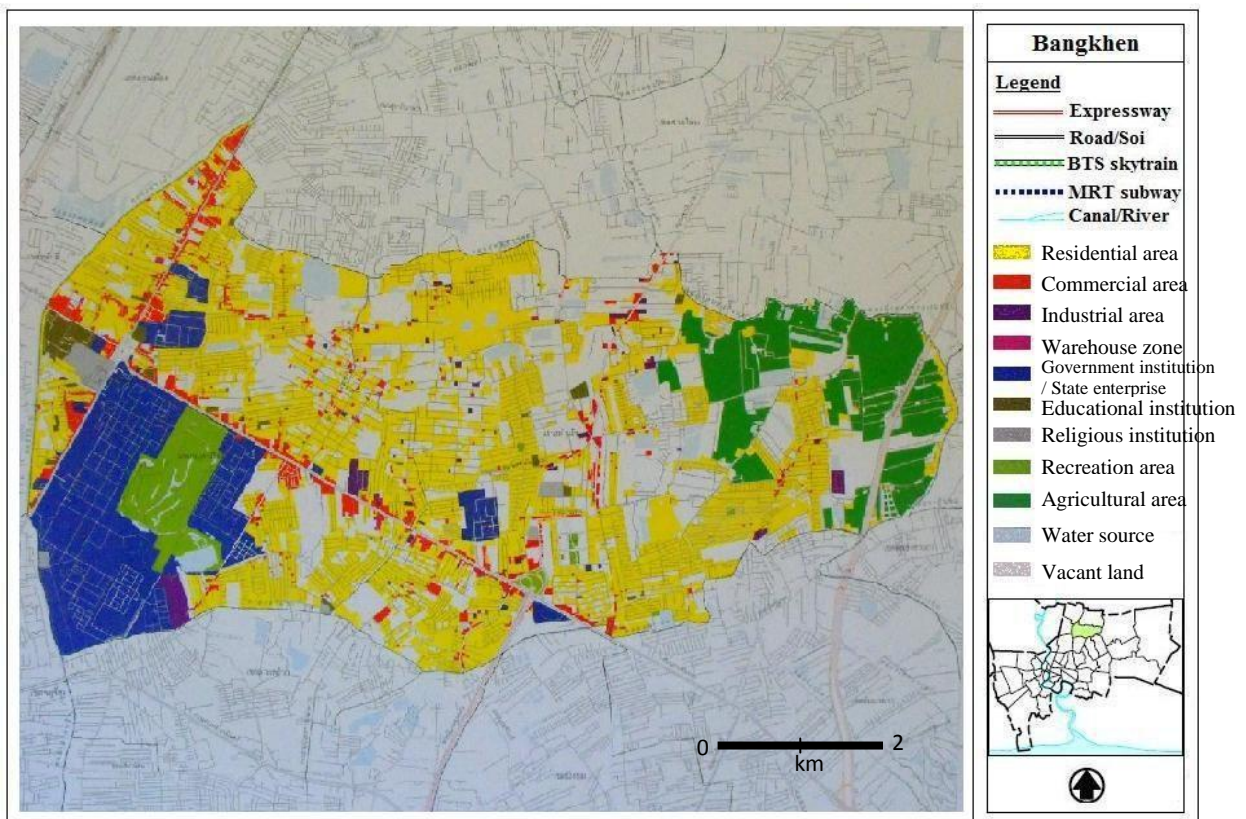
From Map 6.1, it can be seen that roughly half of Ratchathewi area is used for residential purposes. Government institution and State Enterprise also make up a large area, especially in the northwest corner where the hospitals, the military offices and the government agencies are situated. Another blue area stretching from the middle toward the east of the district is the plant of the State Railway of Thailand. Commercial zones are located all over the district. This includes a wide range of shops, such as retailing, markets and shopping malls. Educational institutions are mainly located in the northwestern part. Among them is one of the country's leading university which settles in the northwest surrounded by the government institutions. Hardly no industrial areas are located within the Ratchathewi district and only small pockets of areas classified as religious institutions and recreational areas.



Map 6.1: Ratchathewi district land-use map.

Source: City Planning Department (2002).

The land-use characteristic of Bangkhen district show a quite different pattern compared to the district of Ratchathewi (Map 6.2). The residential areas make up; by far, the largest land area. The military units take up a large portion of land in the southwest of the district. Other government institutions and State Enterprises located in this district are, for example, the Thai Police Aviation Division and the Metropolitan Electricity Authority. The commercial area is concentrated along the main roads and are sparsely located on residential streets. Unlike Rachathewi district, there is also a large agricultural area remaining in the district's eastern part. Vacant lands can be seen all over the district.



Map 6.2: Bangkhen district land-use map.

Source: City Planning Department (2002).

Overall, both districts have a mixed of land-use; however, the components differ. The major components in Ratchathewi district are residential areas, state institutions and commercial areas, while educational institutions are noticeable. Residential areas and state institutions in Bangkhen district also occupy large amount of land. Land-use for commercial purpose takes up less share of area compared to those in Ratchathewi district. Shops, stores, shopping malls and markets are observably situated along the main roads. Another difference between two districts is the existence of agricultural area and vacant land in Bangkhen district.

6.3 Density

Population and employment densities for the whole BMA were presented in the previous chapter. This part takes a look on such characteristics in Ratchathewi district and Bangkhen district.

6.3.1 Population density

At the end of 2010, population density was recorded at 10,698 people/km² and 4,467 people/km² for Ratchathewi district and Bangkhen district respectively (BMA Data Center, 2010). The detailed information for respective district is presented in Figure 6.2a and 6.2b.

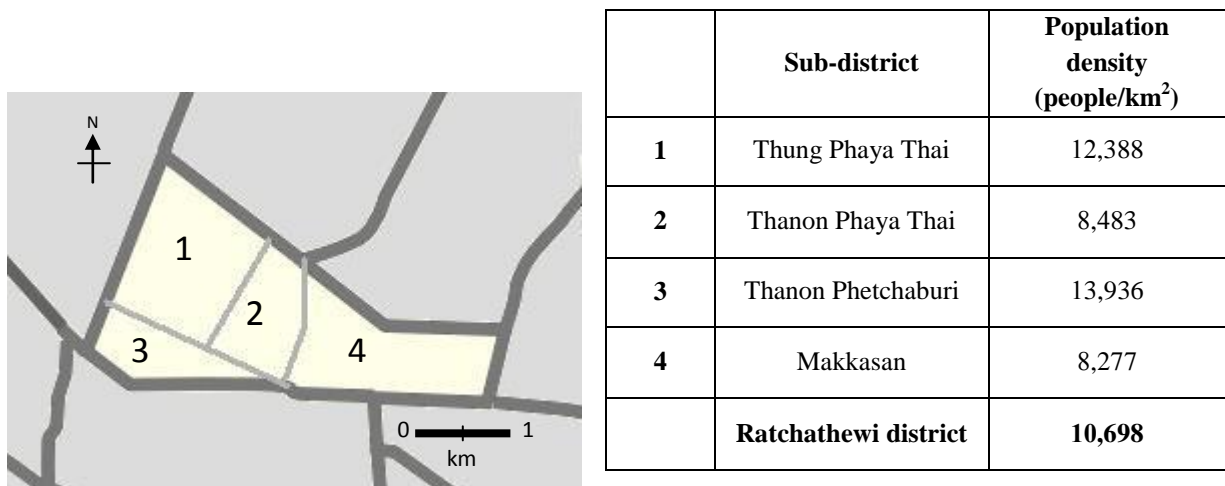


Figure 6.2a: Population density in Ratchathewi district, total and distributed by sub-districts (people/km²).

Source: BMA Data Center (2010), images modified from Wikimedia.

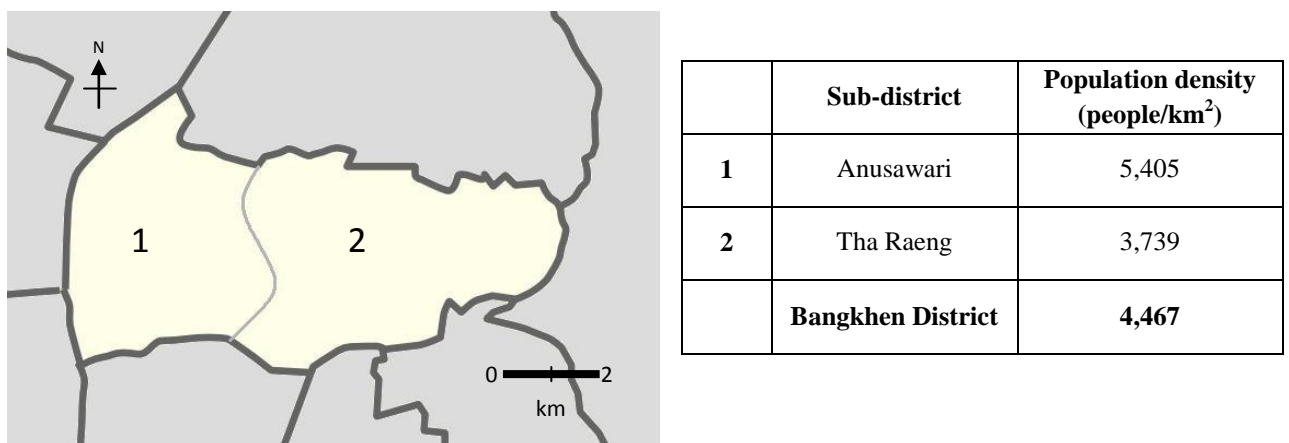


Figure 6.2b: Population density in Bangkhen district, total and distributed by sub-districts (people/km²).

Source: BMA Data Center (2010), images modified from Wikimedia.

The population density figures show a meaningful difference between the two districts. The inner district, Ratchathewi, holds a significantly higher population density (139%) compared

to Bangkhen district. The distribution among sub-districts in Ratchathewi district is more diverse in which the most dense and least dense sub-districts differ around 25.5 percent. Population density of Bangkhen sub-districts differ 18.2 percent.

6.3.2 Employment density

As mentioned in the previous chapter, the most recent employment density data available is in Vichiensan (2007). Though the exact number of employment density at a district level is absent, Figure 6.3 allows us to observe the difference and compare the level of employment density between Ratchathewi and Bangkhen districts.

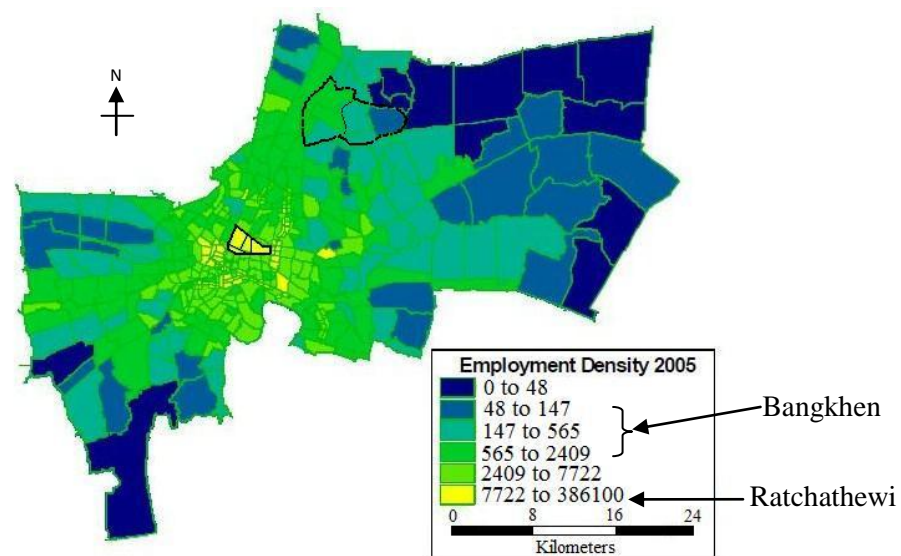


Figure 6.3: Employment density in Ratchathewi district and Bangkhen district.

