

## The Pattern of Travel Behavior in Khon Kaen City

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**Abstract:** Urban Transportation problem especially the rapid growth of motorization has become one of the main problems faced by many cities in developing countries. This paper focuses on the travel survey which identifies the origin and the destination of the home-based trip and the mode of travel as well as the socio-economic characteristics of the travelers in Khon Kaen City, Thailand. Moreover, the relationship between the travel behavior pattern and city structure also was examined in this study. The results show that people with higher income mostly lived in CBD area and made more travel than people with low income. The most of the home-based trip in Khon Kaen City is work trip which most of the workers took Songtaew going to their destination more than other modes. The results of this study could potentially aid in applying urban transportation policy in the future.

*Keywords:* Travel behavior, City structure, Khon Kaen City

### 1. INTRODUCTION

Travel behavior in any city is complex and is guided by its land use distribution and transport network (Puntambekar, 2011). The urbanization in developing countries, including Thailand, is growing rapidly mainly because of the high growth of private mode of transportation including the heavy migration from rural areas (Domencich and McFadden, 1975). Khon Kaen City is the capital city of the north-eastern region of Thailand with total population ranks a third of the country and central business district (CBD) is experiencing one of the fastest growth rates in Thailand (Prabnasak and Yue, 2006). Therefore, the transport system in Khon Kaen City has been being challenged with rapid urbanization, unequal distribution, and a rapidly growing population. One of the main reasons of the transport problems in Khon Kaen City is no integration between transport management and economic growth of Khon Kaen City. Thus it needs urban transportation policy which will integrate economic growth with their future demand of the city. As home-based trips are concerned in Khon Kaen City, over 50 % take Songtaew for going to the workplace and to school which is the cheapest mode in Khon Kaen City (Wongwiriya et al., 2016).

Several previous studies have clearly shown that individual and household socioeconomic characteristics have a strong influence on travel mode choice selection (Miller et al., 2005). Moreover, residential location also plays a significant role in travel mode choice selection (Pinjari et al., 2011). Urban transport studies in developing countries have been done in many metropolitan areas such as in Bangkok, Thailand; Manila, Philippines; Kuala Lumpur,

Malaysia, and Jakarta, Indonesia. However, there is the lack of the studies in medium-sized cities which are now challenged with rapid urbanization and transport problems in many medium-sized cities in developing countries, including Khon Kaen City in Thailand.

Therefore, the main goal of this paper is to reveal travel patterns regarding the relationship with city structure, which could potentially aid in applying urban and transportation policy of Khon Kaen City in the future. Moreover, the existing dimensions of travel behavior in terms of socioeconomic and travel characteristics such as trip types, trip modes, household income, the age of travelers and vehicle ownership in Khon Kaen City will be exposed in this study to expand the knowledge of medium-sized cities' transport situation and to serve as useful information for transportation planners in formulating an appropriate policy and regulation for the sustainable and efficient integrated public transport system in Asian developing countries in the future.

This paper begins by providing the motivation of the study in the introduction, followed by the overview of Khon Kaen City, the data collection, and the research methodology. Finally, the paper concludes with the findings of the travel behavior pattern in Khon Kaen City.

## **2. THE OVERVIEW OF KHON KAEN CITY**

### **2.1 Khon Kaen City Structure**

Khon Kaen City is centrally located in the north-east region of Thailand. Its total area is 46 square kilometers. The city is home to 326,643 people (in 2014). Khon Kaen City has known as the center of economic, education, traffic and urban development in the north-east region of Thailand.

Considering the city structure of Khon Kaen City, the heart of CBD of Khon Kaen City is located in the middle of the city as shown in Figure 1 (1995), then the built-up areas had been developed to other places around the city as shown in Figure 1 (2005 and 2015). Thus, Khon Kaen city has the polycentric pattern of employment and education centers that allow people make many trips around the city.

Sri-Jan Road is one significant arterial road of Khon Kaen City which is crossing the heart of its central business district (CBD). To identify the city structure of Khon Kaen City, we divided Khon Kaen City Structure into four zones as shown in Figure 2. The first zone is CBD or the central business district of Khon Kaen City. The second zone is CBD Fringe (3 Kilometers from the center of CBD) which is characterized by the residential zone and the commercial zone near the CBD. Next zone is Outer CBD Fringe (5 Kilometers from the center of CBD) which is characterized by the new residential zone of the city in the suburban area. The last zone is Rural-urban fringe (over 5 Kilometers from the center of CBD) which is characterized by the area where is the city meet rural area.