Source: Modified form Vichiensan (2007: 1564).

Similar to population density, employment density in Ratchathewi district is much higher than in Bangkhen district. It is worth noting that other districts in the inner area have relatively high employment density as well. This indicated that the further away from the central area of Bangkok, the lower the employment density.

6.4 Access to public transport

6.4.1 Road Network

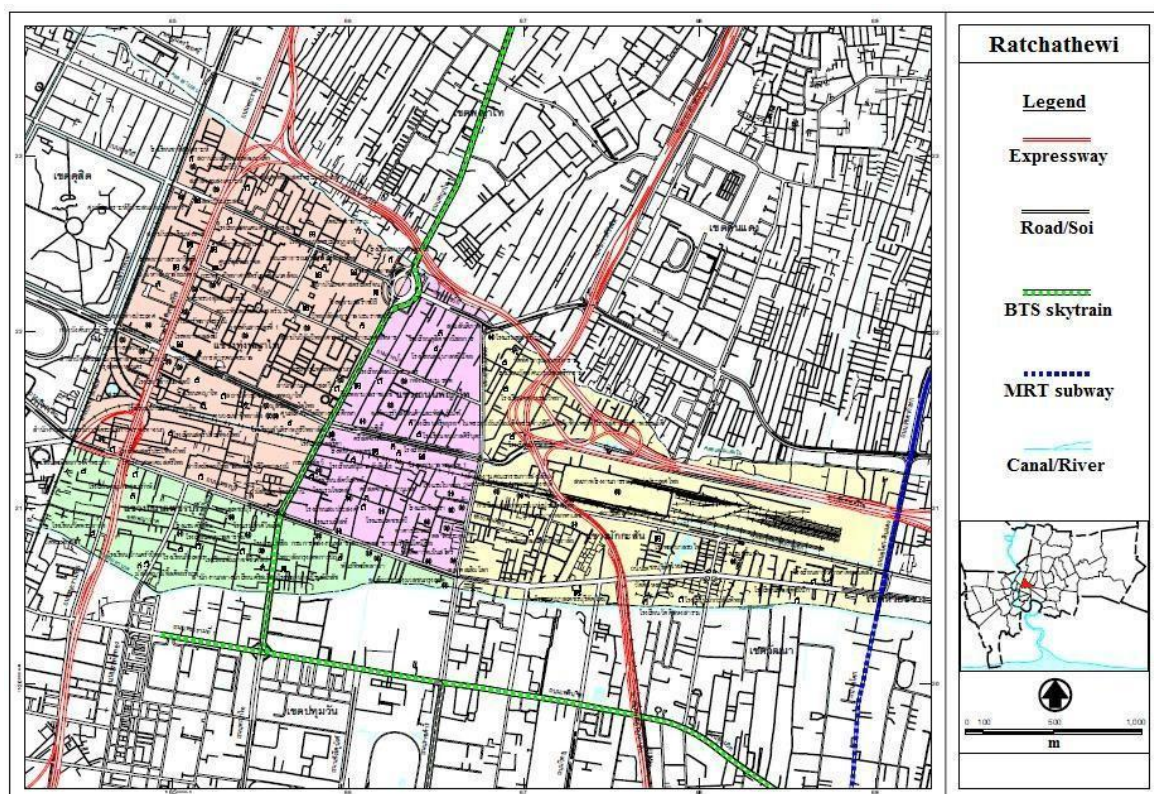
Due to the huge investments in road transport since the early 1900s, the road network has been expanded from the central city to the outer area of Bangkok. Roads and residential streets have been constructed all over the city, even in the farthest outer districts. However, road concentration remains in the inner area. Map 6.3a and 6.3b show the road networks in Ratchathewi district and Bangkhen district. There are seven main roads and two expressways cutting through Ratchathewi district. For Bangkhen district, there are four main roads and

two expressways. Road length, road area and road area as percentage of total land area are shown in Table 6.1.

Table 6.1: Roads and streets in Ratchathewi district and Bangkhen district, distributed by road length (km.), road area (m²), and total road area's share of total district area (percent).

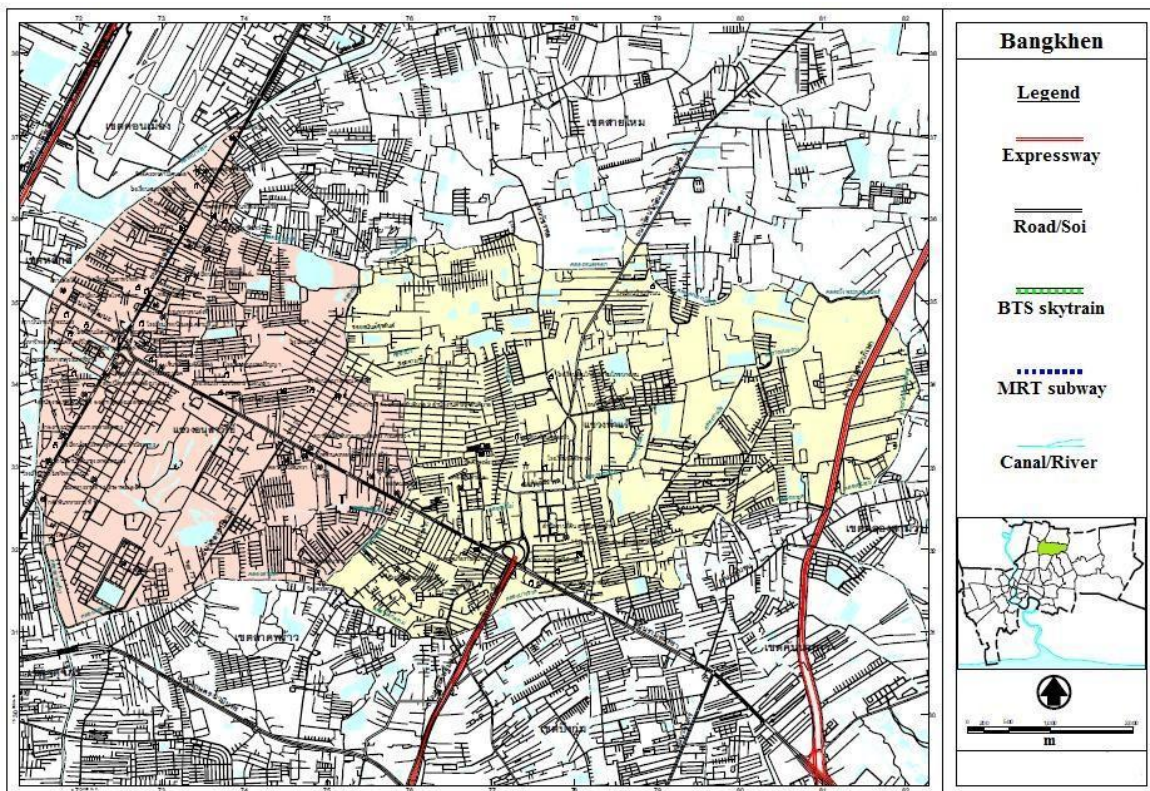
District	Road length (km.)	Road area (m ²)	Road area (% of total land area)
Ratchathewi	41.479	449,383.60	6.31%
Bangkhen	150.914	948,403.00	2.25%

Source: Public Works Department, Bangkok (2004).



Map 6.3a: Transport network of Ratchathewi district, distributed by expressways, other roads, skytrain, subeay, and canals/ivers.

Source: City Planning Department (2011).



Map 6.3b: Transport network of Bangkok district, distributed by expressways, other roads, skytrain, subeay, and canals/rivers.

Source: City Planning Department (2011).

Road network is relatively well-serviced in Ratchathewi district. Concerning that it is smaller in size, it consists more main roads. Besides, there are many secondary roads connecting main roads. The road area shares 6.31 percent of Ratchathewi’s land area while it is 2.25 percent in Bangkok district. In addition, the road network is more orderly established in Ratchathewi district.

6.4.2 Availability of public transport

Whilst road transport, water transport and urban rail transport are all in service in Ratchathewi district, only road transport is available in Bangkok district. The north-south green line passing through the heart of Ratchathewi in Figure 6.4a represents the Sukhumvit line of the BTS skytrain, of which three stations are situated in the district. The blue line on the east border is the MRT subway, of which one station is located in the district and another station is located close to the north border. Since the Saen Saeb canal is used as a natural border between Ratchathewi district and Pathumwan district on the south, water transport is also available.

Despite being serviced in both districts, the degree of bus availability is unequal. Since the bus services are concentrated in the central area, more than 50 bus lines are operated in Ratchathewi district while it is fewer in Bangkok district (BMTA2, 2011). Figure 6.4a and b demonstrates the amount of bus lines operating on the specific roads in both districts.

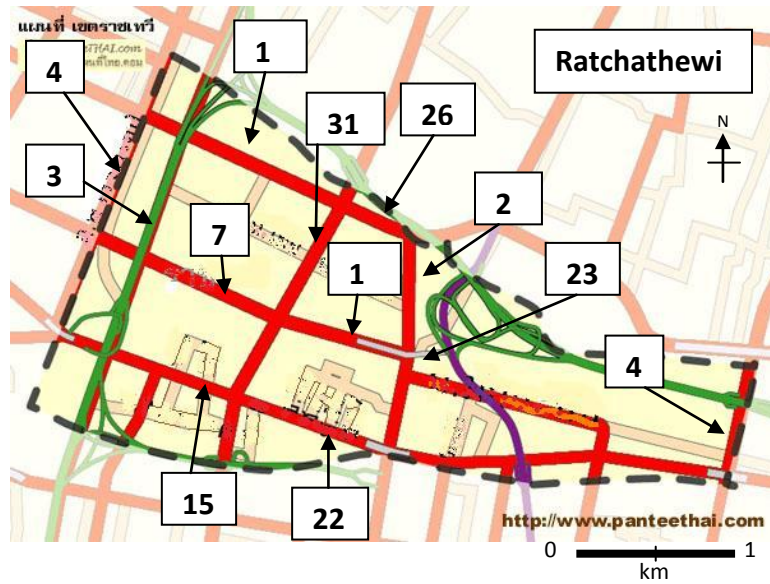


Figure 6.4a: Number of bus lines on specific roads in Ratchathewi district.
 Source: Modified from Panteethai1.

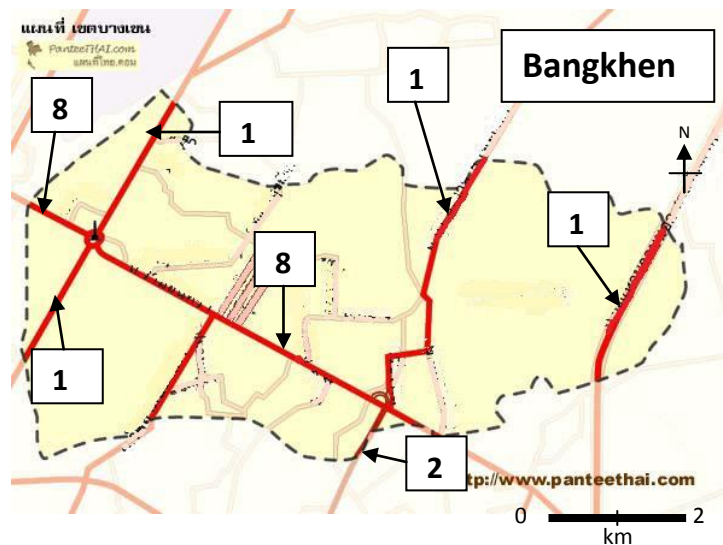


Figure 6.4b: Number of bus lines on specific roads in Bangkhen district.
 Source: Modified from Panteethai2.