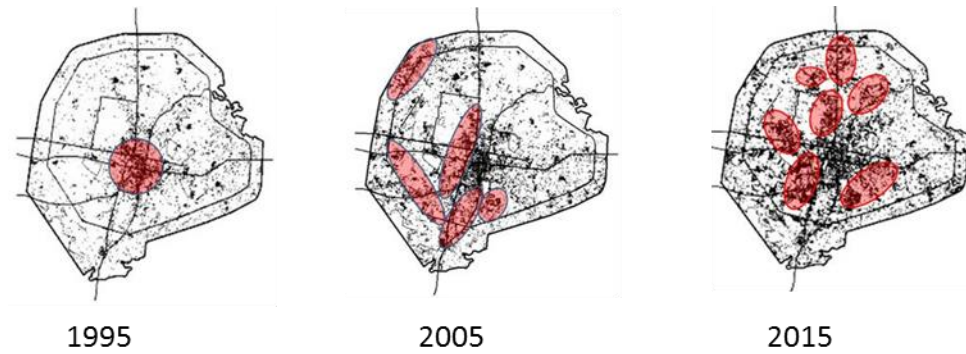


Figure1. The development of Khon Kaen City 1995-2015  
 Source: Sustainable Infrastructure Research and Development Center,  
 Khon Kaen University, 2016

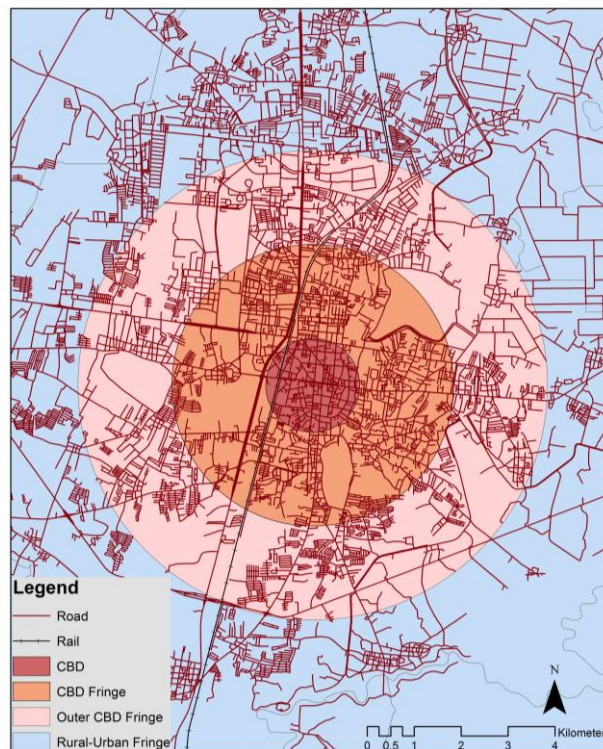


Figure 2. The study area: Khon Kaen City

## 2.2 Public Transportation in Khon Kaen City: Paratransit

In many developing countries, such as Thailand, paratransit or informal public transport plays a role as a predominant urban public mode. There are various types of paratransit in Thailand such as motorcycle-taxi, Tuk-Tuk, Songtaew, and Silor-lek. Especially, Songtaew (ST) or a modified pick-up truck taking passengers on the back with an overhead cage and two-row seats in the back, operates as a main public transport mode in many medium-sized cities of Thailand including Khon Kaen City.

Based on the authors' field survey conducted in August 2015 about the existing Songtaew service, there is a total of 19 Songtaew service routes operated in Khon Kaen City as shown in Figure 3. It can accommodate up to 20 passengers on any trip. Moreover, a

flat-fare system is used, with adults costing 9 Baht and students costing 5 Baht.

Furthermore, based on Songtaew information studied in 2013 by Jaensirisak, this study can be summarized as follows: the average number of hours of work is 12 hours; Songtaew dispatch frequency is every 10 minutes; the average net income per day is 320 Baht; the average maintenance costs is 8,600 Baht per year; the highest expense on fuel is 500 Baht per day, and the most frequent drop-off spot is Khon Kaen Bus Station (Jaensirisak et al., 2013).