6.5 Concluding remarks of selected district

Ratchathewi district and Bangkhen district urban characteristics differ in four major ways. Firstly, Ratchathewi district is located in the inner area close to the important business and commercial areas as well as leading educational institutions. Bangkhen district is situated distant away far from the central city. Secondly, land is used for various purposes in both districts; however, the components differ. Commercial areas which make up a larger share in

Ratchathewi district are located all over the district, while in Bangkhen district commercial areas are situated along main roads. Besides, another difference is the existence of agricultural area and vacant land in Bangkhen district. Thirdly, the population density and the employment density are much higher in the inner district. Lastly, Ratchathewi district has better access to public transport. The next chapter will present the analysis of travel patterns which answer the research question of how the varied urban form characteristics influence travel behavior of the individual residing in two Bangkok districts.

7. TRAVEL PATTERNS

The differences in urban characteristics between the two investigated districts have been presented in the previous chapter. This chapter looks at the travel behaviors in the study districts. It gives the first indication of the relationship between urban form and travel behavior. Travel frequency, trip purpose, mode choice and travel distance among the respondents living in different urban forms are the main interest of the investigation. Trip purpose and mode of transport to perform various activities, namely work, education, shopping, leisure, visiting, socializing and taking children to/from school will be demonstrated. In the mode choice analysis, trips are divided into 6 types as presented in chapter 4. Later on in the trip distribution analysis, trips are categorized based on temporal and spatial flexibility, as presented in chapter 3, into two main groups, namely bounded trips, and non-/semi-bounded trips.

7.1 Travel frequency

The travel frequency among the respondents is illustrated in Table 7.1.

Table 7.1: Total and average number of trips/week among Ratchathewi and Bangkhen respondents.

District	Total trips/week	Average trips/week/respondent
Ratchathewi (n=49)	740	15.10
Bangkhen (n=42)	658	15.67
Total average	1398	15.36

Table 7.1 shows that weekly travel frequency is similar for the respondents in both districts. Ratchathewi respondents made 15.10 trips on average per week, while the respondents from Bangkhen made slightly more trips on average at 15.67 per week. This reflects that respondents from both districts made similar amount of trips though they live in different urban forms. Thus, it is not possible to stress that urban form influence travel frequency significantly.

7.2 Trip purpose

There are seven trip purposes as stated earlier, including work, education, shopping, leisure, socializing and visiting, and taking children to/from school. Trips made by the respondents are shown in Table 7.2.

Table 7.2: Trip purposes made in a week period, distributed by respondents in Ratchathewi district and Bangkhen district (number and percent).

Trip purpose (respondents)	Work	Education	Shopping	Leisure	Socializing/visiting	Taking children to/from school	Total
Ratchathewi (n=49)	156 (35.1%)	59 (13.3%)	184 (41.1%)	37 (8.3%)	8 (1.8%)	0 (0%)	444 (100%)
Bangkhen (n=42)	183 (48.5%)	16 (4.2%)	116 (30.8%)	46 (12.2%)	5 (1.3%)	11 (2.9%)	377 (100%)
Total	339 (41.3%)	75 (9.1%)	300 (36.5%)	83 (10.1%)	13 (1.6%)	11 (1.3%)	821 (100%)

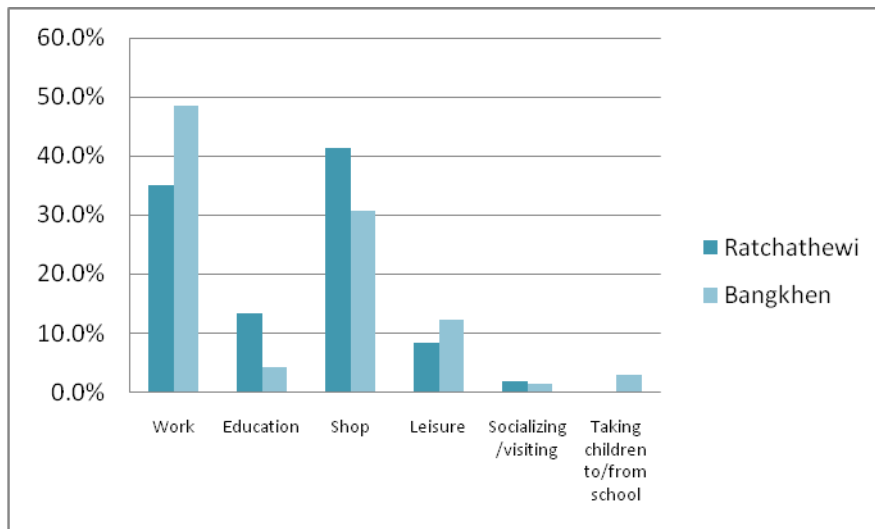


Figure 7.1: Trip purposes made in a week period, distributed by respondents in Ratchathewi district and Bangkhen district (%).

Trips that respondents make most frequently are work trips and shopping trips. Leisure trips take place regularly while visiting/socializing trips do not occur so often. Only a few respondents perform trips in taking children to/from school⁴. Education trip is higher in Ratchathewi district due to a larger share of student respondents. The figure of leisure, socializing/visiting trips does not show a meaningful difference. High number of work trips in both districts reflects the need to perform such activity as a routine activity. However, the difference in number work trips between the districts is large. This is because only 28 out of 49 respondents in Ratchathewi district engaged in work trips during the investigated week⁵.

The number of shopping trips is composed of large share of grocery shopping which usually occurs at the markets or small shops near the residential location. Other locations for shopping are shopping malls and department stores as well as hyper markets. Shopping trips per person is higher in Ratchathewi district ($184/49=3.76$) than Bangkhen district ($116/42=2.76$) because there are more shopping locations in the inner area. Moreover, these locations are situated in a short distance from residential areas making them easily reached by Rathcathewi respondents. On the contrary, for Bangkhen respondents it is more difficult to reach other shopping locations besides markets or small shops nearby. This is compatible with the difference in land-use, presented in chapter 6, that Ratchathewi district consists a larger share of commercial areas located all over the district while much of those in Bangkhen district are located along the main roads.

⁴ The interview took place during the summer break for school kids; therefore, trips relating to them are small.

⁵ Twenty-one Ratchathewi respondents who did not perform work trip comprise; 11 students, 2 retirees, 3 unemployed, 1 housewife, 3 self-employed working at home, and 1 self-employed on a break. Nine Bangkhen respondents who did not perform work trip comprise; 3 students, 2 retirees, 3 housewives, and 1 self-employed working at home.

7.3 Mode choice

This part presents a key element of travel behavior; mode choice. The total number of trips performed in a week period distributed by modes, as well as mode choice distributed by trip purposes is presented. After this, the relationship between purpose and a number of modes used in combination will be presented. This will reveal the similarities and differences in travel patterns between the respondents from the two districts.

7.3.1 Modal choice

Table 7.3 shows the total number of trips made by Ratchathewi and Bangkhen respondents distributed by modes of transport, which are divided into 5 groups; private car, private motorcycle, public transport (bus, minivan, urban rail and boat), paratransit (hired motorcycle, taxi, songtheaw), and walking/cycling.

Table 7.3: Total number of trips performed in a week period distributed by modes of transport (number and percent).

	Private car	Private motorcycle	Public transport	Paratransit	Walk/bicycling	Total
Ratchathewi (n=49)	47 (4.75%)	42 (4.24%)	231 (23.33%)	51 (5.15%)	619 (62.53%)	990 (100%)
Bangkhen (n=42)	298 (32.78%)	72 (7.92%)	161 (17.71%)	110 (12.10%)	268 (29.48%)	909 (100%)
Total	345 (18.17%)	114 (6.00%)	392 (20.64%)	161 (8.48%)	887 (46.71%)	1899 (100%)

It is obvious that non-motorized transport is the dominant mode for Ratchathewi respondents while Bangkhen respondents rely more on private motor-vehicle than walking/cycling. Public transport seems to be more important to Rathathewi than Bangkhen respondents. In contrast, paratransit usage is higher in Bangkhen district. However, this presents only a broad picture of mode choice in two districts. Mode choice distributed by purposes is shown in Table 7.4. However, when it comes to trip-counting, dividing by 7 trip purposes is problematic since a single travel may comprise several activities and several purposes. Therefore, to avoid confusion, trips are divided into 6 categories (as presented in chapter 4).

Table 7.4: Number of trips made by respondents in a week period and mode used, distributed by Ratchathewi and Bangkhen district respondents.

Number of trips	Private car		Private motorcycle		Public transport		Paratransit		Walking/cycling	
	Ratchathewi	Bangkhen	Ratchathewi	Bangkhen	Ratchathewi	Bangkhen	Ratchathewi	Bangkhen	Ratchathewi	Bangkhen
HBW	21	176	16	33	78	102	25	61	170	79
HBE	5	16	10	0	49	3	7	3	60	6
HBS	12	26	12	23	9	8	2	16	220	109
HBL	7	45	0	0	13	14	5	10	39	29
HBS/L	1	10	0	0	20	1	2	0	25	3
NHB	1	25	4	16	62	33	10	20	105	42
Total	47	298	42	72	231	161	51	110	619	268

The differences in travel patterns between two districts are quite clear. Ratchathewi respondents are more dependent on public transport and walking⁶. Travelling by public transport and walking together is counted 850 times, which by far outweighs the use of other modes combined. This is due to the beneficial urban form characteristics. Located within the inner area with high employment density some of the workplaces are situated in a short distance from residential location. Likewise, educational institutions as well as commercial areas concentrated in the district make it easy for residents to reach these locations by walking. Shopping mall and department stores are located in a short distance as well due to the strategic location near the city center. High population density contributes to the concentration and variety of shops, stalls, and restaurants in the area. Accessibility to public transport in Ratchathewi district is relatively high since three kinds of public transport are available. Accordingly, respondents travelled by public transport, particularly urban rail and buses to the locations that are beyond walking distance. Connecting from one out-of-home location to another out-of-home location is, largely, travelled by walking and public transport. This is also because a short travel distance and a high accessibility to public transport.

For Bangkhen district, only HBS has an outstanding figure for walking and cycling. Other trips, namely HBW, HBE, HBL, and HBS/L, are predominantly carried out by private motor-vehicles. The dominant mode of transport is not clear for NHB trips for respondents from this district. Similar to Ratchathewi district, markets and small shops are located near residential location allowing residents travel on foot or bike. Other activity locations, namely, workplaces, locations of education, and leisure locations, are located beyond a walking distance. This is accompanied by the low availability and accessibility of public transport, of

⁶ None of the respondent from Ratchathewi district informed travelling by bicycle.

which only buses and vans are in service. As a result, Bangkok respondents have a higher usage of private vehicle and paratransit. Connecting from one out-of-home location to another out-of-home location does not show a clear dominant mode of transport. This is because the connections that occur in the inner area are usually performed by public transport, especially urban rail.

7.3.2 Number of modes used in a trip

The previous part shows that while the dominant modes of transport are quite apparent for Ratchathewi district, the figure of Bangkok is less obvious. Though, private motor-vehicle is the mode used most frequently, the usage of other modes is not a small one. This reflects the fact that respondents may use various modes of transport in combination. Table 7.5 clarifies this point by illustrating number of trips by amount of modes used.

Table 7.5: Trips by number of modes used, distributed by Ratchathewi and Bangkok district respondents.

Number of modes	HBW		HBE		HBS		HBL		HBS/L		NHB		Total	
	Ratchathewi	Bangkok	Ratchathewi	Bangkok	Ratchathewi	Bangkok	Ratchathewi	Bangkok	Ratchathewi	Bangkok	Ratchathewi	Bangkok	Ratchathewi	Bangkok
1	125	202	21	16	237	144	36	44	10	12	69	64	498	482
2	92	47	55	6	9	13	14	7	19	1	53	27	242	101
3	0	45	0	0	0	2	0	14	0	0	0	4	0	65
4	0	6	0	0	0	2	0	0	0	0	0	2	0	10
Total	217	300	76	22	246	161	50	65	29	13	122	97	740	658

The majority of trips made by the respondents from both district were carried out by one mode (67% and 73% for Ratchathewi and Bangkok respectively). Travelling from one place to another does not comprise more than two modes of transport for Ratchathewi respondents since they live near their locations of activity. For Bangkok district, some trips (11%) may contain 3 to 4 modes from the place of departure to the destination. This is because Bangkok respondents live in residential streets that are located far from the main roads. For those who do not own a private vehicle, they need to travel by paratransit to get to the main roads where buses are operated. In addition, many respondents' workplace is located in the inner area or in the area that is covered by urban rail service. This leads to the transfer from buses, as well as car, to urban rail system. Furthermore, after getting off urban rail, some of them have to walk a few minutes to reach their destination of work. This is also applied to other trips where the destination is beyond the local area.

Overall, longer distance to activity locations is associated with an increase in transfers from one mode of transport to other modes. This is related to that respondents are willing to travel faster. For example, it is possible for Bangkok respondents to reach their destination by bus but they make a transfer to urban rail once it is available. In this case, an inefficiency of public transport can be considered as a contributor.

7.4 Distribution of trip purpose and travel distance

Trip distribution presented in this part not only shows the distances travelled to carry out various activities, but also reflects the supply of facilities in the short distance of residential locations. Seven types of trips are divided into two broader categories which are i) Bounded trips, including work trips, education trips, and taking children to/from school, and ii) Other trips which refers to non-bounded trips, semi-bounded trips, and the intermediary group, including shopping trips, leisure trips, visiting trips, and socializing trips.

The classification is based on temporal and spatial flexibility (presented in chapter 3). Bounded trips are trips in which geographical location and time to perform activity are fixed. Non-bounded trips are trips where time and location of activity is flexible. An intermediary group comprises of trips where time of activity is fixed but location may vary, and trips where location is fixed but may vary in time. The semi-bounded trips are those that location may vary and time can be flexible, but the trips take place quite regularly.

7.4.1 Bounded trips: work trips, education trips, and taking children to/from school trips

The distribution of bounded trips for the respondents in Ratchathewi and Bangkhen districts are presented in Figure 7.2a and b. Work trips make up a large share of total bounded trips, followed by education trips, while trips relating to children make up only a few. Most of the respondents from Ratchathewi district travel to work or education within 5 km. from their residents. This reflects the concentration of workplaces and variety of jobs in the inner parts of the city, demonstrated in chapter 6. Only few of the Ratchathewi respondents travel out of their local area to reach their destinations of work (Figure 7.1a).

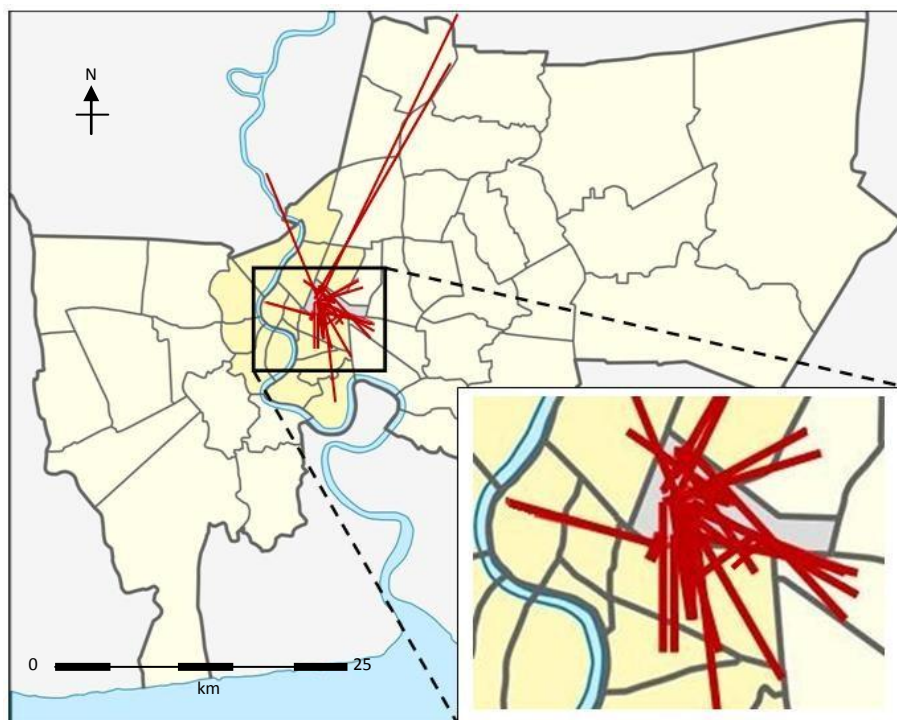


Figure 7.2a: Distribution of bounded trip purposes among Ratchathewi district respondents

The figure for Bangkhen district shows different features (Figure 7.2b). While some of the Bangkhen respondents remain in their district, or in neighboring districts, a much greater travel longer distances toward the central city to reach their destinations. This confirms the concentration and variety of employment in the inner area.

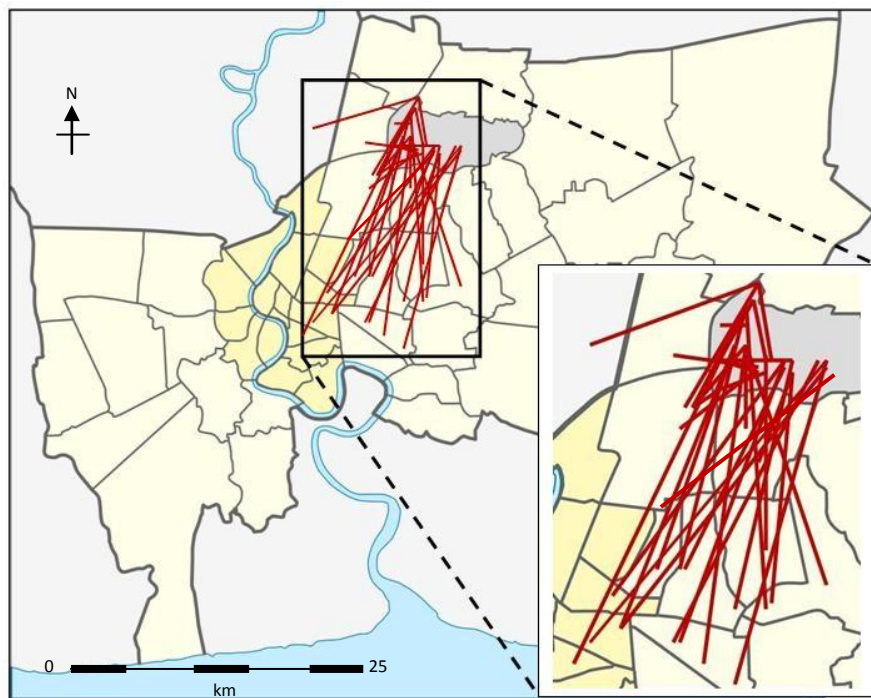


Figure 7.2b: Distribution of bounded trip purposes among Bangkhen district respondents.

Thirty-eight out of 49 Ratchathewi respondents performed bounded trips during one week period. Taking 5 km. from the residential location as a threshold for a short distance, it was found that only four respondents travelled beyond this threshold. For Bangkhen district, 17 out of 35 respondents who carried out bounded trips have travelled a greater distance than the threshold at least once. The concentration of commercial areas and the high employment in the inner area, including Ratchathewi district, contribute to the short travel distance of Ratchathewi respondents. Many Bangkhen respondents had to travel a relatively long distance to reach their workplace, which are mostly located in a higher employment density area, in other words, they travelled towards the city center.

7.4.2 Non-/semi-bounded/ and intermediary group trips

Figure 7.2a and b show the distribution of other trips in Ratchathewi and Bangkhen districts respectively, which comprises shopping trips (red), leisure trips (green) and shopping-leisure combined trips (yellow). At this stage, socializing trips are incorporated in leisure trips since their temporal and spatial flexibility is similar. Visiting trips are also included in leisure trips for simplicity. Both of them can be combined with shopping purpose as well. Trip that the respondents make the shortest distance is shopping for grocery. The existence of street vendors and street stalls allows this kind of trips to takes place within just a couple of hundred meters away from the respondents' residence. Grocery shopping occurs in a varied distance due to a great variety of stores from a nearby small grocery shop to big supermarkets

located in the shopping malls. For Bangkhen respondents, travel distance for grocery shopping depends on the situations; what product is needed and whether it is available at a shop nearby. All Ratchathewi respondents carry out grocery shopping and foodstuff shopping with in the local area.

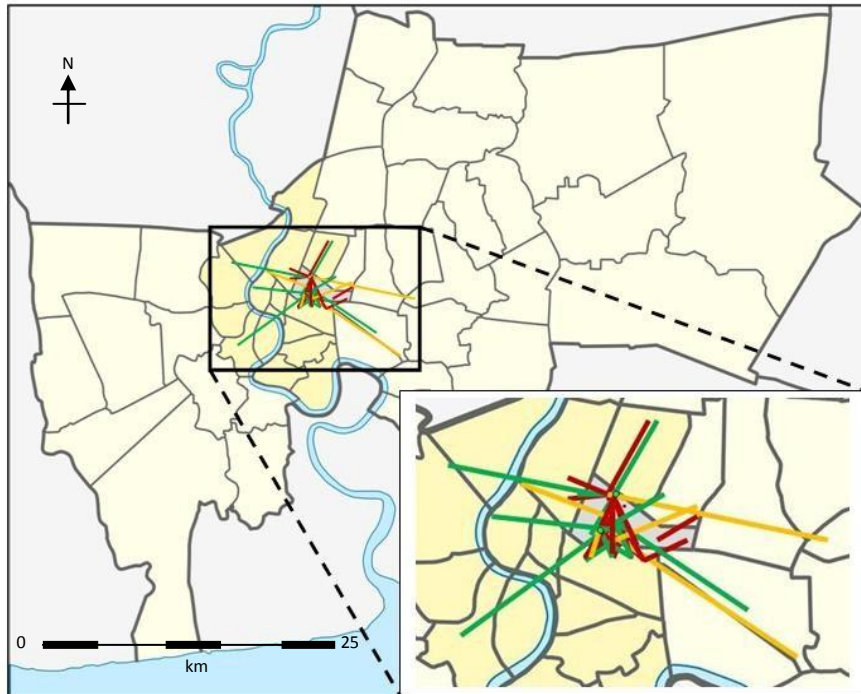


Figure 7.3a: Distribution of non-/semi-bounded trip purposes among Ratchathewi district respondents.