For the type of Songtaew, there are two mainly types of Songtaew related to its design and vehicle. The first type of Songtaew is some vehicles are modified from Toyota Dyna, Mitsubishi Fuso Canter, Isuzu Elf and similar large trucks which can accommodate more than 30 passengers and operates as a fixed - route bus to run on the fixed route between province area connecting the rural and the urban area through the different parts of Thailand. The second type of Songtaew is some vehicles are modified from a pick-up truck such as Toyota Hilux, ISUZU D-MAX, ISUZU D-LUX, etc. which can accommodate up to 20 passengers and operates as a fixed-route bus to run on the fixed route in Bangkok both downtown and suburb, urban and rural areas in other provinces especially in the primary cities in the different regions of Thailand.

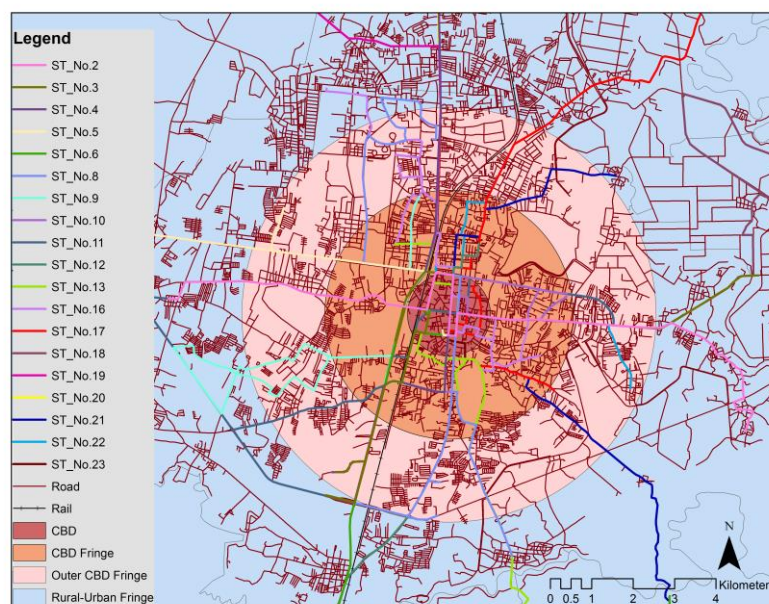


Figure 3. Route map of Songtaew (ST) in Khon Kaen City



Figure 4. The various designs of Songtaew

However, there is only Songtaew design which is modified from a pick-up truck, especially ISUZU D-MAX operating in the urban area of Khon Kaen City.

### **3. DATA AND METHODOLOGY**

To study the travel pattern focusing on the relationship with city structure and the existing situation of travel behavior regarding socio-economic and travel characteristics such as trip types, trip modes, household income, age of travelers in Khon Kaen City, we analyzed results from a comprehensive field survey conducted among the travelers in Khon Kaen City considering the home-based trip. The survey was carried out in August 2015 for two weeks and the survey was conducted on interviewing randomly selected the travelers who made work trip and school trip in the Central Business District (CBD) of Khon Kaen city; 10 interviewing points especially at the offices, shops, and schools which are located in this area.

A 4-page questionnaire was developed for this study. The questionnaire consists of the general questions relating to the respondents' socioeconomic information such as gender, age, occupation, and household income. Another part addresses questions about the present travel pattern in terms of home-based trips both work trip and school trip in regular weekdays, especially in terms of travel mode and the location of the travelers' residence and the location of their destinations to reveal the relationship between the travel pattern and the city structure which is divided into central business district area (CBD), CBD Fringe, Outer CBD Fringe and Rural-Urban Fringe. Then data were analyzed through a descriptive analysis such as percentage and cross-tabulation to reveal the current situation of transportation in Khon Kaen City and the travel behavior pattern of people in Khon Kaen City.

### **4. THE PRESENT SITUATION OF TRANSPORTATION IN KHON KAEN CITY**

This section summarizes the analysis carried out on the data obtained from the survey and the descriptive statistics of the respondents are provided in Table 1.

As shown in Table 1, the majority of respondents (n=602) is female (69.1%). Furthermore, the most of the respondents are the labor (29.2 %) and the government officer (20.8%). However, among the total respondents, there is 45.8 % who do not have a driving license, and this group is the dominant users who select Songtaew as their urban transport mode for going to their regular destination.