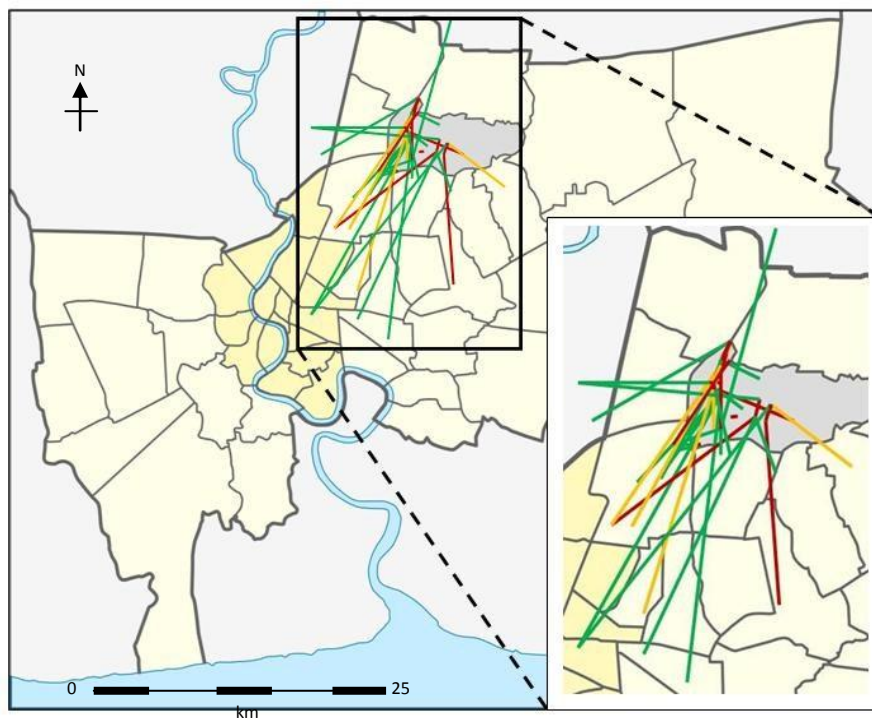


Figure 7.3b: Distribution of non-/semi-bounded trip purposes among Bangkhen district respondents.

For other shopping trips, it seems as if a greater travel distance is acceptable. Respondents are willing to travel further away to reach specific locations reflecting a higher utility they may get from such location. Department stores and shopping malls are the most common destinations for this kind of trips. The most outstanding commercial area where modern department stores, shopping malls and unique shops are situated is in the central city. Since Ratchathewi district is located within the same area, its residents can reach these destinations within a short time and distance. Department stores and shopping malls located in Bangkhen district can substitute those in the central zone to some extent. When Bangkhen respondents need facilities with a large variety, they travel to more modern and larger department stores located in neighboring districts or in the central city.

In both districts, respondents travel the greatest distance for special leisure trips that require a visit to specific locations, such as golf courses, night streets and relatives houses. Apart from these locations, the most popular place to perform leisure activities is a department store where people can meet friends, visit cafes and restaurant, watch movies, attend gym/exercise classes as well as do the shopping. Respondents from both districts indicated that they often combine leisure and shopping purposes into the same trips. From the interviews, it was found that a combination between shopping and leisure trips comes in two forms. On the one hand, it is a shopping trip which is considered as a leisure activity. This means that two purposes are fulfilled simultaneously. On the other hand, it is a trip comprising two purposes in which one purpose is done before the other starts. Destinations for shopping-leisure combined trips are usually in a greater distance than single-purpose shopping trips.

In general, the long distance travel is more acceptable for work/education trips than for shopping/leisure trips, though some leisure trips destinations are more distant away. The majority of Ratchathewi respondents perform both work/education activity and shopping/leisure activity within the central city. This is due to a wide variety of facilities, services and careers available in this area. Bangkhen respondents travel beyond their local area, to the higher employment density area, to reach destinations of work/education to a much greater extent.

Taking 5 km. as a threshold for a short travel, 42 out of 49 Ratchathewi respondents have travelled for shopping purpose. It was found that all of them carried out shopping activity within the short distance. For Bangkhen district, 26 out of 31 respondents who performed shopping activity remained in the local area and have not travelled beyond the threshold during one week time. This reflects that many of shopping facilities are available in the local area, keeping shopping locations within a short distance. For leisure trips, which include visiting and socializing trips, 20 Ratchathewi respondents have travelled for this purpose, in which 16 out of them have not gone further than the threshold. Bangkhen showed a different pattern. Twenty-six respondents have travelled to leisure location, 14 of which travelled a long distance. This is because shopping centers have become a leisure location for city people, central commercial zone was the most frequently visited for leisure trips of Ratchathewi respondents.

7.5 Concluding remarks of travel patterns

Travel frequencies are quite similar between the respondents from both districts. This reflects that urban form does not significantly influence the amount of travel. For trip purposes, trips that respondents make frequently are work trips and shopping trips. Leisure trips also take place regularly while visiting, socializing, and taking children to/from school trips do not occur so often. The compositions of trips by purpose are similar between the two districts. However, shopping trips per person is higher for Ratchathewi than Bangkok respondents because there are more shopping locations in the inner area and in a short distance from residential location. This is compatible with the different land-use, in which Ratchathewi district consist a larger share of commercial areas which located all over the district, while much of those in Bangkok district are located along the main roads.

The differences in travel modes between two districts are obvious. Ratchathewi respondents are more dependent on public transport and walking due to the beneficial urban characteristics of strategic location, high population and employment density, high access to public transport, and a mixed land-use with large share of commercial area. For Bangkok district, only HBS has an outstanding figure for walking and cycling. Other trips, namely HBW, HBE, HBL, and HBS/L, are predominantly carried out by private motor-vehicles. Similar to Ratchathewi district markets and small shops are located near residential location allowing residents travel on foot or bike while other locations are beyond walking and cycling distance. Together with the low availability and accessibility of public transport Bangkok respondents have a higher usage of private vehicle and paratransit.

There is an evidence of using various modes of transport in combination. Travelling from one place to another does not comprise more than 2 modes of transport for Ratchathewi respondents since they live near their locations of activity. In Bangkok, some trips may contain 3 to 4 modes of transport when travelling between home and workplace, home and shopping locations, home and leisure location, and between two out-of-home locations. This is mainly due to their residential locations that are located far from the main roads where bus is operated, resulting in a relatively high paratransit usage in order to connect to other modes. Overall, longer distance to activity locations is associated an increase in transfers from one mode of transport to other modes.

Most of Ratchathewi respondents' workplaces and locations of education are located in a short distance, resulting from the concentration of employment and a variety of jobs in the inner areas. In contrast, a great number of Bangkok respondents travel distances toward the central city to reach their destinations. The existence of street vendors and street stalls allows grocery shopping to take place within the local area of both districts and makes this kind of trips the shortest travel distance. A greater distance is acceptable for other shopping trips and the common destinations are shopping malls as well as department stores, which are also the popular locations for leisure activities. Ratchathewi residents can reach these destinations within a short time and distance due to the strategic location close to the major commercial areas. Bangkok respondents travel to department stores in neighboring districts or in the central city from time to time mostly when they need facilities with a large variety.

8. TRAVEL PATTERNS OF PRIVATE VEHICLE OWNER AND NON-PRIVATE VEHICLE OWNER

This chapter demonstrates the differences in travel patterns between individuals residing in a household with access to private motor vehicles and those residing in a household with no access to a private motor vehicle. In order to compare their travel patterns, respondents are divided into 4 groups, which are i) Ratchathewi respondents without an access to motor-vehicle (25 respondents), ii) Ratchathewi respondents with an access to motor-vehicle (24 respondents), iii) Bangkhen respondents without an access to motor-vehicle (11 respondents), and iv) Bangkhen respondents with an access to motor-vehicle (31 respondents).

8.1 Travel frequency

The travel frequency of each group is illustrated in Table 8.1.

Table 8.1: Total and average number of trips/week among respondents in each group.

Groups	Total trips/week	Average trips/week/respondent
Group 1 (n=25)	402	16.08
Group 2 (n=24)	338	14.08
Group 3 (n=11)	192	17.45
Group 4 (n=31)	466	15.03
Total	1398	15.36

Table 8.1 shows that Bangkhen respondents without access to private vehicle made more trips than those with access to private motor vehicle. Group that made the least trips is Ratchathewi respondents with an access to private vehicle. Respondents who own a private vehicle in their household travel less than respondents from the same district that do not have any private vehicle in the household. This reflects that travel frequency is not associated with access to private vehicles. However, living in a household with access to private motor vehicle does not mean that a household member has an actual access to private motor vehicles. Bangkhen respondents in both groups made more trips than their counterparts in Ratchathewi district, reflecting that urban form may be associated with travel frequency.

8.2 Trip purpose

Trips are classified by purpose into seven categories (the same as in chapter 7), including work, education, shopping, leisure, socializing and visiting, and taking children to/from school. Trip purposes made in a week period, distributed by respondents in four groups is presented in Table 8.2.

Table 8.2: Trip purposes made in a week period, distributed by respondents in four groups (number and percent).

Trip purpose	Work	Education	Shop	Leisure	Socializing /visiting	Taking children to/from school	Total
Group 1 (n=25)	84 (33.1%)	34 (13.4%)	105 (41.3%)	28 (11.0%)	3 (1.2%)	0 (0.0%)	254 (100.0%)
Group 2 (n=24)	72 (37.9%)	25 (13.2%)	79 (41.6%)	9 (4.7%)	5 (2.6%)	0 (0.0%)	190 (100.0%)
Group 3 (n=11)	49 (43.8%)	6 (5.4%)	47 (42.0%)	10 (8.9%)	0 (0.0%)	0 (0.0%)	112 (100.0%)
Group 4 (n=31)	134 (50.6%)	10 (3.8%)	69 (26.0%)	36 (13.6%)	5 (1.9%)	11 (4.2%)	265 (100.0%)
Total	339 (41.3%)	75 (9.1%)	300 (36.5%)	83 (10.1%)	13 (1.6%)	11 (1.3%)	821 (100.0%)

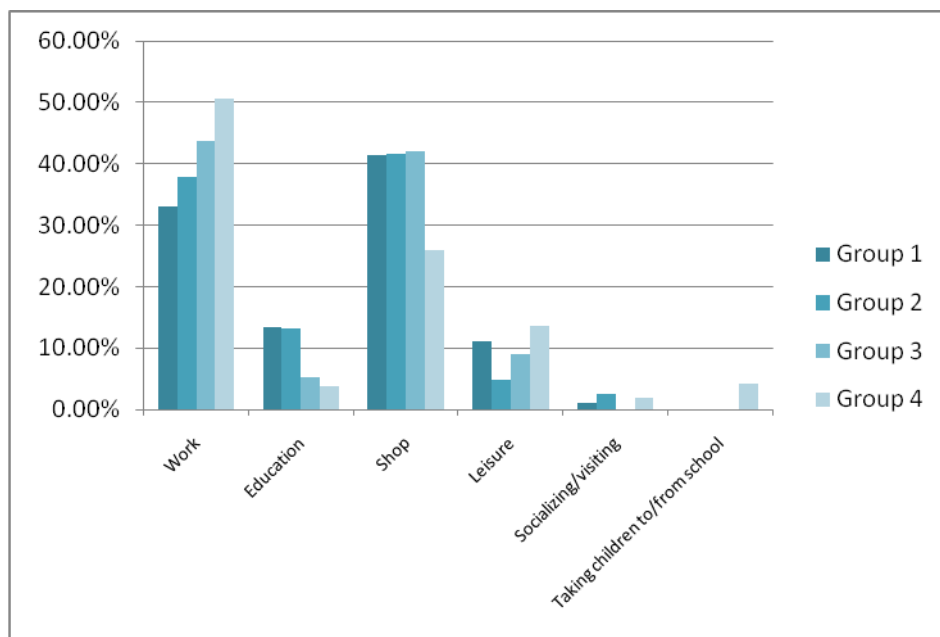


Figure 8.1: Trip purposes made in a week period, distributed by respondents in four groups (%).