For the mode share of respondents, as shown in Figure 5, it revealed that there are the respondents who use public transport mode which is Songtaew 56% and the respondents who do not use this mode or the non-users 44%. Moreover, the non-users select car as their major transport mode (26%) because the most of them have car driving licenses and they claimed that driving car is more convenient and safer for them than using Songtaew then they prefer car more than Songtaew. Moreover, the considerations on the intention to use Songtaew in the future from Figure 6. which are 1) if there will be a new transport mode in the city such as light rail transit (LRT) or bus rapid transit (BRT) for users and 2) if there will be the improvement of Songtaew for non-users revealed that the choice users (37%) and the choice non-users (42%) are the majority groups who intend to keep using and stop using Songtaew (the users) and who intend to shift their modes from private vehicle to Songtaew (the non-users). Therefore, this study is very important to explore more about their perception on Songtaew use to retain the present users and attracting the non-users shifting their modes to use Songtaew in the future.

Considering about the loyalty users who want to keep using Songtaew in the future, it reveals that 78.6% of the Songtaew users expressing their attitude toward still using Songtaew

in the future even there will be a new transport mode like Bus Rapid Transit (BRT) or tram.

Table 1. General Characteristics of Respondents

Characteristics	Statistics
1. Gender	Male (30.9%), Female (69.1%)
2. Age	< 15-year-olds (13.1%), 15-20-year-olds (22.3%), 21-30-year-olds (22.9%), 31-40-year-olds (18.3%), 41-50-year-olds (16.6%), 51-60-year-olds (6.0%), > 60-year-olds (0.9%)
3. Education	Lower than undergraduate (67.3%), Undergraduate (30.7%), Graduate (2.0%)
4. Household income	Low-income (26%), Middle-income (72%), High-income (2%)
5. Occupation	Junior high school student (17.1%), Senior high school student (16.4%), Government officer (20.8%), Private employee (5.5%), Business owner (9.1%), Labor (29.2%), Others (1.8%)
6. Driving license	None (45.8%), MC (17.1%), Car (13.5%), Both (17.3%)
7. Motorcycle driving	Do not drive MC (61.5%), drive MC (38.5%)
8. Car driving	Do not drive car (58.4%), drive car (41.6%)

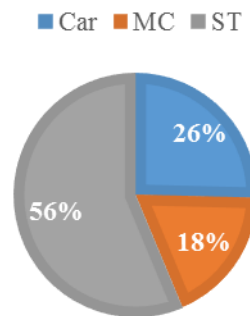


Figure 5. Mode share of respondents  
Source: Wongwiriya et al., 2016.

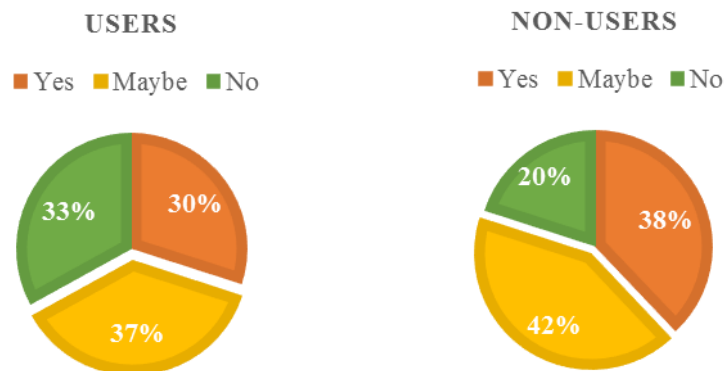


Figure 6. The intention to use Songtaew in the future  
(If there will be a new transport mode for ST users and  
if there will be the improvement of ST for the ST non-users)  
Source: Wongwiriya et al., 2016.

## 5. TRAVEL BEHAVIOR PATTERN IN KHON KAEN CITY

### 5.1 Trip types and Travel mode share

As the home-based trip is explored in this study. The result highlights that the most of the home-based trip in Khon Kaen City is Work trip (65%) as shown in Figure 7. Furthermore, it's not surprising that over 70% of the destinations both workplaces and schools are in CBD area since the most of the government offices, private company offices, commercial shops, and schools are located in this area.

Considering about travel mode share of the home-based trip in Khon Kaen City, it reveals that the most of the workers travel to their workplaces by Songtaew (32%) more than by car and by motorcycle. For the school trip, the most of the students travel to school by Songtaew (24%) as well. However, the second share of school trip mode is motorcycle which is different from the second share of work trip mode as shown in Figure 7. The main reason is that the most of the students have motorcycle driving license more than car driving license because in Thailand they can get a motorcycle driving license at 15 years old which is earlier than getting a car driving license at 18 years old.