Trips that respondents frequently make are work trips and shopping trips as presented in the previous chapter. Work and education trips together shares around 50 percent of total trip purposes in all sub-groups. This reflects the importance of bounded trips in everyday life. Shopping trips make up the largest share for Ratchathewi sub-groups. This is because of a variety of shopping location and a wide range of options available. Work trips make up the largest share for both Bangkok sub-groups. Share of work trips for Bangkok respondents with an access to motor-vehicle is noticeably high while share of shopping trips is relatively low.

8.3 Mode choice

8.3.1 Modal choice

Table 8.3: Total number of trips performed in a week period distributed by modes of transport (number and percent).

	Private car	Private motorcycle	Public transport	Paratransit	Walking/cycling	Total
Group 1 (n=25)	0 (0%)	0 (0%)	177 (30.1%)	29 (4.9%)	382 (65.0%)	588 (100%)
Group 2 (n=24)	47 (11.7%)	42 (10.4%)	54 (13.4%)	22 (5.5%)	237 (59.0%)	402 (100%)
Group 3 (n=11)	9 (2.6%)	0 (0%)	96 (27.9%)	78 (22.7%)	161 (46.8%)	344 (100%)
Group 4 (n=31)	289 (51.2%)	72 (12.7%)	65 (11.5%)	32 (5.7%)	107 (18.9%)	565 (100%)
Total	345 (18.2%)	114 (6.0%)	392 (20.6%)	161 (8.5%)	887 (46.7%)	1899 (100%)

Comparing respondents who do not have access to private vehicle (Group1 and 3) shows that those from Ratchathewi district mostly rely on walking followed by public transport while the number of paratransit is considerably low. Non-motorized transport is the main mode of transport for those from Bangkhen district (Group 3) and, likewise, the usage of public transport is high. However, paratransit usage in Bangkhen made up a larger share (22.7%). This is because Bangkhen respondents need paratransit in combination to walk/bike and public transports presented in chapter 7.

For respondents who have access to private vehicle (Group2 and 4), the figures are different between the districts. Ratchathewi respondents still travel on foot and bicycle the most even though they have access to private vehicle. This is because they can reach locations of activity in so short distance that a private vehicle is unnecessary. Bangkhen respondents use private vehicle dominantly and followed by walking/cycling. This reflects the impacts of urban form on travel behavior. The high employment density and mixed land-use with a large share of commercial area contribute to a relative short distance to activity locations which in turn encourages the non-motorized transport in Ratchathewi district.

The relationship between trip purpose and mode choice for each group is illustrated in Table 8.4. Trips are categorized into 6 types (same as in the previous chapter). Overall, Ratchathewi respondents without access to private vehicle (Group 1) travel by walking/cycling the most (382) followed by public transport (177) while paratransit make up only a small share (29). However, it is noticeable that paratransit usage is higher for a trip between home and workplace (15). For Ratchathewi respondents with access to private vehicle (Group 2), even though the respondents have access to private vehicle, they still rely on walking/cycling, especially trips between home and workplace (77), and between home and shopping locations

(96). This is because these locations are situated within a walking distance. Together with a well-service public transport, private vehicle usage (89) is considerably low compare to the case of Bangkhen district (Group 4).

Table 8.4: Number of trips made by respondents in each group (Group 1 n=25; Group 2 n=24; Group 3 n=11; Group 4 n=31).

Number of trips by mode and purpose		Private car	Private motorcycle	Public transport	Paratransit	Walk/ bicycling
HBW	Group 1	0	0	63	15	93
	Group 2	21	16	15	10	77
	Group 3	0	0	54	47	51
	Group 4	176	33	48	14	28
HBE	Group 1	0	0	30	7	36
	Group 2	5	10	19	0	24
	Group 3	0	0	3	3	6
	Group 4	16	0	0	0	0
HBS	Group 1	0	0	6	0	124
	Group 2	12	12	3	2	96
	Group 3	0	0	4	6	62
	Group 4	26	23	4	10	47
HBL	Group 1	0	0	10	5	30
	Group 2	7	0	3	0	9
	Group 3	9	0	9	6	15
	Group 4	36	0	5	4	14
HBS/L	Group 1	0	0	17	2	17
	Group 2	1	0	3	0	8
	Group 3	0	0	1	0	1
	Group 4	10	0	0	0	2
NHB	Group 1	0	0	51	0	82
	Group 2	1	4	11	10	23
	Group 3	0	0	25	16	26
	Group 4	25	16	8	4	16
Total	Group 1	0	0	177	29	382
	Group 2	47	42	54	22	237
	Group 3	9	0	96	78	161
	Group 4	289	72	65	32	107

Walking/cycling is the major mode (161) of transport for Bangkhen respondents without access to private vehicle (Group 3). Non-motorized transport in work trips and out-of-home connection trips were performed in combination with public transport and paratransit, indicated by the high number in public transport and paratransit usage. Respondents who have access to private vehicle in Bangkhen district heavily rely on private vehicle, especially

a trip to work (176). However, trips between home and shopping locations are also performed by walking/cycling (47). This is due to a large share of grocery shopping that took place near the residential location.

It is obvious that travel behavior is influenced by urban form. High population and employment density, a mixed land-use with a large commercial area, a beneficial location in the central city, and a high access to public transport contribute to a high number of walking/cycling and public transport usage, including for those who have access to private vehicle.

8.3.2 Number of modes used in a trip

Trips by number of modes used for each group are presented in Table 8.5

Table 8.5: Trips by number of modes used, made by respondents in each group (Group 1 n=25; Group 2 n=24; Group 3 n=11; Group 4 n=31).

Number of modes		1	2	3	4	Total
HBW	Group 1	16	87	0	0	103
	Group 2	89	25	0	0	114
	Group 3	9	28	29	0	66
	Group 4	182	30	20	2	234
HBE	Group 1	3	34	0	0	37
	Group 2	20	19	0	0	39
	Group 3	0	6	0	0	6
	Group 4	16	0	0	0	16
HBS	Group 1	119	5	0	0	124
	Group 2	119	3	0	0	122
	Group 3	53	8	0	0	61
	Group 4	86	10	2	0	98
HBL	Group 1	23	11	0	0	34
	Group 2	13	3	0	0	16
	Group 3	0	7	9	0	16
	Group 4	44	0	5	0	49
HBS/L	Group 1	4	16	0	0	20
	Group 2	6	3	0	0	9
	Group 3	0	1	0	0	1
	Group 4	12	0	0	0	12
NHB	Group 1	35	49	0	0	84
	Group 2	27	11	0	0	38
	Group 3	13	24	3	0	40
	Group 4	50	4	1	2	57
Total	Group 1	200	202	0	0	402
	Group 2	274	64	0	0	338
	Group 3	75	74	41	0	190
	Group 4	390	44	28	4	466

None of Ratchathewi respondents (Group 1 and 2) performed a trip comprising more than two modes. Trips made by those who have access to private vehicles (Group 2) usually contain one mode. Half of total trips made by those who do not have access to private vehicles (Group 1) comprise two modes of transport, often a combination of walking and public transport.

Trips made by Bangkok respondents (Group 3 and 4) show a combination of various modes in a single trip. Large share of trips made by those without access to private vehicle (Group 3) contain three modes. Some trips made by those who have access to private vehicle (Group 4) also comprise more than two modes; however, trips that contain only one mode make up the largest share.

8.4 Travel distance

This part present the travel distance of each group by comparing number of respondents who travel beyond the threshold (5 km.) in work/education trips, shopping trips, and leisure trips (Table 8.6)

Table 8.6: Number of respondents in Group1 travelling beyond the threshold (Group 1 n=25; Group 2 n=24; Group 3 n=11; Group 4 n=31).

Number of respondents		Within threshold	Beyond threshold	Total
Work/education	Group 1	19	1	20
	Group 2	14	4	18
	Group 3	8	1	9
	Group 4	7	19	26
Shopping	Group 1	21	0	21
	Group 2	21	0	21
	Group 3	10	1	11
	Group 4	16	4	20
Leisure	Group 1	9	2	11
	Group 2	7	2	9
	Group 3	4	2	6
	Group 4	8	12	20
Total	Group 1	49	3	52
	Group 2	42	6	48
	Group 3	22	4	26
	Group 4	31	35	66

Respondents with access to private vehicle travel a greater distance than those without access to private vehicle in the same district. However, the difference is not obvious for Ratchathewi district. Respondents in Group1, 2 and 3 mostly remain in the local area. Nearly all of their

destinations of work, education, shopping, and leisure are located within the threshold. The most obvious difference is the travel distance for respondents in Group4, of which a large of work, education, and leisure locations are situated outside the 5km. threshold. The similarity between Group1 and 2 indicates that an access to private vehicle does not have a meaningful effect on travel distance, given that various activity locations are situated within the local area. When accessibility to various activities is poor, private vehicle ownership generates a meaningful difference in travel distance. However, it cannot be concluded whether it is private vehicle that allows people to travel a greater distance or it is a great distance that determine the ownership.

8.5 Concluding remarks of travel patterns

The comparison between sub-groups; private vehicle owner and non-private vehicle owner, shows that ownership is not associated with travel frequency since non-vehicle owners in two districts made more trips than vehicle owners. Bangkok respondents made more trips than Ratchathewi respondents in the same sub-groups, reflecting the possible association between urban form and travel frequency. Trip purpose show a similar composition between all sub-groups and is compatible with the finding in chapter 7. The dominant mode of transport for both Ratchathewi sub-groups is walking/cycling, even for those with access to private vehicle. This is because they can reach locations of activity in so short distance that a private vehicle is unnecessary. Non-motorized transport is also the major mode for Bangkok respondents; however, it is outweighed by private vehicles for respondents with access to them. Paratransit usage is relatively high for Bangkok sub-groups. This is because Bangkok respondents, especially without access to private vehicle, often use paratransit in combination with other modes. Respondents without access to private vehicle in Bangkok district made a higher share of trips that contain several than two modes than those in Ratchathewi district. This reflects the association between a longer distance to activity locations and an increase in transfers.

Comparing between sub-groups, those with access to private vehicle travel a greater distance than those without access to private vehicle in the same district. The difference is considerably small for Ratchathewi district but very obvious for Bangkok district. The similarity of travel distance between Ratchathewi sub-groups indicates that an access to private vehicle does not have a meaningful effect on travel distance, given that various activity locations are situated within the local area. For Bangkok district where accessibility to various activities is relatively low, private vehicle ownership generates a meaningful difference in travel distance. However, it cannot be concluded whether it is private vehicle that allows people to travel a greater distance or it is a great distance that determine the ownership.

9. A CAUSAL MECHANISM

Differences in travel patterns between respondents living in different urban forms indicate the possible correlation between urban form and travel behavior. However, nothing confirms the existence of a causal relationship. This chapter presents the materials acquired from the interviews, including the rationales behind the selection of activity location and modes of transport. This reveals a causal mechanism and indicates that urban form is a contributor of travel behavior.

9.1 Rationales for choice of activity location

The main reason as to why people travel is to perform various activities in various locations. In most cases travel does not have value in itself but is rather a derived demand from the need to carry out other activities. For this reason, travel is considered as a cost people want to minimize. While they want to reach the destinations where the best facility is available, they want to limit travel. Therefore, the actual travel is directed by two forces; a wish to reach the best facility and a wish to reduce travel. If the best facility is available at the closest location, this will not be a problem; nevertheless, as the best choice of activity is often not located close, this problem occurs quite often in reality. This part answers the third research question, namely how people make choice of activity location and mode of transport. This will, in turn, reveal whether urban form is a cause of travel behavior.