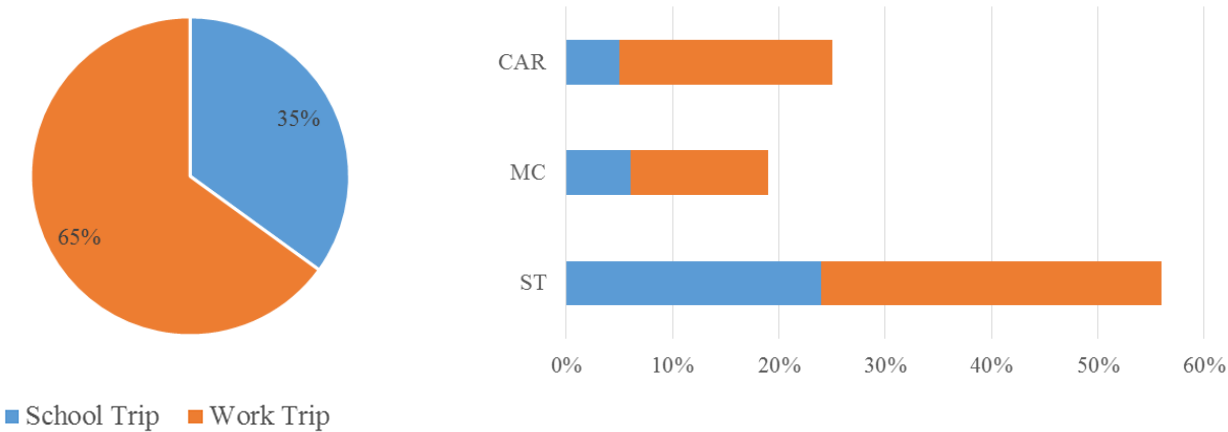


Figure 7. Home-based trip types of Khon Kaen City and Mode Share

### 5.2 The relationships between city structure and travel behavior pattern

The structures of cities are closely related to the travel pattern of their residents. This section summarizes the relationships between city structure and travel behavior pattern in Khon Kaen City. A lot of trips were generated and attracted most between CBD and CBD fringe. One of the reasons to this might be because of different land use facilities between these zones were not so far. In this study as shown in Figure 8, it revealed that most of the origin locations among Songtaew user, car user, and motorcycle user are the same which is CBD fringe area. Turning to consider the destination locations, we found that CBD area is the most destination locations for all transport mode users in Khon Kaen City since Khon Kaen city has a concentration of workplaces, and other service functions in the CBD. In particular, this applies to public and private offices, schools, restaurants, entertainment and specialized stores. Thus, this concentration of workplaces and schools attracts most of the people travel to this areas especially the Songtaew user 52.8% as shown in Figure 8. Moreover, the CBD of Khon Kaen

City has many narrow roads, and many intersections which are the main reasons making some travelers do not drive into the CBD then we can see the percentage of car user who drives to workplaces in CBD area lower than other users.

Moreover, in this study, the age structure was grouped into seven age divisions as less than 15 years old, 15-20 years old, 21-30 years old, 31-40 years old, 41-50 years old, 51-60 years old and greater than 60 years old. It was assumed that people aged greater than 20 years old are active and independent travelers. Meanwhile, people aged under 20 years old can be active but have some limitations as they have no fixed income yet. Most of them are the students whose travel costs are compensated by their parents. Therefore, most of the people aged under 20 years old over 70 % traveled to their destinations by Songtaew.

This study also considered on the travel behavior pattern by exploring the relationship between the location of residence and travel mode selection. Figure 9 and Figure 10 show the findings of the travel behavior pattern in terms of the relationship between the location of residence and travel mode selection focused on the difference of ages and income levels of the Khon Kaen City people. It is seen that most of the low-income people who use Songtaew and private car have the same origin location characteristic that most of them lived in CBD Fringe, Outer Fringe, and Rural-Urban Fringe. Meanwhile, the low-income motorcycle user lived in just CBD Fringe and Rural-Urban Fringe.

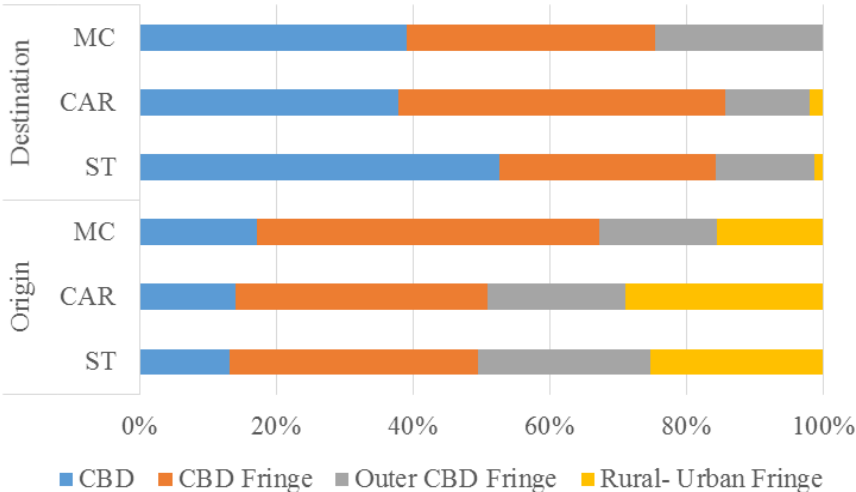


Figure 8. Origin-destination areas and Travel modes

Considering the travel behavior pattern of the middle-income people, it is seen that most of the middle-income Songtaew user lived in CBD Fringe, Outer Fringe and Rural-Urban Fringe, respectively. For the middle-income motorcycle user, we found that CBD Fringe, CBD, Outer Fringe and Rural-Urban Fringe are their residential locations respectively. For the group of the middle-income car user, most of them also lived in CBD Fringe. These results can be assumed that all of the people who have low and middle income mostly live in CBD Fringe area. The main reason might be that this area is closed to CBD where most of their jobs created and many schools are located. Thus living near their destinations in the affordable house is attracted most people to live in this area more than other zones. However, for the high-income people, it is clearly seen that they mostly lived in CBD more than other zones.