9.1.1 Work and education trips

According to the interviews, the respondents take into consideration both a wish to reach the best facility and a wish to reduce travel when referring to work and education trips. However, for around 70 percent of respondents, a wish for the best facility is the stronger force. When asked the reasons why they have chosen the current workplaces, the similar answer from the interviewees was because their job was there. This reflects that somehow they could not freely choose the locations of workplace. A person who travels the greatest distance to work among all respondents is a military officer. He stated that; *“it was not him who decided on the workplaces but he was assigned to be stationed at the specific location”* (Ratchathewi district No.15). He also stated that; *“this is the nature of the job and if asking why he chose the current workplace, the more suitable question would be why he took the job at the first place”*.

Some respondents travel distant to reach their workplace. This is because jobs that are suitable for their qualifications are not available in their local area. Travelling beyond the local area is common among Bangkok respondents. One of the interviewees indicated that; *“much of the famous and credible companies and international companies were located in the inner city. It would be a good opportunity to work for them no matter how far he had to travel”* (Bangkhen district No.42). This shows that a wish to reach the best facility is more powerful.

In some cases, the respondents' workplace is situated in the same area of their residential location. A primary school teacher stated that; *“she used to work more distant away. She was*

lucky she got a job that match her qualification and in a close proximity to her residence; however, she would not have accepted the job if it was inferior to the previous one” (Ratchathewi district No.31). This confirms the importance of a wish to reach the best facility; however, travel distance is also taken into consideration when deciding about the workplace.

A relocation of residence is found among the younger respondents (around 15 people). They move in order to get closer to their workplace and to reduce cost of travel. This is not common among the older respondents. A 52-year-old respondent from Bangkhen district asserted that; *“he had worked in the central city for more than 20 years. It was difficult to reside the whole family to the inner area due to an extremely expensive land price there”* (Bangkhen district, No.10). Likewise, a 39-year-old from Bangkhen district stated that; *“a detached house with some green area would be good for the kid and the elderly in the family. The affordable one would definitely not be the one in the commercial area where his workplace was located”* (Bangkhen district, No.39). Some respondents showed a different opinion. A 46-year-old Bangkhen respondent working in the inner area indicated that; *“he was looking for a new house currently. One alternative would be to move closer to his wife’s workplace. Though it would be farther from his workplace, he would benefit from the subway which would make his journey much easier”* (Bangkhen district, No.28).

For education trips, almost all student respondents (15 people) select their place of education based on the contents of the programs, the reputation of schools and the quality of education. This is confirmed by the fact that some of them originally come from other provinces. That they moved in order to live closer to their school reflects a wish to reduce travel. Some students prefer to remain at their residential location and travel beyond the local area to their place of education. Overall, respondents from Ratchathewi and Bangkhen districts revealed the similar rationales when deciding about workplace and location of education. A wish to reach the best facility is more important in the trip purpose for work and education. A great distance is found acceptable; however, some of the respondents found the best facility within their local area.

9.1.2 Shopping trips

The rationales for selecting shopping locations vary for the different types of shopping. Distance is very important for the selection of grocery shopping locations. All respondents stated that they chose a specific location for this purpose because such location was near their residence or their workplace. The grocery shopping locations are mostly a small restaurant located along the residential streets, a stall in the markets or a convenience store nearby. Respondents see no differences between foodstuffs near their residence and grocery at other locations. Similarly, the distance is important when considering the locations for grocery shopping. It is taken into consideration together with the availability of products since the shops nearby might not have the products needed. One of the interviewees stated that; *“she chose the location where the wanted products were available. Often, that location was the hypermarket in the local area”* (Ratchathewi district, No. 22). The force from a wish to reach the best facility is stronger for the shopping for a specific product. The respondents are

willing to travel farther for a specific location. A 25-year-old interviewee asserted that; *“she went to the famous weekend market because of the variety of products and the reasonable price”* (Bangkhen district, No.29). Even though they are willing to travel to such destination, respondents seem to have their own limit and are unlikely to travel beyond that limit. When asked how far they would travel to buy something the same interviewee answered that; *“it depended on what the product was and how much she wanted it but in general the location should be within Bangkok”*.

Unlike work and education trips, the respondents’ selection of shopping location varies depending of the types of shopping and the types of product. A wish to limit distance is strongest for grocery shopping. On the contrary, distance is less important for specific goods.

9.1.3 Visiting/socializing and leisure trips

The key factor when making decision of the location of leisure is the quality of service, facility and activity at the destinations. Visiting is the purpose so reducing distance is not important. This activity is considered as very specialized and only at the specific location this activity is available. One of the respondents made visiting to his relatives he stated that; *“it was his relatives whom he wanted to visit and since they lived there could not go other places”* (Ratchatewi district, No.7). This show how important a wish to reach the best facility is for visiting purpose. The interviewee who made the longest distance to visit a golf course revealed that; *“a wish to reduce distance was out of his concern as long as the destination could be visited by car and did not have to stay overnight. He normally made a choice of location with his friend and this was not only to exercise but also to socialize”* (Bangkhen district, No.37).

Most respondents (around 80 percent of those participating in leisure activities) expressed a wish to limit distance for leisure activities like watching movies, visiting restaurants and gyms. These activities are available in many locations around both districts and the quality of facilities at different locations is similar. However, when these activities are linked with other purposes like shopping and meeting friends, they may choose a location at a greater distance. One of the interviewees stated; *“that she usually visited the cinema in her local area but when she did it with some friends, the location changed to the central area since it was easy for everyone to meet there”* (Bangkhen district, No.15).

The selection of leisure locations is various. The strength of the forces is different with the types of activity. The one which is specialized, such as visiting friends and relatives, is less affected by a wish to reduce distance. The respondents tend to travel shorter distance for unspecialized leisure activities.

Overall, respondents from both districts showed the same underlying reasons of selecting activity locations; that is the two forces mentioned earlier. The balance between the two forces depends at a significant level on the purpose of travel as well as the individual characteristics, for example, age, sex, and lifestyle, which is not the focus of this study. Hence, this investigation aim to reveal whether an individual choose the best facility over the distance or vice versa.

9.2 Rationales for mode choice

This part presents the rationales for selecting modes of transport. According to the interviews, three main factors affecting decision of travel modes are time consumption, price (monetary cost), and convenience. Besides, respondents mentioned other factors like safety, distance, and a wish to exercise. Focusing on three main factors, any rational individuals prefer the fast, inexpensive, and convenient modes of transport. However, these three conditions are unlikely to be met simultaneously. The convenient and fast mode of transport may not be cheap, while the cheap mode may not be fast. Therefore, mode choice decision making relies on how people perceive the quality of each modes and what is more important; travel time, costs, convenience, or other conditions. Table 9.1 presents the attributes of various modes of transport used by the respondents in terms of speed, comfort, and monetary cost, and how it related to urban form.

Table 9.1: Attributes of various modes of transport and their relation to urban form.

Modes of transport	Speed (time consumption)	Monetary cost	Convenience	Relation to urban form
Private car	Fast	The most expensive	The most convenient	High fuel price; therefore, a long distance can lead to a huge cost
Private motorcycle	Fast	Moderate	Not so comfort but flexible	-
Buses/vans	Moderate-slow	Cheap	Not so comfort, no seat available in rush hours	Very slow in rush hours, it may take hours to reach far destination
Urban rail	Very fast	Moderate	Moderate	It is not available outside the inner area lead to the low access to public transport in the outer area
Hired motorcycle	Fast	Cheap	Not so comfort	-
Taxi	Fast	Expensive	Moderate	-
Boat	Moderate	Cheap	Not so comfort	Available in some areas
Walk/bicycling	Very slow	Very cheap	Require physical effort	A greater distance requires a greater effort

Private car/motorcycle users and urban rail users often mentioned time consumption and the speed of a specific mode of transport when asked the rationales for mode choice. These modes are considered as the faster ones; therefore, it reflects that respondents who travel by these modes give priority to time consumption. One of the respondents asserted that; “*she*

drove because it was the fastest way of travelling around, especially in the outer area. However, when she went to the city center, she travelled by urban rail since it was faster” (Bangkhen district, No. 25).

Time consumption is also important for paratransit users. Some of them stated that they travel by paratransit because it is fast. It seems that time consumption is less important to those who live near locations of activity. This is because the time difference between travelling by fast and slow modes are not much when the location is close. For this reason, living in the inner area where all activity location are in a short distance will reduce the need to travel by fast mode of transport like private car and motorcycle as well as paratransit. This is accordance with the findings of more walking in Ratchathewi district.

Many times the respondents did not choose the faster modes or the more convenient ones because they wanted to reduce monetary costs. One of the respondents indicated that; *“he only used taxi when he travelled with friends since it would be cheaper when they shared”* (Bangkhen district, No. 14). Another respondent has changed travel mode from a private car to public transport due to the high price of fuel. He stated that; *“he had stopped driving to work for two years since he could not afford fuel cost and the charge for the expressway was expensive. Nowadays, he used public van and urban rail instead”* (Bangkhen district, No.10). This statement reflects the quality of urban rail which is fast and cheap; however, it only covers the inner area currently.

Convenience is another important factor and a major contribution for not using public transport or walking/cycling. Apart from saving time, most of car and motorcycle users mention a wish to avoid too much of physical effort. This is why living close to the destinations can encourage non-motorized modes of transport, it require less physical effort than living further. The problems of connection and the poor public transport network decrease the level of convenience. Most of private car/motorcycle users stated that; *“car/motorcycle was more convenience. They could reach any destinations without transferring from one mode to another”* (Ratchathewi district, No. 4). A taxi user stated that; *“by using taxi, she could avoid a crowded skytrain”* (Ratchathewi district, No.48). This reflects that travelling by public transport is more convenient in the inner area than in the outer area since the connections between modes are better and easier.

There are other factors that affect the perception of transport modes. Safety is one of them. Travelers may choose one mode of transport over the others because it is more safe; however, this is a personal opinion. One interviewee gave her opinion that; *“she thought travelling by bus and hired motorcycle was extremely dangerous since the drivers usually drove in a careless manner. For this reason, she preferred a private car or taxi”* (Ratchathewi district, No. 34). Another factor is a wish for exercise. Some respondents are willing to walk in order to exercise as stated by an elderly interviewee that; *“he liked to walk since it was a good way to exercise”* (Ratchathewi district, No. 17).

All factors presented here were mentioned by the interviewees. Usually, respondents take into consideration all factors and there is no such factor as the most important one. They work in

combination either in supportive manner or pull into the different directions. Urban form influences mode choice since it determines the quality of each transport mode.

9.3 The mechanism which urban form influences travel behavior

That activity is located where they are today is influenced by urban form. In other words, urban form is a strong determinant of the location of activities. As the city center, the inner district attracts people and companies to the areas creating a high population and employment density. This is suitable to develop an efficient urban rail and is also appropriated to be promoted as a hub of transport connections. Commercial units as well as government and educational institution want to benefit from a strategic location leading to a mixed land-use in the area. As a consequence, workplaces, schools and universities, shopping malls, and government institutions are situated where they are today.

Accordingly, urban form influences peoples' selection of activity location in a way that it determines the availability of activities, service and facilities in the specific area. When a wish to minimize distance is stronger and people choose the nearest location of activity, this nearest location is a consequence of urban form. When a wish for the best facility is stronger, urban form determines where the best facility is located. A variety of services and facilities in each specific area is established by urban form. For Ratchathewi district, urban form allows the residents to reach their locations within a relatively short distance no matter how they based their selection on a wish to reduce distance or a wish to get the best facility. They are more likely to find the best facility within a short distance when they so desire; however, when they want to reduce travel the destination can even become closer to their residential locations. On the contrary, it is also urban form that locates the activity locations distant away and makes people travel further, as Bangkhen district is inferior in the availability of services and facilities, the nearest place where a specific facility is available is located more distant. Thus, the residents in Bangkhen district have to travel a greater distance to reach the best facility.