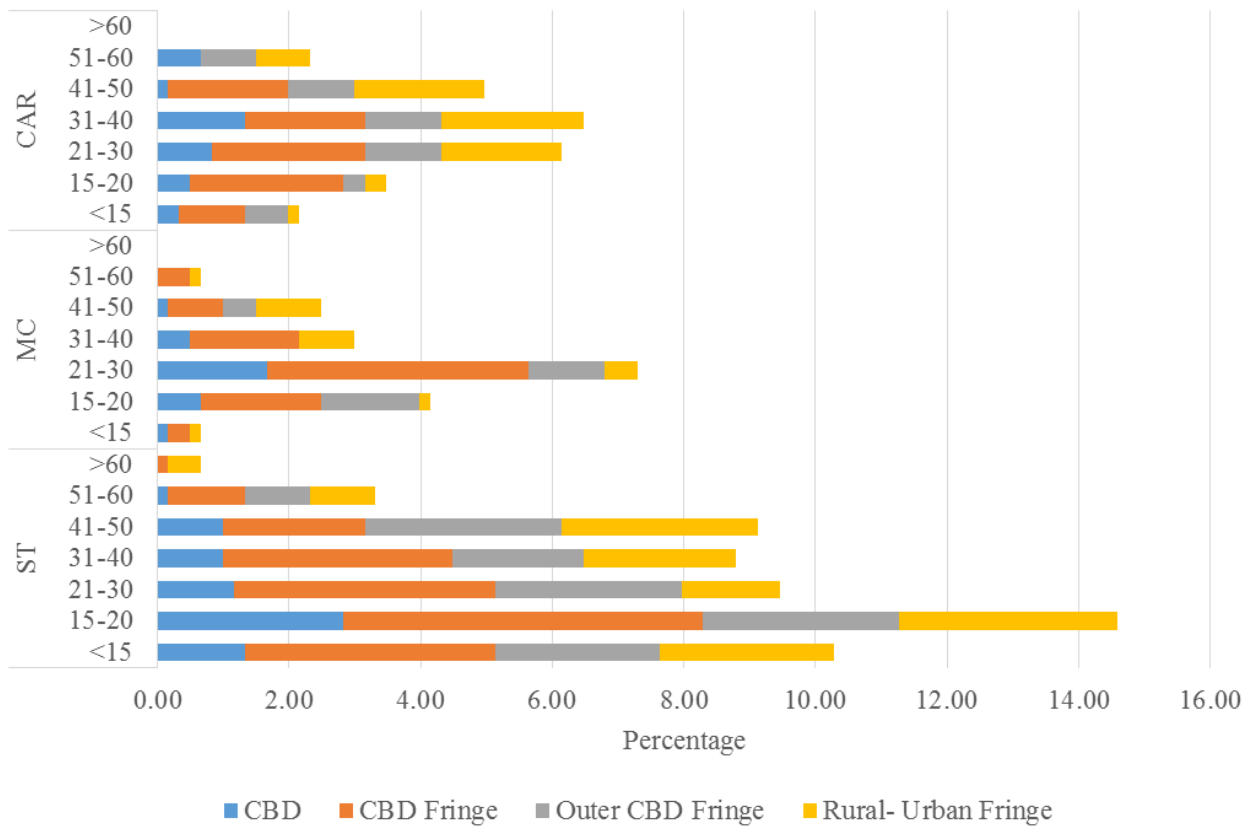


Figure 9. The residential location and Travel mode selection considering the difference in ages

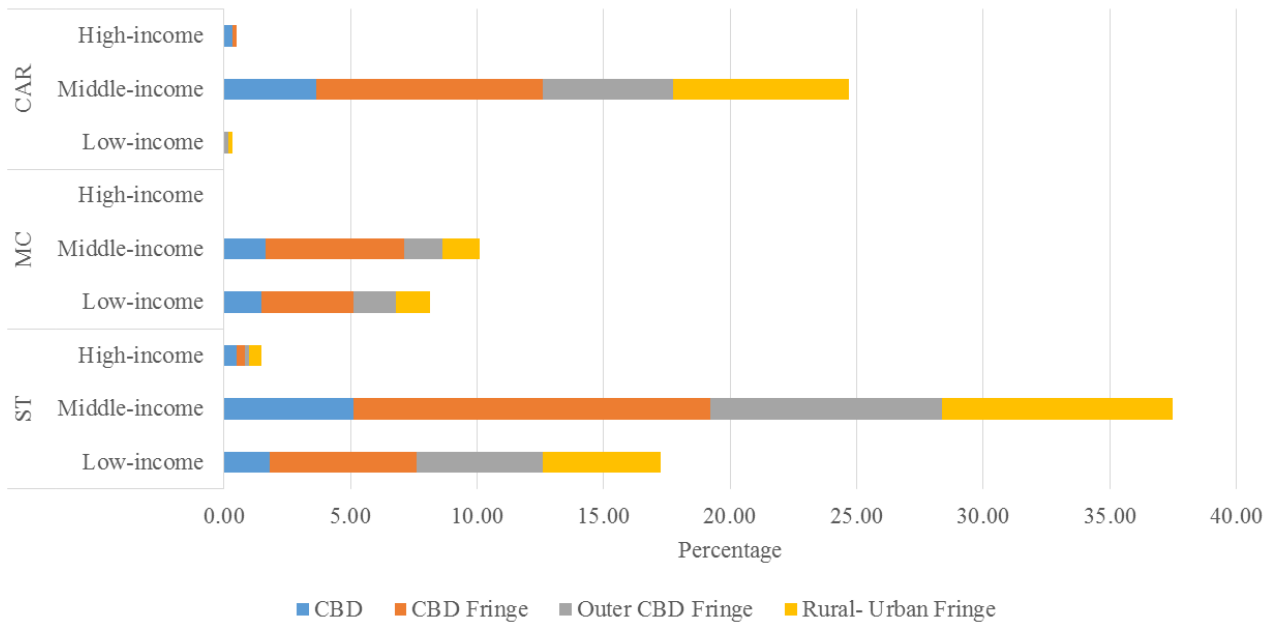


Figure 10. The residential location and Travel mode selection considering the difference in income levels

Furthermore, this study also reveals the average travel time for home-based trips between the residential locations and the destination locations as shown in Figure 11. It is clearly shown that the CBD residents have shorter travel time for going to their destination in CBD area than the outside CBD residents. However, it is interesting that Songtaew users take longest travel time for going to their destination in CBD Fringe area. This might be because of the land use pattern of this area which the workplaces and schools are located quite far in this area, not concentrated like in the CBD. This causes the Songtaew travelers who travel to this area taking more time than traveling to other areas.

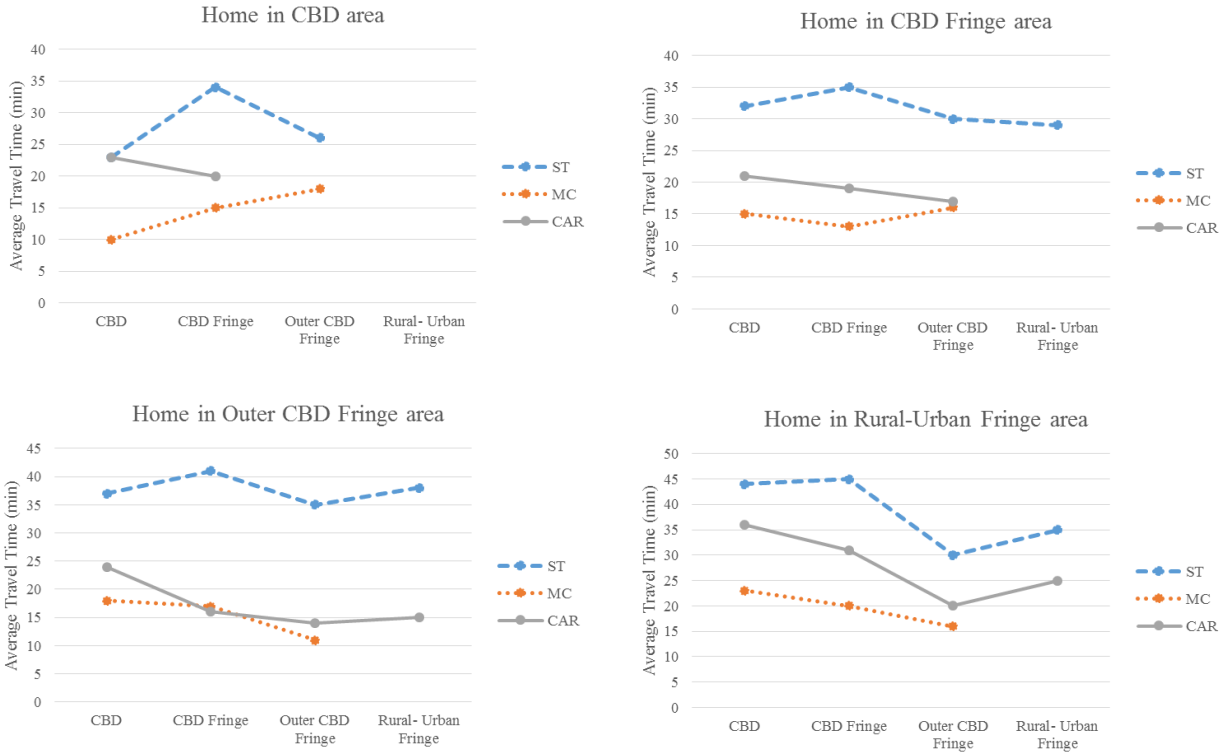


Figure 11. The average travel time for home-based trips between the residential locations and the destination locations

### 6. CONCLUSIONS

This paper focuses on the travel survey which identifies the origin and the destination of the home-based trip and the mode of travel as well as the socio-economic characteristics of the travelers in Khon Kaen City, Thailand. Moreover, the relationship between the travel behavior pattern and city structure also was examined in this study. The results show that people with higher income mostly lived in CBD area. The people who have low and middle income mostly live in CBD Fringe area. The main reason is CBD Fringe area in Khon Kaen city is the place where many jobs and schools are located. Thus living near their destinations in the affordable houses which mostly are located outside the CBD is attracted most people to live in this area more than other zones. The most of the home-based trip in Khon Kaen City is work trip which most of the workers took Songtaew going to their destination more than other modes.

Moreover, it is clear from the study that the city structure of Khon Kaen City which is the polycentric pattern of employment and education centers, along with the dispersal of many jobs and schools outside the CBD, creates more trips outside the CBD, especially for the people who live in the Outer CBD Fringe and Rural-Urban Fringe areas, with the shorter travel time than the people who travel for work trip and school trip in CBD area. Moreover, the accessibility by Songtaew is usually convenient for people who are traveling in the CBD because of the lack of parking space in CBD area and the traffic congestion which are the main reasons, especially for car users to not drive cars in CBD area. According to the results of this study, the suggested actions and policy consideration for urban transportation in Khon Kaen City especially regarding the enhancement of the linkage between land use and public transport which is Songtaew service by implementing a diverse route, and balanced coverage service areas especially the house communities areas that meet the transportation needs of everyone in the city to encourage the car and motorcycle users shift their mode to Songtaew are should be concerned about to reduce the level of private vehicle dependency in Khon Kaen City.

## ACKNOWLEDGEMENTS

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