When making decision of mode choice, people compare the alternatives in various aspects, for instance time consumption, monetary cost and convenience. Urban form affects decision making since it is associated with these aspects. Time consumption increases with an increased distance and the difference in travel time between travelling by fast and slow transport modes are greater for a long distance. For this reason, the speedy modes are perceived less important when distance to destinations is short. This is why Ratchathewi respondents made many trips by walking. Similarly, monetary cost increases with an increased distance. Since the costs difference between travelling by an expensive and cheap mode are less for the short distance than the long one, it may encourage the use of an expensive transport mode like private car and taxi. However, this is unlikely for Ratchathewi district because urban rail, which is faster and cheaper is available, any rational individual will choose this mode of transport instead of private car and taxi.

Level of convenience is also influenced by urban form, especially for walking/bicycling and public transport. Since walking and cycling requires more physical effort than any other

modes, longer distances are likely to discourage walking and bicycling. Convenience in public transport is determined by the quality and number of connection and transfer as well as accessibility and the shape of the public transport network. Travelling from the outer area requires many transfers. Furthermore, the only public transport mode available is bus, which is relatively poor compared to its service in the central area. Accordingly, the convenience of public transport is perceived low in Bangkhen district, which discourages the use of public transport.

Besides, urban form can influence mode choice decision making in the way that it facilitates travelling by any mode of transport. For example, introducing new bus routes will increase accessibility, roads expansion will facilitate road transport, and improving footpath and bicycle ways will assist walking and bicycling. This determines the advantages/disadvantages of the alternatives which, in turn, affect modes selection.

9.4 Concluding remarks on causal mechanism

Rationales for activity location and mode choice reveal that urban form is a contributor in a causal mechanism. The selection of activity location is based on two forces which work in the opposite directions. They are a wish to reduce distance and a wish to reach the best facility. Urban form influences travel distance by determining where the locations are. Therefore, urban form influences the selection of activity location in a way that it determines the availability of activities, services and facilities in the specific area. Ratchathewi district has a greater variety of activities and a wider range of options. Residents in this district are able to reach the destination and find the best facility in a shorter distance than Bangkhen respondents.

Transport mode selection relies on a comparison between the alternatives. A comparison involves many factors like time consumption, monetary costs, and convenience. When making decisions on mode choice, people compare these factors. Time consumption increases with an increased distance and the difference in travel time between travelling by fast and slow transport modes are greater for a long distance. For this reason, the speedy modes are perceived less important when the distance to destinations is short. Monetary cost also increases with an increased distance. As the costs difference between travelling by an expensive and cheap mode are less for the short distance than the long one, it may encourage the use of an expensive transport mode like private car and taxi. While this might be the case for Bangkhen residents, it is unlikely for Ratchathewi residents since urban rail is faster and cheaper. The level of convenience is also influenced by urban form, especially for walking/bicycling and public transport. A long distance is likely to discourage walking and cycling. The level of public transport convenience is higher in the inner area. Consequently, there is a higher usage of public transport and walking in Ratchathewi district than in Bangkhen district.

10. CONCLUSION

Urban land-use planning can be used to manage travel behavior in order to reduce transport-caused environmental problems and achieve a more sustainable transport system. The main objective of this study is to investigate the influence of urban form on individuals travel behavior and to examine the causal mechanism between them. Three research questions are proposed to fulfill the study's objectives. The first research question is how urban form influence travel behavior. The urban form characteristics include population and employment density, location and distance to the city center, the mixture of land-use, and access to public transport while travel behavior covers travel frequency, trip purpose, mode choice, and travel distance. The second research question concern how travel behaviors between those individuals residing within a household with access to privately owned motor vehicles differ from those individuals without access to private motor vehicles. The third research question is how people select activity locations and modes of transport. This helps reveal rationale and motivation behind travel decision.

Qualitative interview was the main method used in the study. Two districts in the Bangkok Metropolitan Area were selected for a case study. The selection was based on the variation in urban characteristics which allow a comparison in travel behavior between districts. Located in the inner area of Bangkok, Ratchathewi district has a high population and employment density, a high level of access to public transport, and mixed land-use with a large share of commercial area located all over the district. In contrast, Bangkok district is situated distant away from the center and the land-use composition is different. Residential area makes up the largest share while commercial areas are located along the main roads. A relatively low population and employment density as well as a poor access to public transport are found in this district.

Concerning the first research question, travel behavior was found related to urban form characteristics. Trip frequency was found similar for respondents in study districts; hence, influence of urban form on trip frequency cannot be implied. This is compatible with Ewing and Cervaro's (2001) findings that trip frequency is mainly affected by household socio-economic characteristics. This reflects a multi-causal situation that urban form is one among several factors influencing travel behavior. For trip purpose, the most frequent trips made are for work and shopping purposes which together made up around 80 percent of total trip purpose. Work trips and education trips together shared around half of total trip purpose, reflecting the important of bounded trips in everyday travel. Higher number of shopping trips in the inner district was contributed by a higher accessibility resulting from the mixed land-use with a large share of commercial area as well as a strategic location close to the city's commercial center. This is similar to Handy's suggestion (1996) that higher accessibility is associated with higher number of trips, in this case shopping trips.

The differences in modes of transport between the two study districts are obvious. The inner district's respondents are more dependent on public transport and walking. This is mainly due to a high access to public transport and a short distance to reach activity locations. Conversely, respondents from the outer district have a higher usage of private vehicles and

paratransit. This finding is in congruence with the previous studies that found a lower usage of private motor-vehicle in the high residential and employment density, high accessibility areas that located in the inner area (e.g. Friedman et al., 1994; Frank and Pivo, 1994; Holtzclaw, 1994; Naess, 2006). The higher usage of private vehicle and paratransit is also contributed by the low availability and poor accessibility of public transport in the outer district. Often residents in this area use several modes of transport in combination. The mode choice pattern is more obvious when comparing between respondents with access to private vehicle in the two districts. The dominant mode for respondents in the inner district was non-motorized transport even for those with access to private vehicle. This is because most of their activity locations are located within walking/cycling distance and private vehicles, cars in particular, are unnecessary. Conversely, respondents with access to private vehicle in the outer district use private vehicle as the major mode.

Travel distance was found to be affected by urban form. First of all, population density, employment density and mixture of land-use determine a variety of activity, a range of options, and number of activity locations in a specific area. Residential location determines the distance to those locations. People travel to the inner area where a greater variety of activity and a wider range of option are available in order to get a better facility and service. Residents in the inner district do not have to travel distant to reach these facilities, while residents in the outer district travel beyond their local area to a much larger extent to reach better facilities of various purposes, namely work, education, shopping, and leisure. The influence of urban form on travel distance was found in many studies, including Friedman et al. (1994), Handy (1996a), Cervero and Wu (1998), and Naess (2006). However, people travel varied distances for different purposes. Respondents in the outer district travel a greater distance for bounded trip, including work, education, and taking children to/from school trips, that are fixed in locations. They performed much of their shopping within the local area, especially grocery shopping which is the shortest travel distance. This was made available by the existence of street vendors and street stalls near residential locations. A greater distance is acceptable for other shopping trips, visiting/socializing and leisure trips. For respondents in the inner district, they mostly remained in their local area where various activity locations are available.

The possible relation between travel distance and vehicle ownership which answer the second research question was found. Respondents with access to private vehicle travel a greater distance than those without access to private vehicle in the same district. The difference is considerably small for the inner district but very obvious for the outer district. The similarity of travel distance between the inner district's sub-groups indicates that an access to private vehicle does not have a meaningful effect on travel distance, given that various activity locations are situated within the local area. For the outer district where accessibility is relatively low, private vehicle ownership generates a meaningful difference in travel distance. However, it cannot be concluded whether it is private vehicle that allows people to travel a greater distance or it is a great distance that determine the ownership.

Rationales for activity location and mode choice reveal that urban form is a contributor in a causal mechanism. The selection of activity location is based on two forces which work in

opposite directions; a wish to reduce distance and a wish to reach the best facility. This is compatible with Naess's (2006) case study. A wish to reach the best facility is more important in the trip purpose for work and education. The respondents' selection of shopping location varies depending of the types of shopping and the types of product. A wish to limit distance is strongest for grocery shopping. On the contrary, distance is less important for specific goods. The selection of leisure location is various. For specialized activities, such as visiting friends and relatives, they are less affected by a wish to reduce distance. The respondents tend to travel shorter distance for unspecialized leisure activities.

Urban form determines the locations of all activities, activity location is situated where it is today is influenced by urban form. Therefore, urban form influences the selection of activity location in a way that it determines the availability of activities, services and facilities in the specific area.

For mode choice selection, three frequently mentioned factors affecting mode choice were identified; time consumption, price (monetary cost), and convenience. A rational individual prefers fast, inexpensive, and convenient transport modes. However, these three conditions are unlikely to be met simultaneously. Therefore, mode choice decision making relies on how people perceive the quality of each modes and what is more important; travel time, costs, convenience, or other conditions, for example, safety and a wish to exercise. Usually, respondents take into consideration all factors, which work in combination either in supportive manner or pull into the different directions. However, these factors are influenced by urban form. For example, Time consumption increases with an increased distance and the difference in travel time between travelling by fast and slow transport modes are greater for a long distance; hence, the speedy modes are perceived less important when the distance to destinations is short. The level of convenience is also influenced by urban form, especially for walking/bicycling when a long distance is likely to discourage walking and cycling.

In sum, the study found the relationship between urban form and travel behavior, in which urban form is a contributor. Therefore, it indicates that it is possible to manage urban conditions in order to change travel behavior, or at least to prevent an undesirable trend. The comparison between two districts varying in urban form is found to be methodologically useful, particularly when compare the districts within the same urban context. However, in order to separate the impacts of each urban characteristic on travel behavior or to take into consideration other factors, this method would need to be developed further. Moreover, a broader theoretical framework which includes more characteristics, such as economic of the household, should be developed. In addition, a larger sample is required to test the statistically significant and to produce generalizable results. The major empirical contribution of this study would be that it reveals how people select activity location and transport modes, which are crucial when considering any transport-related policy.

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APPENDIX 1

Questions used to perform interviews with respondents Ratchathewi and Bangkhen districts.

1. Basic characteristic
 - 1.1 Sex
 - 1.2 Age
 - 1.3 Household size
 - 1.4 Level of education
 - 1.5 Occupation
 - 1.6 Income (household, per capita)
 - 1.7 Residential location/ how long of living here
 - 1.8 The nearest public transport
2. Vehicle ownership/ License
 - 2.1 Number of car/motorcycle in the household
 - 2.2 License ownership car/motorcycle
3. Travel behavior
 - 3.1 Trip frequency
 - 3.1.1 Frequency of participating in various activities (work, education, shopping, leisure, visiting, socializing, taking children to/from school, others)
 - 3.1.2 Actual travel during one week period (work, education, shopping, leisure, visiting, socializing, taking children to/from school, others)
 - 3.2 Activity location
 - 3.2.1 Where various activities take place/ location (work, education, shopping, leisure, visiting, socializing, taking children to/from school, others)
 - 3.3 Mode choice
 - 3.3.1 Modes of transport to perform various activities (walk/bike, bus, van, urban rail, boat, motorcycle, taxi, private car, private motorcycle)
- 4 Rationales for travel decision
 - 4.1 Location of activity
 - 4.1.1 The reason of selecting a specific location
 - 4.1.2 Why choose this location over the others/ why not choose others
 - 4.2 Mode choice
 - 4.2.1 Reason for travelling by a specific mode
 - 4.2.2 Why choose this mode over other/ why not choose other